Energy Conservation (Industry) Sector

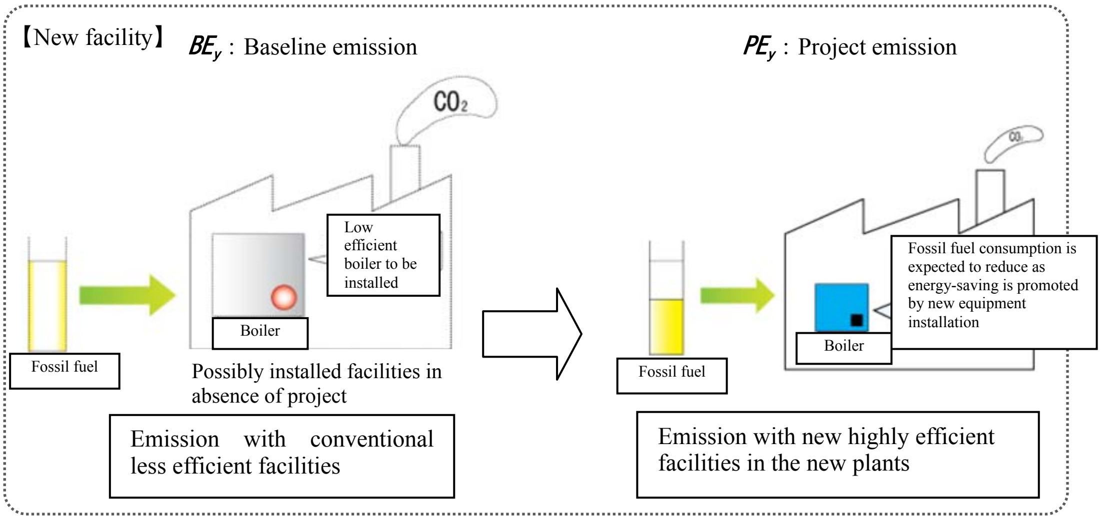
Sub-sector：

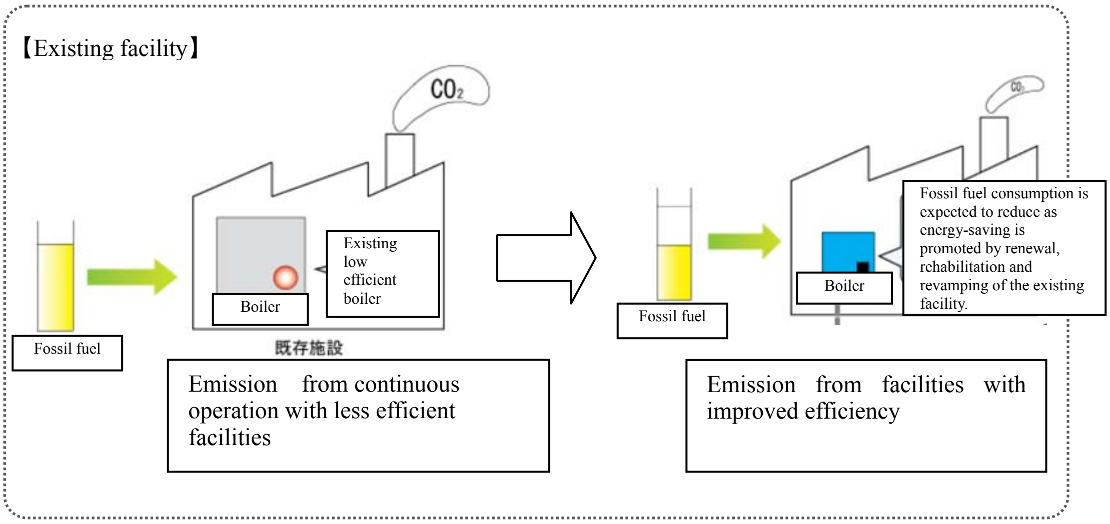
7. Energy Efficiency Improvement

8. Electricity and Heat Supply

9. Fuel Switching

1.Typical Project Outline	The project intends to inhibit greenhouse gas (GHG) emissions by reducing fuel consumption in industrial facilities through energy efficiency improvements such as efficient motors adoption.
2.Applicability	○ For new facility: new facility construction equipped with highly efficient facilities through the project activity ○ For existing facility: replacement, upgrading, and improvement of facilities using conventional fuel
3.Methodology on Emission Reduction	GHG emission reduction through energy efficiency improvement shall be determined as the difference between baseline emissions (from facilities with low efficiency) and project emission (after improvement). In order to compute each emission, electricity consumption (facility that requires electricity) and fuel consumption (facility that requires fuel) is each multiplied by their respective CO_2 emission factors. $$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$ ER_y : GHG emission reduction with project activity in year y ($t\text{-}CO_2/y$) BE_y : GHG emission from low efficiency facilities in year y ($t\text{-}CO_2/y$)(Baseline emission) PE_y : GHG emission from improved efficiency facilities in year y ($t\text{-}CO_2/y$)(Project emission)





(Continuation)

(1) Baseline Emissions

Baseline emission shall be determined by multiplying measured electricity consumption and fuel consumption without replacement, upgrading and improvement of facilities with their respective emission factors.

In the case of new facilities, electricity consumption and fuel consumption necessary to generate the production capacity, equivalent to the existing facilities, shall be used as input.

$$BE_y = (BE_{elec,y} + BE_{i,y}) \times (P_{out} / B_{out})$$

(Emission with electricity consumption)(Emission with fuel consumption)(Production scale ratio)

$$= \{(EC_{BL,y} \times EF_{BL,y}) + (BC_{i,y} \times NCV_i \times COEF_i)\} \times (P_{out} / B_{out})$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission： GHG emission without project activity (t-CO_2/y)
Input	$EC_{BL,y}$	Electricity consumption before project activity (MWh/y)
	$EF_{BL,y}$	CO_2 Emissions Factor of the electricity(t-CO_2/MWh)
	$BC_{i,y}$	Fuel consumption before project activity(kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3,t etc.,)
	$COEF_i$	CO_2 Emission Factor of fuel i(t-CO_2/TJ)
	B_{out}	Production capacity before project activity
	P_{out}	Production capacity after project activity

Determination of $EF_{BL,y}$

【New facility】【Existing facility】

CO_2 emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird.

Emission factor for the target power plant should be obtained through interview to the electric power management entity concerned.

In selecting the target power plant, confirm that the emission factor is comparable to the average grid emission factor (Ref. Annex C-1) determined based on published values in the target country or data adopted by Kyoto Mechanisms or data based on IEA.

If the emission factor is not available, it should be calculated using the net electrical output of the target power plant, fuel type, net fuel consumption, net calorific value and caloric CO_2 emission factor (Ref. Annex C-4).

(2) Project Emission

To calculate project GHG emission, monitor electricity consumption and fuel consumption from facilities that are replaced, upgraded and improved after project activity. That measured consumption is multiplied by the respective emission factor.

$$PE_y = PE_{elec,y} + PE_{i,y}$$

(Emission with electricity consumption) (Emission with fuel consumption)

$$=(EC_{PJ,y} \times EF_{BL,y}) + (PC_{i,y} \times NCV_i \times COEF_i)$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission： GHG emission after project activity (t-CO_2/y)
Input	$EC_{PJ,y}$	Electricity consumption after project activity (MWh/y)
	$EF_{BL,y}$	CO_2 Emissions Factor of the electricity(t-CO_2/MWh)
	$PC_{i,y}$	Fuel consumption after project activity(kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i (t-CO_2/TJ)

4. Data required for estimation and monitoring

【New facilities】

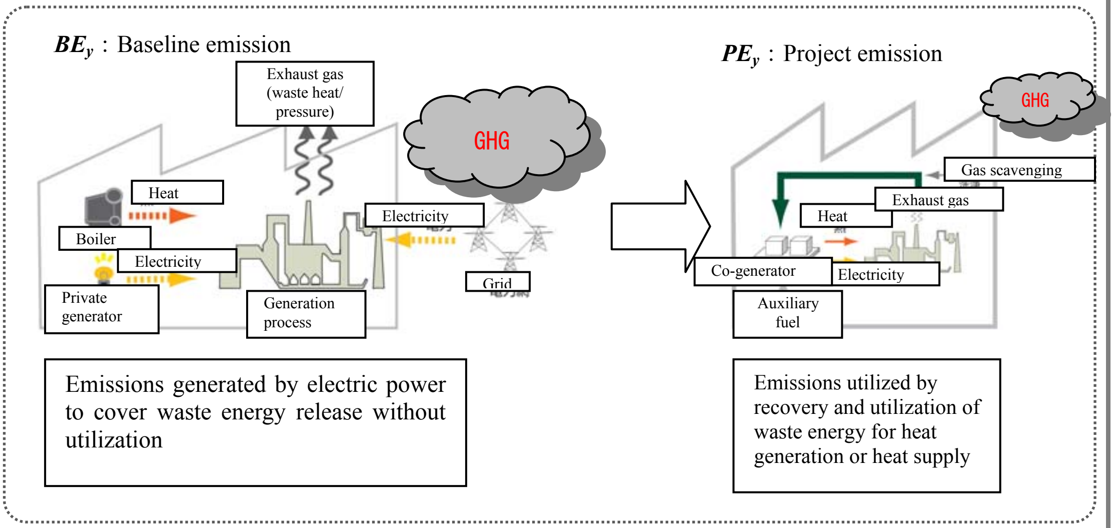
Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electricity consumption	Before：$EC_{BL,y}$	Amount of electricity consumption without the project (MWh/y)	Electricity consumption after project activity		(Not necessary because data is not involved in the calculation)	
	After：$EC_{PJ,y}$	Amount of electricity consumption by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Amount of fuel consumption	Before：$BC_{i,y}$	Amount of fuel consumption without the project (kL, m^3, t etc./y)	Electricity consumption after project activity		(Not necessary because data is not involved in the calculation)	
	After：$PC_{i,y}$	Amount of fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Production capacity	Before：B_{out}	Production capacity without the project	Measured data		(Not necessary because data is not involved in the calculation)	
	After：P_{out}	Production capacity by the project activity	Planned data	Measured data		
CO_2 emissions factor	CO_2 emissions factor of electricity (Before : $EF_{BL,y}$)	Emissions factor of a typical power plants (t-CO_2/MWh)	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned ii) Published values in the target country			
	CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type (t-CO_2/TJ)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
Net Calorific Value (NCV_i)		Net calorific value of each fuel type (GJ/kL, m^3, t etc.)				

【Existing facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electricity consumption	Before：$EC_{BL,y}$	Amount of electricity consumption without the project (MWh/y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After：$EC_{PJ,y}$	Amount of electricity consumption by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Amount of fuel consumption	Before：$BC_{i,y}$	Amount of fuel consumption without the project (kL, m^3, t etc./y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After：$PC_{i,y}$	Amount of fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Production capacity	Before：B_{out}	Production capacity without the project	Measured data		(Not necessary because data is not involved in the calculation)	
	After：P_{out}	Production capacity by the project activity	Planned data	Measured data		
CO_2 emission factor	CO_2 emissions factor of electricity (Before：$EF_{BL,y}$)		Same as【New facilities】			
	CO_2 emission factor of each fuel type ($COEF_i$)					
Net Calorific Value (NCV_i)						

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2)Leakage Leakage associated with improvement of industrial facilities includes CO_2 emissions due to production, transport and disposal in relation to equipment renewal. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. (3) Reviewed Methodologies and Major Differences 1) AMS-II.C.(ver13.0)：Demand side energy efficiency activities for specific technologies 【Differences】 * Because reviewed methodology is applied to small-scale project, it covers projects aiming 60 GWh or less annual electricity reduction through energy efficiency improvement. This methodology has no restrictions with regards to applying the formula. * This formula mainly applies to the calculation of GHG emission reduction in electricity consumption as well as the effects of fuel reduction. * The CO_2 emission factor of the electricity can be used a combined margin (CM) (*1) or the weighted average emissions of the current generation mix. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * Although emission in electricity consumption is comprised of a number of devices, power, average annual operation hours and average annual technical grid losses in the reviewed methodology, the project emission is calculated simply by multiplying the electricity consumption with the baseline emission in this formula. * Leakage from introducing and operating the new facility can be ignored by the existing facilities or equipments disposal in the reviewed methodology. The formula in this section does not consider these disposals. *1: A combined margin (CM) is a combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the “Tool to calculate the Emission Factor for an electricity system” for CDM. 2) AMS-II.D.(ver12.0)：Energy efficiency and fuel switching measures for industrial facilities 【Differences】 * Reviewed methodology is applied to fossil fuel switching measures; however, this formula excludes such measures because another methodology is applied. * In the reviewed methodology, baseline emission reduction is not considered after facility replacement in the context of respective time of existing facility replacement, upgrading and improvement. This formula does not consider these conditions. * The CO_2 emission factor of the electricity can be used a combined margin (CM) (*1) or the weighted average emissions of the current generation mix. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * Leakage from introducing the new facility or uses can be ignored by the existing facilities or equipments disposal in the reviewed methodology. The formula in this section does not consider these disposals. 3) J-MRV002 : Methodologies for energy efficiency project (Revised on February 2011) 【Differences】 * Any of the methods of data acquisition can be selected with reviewed methodology where several methods are available; however, in this formula, priority for data acquisition methods is clearly defined. * Although emission in electricity consumption is comprised of a number of devices, power, average annual operation hours and average annual technical grid losses in the reviewed methodology, the project emission is calculated simply by multiplying the electricity consumption with the baseline emission in this formula. * In the reviewed methodology, baseline emission reduction is not considered after facility replacement in the context of respective time of existing facility replacement, upgrading and improvement. This formula does not

	consider these conditions. * In the reviewed methodology, the CO_2 emission factor of the electricity is the average of all power plants in the target country. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * The reviewed methodology excludes the leakage potential unless there are great influences. This formula also excludes the leakage in the same manner.

1.Typical Project Outline	The project intends to directly suppress electricity/fuel consumption and reduce GHG emissions in industrial facilities, such as steel plants and cement plants, through recovery and utilization from waste energy (waste heat, waste gas pressure).
2.Applicability	* The project should be aimed at GHG emission reduction through installation, upgrading and improvement of facilities, which recover and utilize waste energy from industrial facilities. * The project should promote utilization of waste energy by electricity generation or heat generation.
3.Methodology on Emission Reduction	GHG emission reduction through waste energy recovery and utilization in industrial facilities shall be determined as the difference between the baseline emissions before the project starts and the emission after the project. Emission shall be calculated for electric power generation and heat generation through waste energy recovery and utilization. $$\boldsymbol{ER_y = BE_y - PE_y} \quad \mathbf{(t\text{-}CO_2/y)}$$ $\boldsymbol{ER_y}$: GHG emissions reduction in year y achieved by project ($t\text{-}CO_2/y$) $\boldsymbol{BE_y}$: GHG emissions in year y without waste energy recovery and utilization ($t\text{-}CO_2/y$) (Baseline emission) $\boldsymbol{PE_y}$: GHG emissions in year y with waste energy recovery and utilization ($t\text{-}CO_2/y$)(Project emission)  (1) Baseline Emission Baseline CO_2 emissions factor is defined as the average emission factor of all power plants supplying the grid in the country where project activity is implemented.(Ref. Annex C-1) If the national default average emission factor of the current materials is not available from the existing data or not obtained from interviews with concerned parties, it should be calculated using the net electrical output of all plants supplying the grid in the targeted country, fuel type, net fuel consumption, net calorific value and CO_2 emission factor. (Ref. Annex C-4) Emission factor should be separately defined in the presence or absence of privately owned electrical power facilities. $\boldsymbol{BE_y}$ = $BE_{elec,y}$ (Baseline emissions from electric power) + $BE_{ther,y}$ (Baseline emissions from heat) $=(EG_{PJ,y} \times EF_{BL,y})+(HG_{PJ,y} \times EF_{heat})$

(Continuation)

Type	Items	Description
Output	BE_y	Baseline emission： GHG emissions without waste energy utilization (t-CO_2/y)
Input	$EG_{PJ,y}$	The quantity of electricity generated with waste energy recovery and utilization by the project (MWh/y)
	$EF_{BL,y}$	CO_2 emissions factor of the electricity(t-CO_2/MWh)
	$HG_{PJ,y}$	The quantity of heat recovered and utilized after the project(TJ/y)
	EF_{heat}	CO_2 emission factor of heat(t-CO_2/TJ)

Determination of $EF_{BL,y}$

【Case: currently owned or has plan to install private generating facility】

In the environment where the waste energy collecting facilities are installed with private generating facilities, or where waste energy collecting facilities are newly constructed and private generating facilities are planned to be installed, select whichever higher by comparing with the CO_2 emissions factor for the grid supplying electricity.

The emissions factor should be determined base on one or two typical plants among existing power plants in the target grid.

The emissions factor should be obtained through interview to the electric power management entity concerned.

In selecting the target power plant, confirm that the emissions factor is comparable to the average grid emission factor based on published values in the target country, data adopted by Kyoto Mechanism or IEA (Ref. Annex C-1).

If CO_2 emission factor is not available, it should be calculated using the annual electrical output of the target plant, fuel type, annual fuel consumption, average net calorific value, and caloric CO_2 emission factor (Ref. Annex C-4).

【Case: currently not owned or has no plan to install private generating facility】

Where the existing waste energy generating facilities have no private generating facilities or such facilities are not planned to be installed in new waste energy generating facilities, CO_2 emissions factor in the grid supplying electricity should be used.

Determination of EF_{heat}

EF_{heat} shall be recalculated by the following equation:

$$EF_{heat} = ws\ \frac{EF_{CO2}}{\eta_{EP}}$$

EF_{CO2} ：CO_2 emission factor of the boiler fuel consumed without the project

η_{EP} ：Boiler efficiency

ws ：Rate of total heat from boiler without the project to heat capacity with waste energy recovery and utilization

(2) Project Emission

To calculate project GHG emission, monitor electricity consumption and supplemental fuel consumption from facilities with waste energy recovery and utilization. That measured consumption is multiplied by their respective emission factors.

$$\boldsymbol{PE_y} = \underbrace{PE_{elec,y}}_{\text{(Emission with electricity consumption)}} + \underbrace{PE_{i,y}}_{\text{(Emission with fuel consumption)}}$$

$$= (PC_y \times EF_{BL,y}) + (PC_{i,y} \times NCV_i \times COEF_i)$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission： GHG emission after project activity (t-CO_2/y)
Input	PC_y	Electricity consumption after project in year y(MWh/y)
	$EF_{i,y}$	CO_2 emissions factor of electricity(t-CO_2/MWh)
	$FC_{i,y}$	Fuel consumption i after the project in year *y* (kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i(t-CO_2/TJ)

4.Data required for estimation and monitoring

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electric power supply with waste energy recovery and utilization (後：$EG_{PJ,y}$)		Amount of electric power supply with waste energy recovery and utilization by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
CO_2emission factor(Before：$EF_{BL,y}$)	Either higher rate of factor in the followings where the case【currently own the private generating facilities or plan to install】					
	CO_2 emissions factor of electricity	Emissions factor of a typical power plants (t-CO_2/MWh)	Data availability is validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned ii) Published values in the target country			
	CO_2 emission factor in private generating facilities	CO_2 emission factor every fuel type (t-CO_2/TJ)	Interview with power management entity			
	CO_2 emission factor supplying to grid for the case where【currently do not own the private generating facilities nor plan to install】					

(Cont)

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of heat with waste energy recovery and utilization (After：$HG_{PJ,y}$)		Amount of heat with waste energy recovery and utilization by the project activity (TJ/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
CO_2 emission factor(Before：$EF_{heat,y}$)	Before：EF_{CO2}	The CO_2 emission factor of the boiler fuel consumed without the project ($t\text{-}CO_2$/TJ)	Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default IPCC Guideline default data (AnnexC-3)		(Not necessary because data is not involved in the calculation)	
	Heat efficiency (η_{EP})	Heat efficiency from boiler(%)	Data availability is validated in the following order: i) Unique data from interview with power management entity ii) Measured data of similar case			
	Heat ratio (*ws*)	Rate of total heat from boiler without the project to heat capacity with waste energy recovery and utilization	Heat capacity with waste energy recovery and utilization equal to heat capacity from boiler without the project The ratio is “1”.			
Amount of electricity consumption by the project activity (After：PC_y)		Amount of electricity consumption by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Amount of fuel consumption by the project activity (After：$PC_{i,y}$)		Amount of fuel consumption by the project activity for every fuel type (kL/y、m^3/y、t/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Other factors	Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3,t etc.,)	Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
	CO_2 emissions factor of each fuel type ($COEF_i$)	CO_2 emissions factor of each fuel type ($t\text{-}CO_2$/TJ)				

5.Others

(1) Project Boundary

The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented.

(2) Leakage

Recovery and utilization of waste energy in industrial facilities:
the indirect emissions that potentially lead to leakage due to activities such as product manufacturing or materials transport.

This corresponding emission is temporary and negligible considering the project scale. Therefore, this can be ignored.

(3) Reviewed Methodologies and Major Differences

1) ACM0012(ver4.0.0)：Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects

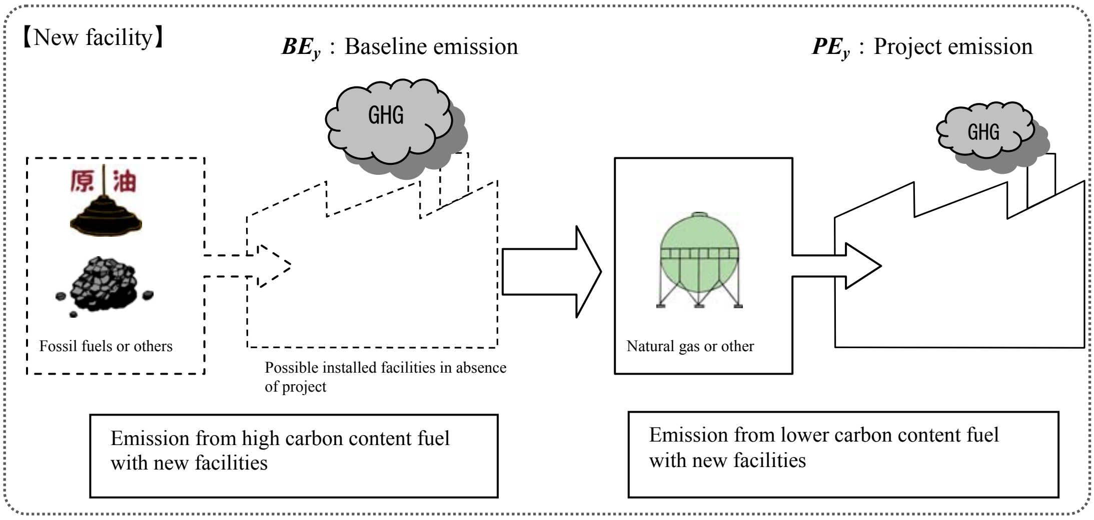
	【Differences】 * Waste energy is utilized in the project. Thus, without the project, waste energy flared or released into the atmosphere should be proved by directly measuring the amount of waste energy over three years before project implementation. This formula excludes these conditions. * Reviewed methodology adopts several formulas depending on current situations and projects; however, in this formula, it is simplified by multiplying the electric power supply from waste energy with CO_2 emissions factor. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * This formula does not consider the leakage because the reviewed methodology also mentions that there is no leakage to be considered. 2) AM0024(ver02.1)：Baseline methodology for GHG reductions through waste heat recovery and utilization for power generation in cement plants 【Differences】 * Though the reviewed methodology is applied to waste heat recovery and utilization during clinker making process in cement plants, the formula in this section is also applied to plants other than cement plants. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * Though the reviewed methodology is applied to waste heat recovery and utilization during clinker making process in cement plants, the formula in this section is applied to waste gas not limited to waste heat. * Emission from gas leak from the construction of power plants or fuel processing facilities may be considered as leakage which can be ignored in the reviewed methodology. This formula also ignores it the same manner. 3) ACM0013(ver4.0.0)：Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology 【Differences】 * Though the reviewed methodology excludes new facilities as element, new facilities are used in this formula. * Regarding the baseline emission based on the reviewed methodology, applicability of the formula is for fossil fuel used in the absence of the project, which is more than 50% of the net electricity power supply in the last three years. This formula excludes these conditions. * In the reviewed methodology, the CO_2 emission factor of the electricity is one of the value calculated by the caloric CO_2 emission factor of each fuel type and efficiency in power generation or the value calculated by the amount of power generation, type of fossil fuel, amount of fuel consumption, net calorific value, caloric CO_2 emissions factor of each fuel type. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * This formula does not consider the leakage because the reviewed methodology also mention that there is no leakage to be considered. 4) AMS-III.Q(ver4.0)：Waste Energy Recovery (Gas/Heat/Pressure) Projects 【Differences】 * The formula in the reviewed methodology is applied to approve methodologies for small-scale CDM projects, which aim at 60 GWh or less annual electricity reduction, through energy efficiency improvement. There is no restriction in applying the formula from this methodology. * In the reviewed methodology, the CO_2 emission factor of the electricity is calculated by the caloric CO_2 emission factor of each fuel type and efficiency in power generation. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily.

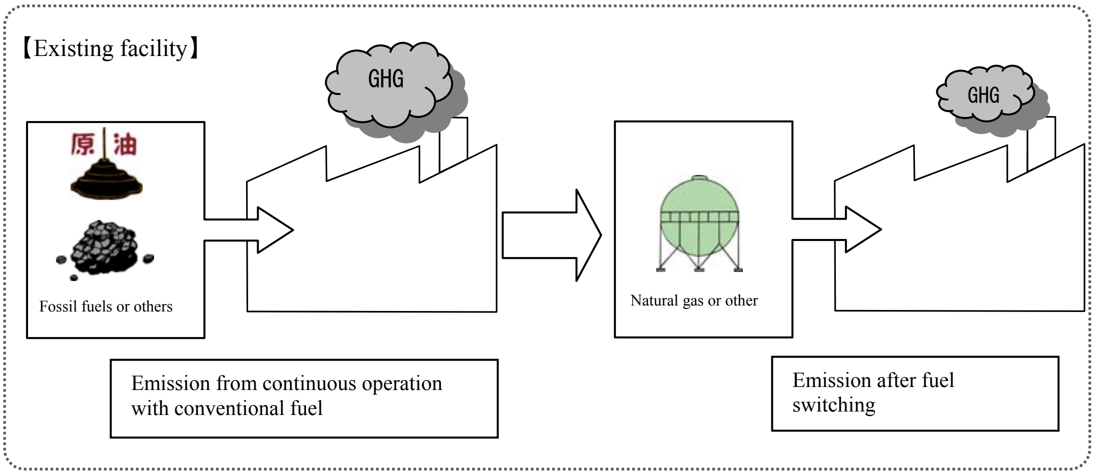
	* In the reviewed methodology, if the power plants are transferred from other projects, leakage should be considered. However, this formula excludes these conditions. 5)J-MRV003: Methodology for waste energy recovery and utilization project (Revised on February 2011) 【Differences】 *Any of the methods on data acquisition can be selected from reviewed methodology where several methods are available; however, in this formula, prior selection is clearly defined. * In the reviewed methodology, the formula for baseline emission is intended for electricity use. This formula here also includes heat use. * In the reviewed methodology, the CO_2 emission factor of the electricity is the average of all power plants in the target country. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. * The reviewed methodology excludes the leakage potential unless there are great influences. This formula also excludes the leakage in the same manner.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to inhibit GHG emissions through switching from high carbon content heavy oil fuel in order to lower carbon content fuel in new and existing industrial facilities.</td></tr>
<tr><td>2.Applicability</td><td>* The project should aim at switching from high carbon content fossil fuel in order to lower carbon content fuel both at new and existing industrial facilities through this project.</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>
GHG emission reduction through fuel switching at industrial facilities shall be determined as the difference between the baseline emissions before the project starts and emission after the project.
Baseline emission can be computed by multiplying fuel consumption before and after the project, respectively, by their respective CO_2 emission factors. Baseline emission can be computed by multiplying respective fuel consumption before and after the project with their respective CO_2 emission factors.

$$ER_y = BE_y - PE_y \quad (\text{t-}CO_2/\text{y})$$

ER_y : GHG emissions reduction in year y achieved by the project (t-CO_2/y)
BE_y : GHG emissions reduction in year y before fuel switching (t-CO_2/y)(Baseline emission)
PE_y : GHG emissions reduction in year y after fuel switching (t-CO_2/y)(Project emission)





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(1) Baseline Emissions

Baseline emission shall be determined by multiplying measured fuel consumption in the absence of fuel switching by their respective emission factors

In the case of new facilities, fuel consumption necessary to generate the production capacity equivalent to the existing facilities after the project start shall be used as input.

$$\boldsymbol{BE_y} = EG_{PJ,y} \times \left(\frac{BC_{BL,y} \times NCV_i \times COEF_i}{PG_{BL,y}}\right)$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission： GHG emission without project activity (t-CO_2/y)
Input	$EG_{BL,y}$	Production capacity before project activity
	$EG_{PJ,y}$	Production capacity after project activity
	$BC_{i,y}$	Fuel consumption before the project (kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i(t-CO_2/TJ)

(2) Project Emission

To calculate project GHG emission, monitor fuel consumption from facilities with fuel switching after project activity. Such measured consumption is multiplied by a corresponding emission factor.

$$\boldsymbol{PE_y} = PC_{i,y} \times NCV_i \times COEF_i$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission： GHG emission after project activity (t-CO_2/y)
Input	$PC_{i,y}$	Fuel consumption after project activity (kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3,t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i(t-CO_2/ TJ)

4.Data Required for Estimation and Monitoring

【New facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Production capacity	Before: $EG_{BL,y}$	Production capacity without the project (Output)	Measured data		(Not necessary because data is not involved in the calculation)	
	After: $EG_{PJ,y}$	Production capacity by the project activity	Planned data	Measured data		
Fuel consumption	Before: $BC_{i,y}$	Fuel consumption without the project (kL、m^3、t etc. /y)	Estimated data based on results from similar facilities		(Not necessary because data is not involved in the calculation)	
	After: $PC_{i,y}$	Fuel consumption by the project activity (kL、m^3、tetc. /y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Net calorific value (NCV_i)		Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emissions factor ($COEF_i$)		CO_2 emissions factor of each fuel type (t-CO_2/TJ)				

【Existing facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Production capacity	Before: $EG_{BL,y}$	Production capacity without the project (Output)	Measured data		(Not necessary because data is not involved in the calculation)	
	After: $EG_{PJ,y}$	Production capacity by the project activity	Planned data	Measured data		
Fuel consumption	Before: $BC_{i,y}$	Fuel consumption without the project (kL, m^3, t etc./y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After: $PC_{i,y}$	Fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Net calorific value (NCV_i)		Same as 【New facilities】				
CO_2 emissions factor ($COEF_i$)						

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes facilities where project activity is implemented. (2) Leakage Fuel switching in industrial facilities: indirect emissions potentially leading to leakage due to activities such as product manufacturing or materials transport. This corresponding emission is temporary and negligible considering the project scale. Therefore, it can be ignored. Fugitive CH_4 emissions associated with the fuel extraction, processing, liquefaction, transportation, re-gasification and distribution, or CO_2 emissions from natural gas transportation and distribution and compression shall be calculated in reference to the Annex C-5&6, if it consists around 10-20% of the project emission, it should be subtracted from GHG emission reduction. (3) Reviewed Methodologies and Major Differences 1) ACM0009 (ver3.2) : Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas 【Differences】 * Reviewed methodology is applied to fuel switching in the heat generation process; however, this formula is not limited to fuel switching. * Though the reviewed methodology is applied to fuel switching from coal or petroleum fuel to natural gas, the formula in this section is also applied to any other kind of fuel. * Though reviewed methodology expects that the condition where the amount of heat supply before and after the project are the same, the methodology here adopts the formula corresponding to the amount of heat supply increase. *Leakage emissions comprise mainly fugitive CH_4 emissions from fuel production and, in the case of natural gas, from fuel transportation and distribution. This formula should consider in the same manner. 2) AMS-III.B (ver15.0) : Switching fossil fuels 【Differences】 * The formula in the reviewed methodology is applied to approve methodologies for small-scale CDM projects, which aims at 60 kg or less annual GHG emission reduction through fuel switching. There is no restriction for applying the formula in this methodology. * In the reviewed methodology, fugitive CH_4 emissions from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution, or CO_2 emissions from natural gas transportation, distribution and compression should be considered for leakage. This formula considers it also. 3) AMS-III.AN (ver2.0)：Fossil fuel switch in existing manufacturing industries 【Differences】 * The formula in the reviewed methodology is applied to approve methodologies for small-scale CDM projects, which aims at 60 kg or less annual GHG emission reduction through fuel switching. There is no restriction for applying formula in this methodology. * In the reviewed methodology, the formula for project emission is intended to include emissions generated by electricity consumption in the project. This formula here excludes the corresponding emission because it is negligible considering the project scale. * In the reviewed methodology, if the power plants or equipments are transferred from other projects, leakage should be considered. In this methodology, fugitive CH_4 emissions associated with fuel production in the case of natural gas, from fuel transportation and distribution should be considered.

Energy Sector

Sub-sector：

10. Energy Plant with Fuel Switching

11. Thermal Power with Electricity and Heat Supply

12. Thermal Power with Fuel Switching

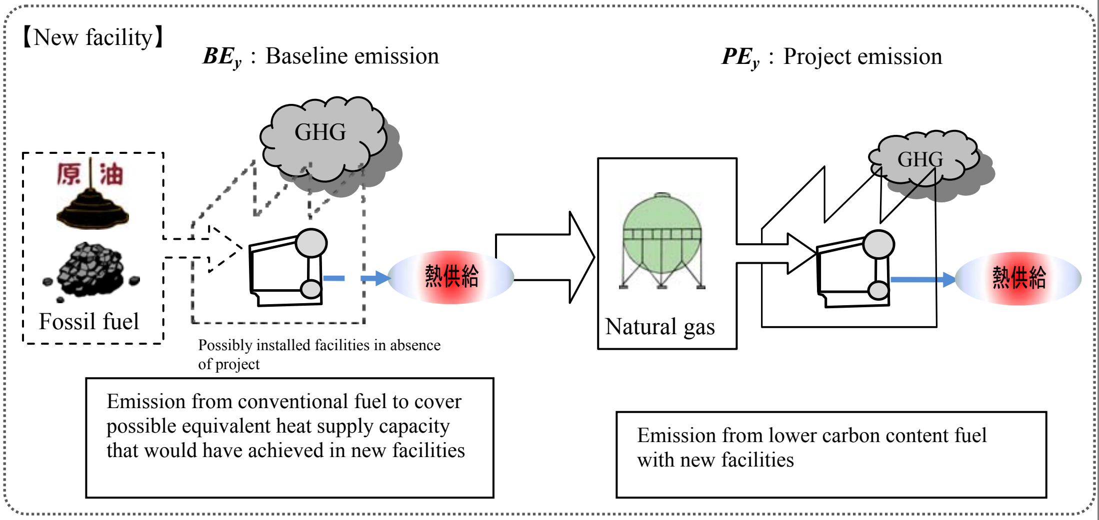
13. Thermal Power with Higher Efficiency

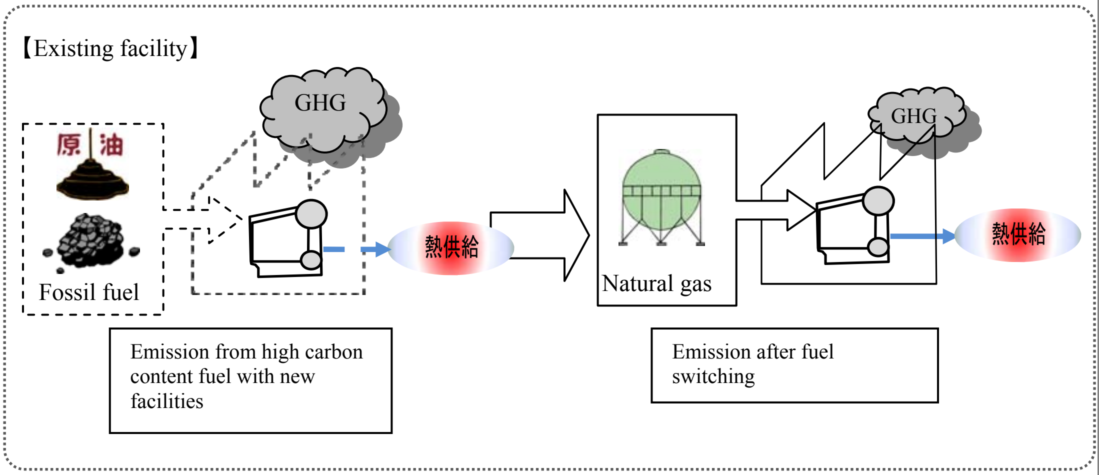
14. Power Transmission with Improved Efficiency

15. Power Distribution with Improved Efficiency

16. Rural Electrification

1.Typical Project Outline	The project intends to inhibit GHG emissions by switching from high carbon content heavy oil fuel in order to lower carbon content fuel of new and existing intensive heat-supply facilities.
2.Applicability	○ The aim is to switch to lower carbon content fuel through the project, both at new and existing facilities.
3.Methodology on Emission Reduction	GHG emission reduction through fuel switching in industrial facilities shall be determined as the difference between baseline emissions (emissions from high carbon content fuel) and project emission (emissions after fuel switching). Baseline emission can be computed by multiplying respective fuel consumption before and after the project with their respective CO_2 emission factors. $$ER_y = BE_y - PE_y \quad (\text{t-}CO_2/\text{y})$$ ER_y : GHG emissions reduction in year y achieved by the project (t-CO_2/y) BE_y : GHG emissions reduction in year y before fuel switching (t-CO_2/y)(Baseline emission) PE_y : GHG emissions reduction in year y after fuel switching (t-CO_2/y)(Project emission)





3.Methodology on Emission Reduction (Continuation)

(1) Baseline Emission

To calculate baseline emission, monitor fuel consumption in the absence of fuel switching. Such measured consumption is multiplied by a corresponding emission factor.

In the case of new facilities, measure fuel consumption necessary to generate the amount of heat supply capacity after the project start, equivalent to that of the existing facilities.

$$\boldsymbol{BE_y} = HG_{PJ,y} \times \left(\frac{BC_{BL,y} \times NCV_i \times COEF_i}{HG_{BL,y}} \right)$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission： GHG emission without project activity (t-CO_2/y)
Input	$HG_{BL,y}$	Amount of heat supply before the project starts(TJ/y)
	$HG_{PJ,y}$	Amount of heat supply after the project(TJ/y)
	$BC_{i,y}$	Fuel consumption before project activity(kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i (t-CO_2/TJ)

(2)Project Emission

To calculate project GHG emission, monitor fuel consumption from facilities that adopt fuel switching after project activity. Such measured consumption is multiplied by a corresponding emission factor.

$$\boldsymbol{PE_y} = PC_{i,y} \times NCV_i \times COEF_i$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission： GHG emission after project activity (t-CO_2/y)
Input	$PC_{i,y}$	Fuel consumption after project activity(kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i(t-CO_2/TJ)

4. Data Required for Estimation and Monitoring

【New facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of heat supply	Before : $HG_{BL,y}$	Amount of heat supply without the project (TJ/y)	Estimated data based on the results obtained from similar facilities		(Not necessary because data is not involved in the calculation)	
	After : $HG_{PJ,y}$	Amount of heat supply by the project activity (TJ/y)	Planned data	Measured data		
Amount of fuel consumption	Before : $BC_{i,y}$	Amount of fuel consumption without the project (kL, m^3, t etc./y)	Estimated data based on the results obtained from similar facilities		(Not necessary because data is not involved in the calculation)	
	After : $PC_{i,y}$	Amount of fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Net calorific value (NCV_i)		Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it should preferably be calculated with data and information unique to the project : i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emissions factor ($COEF_i$)		CO_2 emissions factor of each fuel type ($t\text{-}CO_2$/TJ)				

【Existing facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of heat supply	Before : $HG_{BL,y}$	Amount of heat supply without the project (TJ/y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After : $HG_{PJ,y}$	Amount of heat supply by the project activity (TJ/y)	Planned data	Measured data		
Amount of fuel consumption	Before : $BC_{i,y}$	Amount of fuel consumption without the project (kL, m^3, t etc./y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After : $PC_{i,y}$	Amount of fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Net calorific value (NCV_i)		Same as 【New facilities】				
CO_2 emissions factor ($COEF_i$)						

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2) Leakage Fuel switching: the indirect emissions that potentially lead to leakage due to activities such as product manufacturing or materials transport. This corresponding emission is temporary and negligible considering the project scale. Therefore, it can be ignored. Fugitive CH_4 emissions associated with fuel production in the case of natural gas, from fuel transportation and distribution shall be calculated in reference to the Annex C-5&6, If it consists around 10-20 % of the project emission, it should be subtracted from GHG emission reduction. (3) Reviewed Methodologies and Major Differences 1) ACM0009 (ver3.2) : Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas 【Differences】 * Reviewed methodology is applied to fuel switching in heat generation process; however, this formula is not limited to fuel switching. * Though reviewed methodology expects the condition where the amount of heat supply before and after the project are the same, the methodology here uses the formula corresponding to the amount of heat supply increase. * Leakage emissions comprise mainly fugitive CH_4 emissions from fuel production and, in the case of natural gas, from fuel transportation and distribution. This formula should consider in the same manner. 2) AMS-III.B (ver15) : Switching fossil fuels 【Differences】 * The formula in the reviewed methodology is applied to approve methodologies for small-scale CDM projects, which aims at 60 kg or less annual GHG emission reduction through fuel switching. There is no restriction for applying the formula on this methodology. * The reviewed methodology ignores the leakage with fugitive CH_4 emissions associated with fuel production in the case of natural gas, from fuel transportation and distribution. However, in this formula, leakage shall be considered 3) AMS-III.AN(ver2.0)：Fossil fuel switch in existing manufacturing industries 【Differences】 * The formula in the reviewed methodology is applied to approve methodologies for small-scale CDM projects, which aims at 60 kg or less annual GHG emission reduction through fuel switching. There is no restriction for applying the formula on this methodology. * In the reviewed methodology, the formula for project emission is intended to include emissions generated by electricity consumption in the project. This formula here excludes the corresponding emission because it is negligible considering the project scale. * In the reviewed methodology, if the power plants or equipments are transferred from other projects, leakage should be considered. This formula consider the fugitive CH_4 emissions from fuel production and, in the case of natural gas, from fuel transportation and distribution.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to directly reduce GHG emissions and suppress fuel consumption for electricity generation through recovery and utilization (new construction of combined cycle power plants etc.) from waste energy (waste heat, waste) at fossil fuel fired power plants.</td></tr>
<tr><td>2.Applicability</td><td>○ The project should aim at GHG emission reduction through installation, upgrading and improvement of facilities, which recover and utilize waste energy at fossil fuel fired power plant.
○ The project should promote utilization of waste energy by electricity generation or heat generation.</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>

GHG emission reduction through waste energy recovery and utilization in fossil fuel fired facilities shall be determined as the difference between baseline emissions before the project starts and emissions after the project.

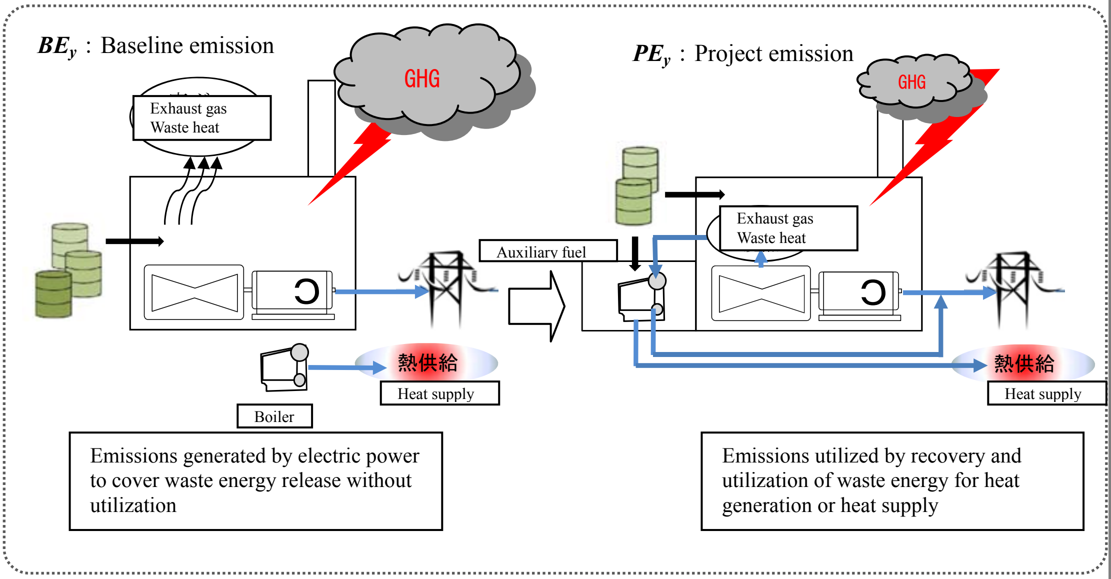
Emission can be calculated for electric power generation and heat generation through waste energy recovery and utilization.

$$ER_y = BE_y - PE_y \quad (\text{t-}CO_2/\text{y})$$

ER_y : GHG emissions reduction in year y achieved by the project (t-CO_2/y)

BE_y : GHG emissions in year y without waste energy recovery and utilization (t-CO_2/y) (Baseline emission)

PE_y : GHG emissions in year y with waste energy recovery and utilization (t-CO_2/y) (Project emission)



(1) Baseline Emissions

Baseline emissions from fuel consumed for electric power and heat energy, if any, is that which would have been generated in the project in the absence of recovery and utilization of waste energy after the project.

In order to compute each baseline emission, the amount of electric power supply (MWh/y) and heat supply (TJ/y) from recovery and utilization of waste energy after the project is multiplied by their respective CO_2 emission factors.

$$BE_y = BE_{elec,y} + BE_{ther,y}$$

(Emissions generated by electric power supply) (Emissions generated by heat supply)

$$=(EG_{PJ,y} \times EF_{BL,y}) + (HG_{PJ,y} \times EF_{heat})$$

</td></tr>
</table>

3.Methodology of Emission Reduction (Continuation)

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission： GHG emission without recovery and utilization of waste energy (project activity) (t-CO_2/y)
Input	$EG_{PJ,y}$	Amount of electric power supply after the project activity(MWh/y)
	$EF_{BL,y}$	CO_2 emissions factor of the electricity(t-CO_2/MWh)
	$HG_{PJ,y}$	Amount of heat supply after the project activity (TJ/y)
	EF_{heat}	CO_2 emission factor of heat(t-CO_2/TJ)

Determination of $\boldsymbol{EF_{BL,y}}$

Baseline CO_2 emissions factor of the electric power is defined as the emission factor of the target power plant where project activity is expected to reduce emission.

Emission factor for the target power plant should be obtained through interview to the electric power management entity concerned or based on published values.

If the emission factor is not available, it should be calculated using the net electrical output of the target power plant, fuel type, net fuel consumption, net calorific value and caloric CO_2 emission factor (Ref. Annex C-4).

Determination of $\boldsymbol{EF_{heat}}$

EF_{heat} shall be calculated by the following equation:

$$EF_{heat} = ws\,\frac{EF_{CO2}}{\eta_{EP}}$$

EF_{CO2} : The CO_2 emission factor per unit of energy of the boiler fuel consumption without the project

η_{EP} : Boiler efficiency

ws : Rate of total heat from boiler without the project

(2) Project Emission

To calculate project GHG emission, monitor electricity consumption and supplemental fuel consumption from facilities with waste energy recovery and utilization. That measured consumption is multiplied by each respective emission factor.

$$\boldsymbol{PE_y} = \underbrace{PE_{elec,y}}_{\text{(Emission with electric consumption)}} + \underbrace{PE_{i,y}}_{\text{(Emission with fuel consumption)}}$$

$$= (PC_y \times EF_{BL,y}) + (PC_{i,y} \times NCV_i \times COEF_i)$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission： GHG emission after project activity (t-CO_2/y)
Input	PC_y	Electricity consumption after the project in year y(MWh/y)
	$EF_{BL,y}$	CO_2 emissions factor of the electricity(t-CO_2/MWh)
	$PC_{i,y}$	Fuel consumption i after the project in year y (kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i(t-CO_2/TJ)

4. Data Required for Estimation and Monitoring

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electricity power supply with waste energy recovery and utilization (After: $EG_{PJ,y}$)		Amount of electricity power supply with waste energy recovery and utilization by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
CO_2emision facto(Before: $EF_{BL,y}$)	CO_2 emissions factor of electricity	Emissions factor of the target power plants (t-CO_2/MWh)	Data availability is validated in the following order because it should preferably be calculated with unique national data and information: i) Data specific to the project obtained through interview to the electric power management entity concerned ii) Published values in the target country		(Not necessary because data is not involved in the calculation)	
Amount of heat from waste energy recovery and utilization (After: $HG_{PJ,y}$)		Amount of heat from waste energy recovery and utilization by the project activity (TJ/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
CO_2 emission factor(Before: $EF_{heat,y}$)	Before: EF_{CO2}	The CO_2 emission factor of the boiler fuel type without the project (t-CO_2/TJ)	Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project: i) Unique data from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)		(Not necessary because data is not involved in the calculation)	
	Heat efficiency (η_{EP})	Heat efficiency form boiler(%)	Data availability is validated in the following order: i) Unique data obtained from interviews with power management entity ii) Measured data of similar cases			
	Heat ratio (*ws*)	Rate of total heat from boiler without the project	Heat capacity with waste energy recovery and utilization = heat capacity from boiler in the absence of project activity. Thus, the ratio is “1”.			
Electricity consumption by the project activity (After: PC_y)		Net electricity consumption(MWh/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Fuel consumption by the project activity (After: $PC_{i,y}$)		Net fuel consumption of each fuel type (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Other factors	Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project: i) Unique data from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
	CO_2 emissions factor of each fuel type ($COEF_i$)	CO_2 emissions factor of each fuel type (t-CO_2/TJ)				

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2) Leakage Recovery and utilization of waste energy in power plant: the indirect emissions potentially leading to leakage due to activities such as product manufacturing or materials transport. This corresponding emission is temporary and negligible considering the project scale. Therefore, it can be ignored. (3) Reviewed Methodologies and Major Differences 1) ACM0012(ver4.0.0) : Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects 【Differences】 * Waste energy utilized in the project. Thus, without the project, waste energy that would be flared or released into the atmosphere should be proved by directly measuring waste energy amount over three years before project implementation. This formula excludes these conditions. * Reviewed methodology adopts several formulas depending on current situations and projects; however, in this formula, it is simplified by multiplying the electric power supply from waste energy by CO_2 emissions factor. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of the target power plants. * This formula does not consider the leakage because the reviewed methodology also mentions that there is no leakage to be considered. 2) AM0048(ver03) : New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels 【Differences】 * Baseline emission in the reviewed methodology is calculated for each electric power supply to each individual customer and electricity supplying the grid; however, all electricity is assumed to supply the grid in applying the formula in this section. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of the target power plants. * Leakage may be calculated with the fugitive CH_4 from the extraction, processing, liquefaction, transportation, re-gasification and CO_2 emissions from associated fuel combustion and flaring in transportation, re-gasification and pressure of natural gas. This formula here excludes the corresponding emission because it is negligible considering the project scale.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to inhibit GHG emissions by switching from high carbon content heavy oil fuel to lower carbon content fuel at new and existing intensive heat supply facilities.</td></tr>
<tr><td>2.Applicability</td><td>○ The aim is to switch to lower carbon content fuel through the project both at new and existing facilities.</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>

GHG emission reduction through fuel switching at fossil fuel fired power plant shall be determined as the difference between baseline emissions (emissions from high carbon content fuel) and project emission (emissions after switching fuel).

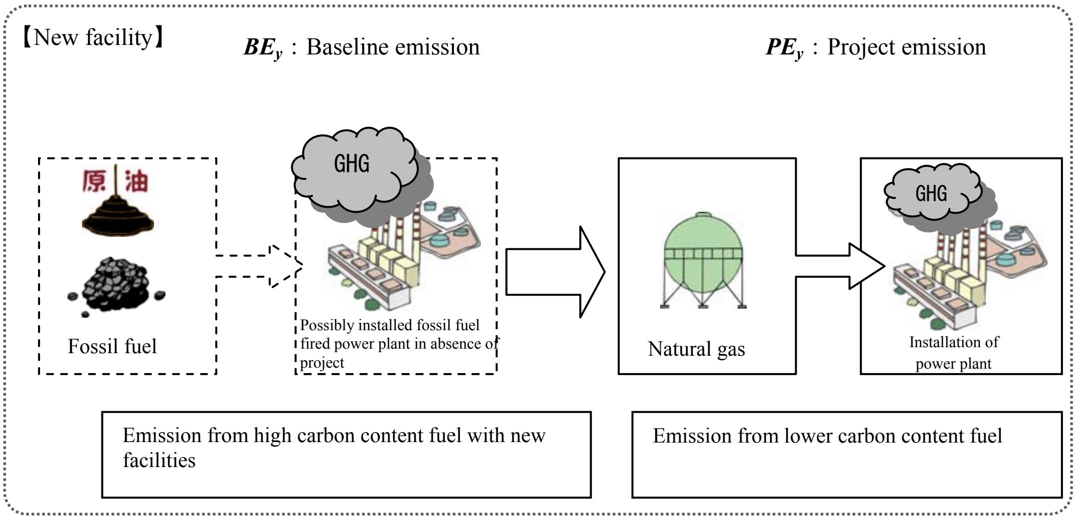
Baseline emission can be computed by multiplying respective fuel consumption before and after the project with their respective CO_2 emission factors.

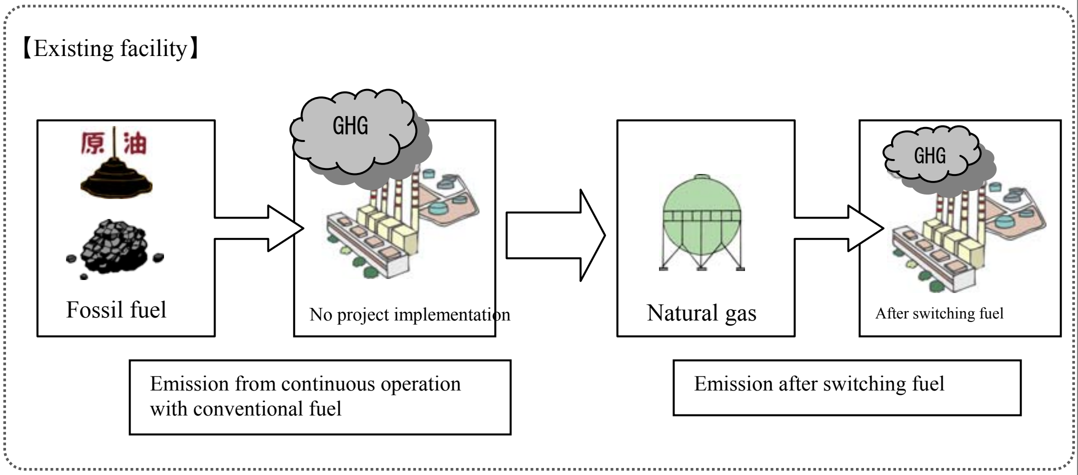
$$\boldsymbol{ER_y} = \boldsymbol{BE_y} - \boldsymbol{PE_y} \quad (\text{t-}CO_2/y)$$

$\boldsymbol{ER_y}$: GHG emissions reduction in year y achieved by project (t-CO_2/y)

$\boldsymbol{BE_y}$: GHG emissions reduction in year y before fuel switching (t-CO_2/y)(Baseline emission)

$\boldsymbol{PE_y}$: GHG emissions reduction in year y after fuel switching (t-CO_2/y)(Project emission)





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</table>

(Continuation)

(1) Baseline Emissions

To calculate baseline emission, monitor fuel consumption in the absence of fuel switching. Such measured consumption is multiplied by its corresponding emission factor.

In the case of new facilities, measure fuel consumption necessary to generate the amount of electric power supply capacity after the project start equivalent to the existing facilities.

$$\boldsymbol{BE_y} = EG_{PJ,y} \times \left(\frac{BC_{BL,y} \times NCV_i \times COEF_i}{EG_{BL,y}} \right)$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission： GHG emission with no project activity (t-CO_2/y)
Input	$EG_{BL,y}$	Electricity generating capacity before the project(MWh/y)
	$EG_{PJ,y}$	Electricity generating capacity after the project(MWh/y)
	$BC_{i,y}$	Fuel consumption before project activity(kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i (t-CO_2/TJ)

(2) Project Emission

To calculate project GHG emission, monitor fuel consumption from facilities with fuel switching after project activity. That measured consumption is multiplied by its corresponding emission factor.

$$\boldsymbol{PE_y} = PC_{i,y} \times NCV_i \times COEF_i$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission： GHG emission after project activity (t-CO_2/y)
Input	$PC_{i,y}$	Fuel consumption after project activity(kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 Emission Factor of fuel i (t-CO_2/TJ)

4. Data Required for Estimation and Monitoring

【New facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of power supply	Before : $EG_{BL,y}$	Electricity generating capacity without the project (MWh/y)	Estimated data based on the results of similar facilities		(Not necessary because data is not involved in the calculation)	
	After : $EG_{PJ,y}$	Electricity generating capacity by the project activity (MWh/y)	Planned data	Measured data		
Fuel consumption	Before : $BC_{i,y}$	Fuel consumption without the project (kL, m^3, t etc./y)	Estimated data based on the results of similar facilities		(Not necessary because data is not involved in the calculation)	
	After : $PC_{i,y}$	Fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Net calorific value (NCV_i)		Net calorific value of each fuel type (GJ/kL, m^3,t etc.,)	Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project: i) Unique data from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emissions factor ($COEF_i$)		CO_2 emissions factor of each fuel type (t-CO_2/TJ)				

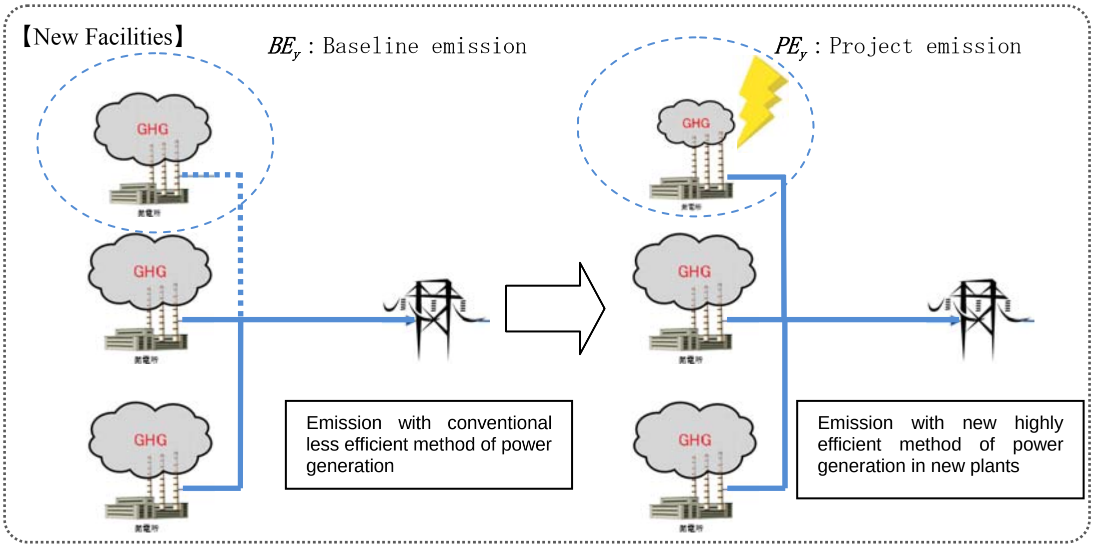
【Existing facilities】

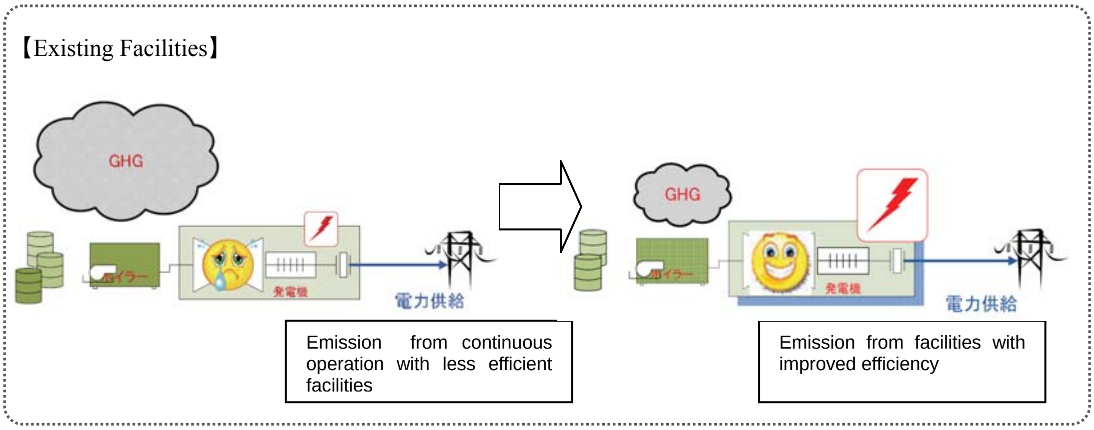
Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of power supply	Before : $EG_{BL,y}$	Electricity generating capacity without the project (MWh/y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After : $EG_{PJ,y}$	Electricity generating capacity by the project activity (MWh/y)	Planned data	Measured data		
Fuel consumption	Before : $BC_{i,y}$	Fuel consumption without the project (kL, m^3, t etc./y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After : $PC_{i,y}$	Fuel consumption by the project activity (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Net calorific value (NCV_i)		Same as 【New facilities】				
CO_2 emissions factor ($COEF_i$)						

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2) Leakage Switching fuel at fossil fuel fired power plants: the indirect emissions that potentially lead to leakage due to activities such as product manufacturing or materials transport. This corresponding emission is temporary and negligible considering the project scale. Therefore, it can be ignored. Fugitive CH_4 emissions associated with the fuel extraction, processing, liquefaction, transportation, re-gasification and distribution, or CO_2 emissions from natural gas transportation and distribution and compression shall be calculated in reference to the Annex C-5&6, if it consists around 10-20% of the project emission, it should be subtracted from GHG emission reduction. (3) Reviewed Methodologies and Major Differences 1) ACM0011 (ver2.2): Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation. 【Differences】 ・Reviewed methodology consists of approved consolidated methodologies and show comes formulas for every scenario; however, it is simply calculated based on fuel consumption in this formula. 2)AMS-III.B (ver15.0) : Switching fossil fuels 【Differences】 * The formula in the Reviewed methodology is applied to approve methodologies for small-scale CDM projects, which aims at 60 kg or less annual CO_2 emissions reduction through switching fuel. There is no restriction for applying the formula in this methodology. *The Reviewed methodology does not consider, however, fugitive CH_4 emission from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fuel, CO_2 emission from natural gas transportation and distribution in the case of, compression should be considered in this formula.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to suppress the greenhouse gas (GHG) from fossil fuel combustion in the fossil fired plants by reducing the fuel consumption per electric supply through the new construction of high efficient fossil fired plants or improvement of the existing power plants (upgrading to the combined cycle power plants, efficiency improvement by the improvement/upgrading of the power plants or upgrading to the higher efficiency power plants)</td></tr>
<tr><td>2.Applicability</td><td>○ New facility construction equipped with highly efficient facilities through the project activity
○ For existing facilities, replacement, upgrading, and improvement of facilities using conventional fuel
○ For new and existing facilities, i) fossil fuel fired plants connected to the grid, and ii) non-cogeneration facilities</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>GHG emissions reduction through the improvement of energy efficiency shall be determined as the difference between baseline emissions from facilities with low efficiency and project emissions after improvement.
In order to compute GHG emissions, the amount of electricity power supply is multiplied by its CO_2 emission factors. The GHG emission factor is computed from the respective efficiency in power generation before and after the project starts. Compute the emission from generating the same amount of power supply after the project starts and compare both results. For the existing facilities, baseline emission is computed with the measured emission factor before the improvement of the power plants.

$$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$
ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$)
BE_y : GHG emission from low efficiency facilities in year y ($t\text{-}CO_2/y$)(Baseline emission)
PE_y : GHG emission from improved efficiency facilities in year y ($t\text{-}CO_2/y$)(Project emission)




</td></tr>
</table>

(Continuation)

(1) Baseline Emission

The CO_2 emission factor is computed from the power generation efficiency without the replacement, upgrading and improvement of power generator before the project starts. GHG emissions necessary to generate the amount of electricity equivalent to the existing power generators after the project starts.

$$\boldsymbol{BE_y} = EG_{PJ,y} \times EF_{BL,y}$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission: GHG emission from low efficiency power generators ($t\text{-}CO_2/y$)
Input	$EG_{PJ,y}$	annual energy production after the project starts at the transmission edge (MWh)
	$EF_{BL,y}$	CO_2 emission factor per electricity supplied ($t\text{-}CO_2/MWh$)

<u>Determination of $EF_{BL,y}$</u>

For new facilities:

CO_2 emission factor of electricity in the new facilities is defined from the efficiency in power generation of one or two old and typical power plants existing in the gird.

The efficiency in power generation of the target power plant should be obtained through interview to the electric power management entity concerned of the target country or neighborhood countries.

$$EF_{BL,y} = \frac{COEF_i}{\eta_{BL,y}} \times 3.6 \ \left(\frac{GJ}{MWh}\right)$$

$COEF_i$: CO_2 emission factor of fuel i ($t\text{-}CO_2/TJ$)

$\eta_{BL,y}$: Measured efficiency in power generation in the power plants without improvement

3.6 : Electrical output per electric energy(1 MWh＝3.6 GJ)

For existing facilities:

The measured emission factor in the power plants without improvement is used as the CO_2 emission factor for the existing plants with improvement/upgrading (*1).

$$EF_{BL,y} = \frac{COEF_i}{\eta_{BL,y}} \times 3.6 \ \left(\frac{GJ}{MWh}\right)$$

$COEF_i$: CO_2 emission factor of fuel i ($t\text{-}CO_2/TJ$)

$\eta_{BL,y}$: Measured efficiency in power generation in the power plants without improvement

3.6 : Electrical output per electric energy(1 MWh＝3.6 GJ)

*1: When the measured emission factor in the power plants without improvement is unavailable, use the designed data.

(2) Project Emission

In order to calculate project GHG emission, monitor CO_2 emission from the power generation efficiency with the power generators that are replaced, upgraded and improved after project activity.

$$\boldsymbol{PE_y} = EG_{PJ,y} \times EF_{PJ,y}$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission: GHG emission after the project starts (t-CO_2/y)
Input	$EG_{PJ,y}$	Annual energy production after the project starts at the transmission edge (MWh)
	$EF_{PJ,y}$	CO_2 emission factor per electricity supplied (t-CO_2/MWh)

Determination of $EF_{PJ,y}$

For new and existing facilities

The CO_2 emission factor per electricity supplied after the project starts is computed using the efficiency after improvement. In order to compute ***$EF_{PJ,y}$***, use the planned data before the project starts and the monitoring data after the project starts.

$$EF_{PJ,y} = \frac{COEF_i}{\eta_{PJ,y}} \times 3.6 \ \left(\frac{\text{GJ}}{\text{MWh}}\right)$$

$COEF_i$:CO_2 emission factor of fuel i (t-CO_2/TJ)

$\eta_{PJ,y}$: Planned or monitoring efficiency data after the efficiency improvement of the power generation

3.6 : Electrical output per electric energy(1 MWh＝3.6 GJ)

4. Data Required for Estimation and Monitoring

【New Facilities】

<table>
<tr><th colspan="2" rowspan="3">Data Type</th><th rowspan="3">Description of Data</th><th colspan="4">Data Acquisition Methods</th></tr>
<tr><th colspan="2">Baseline Emissions</th><th colspan="2">Project Emissions</th></tr>
<tr><th>Before the Project Starts</th><th>After Project Completion</th><th>Before the Project Starts</th><th>After Project Completion</th></tr>
<tr><td colspan="2">Quantity of power supply
(After : $EG_{PJ,y}$)</td><td>Quantity of power supply of the fossil fuel fired plants by the project activity(MWh/y)</td><td>Planned data</td><td>Measured data</td><td>Planned data</td><td>Measured data</td></tr>
<tr><td colspan="2">Efficiency of power generation
(Before : $\eta_{BL,y}$)
(After : $\eta_{PJ,y}$)</td><td>Efficiency of power generation in the fossil fuel-fired plants</td><td colspan="2">Measured data of one or two old and typical power plants existing in the gird.</td><td>Planned data</td><td>Measured data</td></tr>
<tr><td>CO_2 emission factor</td><td>CO_2 emission factor of each fuel type($COEF_i$)</td><td>CO_2 emissions factor of each fuel type (t-CO_2/TJ)</td><td colspan="4">Data availability is validated in the following order because it is preferable to calculate using data and information unique to the project:
i) Unique data obtained from interview with power management entity
ii) National default
iii) IPCC Guideline default data(Annex C-3)</td></tr>
</table>

【Existing Facilities】

<table>
<tr><th colspan="2" rowspan="3">Data Type</th><th rowspan="3">Description of Data</th><th colspan="4">Data Acquisition Methods</th></tr>
<tr><th colspan="2">Baseline Emissions</th><th colspan="2">Project Emissions</th></tr>
<tr><th>Before the Project Starts</th><th>After Project Completion</th><th>Before the Project Starts</th><th>After Project Completion</th></tr>
<tr><td colspan="2">Quantity of power supply
(After : $EG_{PJ,y}$)</td><td>Quantity of power supply of the fossil fuel fired plants by the project activity(MWh/y)</td><td>Planned data</td><td>Measured data</td><td>Planned data</td><td>Measured data</td></tr>
<tr><td colspan="2">Efficiency of power generation
(Before : $\eta_{BL,y}$)
(After : $\eta_{PJ,y}$)</td><td>Efficiency of power generation in the fossil fuel-fired plants</td><td colspan="2">Measured data Before the Project Starts</td><td>Planned data</td><td>Measured data</td></tr>
<tr><td>CO_2 emission factor</td><td>CO_2 emission factor of each fuel type($COEF_i$)</td><td>CO_2 emissions factor of each fuel type (t-CO_2/TJ)</td><td colspan="4">Data availability is validated in the following order because it is preferable to calculate using data and information unique to the project:
i) Unique data obtained from interview with power management entity
ii) National default
iii) IPCC Guideline default data(Annex C-3)</td></tr>
</table>

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2) Leakage Higher efficiency at fossil fuel fired power plants: the indirect emissions that potentially lead to leakage due to activities such as product manufacturing or materials transport. This corresponding emission is temporary and negligible considering the project scale. Therefore, it can be ignored. (3) Reviewed Methodologies and Major Differences 1) AM0061 (Ver.2.1): Methodology for Rehabilitation and/or Energy Efficiency Improvement in Existing Power Plants 【Differences】 ・ Though the reviewed methodology excludes new facilities as its element, new facilities are considered in this methodology. ・ Power plants which run over ten years and having available data in the five most recent years are used in the reviewed methodology. The formula in this methodology excludes these conditions. ・ Different calculation method is used for baseline emission when it exceeds the average electric power supply. It is determined using the efficiency in power supply with a specific formula. However, it is determined simply using the net power supply or the amount of power supply of the representative year in this methodology. ・ The reviewed methodology excludes the leakage potential unless there are great influences. The formula in this methodology also excludes the leakage in the same manner. 2)AM0062 (Ver.2.0): Energy Efficiency Improvement of a Power Plant through Retrofitting Turbines 【Differences】 ・ Though the reviewed methodology excludes new facilities as its element, new facilities are used in this formula. ・ The reviewed methodology is applied to steam and gas turbines. The amount of steam and the power supplied by the steam turbine will indicate which should be improved in the turbine. However, the formula in this methodology excludes these conditions. ・ Different calculation method is used for baseline emission when it exceeds the average electric power supply. It is determined using the efficiency in power supply with a specific formula. However, it is determined simply using the net power supply or the amount of power supply of the representative year in this methodology. ・ The reviewed methodology excludes the leakage potential unless there are great influences. The formula in this methodology also excludes the leakage in the same manner. 3)ACM0013 (Ver. 02): Consolidated Baseline and Monitoring Methodology for New Grid Connected Fossil Fuel-Fired Power Plants using a Less GHG Intensive Technology 【Differences】 ・ Though the reviewed methodology excludes new facilities as element, new facilities are used in the formula of this methodology. ・ Regarding the baseline fuel based on the reviewed methodology, the formula is applicable for fossil fuel used without the project, which is more than 50% of the net electricity power supply in the last three years. This formula excludes these conditions. ・ In the reviewed methodology, the CO_2 emission factor of the electricity is one of the value calculated by the caloric CO_2 emission factor of each fuel type and efficiency in power generation or the value calculated by the amount of power generation, type of fossil fuel, amount of fuel consumption, net calorific value, caloric CO_2 emissions factor of each fuel type. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to

	calculate easily. ・ Project emission is computed from the fuel consumption in the reviewed method. This project computes the efficiency in power generation after implementation. ・ The reviewed methodology excludes the leakage potential unless there are great influences. The formula in this methodology also excludes the leakage in the same manner. 4)AMS-II.B (Ver. 09): Supply Side Energy Efficiency Improvements–Generation 【Differences】 ・ The reviewed methodology is applied to reduce electric power to 60 GWh or less, and to reduce fuel consumption through thermal application with the improvement of existing facilities. However, the formula in this methodology does not restrict the quantity of electricity and excludes heat supply. ・ The reviewed methodology applies to the cogeneration facilities. However, cogeneration facilities are not applicable in this methodology since these are categorized into the different sub sectors. ・ In the reviewed methodology, if the efficiency technology or existing facilities and equipment are transferred from other projects, leakage should be considered. However, the formula in this methodology excludes leakage. 5)J-MRV004: Fossil Fuel-Fired Power Generation Projects introducing Low Carbon Technology (Revised on February 2011) 【Differences】 ・ Any of the methods on data acquisition can be selected from the reviewed methodology where several methods are available. However, in the formula of this methodology, selection priority is clearly defined. ・ Project emission is computed from the fuel consumption in the reference method. This project computes the efficiency in power generation after implementation. ・ In the reviewed methodology, the CO_2 emission factor of the electricity is the average of all power plants in the target country. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ When there are small emission sources within the boundary, emissions should be reduced by 5% as stated in the reviewed methodology. In this methodology, leakage can be assumed to be 0. ・ The reviewed methodology excludes the leakage potential unless there are great influences. The formula in this methodology also excludes leakage in the same manner.

1.Typical Project Outline

The project intends to directly suppress GHG emissions associated with transmission loss, through reducing power loss in the transmission grid or through maintenance of high voltage substation at new and existing facilities for electric energy transmission-transformation.

2.Applicability

○ The project should aim at reducing fuel consumption through transmission loss reduction compared to losses in the existing transmission-transformation facilities, by maintaining transmission wire, improving, reduction in power loss, maintaining/upgrading/improving high voltage substation.

3.Methodology on Emission Reduction

GHG emission reduction through streamlining of transmission-transformation facilities in the transmission grid shall be determined as the difference between baseline emissions (high transmission power loss) and project emissions (after streamlining).

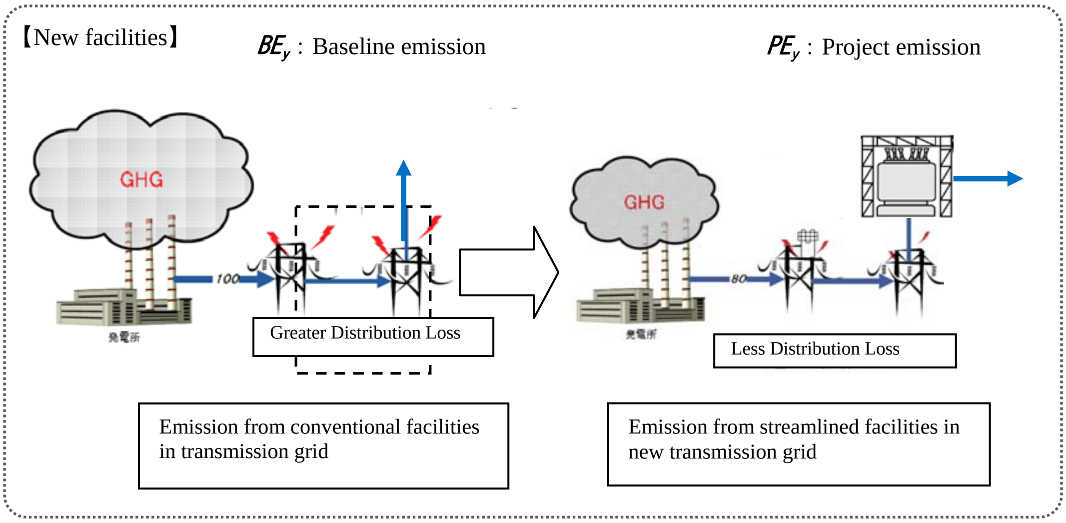
Baseline emissions are computed by multiplying transmission power loss with respective emission factors. In order to be more precise, compute each transmission power loss before and after the project starts, then multiply each with their respective emission factors.

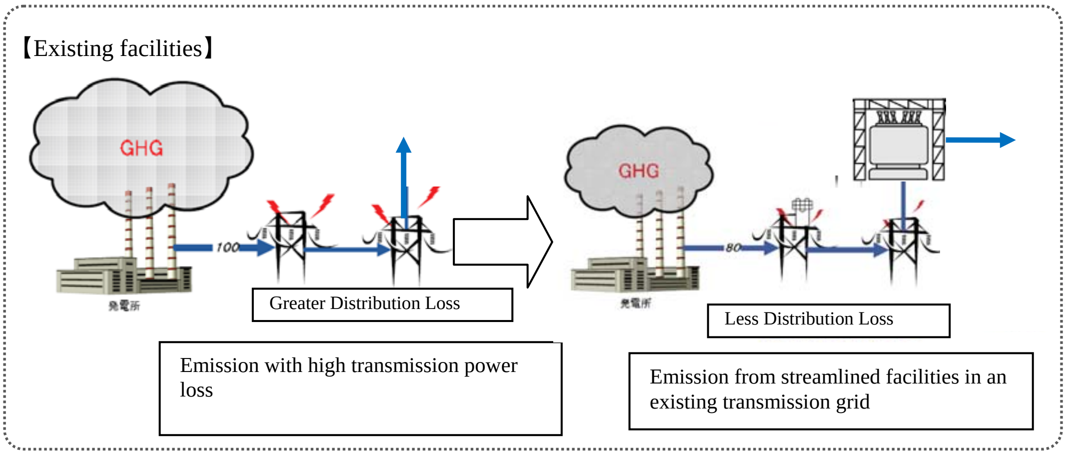
$$ER_y = BE_y - PE_y \quad (\text{t-CO}_2/\text{y})$$

ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$)

BE_y :GHG emissions in year y without streamlining facilities in transmission grid ($t\text{-}CO_2/y$) (Baseline emission)

PE_y :GHG emissions in year y after streamlining facilities in transmission grid ($t\text{-}CO_2/y$) (Project emission)





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(1) Baseline Emission

In order to compute GHG emission, monitor transmission power loss without streamlining facilities in the transmission grid (in transmitting the amount of electricity which is equivalent to the quantity of electricity supplied after the project starts). Such measured quantity of power loss is multiplied with the GHG emission factor.

$$BE_y = BL_y \times EF_{BL,y}$$

Type	Items	Description
Output	BE_y	Baseline emission: GHG emissions without streamlining facilities in the transmission grid ($t\text{-}CO_2/y$)
Input	BL_y	Transmission power loss before the project starts (MWh/y)
	$EF_{BL,y}$	CO_2 Emission factor of a power plant where emission reduction is expected by the project activity.($t\text{-}CO_2/MWh$)

Determination of $EF_{BL,y}$

【New facilities】【Existing facilities】

Baseline CO_2 emissions factor from electricity is defined as the emission factor of the power plant where emission reduction is highly expected through the project activity on the basis of the concept to eliminate the worst fuel-efficient power plants in grid-connected plants.

The emission factor for the target should be determined through interview to the electric power management entity or based on published data in the target country. If emission factor is not available, it should be calculated using the net electrical output of the target power plant, fuel type, net fuel consumption, net calorific value and caloric CO_2 emission factor (Ref. Annex C-4).

(2) Project Emission

In order to calculate project GHG emission, monitor power loss in transmission-transformation facilities after the project starts (streamlining in facilities in transmission grid). Such measured power loss is multiplied with the CO_2 emission factor.

$$PE_y = PL_y \times EF_{BL,y}$$

Type	Items	Description
Output	PE_y	Project emission: GHG emission after the project starts ($t\text{-}CO_2/y$)
Input	PL_y	Transmission power loss after the project starts (MWh/y)
	$EF_{BL,y}$	CO_2 Emission factor of a power plant where emission reduction is expected by the project activity.($t\text{-}CO_2/MWh$)

4. Data Required for Estimation and Monitoring

【New facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Transmission power loss	Before：BL_y	Transmission power loss without the project (MWh/y)	Simulated data		(Not necessary because data is not involved in the calculation)	
	After：PL_y	Transmission power loss by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Simulated data	Measured data
CO_2 emission factor	CO_2 Emission factor of a power plant where emission reduction is expected($EF_{BL,y}$)	Emission factor of a power plant where emission reduction is expected by the project activity (t-CO_2/MWh)	Data availability is validated in the following order in filtering power plants where emission reduction is expected through project activity and obtaining the emission factor. i) Interview to the electric power management entity concerned ii) Published values in the target country			

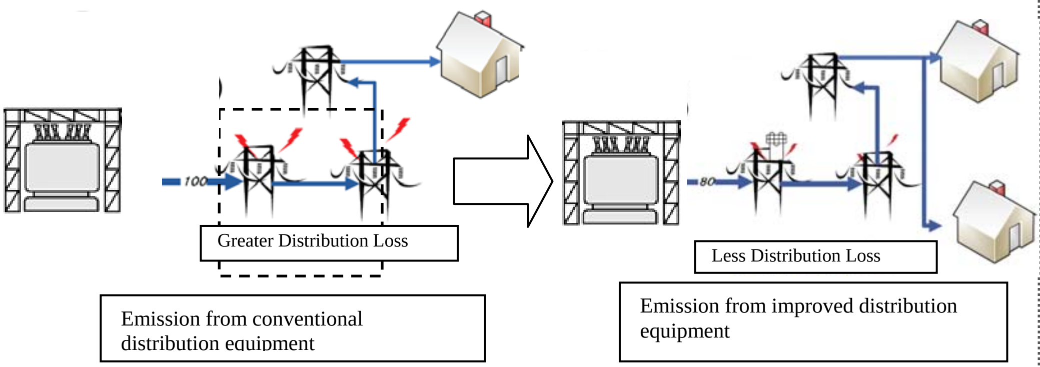
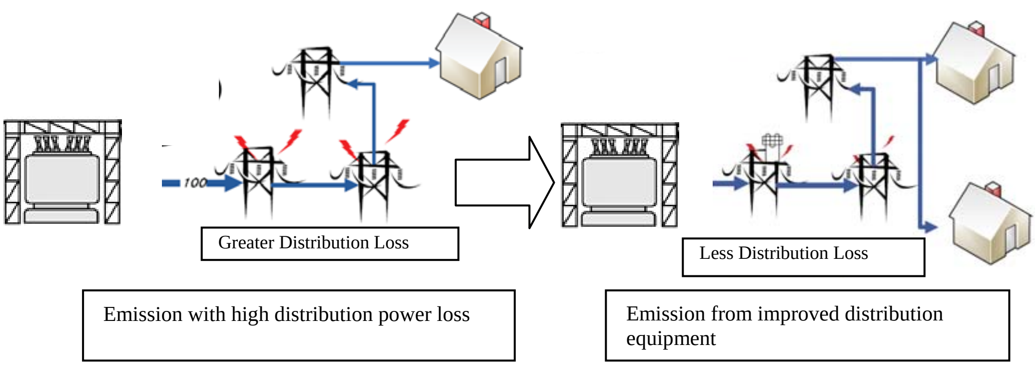
【Existing facilities】

Data Type		Description of Data	Data acquisition methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Transmission power loss	Before：BL_y	Transmission power loss without the project (MWh/y)	Measured data		(Not necessary because data is not involved in the calculation)	
	After：PL_y	Transmission power loss by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Simulated data	Measured data
CO_2 emission factor	CO_2 Emission factor of a power plant where emission reduction is expected($EF_{BL,y}$)	Emission factor of a power plant where emission reduction is expected by the project activity (t-CO_2/MWh)	Data availability is validated in the following order in filtering power plants where emission reduction is expected through project activity and obtaining the emission factor. i) Interview to the electric power management entity concerned ii) Published values in the target country			

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes transmission grid where project activity is implemented. (2) Leakage Leakage associated with improvement of transmission grid efficiency includes CO_2 emissions due to production and transport in relation to equipment renewal. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. (3) Reviewed Methodologies and Major Differences 1)AM0067(ver02):Methodology for installation of energy efficient transformers in a power distribution grid 【Differences】 * Reviewed methodology is applied to distribution grid, which distributes medium voltage electricity (around less than 50,000 volts) to consumers; however, the formula in this section is applied for transmission grid. Hence, conditions on transmission voltage can be ignored. * Transformer used should meet the International QA/QC criteria in the reviewed methodology; however, this formula excludes these conditions. * The reviewed methodology recommends the introduction of systems, which validates that such transformer is not used at other places within the grid; however, this formula excludes these conditions. * The reviewed methodology requires a transformer with positional information so that it can identify each location; however, this formula excludes these conditions. * Project emission in the reviewed methodology is calculated by multiplying load loss of all transformers with CO_2 emission factor. The formula in this section simply is computed from the simulated transmission power loss in the whole transmission grid. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of the target power plants. * In the reviewed methodology, disposal of the converted transformer does not consider leakages; however, such disposal should be evident. This formula excludes these conditions. 2)AMS-II.A(ver10):Supply side energy efficiency improvements – transmission and distribution. 【Differences】 * The reviewed methodology is applied to transmission grid and distribution grid; however, this formula is applied only to transmission grid. * The reviewed methodology is applied to fuel consumption reduction from electric power at 60 GWh or less, or thermal application at 180GWh or less, through improvement of existing facilities; however, the formula here has neither restrictions with respect to the quantity of electricity nor excludes heat supply. * In the reviewed methodology, emission reduction is not considered after facilities replacement in the context of respective time of existing facilities replacement, upgrading and improvement. This formula excludes these conditions. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of the target power plants. * In the reviewed methodology, if efficient technology is transferred from other projects, then it should be considered. However, this formula excludes these conditions.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to directly suppress GHG emissions associated with distribution loss, through reducing power loss in the distribution grid or efficiency improvements of distribution equipment at new and existing facilities for electric energy distribution.</td></tr>
<tr><td>2.Applicability</td><td>○ The project should aim at reducing fuel consumption by electric loss reduction in the existing distribution equipment resulting from upgrade, rehabilitation or improvement of distribution lines and other equipment.</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>GHG emission reduction through improvement of the distribution equipment efficiency shall be determined as the difference between baseline emissions (with more distribution loss) and project emissions (after improvement of efficiency).
Baseline emissions are computed by the multiplying distribution power loss by emission factors. Distribution power loss should be computed for before and after the project activity, respectively by multiplying the loss by applicable CO_2 emission factors.

$$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$
ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$)
BE_y :GHG emissions in year y in absence of improvement of distribution equipment efficiency ($t\text{-}CO_2/y$)(Baseline emission)
PE_y :GHG emissions in year y after improvement of distribution equipment efficiency ($t\text{-}CO_2/y$)(Project emission)

【 New facilities】 BE_y : Baseline emission PE_y : Project emission

【Existing facilities】
</td></tr>
</table>

(Continuation)

(1) Baseline Emission

In order to compute GHG emission, monitor distribution power loss without streamlining facilities in the distribution grid (in distributing the amount of electricity, which is equivalent to the quantity of electricity supplied after the project starts). Such measured quantity of power loss is multiplied with a GHG emission factor.

$$\boldsymbol{BE_y} = BL_y \times EF_{BL,y}$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission: GHG emissions in absence of improvement of distribution equipment efficiency (t-CO_2/y)
Input	BL_y	Distribution power loss before the project activity (MWh/y)
	$EF_{BL,y}$	CO_2 Emission factor of a power plant where emission reduction is expected by the project activity.(t-CO_2/MWh)

<u>Determination of $EF_{BL,y}$</u>

【New facilities】【Existing facilities】

Baseline CO_2 emissions factor from electricity is defined as the emission factor of the power plant where emission reduction is highly expected through the project activity on the basis of the concept to eliminate the worst fuel-efficient power plants in grid-connected plants.

The emission factor for the target should be determined through interview to the electric power management entity or based on published data in the target country. If emission factor is not available, it should be calculated using the net electrical output of the target power plant, fuel type, net fuel consumption, net calorific value and caloric CO_2 emission factor (Ref. Annex C-4).

(2) Project Emission

In order to calculate the project GHG emission, monitor power loss in distribution equipment after the project starts (streamlining in facilities in distribution grid). Such measured power loss is multiplied with the CO_2 emission factor.

$$\boldsymbol{PE_y} = PL_y \times EF_{BL,y}$$

Type	Items	Description
Output	PE_y	Project emission: GHG emission after the project starts (t-CO_2/y)
Input	PL_y	Distribution power loss after the project activity (MWh/y)
	$EF_{BL,y}$	CO_2 Emission factor of a power plant where emission reduction is expected by the project activity.(t-CO_2/MWh)

4. Data Required for Estimation and Monitoring

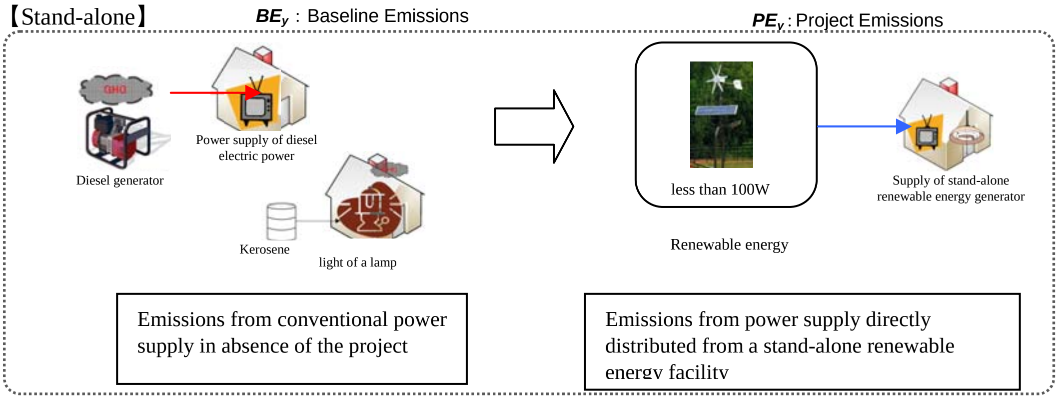
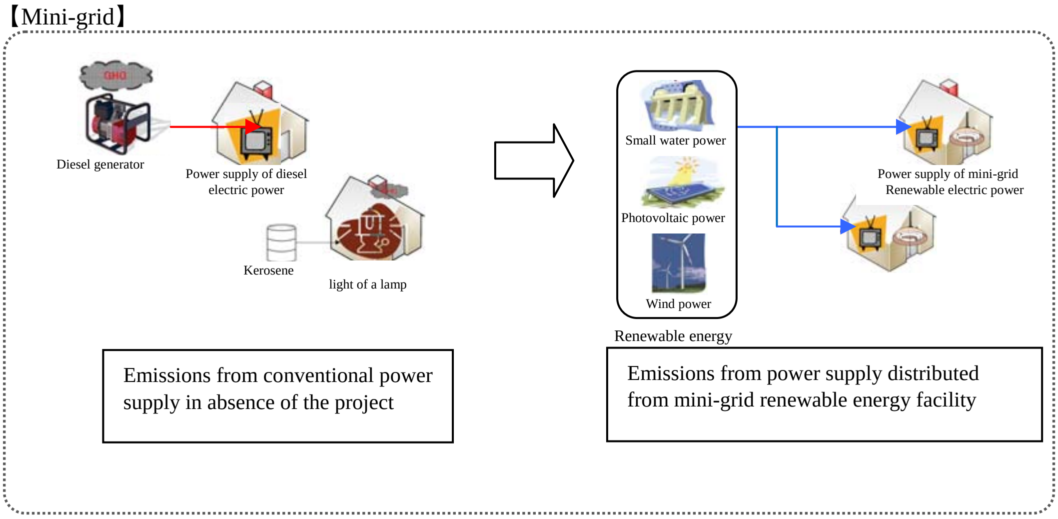
【New facilities】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Distribution power loss	Before : BL_y	Distribution power loss without the project (MWh/y)	Simulated data		(Not necessary because data is not involved in the calculation)	
	After : PL_y	Distribution power loss by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Simulated data	Measured data
CO_2 emission factor	CO_2 Emission factor of a power plant where emission reduction is expected($EF_{BL,y}$)	Emission factor of a power plant where emission reduction is expected by the project activity (t-CO_2/MWh)	Data availability is validated in the following order in filtering power plants where emission reduction is expected through project activity and obtaining the emission factor. i) Interview to the electric power management entity concerned ii) Published values in the target country			

【Existing facilities】

Data Type		Description of Data	Data acquisition methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Distribution power loss	(Before : BL_y)	Distribution power loss without the project (MWh/y)	Measured data		(Not necessary because data is not involved in the calculation)	
	(After : PL_y)	Distribution power loss by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Simulated data	Measured data
CO_2 emission factor	CO_2 Emission factor of a power plant where emission reduction is expected($EF_{BL,y}$)	Emission factor of a power plant where emission reduction is expected by the project activity (t-CO_2/MWh)	Data availability is validated in the following order in filtering power plants where emission reduction is expected through project activity and obtaining the emission factor. i) Interview to the electric power management entity concerned ii) Published values in the target country			

5.Others	(1)Project Boundary The physical boundary for measuring GHG emissions includes is distribution grid where the project activity is implemented. (2)Leakage Leakage associated with improvement of distribution facilities efficiency includes CO_2 emissions due to production and transport in relation to equipment renewal. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. (3) Reviewed Methodologies and Major Differences 1)AM0067(ver02): Methodology for installation of energy efficient transformers in a power distribution grid. 【Differences】 * Reviewed methodology is applied to distribution grid, which distributes electricity with medium voltage (around less than 50,000 volts) to consumers; however, the formula in this section does not include voltage conditions. * Transformer used should meet the International QA/QC criteria in the reviewed methodology; however, this formula excludes these conditions. * The reviewed methodology recommends the introduction of systems, which validates that such transformer is not used at other places within grid; however, this formula excludes these conditions. * The reviewed methodology requires transformer with positional information so that it can identify each location; however, this formula excludes these conditions. * Project emission in the reviewed methodology is calculated by multiplying load loss of all transformers with CO_2 emission factor. The formula in this section simply is computed from the electricity consumption in whole distribution grid. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of the target power plants. * In the reviewed methodology, disposal of the converted transformer does not consider leakage but such disposal should be evident. This formula excludes these conditions. 2)AMS-II.A(ver10):Supply side energy efficiency improvements – transmission and distribution. 【Differences】 * The reviewed methodology is applied to transmission grid and distribution grid; however, this formula is applied only to distribution grid from high voltage substation to consumers (excluding transmission grid). * The reviewed methodology is applied to fuel consumption reduction from electric power at 60 GWh or less or thermal application at 180 GWh or less, through improvement of existing facilities; however, the formula here has neither restriction with respect to quantity of electricity nor excludes heat supply. * In the reviewed methodology, emission reduction is not considered after facilities replacement in the context of respective time of existing facilities replacement, upgrading and improvement. This formula excludes these conditions. * In the reviewed methodology, the CO_2 emission factor of the electricity is the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity is defined as the emission factor of the target power plants. * In the reviewed methodology, if efficient technology is transferred from other projects, it should be considered. However, this formula excludes these conditions.

1.Typical Project Outline	The project intends to directly reduce greenhouse gas (GHG) emissions by generating power from renewable energy sources, which generate limited amounts of GHG. This is realized through the implementation of renewable energy utilization project in the area where there is no connection to the main electricity transmission grid, or diesel power generation or kerosene lamp is not applied.
2.Applicability	○ The project should aim at electrification in a rural area not connected to the power grid. ○ Standalone or mini-grid electric power supply should be implemented using renewable energy source.
3.Methodology on Emission Reduction	GHG emission reduction by rural electrification with renewable energy shall be determined as the difference between baseline emissions (GHG emissions from conventional energy consumption which is assumed to be replaced by renewable energy) and project emissions from energy consumption in use of renewable energy source. $$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$ ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$) BE_y :GHG emissions from diesel generators in year y in absence of renewable energy ($t\text{-}CO_2/y$) (Baseline Emissions) PE_y :GHG emissions from a renewable energy source in year y ($t\text{-}CO_2/y$)(Project Emissions) 【Stand-alone】 BE_y : Baseline Emissions PE_y : Project Emissions  【Mini-grid】 

(1) Baseline Emission

In absence of renewable energy power facilities, conventional electric power may be continuously supplied. By replacing fuel with renewable energy, conventional fuel consumption may be reduced. Thus, reduction in GHG emissions can be computed based on reduction of conventional fuel consumption. In most of these rural areas without access to electricity, diesel generator and kerosene for lighting will continue to be used in absence of power supply. Therefore, diesel oil and kerosene are assumed as the target fuel for reduction.

$$\boldsymbol{BE_y} = EC_{diesel,y} \times NCV_{diesel,y} \times CEF_{diesel,y} + EC_{kerosene,y} \times NCV_{kerosene,y} \times CEF_{kerosene,y}$$

Type	Items	Description
Output	BE_y	Baseline Emissions: GHG emissions from using renewable energy as substitute fuel (t-CO_2/y)
Input	$EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television (kL/y)
	$NCV_{diesel,y}$	Net Calorific Value of diesel oil (GJ/kL)
	$CEF_{diesel,y}$	CO_2 Emission Factor of diesel oil(t-CO_2/TJ)
	$EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)
	$NCV_{kerosene,y}$	Net Calorific Value of kerosene(GJ/kL)
	$CEF_{kerosene,y}$	CO_2 Emission Factor of kerosene(t-CO_2/TJ)

(2) Project Emission

GHG emissions from renewable energy power supply after the project starts will be "0".

$$\boldsymbol{PE_y} = 0$$

4. Data Required for Estimation and Monitoring

【Stand-alone】【Mini-grid】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of fuel consumption	Before : $EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television. (kL/y)	Planned data		(Not necessary because data is not involved in the calculation)	
	Before : $EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)	Planned data			
Net calorific value	Before : $NCV_{diesel,y}$	Net calorific value of diesel oil (GJ/kL)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2)			
	Before : $NCV_{kerosene,y}$	Net calorific value of kerosene(GJ/kL)				
CO_2 emission factor	Before : $CEF_{diesel,y}$	CO_2 emission factor of diesel oil ($t-CO_2/TJ$)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)			
	Before : $CEF_{kerosene,y}$	CO_2 emission factor of kerosene ($t-CO_2/TJ$)				

5.Others	(1) Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2)Leakage Leakage associated with renewable energy includes CO_2 emissions due to production and transport in relation to renewable energy plant construction. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. (3) Reviewed Methodologies and Major Differences 1)AMS-I.A(ver14.0): Electricity generation by the user 【Differences】 ・ Since the reviewed methodology is intended for small-scale generation, it is applied to plants with power supply from renewable energy of 15 MW or less, or CO_2 emission reduction from kerosene lamp which is 5t-CO_2 or less; however, there is no restriction on these conditions in the formula in this section. ・ The reviewed methodology is applied to plants with power density of over 4 W/m^2 from water reservoirs of hydropower plants; however, there is no restriction on scale capacity in the formula in this section. ・ Baseline emission from the reference GHG emission level is computed from the equivalent diesel power source substitute. The applied formula in this section is based on the substitution of diesel power generation and kerosene lamp uses. ・ In the reviewed methodology, if power plants are transferred from other projects, or vice versa, leakages should be considered. However, this formula excludes such conditions for simplification purpose. 2)AM0019(ver2.0): Renewable energy projects replacing the electric power produced from fossil fuel-fired power plant that either stands alone, or supplies to a grid, excluding biomass projects 【Differences】 ・ The reviewed methodology is applied to new plants with power density of over 4W/m^2 from water reservoirs of hydropower plants; however, there is no restriction on scale capacity in the formula in this section. ・ Although the reviewed methodology shall account for GHG (CH_4 and CO_2) emissions from water reservoirs as the project emissions, this formula excludes these conditions because it is applied only to small-scale hydropower generation in the rural area without electrification. ・ In the reviewed methodology, the CO_2 emission factor of the electricity of baseline emission is calculated by emission for fuel consumption and amount of power generation. In this methodology, amount of diesel power generation and kerosene consumption is substituted by renewable energy. ・ No consideration for leakage is required in the reviewed methodology in the same way this formula is applied. 3) AMS-I.F.(ver1.0)：Renewable energy generation for captive use and mini-grid 【Differences】 ・ In addition to construction of new power plants, capacity increase, upgrading and replacement of the existing plants are targeted for application of the formula in the reviewed methodology. The applicable conditions are as follows: renewable energy power supply should be 15 MW or less; power density of hydropower plants with reservoir should be 4W/m^2 or higher; power plants are connected to the mini-grid. This formula excludes these conditions. ・ A baseline emission in the reviewed methodology is computed by multiplying power supplied by the project activity with the CO_2 emission factor of grid (*2). When the project involves substitution of crude oil or diesel fuel power plants, emission factor per power supply is as shown in the methodology. On the other hand, amount of diesel power generation and kerosene consumption is substituted by renewable energy. ・ In the reviewed methodology, GHG emission (CH_4 and CO_2) from reservoir as project emission should be considered for the hydro power plants with reservoirs; however, there is no restriction in the formula in this section because the hydropower generation applied is relatively small. ・ In the reviewed methodology, if the power plants are transferred from other projects, leakage should be considered. However, this formula excludes these conditions.

Renewable Energy Sector

Sub-sector:

17. Hydro Power

18. Wind Power

19. Photovoltaic Power / Solar Heat

20. Geothermal Power

21. Biomass

1.Typical Project Outline	The project intends to directly contribute to GHG emission reduction through hydropower plants construction aiming to generate renewable energy, which does not emit GHG at flaring, with the use of natural resources such as hydro power.
2.Applicability	○ The project should aim at new construction of hydropower plants or upgrading. ○ Hydropower plants powered by either fossil fuel or standalone should be able to supply electricity when connected to transmission grid.
3.Methodology on Emission Reduction	GHG emission reduction through hydropower shall be determined as the difference between baseline emissions (GHG emissions at fossil fired power plants) and project emissions after running hydro power plants. The hydropower plants may be connected to the main grid or mini-grid, or run as stand-alone.

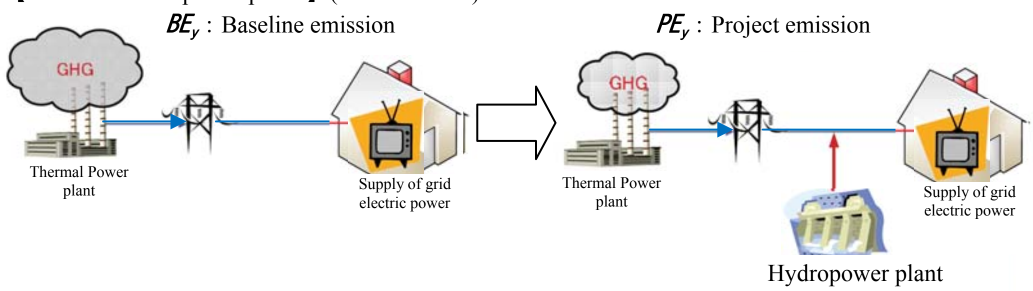
$$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$

ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$)

BE_y :GHG emissions at fossil fired power plants in year y ($t\text{-}CO_2/y$)(Baseline emission)

PE_y :GHG emissions after running hydro power plants in year y ($t\text{-}CO_2/y$)(Project emission)

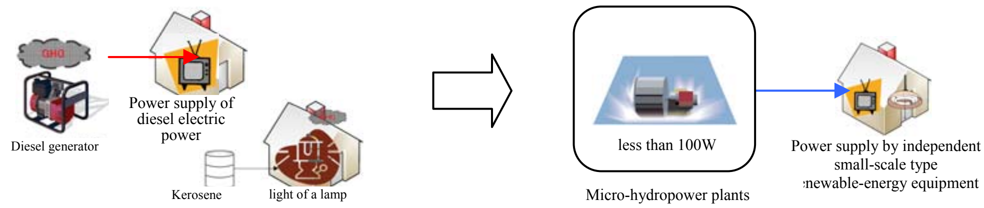
【Grid-connected power plants】(New facilities)



Emission from conventional electric power supply in absence of hydropower plants construction

Emission with additional electric power supply generated in hydropower plants

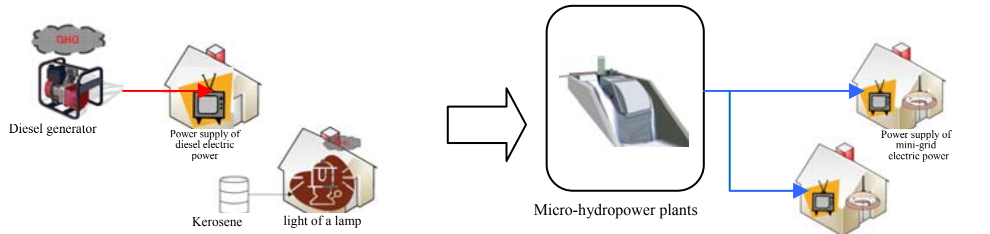
【Stand-alone】



Emission from conventional electric power supply

Emissions from direct power supply generated in stand-alone micro-hydropower plants

【Mini-grid】



Emission from conventional electric power supply

Emissions from power supplied by micro-hydropower plants (mini-grid power supply)

(1)Baseline Emission

If hydropower plants are not constructed, electric power is continuously supplied from the fossil fired power plants. Amount of electric power supply is reduced through the replacement of conventional fossil fired power plants with hydropower plants. Thus, GHG emission should be equal to that from suppressed fuel combustion. When the existing hydropower plants decrease in performance by deterioration, plant improvement increases the power generation efficiency and reduces the electric power supply from the existing power plants. Thus, GHG emission should be equal to that from suppressed fuel combustion.

$$\boldsymbol{BE_y} = \Sigma FC_i \times NCV_i \times COEF_i$$

Type	Items	Description
Output	BE_y	Baseline emission: GHG emissions of fuel consumption replaced by the hydropower (t-CO_2/y)
Input	$FC_{i,y}$	Suppressed amount of fuel i (kL,m^3,t etc./y)
	NCV_i	Net Calorific Value a of each fuel type (GJ/ kL, m^3, t etc.)
	$COEF_i$	CO_2 emission factor of each fuel type (t-CO_2/TJ)

Determination of $FC_{i,y}$

【Grid-connected power plants】

When hydro power plants connect to grid, the existing power plants in the grid should be replaced in the decreasing order of unit fuel cost. Reducing fuel type and its priority should be determined on such view.

a) Monitoring electric power supply in each fuel type of national grid power

Monitor type of fuels and its electric power supply (GWh/y) and consumption (kL,m^3,t etc./y) in each fuel type which comprise the national grid power.

b)Determining priority of target fuel for reducing

Verify unit fuel cost used in existing plants connected to the national grid, and utilize them as target for reducing the order of unit fuel cost (*1). Determine the priority for reduction in consideration of the target nation's future plans (energy plans), as required.

*1:If the national unit fuel cost is unknown, set fuel unit cost in the order of petroleum, gas, and coal for evaluation.

c)Checking essential amount of fuels

In the target nation, because of energy source diversification promotion, multiple fuel types (petroleum, gas, coal etc.) can be used within the grid. Therefore, fuels at some level of amount should be set aside for minimum operation of plants for each fuel type. In conclusion, 5% of the total electric power supply is set aside as essential amount of fuels.

When the actual power supply is less than the essential amount of fuels, total amount of actual power supply is applicable as the essential amount of fuels.

d)Monitoring power supply contribution from target fuel for reduction

Excluding the essential amount of fuels computed in c), identify the reducible amount of fuels in the decreasing order of unit fuel cost, and compute the reducible fuel type and electric power supply.

e)Determination of CO_2 emission from hydro power

Based on the reducible amount of fuels in d), compute GHG emissions in order to generate electric power supply, replacing hydro power supply ($EG_{pj,y}$).

【Standalone】【Mini-grid】

The target area of standalone or mini-grid is non-electrification area. If hydropower facilities are not constructed, electric power is continuously supplied from the existing power facilities. Amount of fuel consumption in conventional power facilities is reduced through substitution with renewable energy from hydropower facilities. Thus, GHG emission should be equal to such emission from the decrease in suppression of fuel combustion.

In most of these rural areas without access to electricity, diesel generator and kerosene for lighting will continue to be used in absence of power supply. Therefore, diesel oil and kerosene are assumed as the target fuel for reduction.

$$\boldsymbol{BE_y} = EC_{diesel,y} \times NCV_{diesel,y} \times CEF_{diesel,y} + EC_{kerosene,y} \times NCV_{kerosene,y} \times CEF_{kerosene,y}$$

Type	Items	Description
出力	BE_y	Baseline Emissions: GHG emissions from using renewable energy as substitute fuel (t-CO_2/y)
Input	$EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television (kL/y)
	$NCV_{diesel,y}$	Net Calorific Value of diesel oil (GJ/kL)
	$CEF_{diesel,y}$	CO_2 Emission Factor of diesel oil(t-CO_2/TJ)
	$EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)
	$NCV_{kerosene,y}$	Net Calorific Value of kerosene(GJ/kL)
	$CEF_{kerosene,y}$	CO_2 Emission Factor of kerosene(t-CO_2/TJ)

(2)Project Emission

GHG emissions from hydropower supply after the project starts will be "0".

$$\boldsymbol{PE_y} = 0$$

If the hydropower plant has reservoir, methane will be generated from landfill. If this is the case, the formula below shall be applied. When methane is less than 1 % of baseline emission, it can be ignored.

$$PE_y = \frac{EF_{Res} \times EG_{PJ,y}}{1000}$$

EF_{Res} : Default GHG emission factor from reservoir

(Default vale at 23rd CDM conference: 90kg-CO_2/MWh)

$EG_{PJ,y}$: Amount of power supply from hydropower plants in year y(MWh/y)

1000 : Net conversion factor(1t-CO_2=1000kg-CO_2)

4. Data Required for Estimation and Monitoring

【Grid-connected power plants】

Data Type	Description of Data	Data Acquisition Methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electric power supply (After : $EG_{PJ,y}$)	Amount of electric power supply from hydro power plants by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
Suppressed amount of fuel i (Before : $FC_{i,y}$)	Suppressed amount of fuel i by the project activity (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IEA Energy balance sheet			
Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type (t-CO_2/TJ)				
Default GHG emission factor from reservoir(EF_{Res})	Default vale at 23rd CDM conference(kg-CO_2/MWh)	(Not necessary because data is not involved in the calculation)		90	90

【Stand-alone】【Mini-grid】

Data type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of fuel consumption	Before : $EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television. (kL/y)	Planned data		(Not necessary because data is not involved in the calculation)	
	Before : $EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)	Planned data			
Net calorific value	Before : $NCV_{diesel,y}$	Net calorific value of diesel oil (GJ/kL)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2)			
	Before : $NCV_{kerosene,y}$	Net calorific value of kerosene(GJ/kL)				
CO_2 emission factor	Before : $CEF_{diesel,y}$	CO_2 emission factor of diesel oil ($t\text{-}CO_2/TJ$)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii)IPCC Guideline default data (Annex C-3)			
	Before : $CEF_{kerosene,y}$	CO_2 emission factor of kerosene ($t\text{-}CO_2/TJ$)				

5.Others

(1)Project Boundary

The physical boundary for measuring GHG emissions includes power facilities where the project activity is implemented.

(2)Leakage

Project activity could lead to the following leakages:

Hydropower plants construction: the indirect emissions potentially leading to leakage due to activities such as product manufacturing or materials transport. This respective emission is temporary and negligible considering the project scale. Therefore, it can be ignored. Leakage may result from extraction, processing or transportation of the fuel. Regarding the renewable energy, this fuel-handling situation can be ignored.

(3) Reviewed Methodologies and Major Differences

1)ACM0002(ver12.1):Consolidated baseline methodology for grid-connected electricity generation from renewable sources.

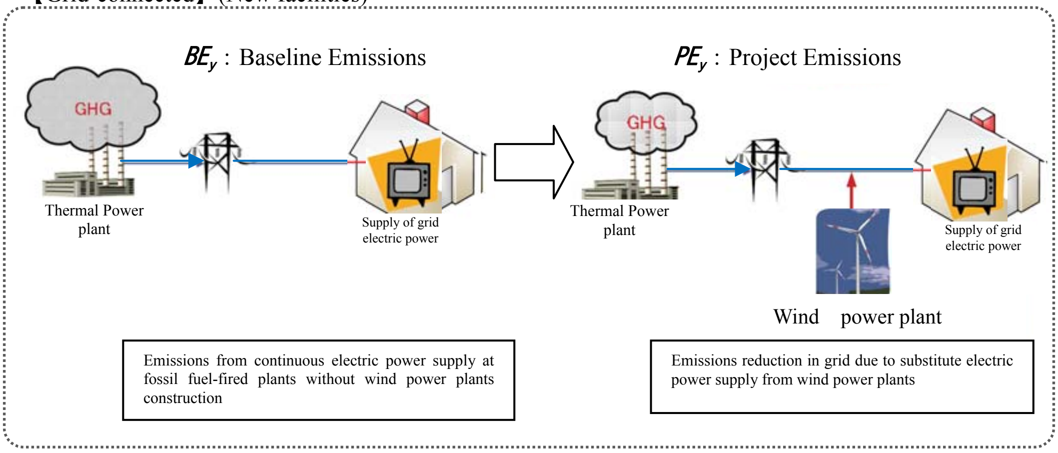
【Differences】

	・Reviewed methodology is applied to plants with power density of over 4W/m^2 from water reservoirs of hydro power plants; however, there is no restriction on scale capacity in the formula in this section. ・Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid (*2). In this formula, amount of fuel required for grid power generation by replaced hydro power supply is multiplied with emission factor. ・Leakage may result from the emission increased by power plants construction, fuel handling (extraction, processing or transportation) or flooding. These conditions are excluded in the reviewed methodology as confirmed by the study team. *2: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM). 2)AM0019(ver2.0):Renewable energy projects replace part of the electricity production of a single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects. 【Differences】 ・Reviewed methodology is applied to new plants with power density of over 4 W/m^2 from water reservoirs of hydro power plants; however, there is no restriction on scale capacity in the formula in this section. ・In the reviewed methodology, the CO_2 emission factor of the electricity of baseline emission is calculated by emission for fuel consumption and amount of power generation. In this methodology, emission is calculated by the amount of suppressed fuel. ・No consideration for leakage is required in the reviewed methodology in the same way this formula is applied. 3)AMS-I.D.(ver16.0):Grid connected renewable electricity generation. 【Differences】 ・Reviewed methodology is applied to plants with power density of over 4 W/m^2 from water reservoirs of hydro power plants and power supply from renewable energy at 15 MW or less; however, there is no restriction on scale capacity in the formula in this section. ・Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid (*2) In this formula, amount of fuel required for grid power generation by replaced hydro power supply is multiplied by the emission factor. ・Although the reviewed methodology shall account for GHG (CH_4 and CO_2) emission form water reservoirs into project emission. This formula excludes these conditions. ・In the reviewed methodology, it should consider if the power plants are transferred from other projects or the existing plants are transferred to other projects. However, this formula excludes these conditions. 4)AMS-I.F.(ver1.0):Renewable electricity generation for captive use and mini-grid. 【Differences】 ・Reviewed methodology is applied to plants with power density of over 4W/m^2 from water reservoirs of hydro power plants and power supply from renewable energy at 15MW or less, plants connecting to min-grid; however, there is no restriction on scale capacity of the formula in this section. ・Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid. Also, emission factor per power supply is defined in the reviewed methodology when the crude oil or diesel fired power plant is replaced in the project. In this formula, amount of fuel required for grid power generation by replaced hydro power supply is multiplied by emission factor. ・In the reviewed methodology, it should consider if the power plants are transferred from other projects. However, this formula excludes these conditions. 5)J-VER E015(ver2.0): Substitution of grid electric power with small scale hydropower. 【Differences】 ・Reviewed methodology is applied to plants with capacity of less than 10,000 kW. This formula excludes these

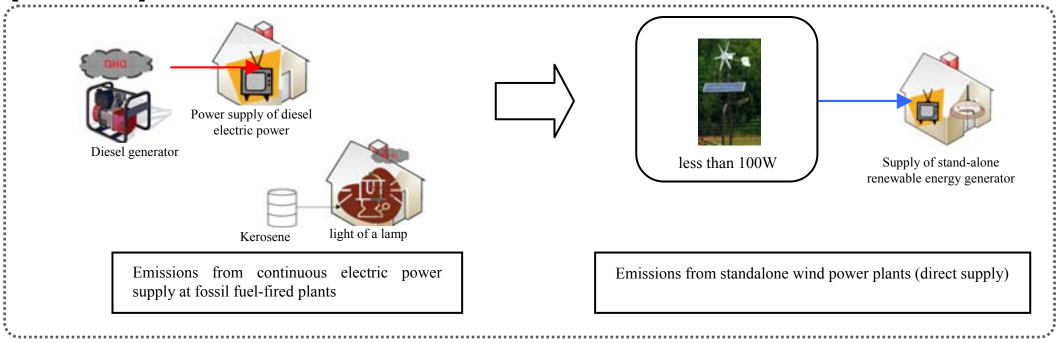
	conditions. ・Baseline emission is computed by multiplying the total of "electric power supply after the project starts" and "grid power supply which would be consumed without hydro power plants", with the CO_2 emission factor of grid. In this formula, amount of fuel required to generate grid power supply replaced by hydro power generation is multiplied with emission factor. ・For project emission in the referenced methodology, GHG emission generated from the use of grid power through the operation of power plants (operation of supplementary facilities etc.), and uses of in-house power generating supply. This formula excludes these emissions. ・Leakage is not mentioned in the reviewed methodology.

1.Typical Project Outline	The project intends to directly contribute to GHG emission reduction through the use of wind power plants in generating power. Thus, no GHG is generated with the use of natural resources such as wind power.
2.Applicability	○ The project should aim at new construction or upgrading of wind power plants. ○ Wind farms should be able to supply electricity by connecting to the transmission grid by combining it with fossil fuel-fired plants, or as standalone.
.Methodology of Emission Reduction	GHG emission reduction through wind power shall be determined as the difference between baseline emissions (GHG emissions at fossil fired power plants) and project emissions after operation of the wind farms. The wind farms can be connected to the grid or run as standalone. $$ER_y = BE_y - PE_y \quad \text{(t-CO}_2\text{/y)}$$ ER_y :GHG emissions reduction in year y achieved by the project (t-CO_2/y) BE_y :GHG emissions from existing power plants in year y (t-CO_2/y)(Baseline Emissions) PE_y :GHG emissions after operation of wind farms in year y (t-CO_2/y)(Project Emissions)

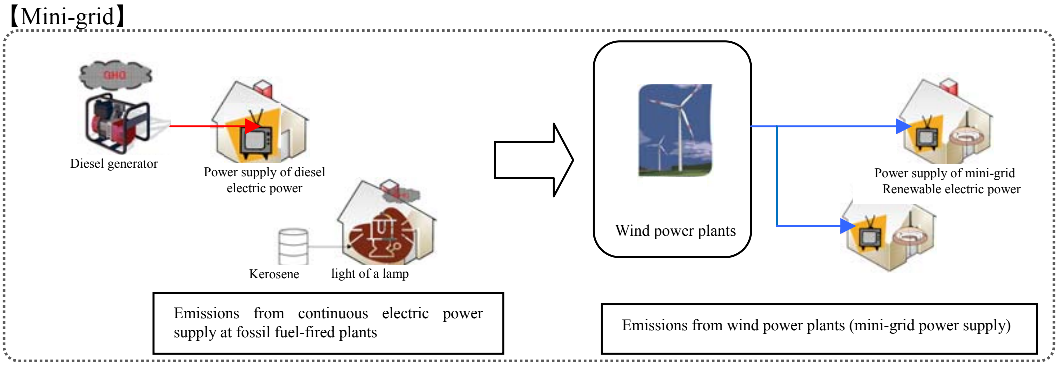
【Grid-connected】(New facilities)



【Stand-alone】



【Mini-grid】



(1)Baseline Emission

If wind power plants are not constructed, electric power will be continuously supplied by fossil fuel-fired power plants. The amount of electric power supply is reduced through the replacement of conventional fossil-fired power plants with wind power plants. Thus, the reduction in GHG emissions should be equal to the emissions from suppressed fossil fuel combustion. When existing wind power plants decrease in performance due to deterioration, improving the plant will increase the power generation efficiency and reduce the electric power supply from the existing fossil fuel-fired power plants. Thus, reduction in GHG emissions due to plant improvement should be equivalent to the suppressed emissions from fossil fuel combustion.

$$BE_y = \Sigma FC_i \times NCV_i \times COEF_i$$

Type	Items	Description
Output	BE_y	Baseline emission: GHG emissions of fuel consumption replaced by the wind power (t-CO_2/y)
Input	$FC_{i,y}$	Suppressed amount of fuel i (kL, m^3, t etc. /y)
	NCV_i	Net Calorific Value of each fuel type (GJ/ kL,m^3,t etc.)
	$COEF_i$	CO_2 emission factor of each fuel type (t-CO_2/TJ)

Determination of $FC_{i,y}$

【Grid-connected power plants】

When wind power plants connect to the grid, existing fossil-based power plants connected to the grid should be successively replaced by starting from the power plant with the lowest unit fuel cost. Reducing dependence on the fossil fuel type and the priority levels should be established considering the following criteria.

a) Monitoring electric power supply share of each fuel type on the national power grid

Monitor types of fuel and its electric power supply contribution (GWh/y) and consumption (kL,m^3,t etc/y), which comprise the national power grid.

b) Selection of fuel types for reduction

Verify unit fuel costs used at the existing plants within the national grid, and utilize them as criteria for reduction based on the decreasing order of unit fuel cost (*1). Determine the priority for such reduction in consideration of the target nation's future energy plans.

*1:If national unit fuel cost is unknown, set fuel unit cost in the order of petroleum, gas, coal for evaluation.

c) Establish essential amount of fuels

In the target nation, because of energy source diversification promotion, multiple fuel types (petroleum, gas, coal etc.) can be used within the grid. Therefore, for each fuel type, a specific level of amount should be set aside for the minimum operation of each plant. In principle, 5% of total electric power supply is set aside as the essential amount of fuel.

When the actual power supply is less than the essential amount of fuel, total amount of actual power supply is applicable as the essential amount of fuel.

d) Monitoring power supply contribution from target fuel for reduction

Excluding the essential amount of fuel computed in c), identify the reducible amount of fuel, in the decreasing order of unit fuel cost, and compute the reducible fuel type and electric power supply.

e) Determination of CO_2 emission from wind power

Based on the reducible amount of fuel in d), compute GHG emissions in order to generate electric power supply to replace wind power supply ($EG_{pj,y}$).

【Standalone】【Mini-grid】

The target area of standalone or mini-grid is non-electrification area. If hydropower facilities are not constructed, electric power is continuously supplied from the existing power facilities. Amount of fuel consumption in conventional power facilities is reduced through substitution with renewable energy from hydropower facilities. Thus, GHG emission should be equal to such emission from the decrease in suppression of fuel combustion.

In most of these rural areas without access to electricity, diesel generator and kerosene for lighting will continue to be used in absence of power supply. Therefore, diesel oil and kerosene are assumed as the target fuel for reduction.

$$\boldsymbol{BE_y} = EC_{diesel,y} \times NCV_{diesel,y} \times CEF_{diesel,y} + EC_{kerosene,y} \times NCV_{kerosene,y} \times CEF_{kerosene,y}$$

Type	Items	Description
Output	BE_y	Baseline Emissions: GHG emissions from using renewable energy as substitute fuel (t-CO_2/y)
Input	$EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television (kL/y)
	$NCV_{diesel,y}$	Net Calorific Value of diesel oil (GJ/kL)
	$CEF_{diesel,y}$	CO_2 Emission Factor of diesel oil(t-CO_2/TJ)
	$EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)
	$NCV_{kerosene,y}$	Net Calorific Value of kerosene(GJ/kL)
	$CEF_{kerosene,y}$	CO_2 Emission Factor of kerosene(t-CO_2/TJ)

(2) Project Emission

GHG emissions from wind power supply after the project starts will be "0".

$$\boldsymbol{PE_y} = 0$$

4. Data Required for Estimation and Monitoring

【Grid-connected power plants】

Data Type	Description of Data	Data Acquisition Methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electric power supply (After : $EG_{PJ,y}$)	Amount of electric power supply from wind power plants by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
Suppressed amount of fuel i (Before : $FC_{i,y}$)	Suppressed amount of fuel i by the project activity (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IEA Energy balance sheet			
Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type ($t\text{-}CO_2/TJ$)				

【Stand-alone】【Mini-grid】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of fuel consumption	Before : $EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television. (kL/y)	Planned data		(Not necessary because data is not involved in the calculation)	
	Before : $EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)	Planned data			
Net calorific value	Before : $NCV_{diesel,y}$	Net calorific value of diesel oil (GJ/kL)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2)			
	Before : $NCV_{kerosene,y}$	Net calorific value of kerosene(GJ/kL)				
CO_2 emission factor	Before : $CEF_{diesel,y}$	CO_2 emission factor of diesel oil ($t\text{-}CO_2$/TJ)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)			
	Before : $CEF_{kerosene,y}$	CO_2 emission factor of kerosene ($t\text{-}CO_2$/TJ)				

5.Others

(1)Project Boundary

The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented.

(2)Leakage

Leakage associated with wind power generation includes CO_2 emissions due to production and transport in relation to wind power plant construction. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. In addition, fuel handling such as extraction, processing, transportation, and others should not be considered for renewable energy.

(3) Reviewed Methodologies and Major Differences

a) ACM0002(ver12.1) : Consolidated baseline methodology for grid-connected electricity generation from renewable sources.

【Differences】

・Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid(*2). In this formula, amount of fuel required for grid power generation replaced with wind power supply is multiplied by the emission factor.

・Leakage may result from the emissions increase attributed to power plant construction, fuel handling (extraction, processing or transportation) or flood. These conditions are excluded in the reviewed methodology as confirmed by the study team.

*2: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM).

b) AM0019(ver2.0) : Renewable energy projects replacing the electric power produced from fossil fuel-fired power plant that either stands alone or supplies to a grid, excluding biomass projects

【Differences】

・In the reviewed methodology, the CO_2 emission factor of the electricity of baseline emission is calculated by emission for fuel consumption and amount of power generation. In this methodology, emission is calculated by the amount of suppressed fuel.

・No consideration for leakage is required in the reviewed methodology in the same way this formula is applied.

c) AMS-I.D.(ver16.0) : Grid-connected renewable electricity generation.

【Differences】

・The reviewed methodology is applied to power supply from renewable energy of 15 MW or less; however, there is no restriction on scale capacity in the formula in this section.

・ Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid (*2). In this formula, amount of fuel required for grid power generation replaced by wind power supply is multiplied with the emission factor.

・ Although the reviewed methodology shall account for GHG (CH_4 and CO_2) emissions from water reservoirs as the project emissions, this formula excludes these conditions because it is applied only to small-scale hydropower generation in the rural area without electrification.

・ In the reviewed methodology, if the power plants are transferred from other projects or vice versa, leakage should be considered. However, this formula excludes these conditions.

4) AMS-I.F.(ver1.0) : Renewable electricity generation for captive use and mini-grid.

【Differences】

・ The reviewed methodology is applied to wind power plants with power supply from renewable energy of 15 MW or less, and plants connected to mini-grid; however, there is no restriction on the scale capacity of the formula in this section.

・ Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid. Also, emission factor per power supplied is defined in the reviewed methodology when heavy fuel oil or diesel-fired power plant is replaced in the project. In this formula, amount of fuel required for grid power generation replaced by hydropower supply is multiplied with the emission factor.

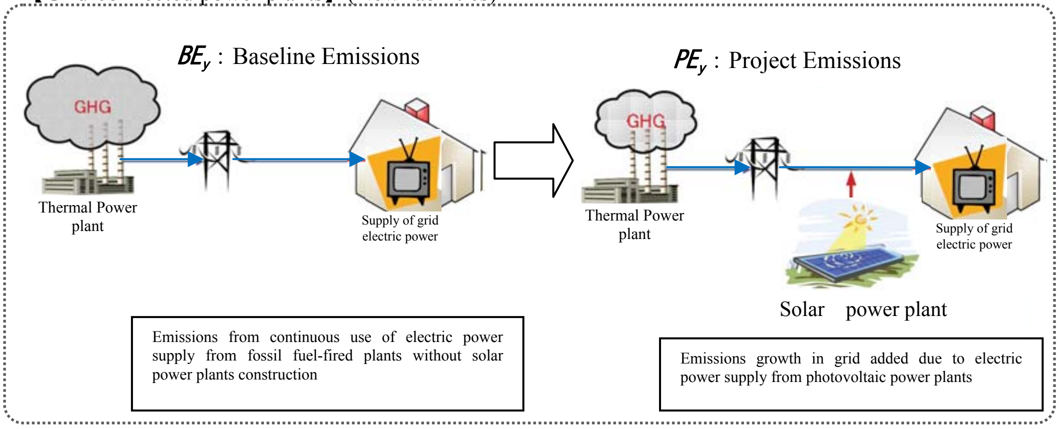
・ In the reviewed methodology, if the power plants are transferred from other projects, leakage should be considered. However, this formula excludes these conditions.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to directly contribute to GHG emission reduction through generation of power from photovoltaic power plants. Thus there is reduction in GHG emission with the use of non-fossil fuel source such as photovoltaic power.</td></tr>
<tr><td>2.Applicability</td><td>○ The project should aim at new construction or upgrading of photovoltaic power plants.
○ Photovoltaic power plants should be able to supply electricity when connected to the transmission grid either in combination with fossil fuel-fired plants or as standalone.</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>GHG emission reduction through the use of photovoltaic power shall be determined based on the difference between baseline emissions (GHG emissions from conventional fossil-fired power plants) and project emissions at the start of operation of photovoltaic power plants.
The photovoltaic power plants may connect to the grid or run as stand-alone.

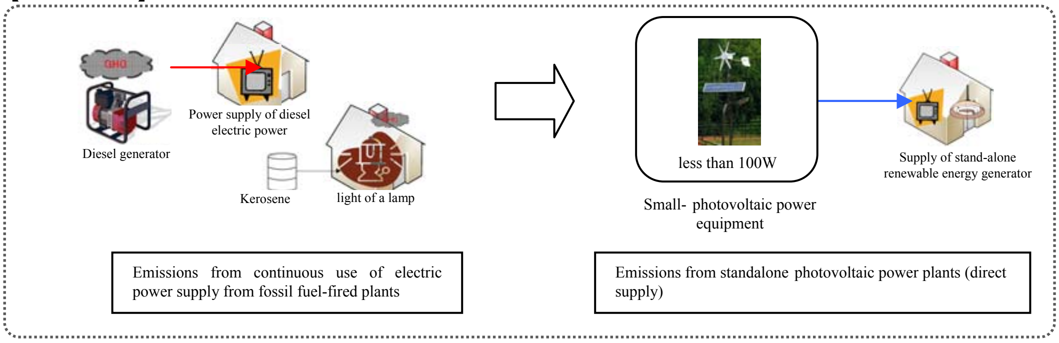
$$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$

ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$)
BE_y :GHG emissions from existing power plants in year y ($t\text{-}CO_2/y$) (Baseline Emissions)
PE_y :GHG emissions at the operation of photovoltaic power plants in year y ($t\text{-}CO_2/y$) (Project Emissions)

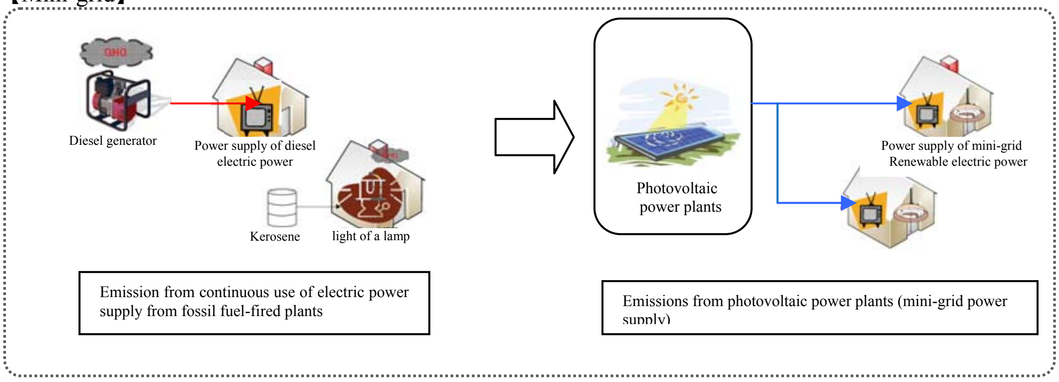
【Grid-connected power plants】(New facilities)



【Stand-alone】



【Mini-grid】



</td></tr>
</table>

(1)Baseline Emission

If photovoltaic power plants are not constructed, electric power will be continuously supplied from fossil fuel-fired power plants. Amount of electric power supply is reduced through the replacement of conventional fossil fuel-fired power plants with photovoltaic power plants. Thus, GHG emission should be equal to such emission from suppressed fuel combustion. When the existing photovoltaic power plants decrease in performance due to deterioration, improving the plant will increase the power generation efficiency and reduce dependence on electric power supply from the existing power plants. Thus, GHG emission reduction should be equal to the emission from suppressed fossil fuel combustion.

$$\boldsymbol{BE_y} = \Sigma FC_i \times NCV_i \times COEF_i$$

Type	Items	Description
Output	BE_y	Baseline Emissions: GHG emissions of fuel consumption replaced by the photovoltaic power (t-CO_2/y)
Input	$FC_{i,y}$	Suppressed amount of fuel i (kL, m^3, t etc./y)
	NCV_i	Net Calorific Value of each fuel type (GJ/ kL, m^3 , t etc.)
	$COEF_i$	CO_2 Emission Factor of each fuel type (t-CO_2/TJ)

Determination of $FC_{i,y}$

【Grid-connected power plants】

When photovoltaic power plants are connected to the grid, the existing power plants connected to the grid should be replaced based on their ranking on unit fuel cost, starting with the highest unit fuel cost. Reducing dependence on fossil fuel based fuel type and its priority should be determined on such view.

a) Monitoring electric power supply in each fuel type of national power grid

Monitor different types of fuel and the proportion of its contributed electric power supply (GWh/y) and consumption (kL, m^3, t etc./y) to the national power grid.

b)Determining priority of target fuel for reduction

Verify unit fuel cost used at the existing plants within the national grid and make them target for the reduction in decreasing order of unit fuel cost (*1). Determine the priority for such reduction in consideration of the target nation's future plans (energy plans).

*1:If national unit fuel cost is unknown, set fuel unit cost in the order of petroleum, gas, coal for evaluation.

c) Checking essential amounts of fuel

In the target nation, because of energy source diversification promotion, multiple fuel types (petroleum, gas, coal etc.) can be used within the grid. Therefore, for each fuel type, a specific level of amount should be set aside for the minimum operation of each plant. In principle, 5% of total electric power supply is set aside as the essential amount of fuel.

When the actual power supply is less than the essential amount of fuel, total amount of actual power supply is applicable as the essential amount of fuel.

d)Monitoring power supply contribution from target fuel for reduction

Excluding the essential amount of fuel computed in c), identify the reducible amount of fuel, in the decreasing order of unit fuel cost, and compute the reducible fuel type and electric power supply

e)Determination of CO_2 emission from photovoltaic power

Based on the reducible amount of fuel in d), compute GHG emissions in order to generate power supply to replace photovoltaic power supply ($EG_{pj,y}$).

【Standalone】【Mini-grid】

The target area of standalone or mini-grid is non-electrification area. If hydropower facilities are not constructed, electric power is continuously supplied from the existing power facilities. Amount of fuel consumption in conventional power facilities is reduced through substitution with renewable energy from hydropower facilities. Thus, GHG emission should be equal to such emission from the decrease in suppression of fuel combustion.

In most of these rural areas without access to electricity, diesel generator and kerosene for lighting will continue to be used in absence of power supply. Therefore, diesel oil and kerosene are assumed as the target fuel for reduction.

$$\boldsymbol{BE_y} = EC_{diesel,y} \times NCV_{diesel,y} \times CEF_{diesel,y} + EC_{kerosene,y} \times NCV_{kerosene,y} \times CEF_{kerosene,y}$$

Type	Items	Description
Output	BE_y	Baseline Emissions: GHG emissions from using renewable energy as substitute fuel (t-CO_2/y)
Input	$EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television (kL/y)
	$NCV_{diesel,y}$	Net Calorific Value of diesel oil (GJ/kL)
	$CEF_{diesel,y}$	CO_2 Emission Factor of diesel oil(t-CO_2/TJ)
	$EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)
	$NCV_{kerosene,y}$	Net Calorific Value of kerosene(GJ/kL)
	$CEF_{kerosene,y}$	CO_2 Emission Factor of kerosene(t-CO_2/TJ)

(2) Project Emission

GHG emissions from photovoltaic power supply after the project starts will be "0".

$$\boldsymbol{PE_y} = 0$$

4. Data Required for Estimation and Monitoring

【Grid-connected power plants】

Data Type	Description of Data	Data Acquisition Methods: Baseline Emissions – Before the Project Starts	Data Acquisition Methods: Baseline Emissions – After Project Completion	Data Acquisition Methods: Project Emissions – Before the Project Starts	Data Acquisition Methods: Project Emissions – After Project Completion
Amount of electric power supply (After : $EG_{PJ,y}$)	Amount of electric power supply from Photovoltaic power plants by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
Suppressed amount of fuel i (Before : $FC_{i,y}$)	Suppressed amount of fuel i by the project activity (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IEA Energy balance sheet			
Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type (t-CO_2/TJ)				

【Stand-alone】【Mini-grid】

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of fuel consumption	Before : $EC_{diesel,y}$	Amount of diesel oil consumption without the project, in case that diesel generator is used for television. (kL/y)	Planned data		(Not necessary because data is not involved in the calculation)	
	Before : $EC_{kerosene,y}$	Amount of kerosene consumption without the project, in case kerosene lamp is used for lighting (kL/y)	Planned data			
Net calorific value	Before : $NCV_{diesel,y}$	Net calorific value of diesel oil (GJ/kL)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2)			
	Before : $NCV_{kerosene,y}$	Net calorific value of kerosene(GJ/kL)				
CO_2 emission factor	Before : $CEF_{diesel,y}$	CO_2 emission factor of diesel oil (t-CO_2/TJ)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)			
	Before : $CEF_{kerosene,y}$	CO_2 emission factor of kerosene (t-CO_2/TJ)				

5.Others

(1) Project Boundary

The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented.

(2)Leakage

Leakage associated with solar power generation includes CO_2 emissions due to production and transport in relation to solar power plant construction. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. In addition, fuel handling such as extraction, processing or transportation should not be considered for renewable energy.

(3) Reviewed Methodologies and Major Differences

1) ACM0002(ver12.1):Consolidated baseline methodology for grid-connected electricity generation from renewable sources.

【Differences】

・ Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid(*2). In this formula, amount of fuel required for grid power generation replaced by photovoltaic power supply is multiplied with the emission factor.

- For the baseline emission calculation, CO_2 emission from the supplemental fuel (fossil fuel) in the power plants should be considered in the reviewed methodology. This formula excludes this condition.
- Leakage may result from the emissions increase attributed to power plant construction, fuel handling (extraction, processing or transportation) or flood. These conditions are excluded in the reviewed methodology as confirmed by the study team.

*2: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM).

2) AM0019(ver2.0):Renewable energy projects replacing part of the electricity production of a single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects.

【Differences】

- In the reviewed methodology, the CO_2 emission factor of the electricity of baseline emission is calculated by emission for fuel consumption and amount of power generation. In this methodology, emission is calculated by the amount of suppressed fuel.
- No consideration for leakage is required in the reviewed methodology in the same way this formula is applied.

3) AMS-I.D.(ver16.0):Grid connected renewable electricity generation.

【Differences】

- The reviewed methodology is applied to plants with power density of over $4W/m^2$; however, there is no restriction on scale capacity in the formula in this section.
- Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid (*2). In this formula, amount of fuel required for grid power generation replaced by photovoltaic power supply, is multiplied with the emission factor.
- In the reviewed methodology, if the power plants are transferred from other projects or vice versa, leakage should be considered. However, this formula excludes these conditions.

4) AMS-I.F.(ver1.0):Renewable electricity generation for captive use and mini-grid.

【Differences】

- The reviewed methodology is applied to power supply from renewable energy is 15MW or less, and plants connected to min-grid; however, there is no restriction on scale capacity of the formula in this section.
- Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid. Also, emission factor per power supply is defined in the reviewed methodology when the heavy fuel oil or diesel fired power plant is replaced in the project. In this formula, amount of fuel required for grid power generation replaced by hydro power supply is multiplied with the emission factor.
- In the reviewed methodology, if the power plants are transferred from other projects, leakage should be considered. However, this formula excludes these conditions.

5) J-VER　E024(ver2.0): Methodology for grid-connected electricity generation from photovoltaic power system

【Differences】

- The reviewed methodology is applied to plants that consume electricity, while that from photovoltaic power system is self-consumed. This formula excludes these conditions.
- Baseline emission is computed by multiplying the total of "electric power supply after the project starts" and "grid power supply which would be consumed without photovoltaic power plants", with the CO_2 emission factor of grid. In this formula, amount of fuel required to generate grid power supply replaced by photovoltaic power generation is multiplied with the emission factor.
- For project emission in the reviewed methodology, GHG emission generated from the uses of power grid through operation of power plants (operation of supplementary facilities etc.), and the uses of in-house power generating

	supply. This formula excludes these emissions. ・Leakage is not mentioned in the reviewed methodology.

<table>
<tr><td>1.Typical Project Outline</td><td>The project intends to directly reduce GHG emissions by generating power from solar power plants, which generate limited amounts of GHG. The requirement for flaring of GHGs to reduce emissions, with the use of natural resources such as concentrated solar power, is eliminated.</td></tr>
<tr><td>2.Applicability</td><td>○ The project should aim at generating power or supplying hot water by utilizing concentrated solar energy.
○ Concentrated solar power plants should be able to supply electricity when connected to transmission grid with fossil fuel fired plants.
○ Hot water supply should be made available from standalone concentrated solar power plants.</td></tr>
<tr><td>3.Methodology on Emission Reduction</td><td>

GHG emissions reduction through concentrated solar power shall be determined as the difference between baseline emissions (GHG emissions at fossil fuel-fired power plants) and project emissions after running concentrated solar power plants.

The concentrated solar power plants may be connected to the grid or run as stand-alone.

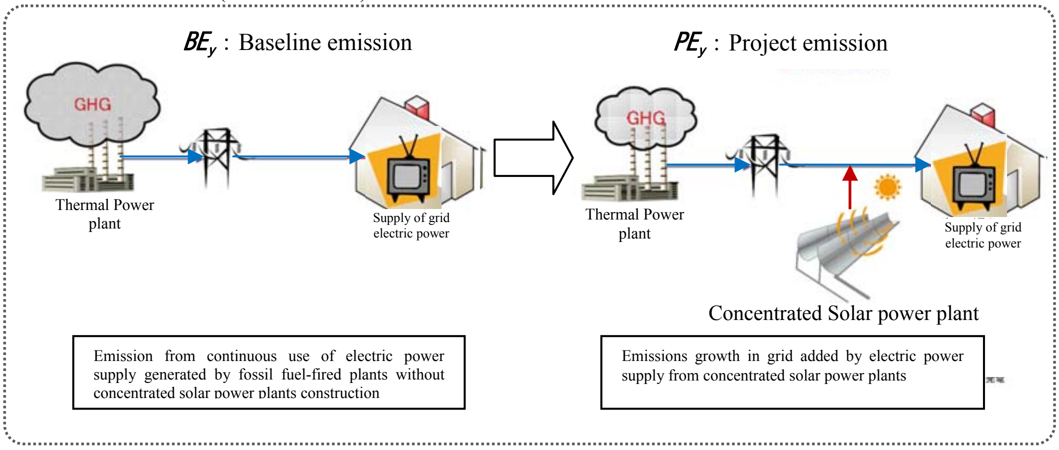
$$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$

ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$)

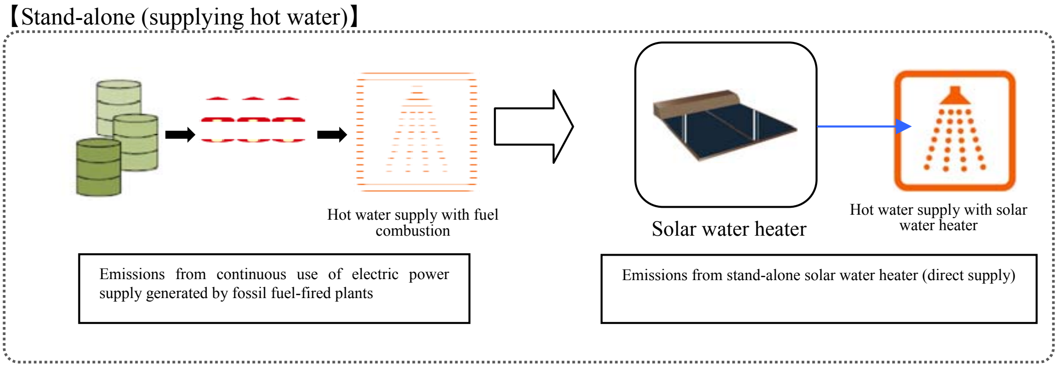
BE_y :GHG emissions at existing power plants in year y ($t\text{-}CO_2/y$)(Baseline Emissions)

PE_y :GHG emissions after running concentrated Solar power plants in year y ($t\text{-}CO_2/y$)(Project Emissions)

【Grid-connected】(New facilities)



【Stand-alone (supplying hot water)】



</td></tr>
</table>

(1)Baseline Emissions

If concentrated solar power plants are not constructed, electric power is continuously supplied from the fossil fuel-fired power plants. Amount of electric power supply generated from conventional fossil fuel-fired power plants is replaced with concentrated solar power plants. Thus, GHG emission reduction should be equal to emissions from suppressed fossil fuel combustion.

$$\boldsymbol{BE_y} = \Sigma FC_i \times NCV_i \times COEF_i$$

Type	Items	Description
Output	BE_y	Baseline Emissions: GHG emissions of fuel consumption replaced by the solar power ($t\text{-}CO_2/y$)
Input	$FC_{i,y}$	Suppressed amount of fuel i (kL,m^3,t etc./y)
	NCV_i	Net Calorific Value of each fuel type (GJ/kL,m^3,t etc.)
	$COEF_i$	CO_2 Emission Factor of each fuel type ($t\text{-}CO_2$/TJ)

Determination of $FC_{i,y}$

【Grid-connected power plants】

When concentrated solar power plants connect to grid, the existing power plants in the grid should be replaced in decreasing order of unit fuel cost. Reducing fuel type and its priority should be determined with such view.

a) Monitoring electric power supply in each fuel type of national power grid

Monitor types of fuel, its proportion of electric power supply (GWh/y) and consumption (kL,m^3,t etc /y) supplied to the national power grid.

b) Determining priority of target fuel to be reduced

Verify unit fuel cost used at existing plants within the national grid and utilize them as target for reducing the decreasing order of unit fuel cost (*1). Determine the priority for reduction in consideration of the target nation's future plans (energy plans) as required.

*1:If national unit fuel cost is unknown, set fuel unit cost in the order of petroleum, gas, and coal for evaluation.

c) Checking essential amounts of fuel

In the target nation, because of energy source diversification promotion, multiple fuel types (petroleum, gas, coal etc.) can be used within grid. Therefore, for each fuel type, a specific level of amount should be set aside for the minimum operation of each plant. In principle, 5% of total electric power supply is set aside as essential amount of fuel.

When the actual power supply is less than essential amount of fuel, total amount of actual power supply is applicable as essential amount of fuels.

d) Monitoring power supply from target fuel for reduction

Excluding the essential amount of fuel computed in c), identify the reducible amount of fuel, in the decreasing order of unit fuel cost, and compute the reducible fuel type and electric power supply.

e) Determination of CO_2 emission from concentrated solar power

Based on the reducible amount of fuel in d), compute GHG emissions in order to generate power supply to replace concentrated solar power supply ($EG_{pj,y}$).

【Standalone】

Electric power is not supplied from grid in areas where concentrated solar power equipment run as standalone and solar water heater is not equipped. If concentrated solar power equipments are not constructed, electric power will be continuously supplied from the existing power plants. Amount of fuel consumption in the conventional power plants is reduced by utilizing renewable energy from concentrated solar power plants as alternative. Thus, GHG emissions reduction should be equal to the emissions from suppressed in fuel combustion.

$$BE_y = EC_{BL,y} \times EF_{BL,y}$$

Type	Items	Description
Output	BE_y	Baseline Emission: GHG emissions of fuel consumption replaced by the solar power ($t\text{-}CO_2/y$)
Input	$EC_{BL,y}$	Amount of electricity consumption to supply hot water equivalent to that of solar water heater (MWh/y)
	$EF_{BL,y}$	CO_2 emission factor of the electricity($t\text{-}CO_2/MWh$)

Determination of $EC_{BL,y}$

Amount of electricity consumption to supply hot water equivalent to the one with solar water heater after the project starts shall be computed using the following formula.

$$EC_{BL,y} = \frac{Q_y \times \Delta T \times CUF}{EF_{wh} \times 860}$$

Q_y : Amount of hot water supplied by solar water heater(kL/y)

ΔT : Temperature increase of water(^{O}C℃)

CUF : Production ratio(%)

EF_{wh} : Efficiency of solar water heater(%)

860 : Calorific value per electric capacity(1kWh＝860kcal)

Determination of $EF_{BL,y}$

CO_2 emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird.

Emission factor for the target power plant should be obtained through interview to the electric power management entity concerned.

In selecting the target power plant, confirm that the emission factor is comparable to the average grid emission factor (Ref. Annex C-1) determined based on published values in the target country or data adopted by Kyoto Mechanisms or data based on IEA.

If the emission factor is not available, it should be calculated using the net electrical output of the target power plant, fuel type, net fuel consumption, net calorific value and caloric CO_2 emission factor (Ref. Annex C-4).

(2) Project Emission

GHG emissions from concentrated Solar power supply after the project starts will be "0".

$$PE_y = 0$$

4. Data Required for Estimation and Monitoring

【Grid-connected power plants】

Data Type	Description of Data	Data Acquisition Methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electric power supply (After : $EG_{PJ,y}$)	Amount of electric power supply from solar power plants by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
Suppressed amount of fuel i (Before : $FC_{i,y}$)	Suppressed amount of fuel i by the project activity (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IEA Energy balance sheet			
Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)			
CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type (t-CO_2/TJ)				

【Stand-alone (supplying hot water)】

Data Type	Description of Data	Data acquisition methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electricity consumption (Before : $EC_{BL,y}$)	Amount of electricity consumption to supply hot water equivalent to the that using solar water heater(MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
Temperature increase of water(ΔT)	Water temperature increase from solar water heater(K)	Planned data	Measured data or Design value		
Efficiency of solar water heater(CUF)	Net production rate of solar water heater (%)	Planned data	Measured data		
Efficiency of solar water heater(Before : EF_{wh})	Efficiency of solar water heater to supply the hot water equivalent to the one with solar water heater (%)	Planned data	Planned data		
CO_2 emission factor of the electricity($EF_{BL,y}$)	Emission factor of the typical power plant (t-CO_2/MWh)	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned ii) Published values in the target country			

5.Others	(1)Project Boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented. (2)Leakage Leakage associated with solar power/ heat generation includes CO_2 emissions due to production and transport in relation to solar power plant and/or solar water heater construction. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered. In addition, fuel handling such as extraction, processing or transportation should not be considered for renewable energy. (3) Reviewed Methodologies and Major Differences 1)ACM0002(ver12.1):Consolidated baseline methodology for grid-connected electricity generation from renewable sources. 【Differences】 ・ Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid(*2). In this formula, amount of fuel required for grid power generation replaced by concentrated solar power supply is multiplied with the emission factor. ・ For the baseline emission calculation, CO_2 emission from the supplemental fuel (fossil fuel) in the power plants should be considered in the reviewed methodology. This formula excludes this condition. ・ Leakage may result from the emission increase by the power plants construction, fuel handling (extraction, processing or transportation) or flood. These conditions are excluded in the reviewed methodology as confirmed by the study team. *2: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM). 2)AM0019(ver2.0):Renewable energy projects replacing part of the electricity production of a single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects. 【Differences】 ・In the reviewed methodology, the CO_2 emission factor of the electricity of baseline emission is calculated by emission for fuel consumption and amount of power generation. In this methodology, emission is calculated by the amount of suppressed fuel. ・ No consideration for leakage is required in the reviewed methodology in the same way this formula is applied. 3)AMS-I.D.(ver16.0):Grid connected renewable electricity generation . 【Differences】 ・ The reviewed methodology is applied to power supply from renewable energy of 15 MW or less; however, there is no restriction on scale capacity in the formula in this section. ・ Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid (*2). In this formula, amount of fuel required for grid power generation by replaced concentrated solar power supply, is multiplied with the emission factor. ・ In the reviewed methodology, if the power plants are transferred from other projects or vice versa, leakage should be considered. However, this formula excludes these conditions.

1.Typical Project Outline

The project intends to directly reduce GHG emissions by generating power from geothermal power plants, which generate limited amounts of GHG. The requirement for flaring of GHGs to reduce emissions with the use of natural resources such as geothermal power, is eliminated.

2.Applicability

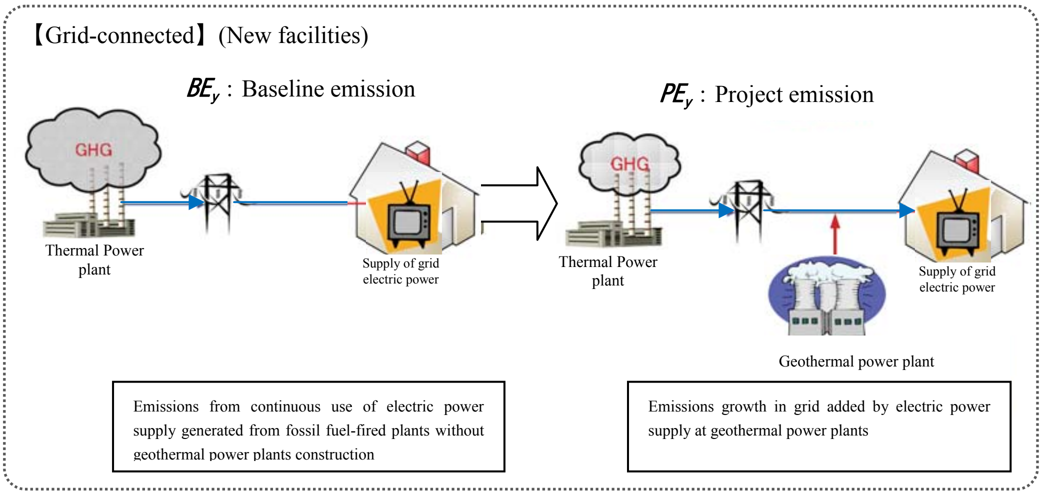
- ○ The project should aim at new construction or upgrading of geothermal power plants.
- ○ Geothermal power plants should be able to supply electricity when connected to transmission grid with fossil fuel fired plants.

3.Methodology on Emission Reduction

GHG emissions reduction through geothermal power shall be determined as the difference between baseline emissions (GHG emissions at fossil fired power plants) and project emissions after running geothermal power plants.

$$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$

ER_y :GHG emissions reduction in year y achieved by the project (t-CO_2/y)
BE_y :GHG emissions at existing power plants in year y (t-CO_2/y)(Baseline Emissions)
PE_y :GHG emissions after running geothermal power plants in year y (t-CO_2/y)(Project Emissions)



(1)Baseline Emission

If geothermal power plants are not constructed, electric power is continuously supplied from the fossil fired power plants. Amount of electric power supply is reduced by replacing conventional fossil fired power plants with geothermal power plants. Thus, GHG emission should be equal to such emission from suppressed fuel combustion.

$$BE_y = \Sigma FC_{i,y} \times NCV_i \times COEF_i$$

Type	Items	Description
Output	BE_y	Baseline emission: GHG emissions of fuel consumption replaced by the geothermal (t-CO_2/y)
Input	$FC_{i,y}$	Suppressed amount of fuel i (kL,m^3,t etc./y)
	NCV_i	Net Calorific Value of each fuel type (GJ/ kL,m^3,t etc.)
	$COEF_i$	CO_2 Emission Factor of each fuel type (t-CO_2/TJ)

Determination of $FC_{i,y}$

When geothermal power plants connected to grid, existing power plants connected to the grid should be replaced in decreasing order of unit fuel cost. Reducing fuel type and its priority should be determined with such view.

a) Monitoring electric power supply in each fuel type of national power grid

Monitor type of fuels and its electric power supply (GWh/y) and consumption (kL,m^3,t etc /y) in each fuel type, which comprise the national power grid.

b) Determining priority of target fuel for reduction

Verify unit fuel cost used at existing plants within the national grid and utilize them as target for reduction the decreasing order of unit fuel cost (*1). Determine the priority for such reduction in consideration of the target nation's future plans (energy plans) as required.

*1: If national unit fuel cost is unknown, set fuel unit cost in the order of petroleum, gas, and coal for evaluation.

c) Checking essential amount of fuels

In the target nation, because of energy source diversification promotion, multiple fuel types (petroleum, gas, coal etc.) can be used within the grid. Therefore, for each fuel type, a specific level of amount should be set aside for the minimum operation of each plant. In principle, 5% of total electric power supply is set aside as the essential amount of fuel.

When the actual power supply is less than essential amount of fuel, total amount of actual power supply is applicable as the essential amount of fuel.

d) Monitoring power supply from target fuel for reduction

Excluding the essential amount of fuel computed in c), identify the reducible amount of fuel, in the decreasing order of unit fuel cost, and compute the reducible fuel type and electric power supply.

e) Determination of CO_2 emission from geothermal power

Based on the reducible amount of fuel in d), compute GHG emissions reduction from the replacement of power supply from fossil-based power plants with geothermal power supply ($EG_{pj,y}$).

(2)Project Emission

GHG emissions from geothermal power supply after the project starts will be "0".

$$\boldsymbol{PE_y} = PES_y + PEFF_y$$

Type	Items	Description
Output	PE_y	Project Emissions: GHG emission after project activity (t−CO_2/y)
Input	PES_y	CO_2・CH_4 emission with vapor emission(t-CO_2/y)
	$PEFF_y$	CO_2 emission with fuel combustion in the geothermal power plants (t-CO_2/y)

Determination of PES_y

CO_2・CH_4 emission with vapor emission shall be calculated as follows:

$$PES_y = (w_{Main,CO2} + w_{Main,CH4} \times GWP_{CH4}) \times M_{S,y}$$

(Continued)

$w_{Main,CO2}$: Average molecular mass for carbon dioxide in generated vapor($t\text{-}CO_2/t$)

$w_{Main,CH4}$: Average molecular mass for methane in generated vapor($t\text{-}CH_4/t$)

GWP_{CH4} : Methane global warming potential (GWP)(－)

$M_{S,y}$: Amount of vapor in year y (t)

Determination of $PEFF_y$

CO_2 emission with fuel combustion in the geothermal power plants shall be calculated as follows:

$$PEFF_y = \Sigma FC_{i,y} \times NCV_i \times COEF_i$$

$FC_{i,y}$: Fuel Consumption of fuel i in the geothermal power plants (kL,m^3,t etc./y)

NCV_i : Net Calorific Value of each fuel type(GJ/kL,m^3,t etc.)

$COEF_i$: CO_2 Emission Factor of each fuel type ($t\text{-}CO_2$/TJ)

4. Data Required for Estimation and Monitoring

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of electric power supply (After : $EG_{PJ,y}$)		Amount of electric power supply from geothermal power plants a by the project activity (MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
Baseline emission	Suppressed amount of fuel i (Before : $FC_{i,y}$)	Suppressed amount of fuel i by the project activity (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IEA Energy balance sheet			
	Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data(Annex C-2,3)			
	CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type ($t\text{-}CO_2$/TJ)				

(Continued)

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
GHG emission with vapor emission	Average molecular mass for CO_2 (After : $w_{Main,CO2}$)	Average molecular mass for CO_2 in vapor generated in year y(t-CO_2/t)			Planned data based on the Measured data of similar cases	Measured data
	Average molecular mass for CH_4(After : $w_{Main,CH4}$)	Average molecular mass for CH_4 in vapor generated in year y(t-CH_4/t)			Planned data based on the Measured data of similar cases	Measured data
	GWP for CH_4(After : GWP_{CH4})	21(−)			21	
	Amount of vapor in(After : $M_{S,y}$)	Amount of vapor in year y(t)			Planned data	Measured data
GHG emission with fuel combustion	Fuel consumption of fuel i (Before : $FC_{i,y}$)	Energy consumption required to generate electric power supply of fuel i . (kL,m^3,t etc/y)	(Not necessary because data is not involved in the calculation)		Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IEA Energy balance sheet	
	Net calorific value of each fuel type (NCV_i)	Net calorific value of each fuel type (GJ/kL,m^3,t etc)			Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2,3)	
	CO_2 emission factor of each fuel type ($COEF_i$)	CO_2 emission factor of each fuel type (t-CO_2/TJ)				

5.Others

(1) Project Boundary

The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented.

(2)Leakage

Leakage associated with geothermal power generation includes CO_2 emissions due to production and transport in relation to geothermal power plant construction. However, such emissions are temporary and negligibly small in comparison with the project size, thus they are not considered.

(3) Reviewed Methodologies and Major Differences

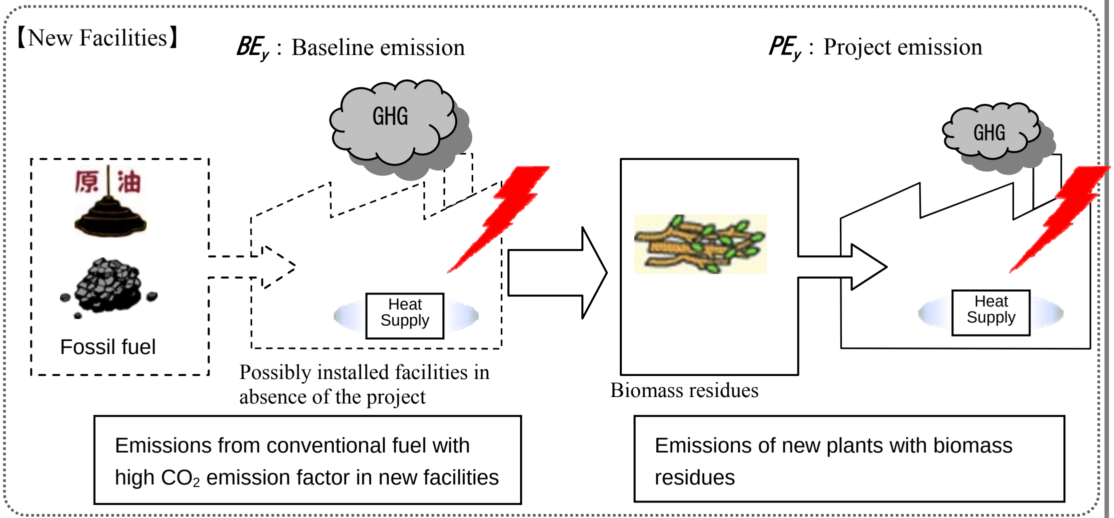
a)ACM0002(ver12.1):Consolidated baseline methodology for grid-connected electricity generation from renewable sources.

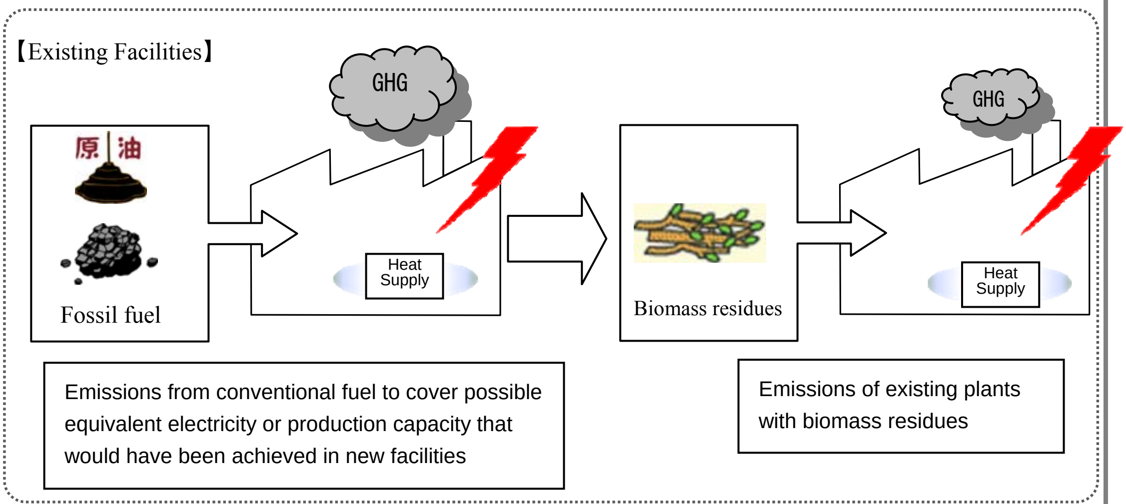
【Differences】

・Baseline emissions in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid(*2) In this formula, amount of fuel required for

	grid power generation by replaced geothermal power supply is multiplied with the emission factor. ・Leakage may result from the emissions increase due to power plant construction, fuel handling (extraction, processing or transportation) or flood. These conditions are excluded in the reviewed methodology as confirmed by the study team. *2: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM). b) AM0019(ver2.0) : Renewable energy projects replacing the electricity produced from a fossil fuel-fired power plant that either stands alone or supplies to a grid, excluding biomass projects. 【Differences】 ・In the reviewed methodology, the CO_2 emission factor of the electricity of baseline emission is calculated by emission for fuel consumption and amount of power generation. In this methodology, emission is calculated by the amount of suppressed fuel. ・No consideration for leakage is required in the reviewed methodology in the same way this formula is applied. c) AMS-I.D.(ver16.0):Grid connected renewable electricity generation. 【Differences】 ・Reviewed methodology is applied when the power supply from renewable energy is 15 MW or less; however, there is no restriction on scale capacity in the formula in this section. ・Baseline emission in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid (*2). In this formula, amount of fuel required for grid power generation replaced by geothermal power supply is multiplied with the emission factor. ・ In the reviewed methodology, if the power plants are transferred from other projects or vice versa, leakage should be considered. However, this formula excludes these conditions. 4) AMS-I.F.(ver1.0) : Renewable electricity generation for captive use and mini-grid. 【Differences】 ・Reviewed methodology is applied when the power supply from renewable energy is 15 MW or less, or plants are connected to the mini-grid. However, there is no restriction on scale capacity of the formula in this section. ・Baseline emissions in the reviewed methodology is computed by multiplying the electric power supply by the project activity, with the CO_2 emission factor of grid. Also, emissions factor per unit of power supply is defined in the reviewed methodology when heavy fuel oil or diesel-fired power plant is replaced in the project. In this formula, amount of fuel required for grid power generation replaced by geothermal power supply is multiplied with the emission factor. ・ In the reviewed methodology, if the power plants are transferred from other projects, leakage should be considered. However, this formula excludes these conditions.

1.Typical Project Outline	The project indents to directly reduce GHG emissions through electricity generation or heat generation from biomass residues instead of fossil fuel fired at power plants or factories which leads to reduce consumption of electricity or fossil fuel.
2.Applicability	○ Biomass residues used in the project are defined as biomass that are by-products, residues and wastes from agriculture, forestry and other related industries. These shall not include municipal waste or other wastes. ○ The project should be aimed to constructing new electricity and heat generating plants from biomass residues, or replacement, fuel switching or improvement of existing power plants. ○ Biomass residues shall be collected from the project site within the project boundary. ○ Biomass residues used as fuel should be preserved under aerobic condition to reduce methane generation in order to prevent fire and possible explosion.
3.Methodology on Emission Reduction	GHG emissions reduction through electricity or heat generation from biomass residues shall be determined as the difference between baseline emissions without biomass residues before the project starts and project emissions with biomass residues after the project starts. Baseline emission can be computed by multiplying each fuel consumption before and after the project with their respective CO_2 emission factors. $$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$ ER_y : GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$) BE_y : GHG emissions without biomass residues in year y ($t\text{-}CO_2/y$) (Baseline emission) PE_y : GHG emissions with biomass residues in year y ($t\text{-}CO_2/y$) (Project emission)





(Continuation)

(1) Baseline Emission

When biomass residues are not used as fuel, GHG emission is computed by electricity consumption to generate the quantity of electric power generation and heat generation after the project starts. Baseline emission shall be determined by multiplying the quantity of fuel consumption from electricity generation (MWh/y) and heat generation (TJ/y) equivalent to the electricity and heat generated from biomass residues after the project starts with their respective GHG emission factors.

The emission factors should be individually applied for plants of public and private generating facilities.

$$BE_y = BE_{elec,y} + BE_{ther,y}$$

(Emissions generated by electricity supplied) (Emissions generated by heat supplied)

$$= (EG_{PJ,y} \times EF_{BL,y}) + (HG_{PJ,y} \times EF_{heat})$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission: GHG emissions without waste energy recovery (t-CO_2/y)
Input	$EG_{PJ,y}$	Quantity of electric power generation through waste energy recovery and utilization after the project starts (MWh/y)
	$EF_{BL,y}$	CO_2 emissions per electric power supplied (t-CO_2/MWh)
	$HG_{PJ,y}$	Quantity of heat generation recovered and utilized after the project starts (MWh/y)
	EF_{heat}	CO_2 emission factor (t-CO_2/TJ)

Determination of $EF_{BL,y}$

【Case: currently owned or has plan to install private generating facility】

In the environment where the biomass residual power plants are installed with private generating facilities, or where biomass residual power plants are newly constructed and private generating facilities are planned to be installed, select whichever higher by comparing with the CO_2 emissions factor for the grid supplying electricity (Annex C-1).

The emissions factor should be determined base on one or two typical plants among existing power plants in the target grid. The emissions factor should be obtained through interview to the electric power management entity concerned.

In selecting the target power plant, confirm that the emissions factor is comparable to the average grid emission factor based on published values in the target country, data adopted by Kyoto Mechanism or IEA (Annex C-1).

If CO_2 emission factor is not available, it should be calculated using the annual electrical output of the target plant, fuel type, annual fuel consumption, average net calorific value, and caloric CO_2 emission factor (Annex C-4).

【Case: currently not owned or has no plan to install private generating facility】

Where the existing biomass residual power plants have no private generating facilities or such facilities are not planned to be installed in new biomass residual power plants, CO_2 emissions factor in the grid supplying electricity should be used.

Determination of EF_{heat}

EF_{heat} shall be calculated by the following equation:

(Continuation)

$$EF_{heat} = ws \frac{EF_{CO2}}{\eta_{EP}}$$

EF_{CO2} : CO_2 emission factor per unit of energy of the boiler fuel consumption without the project

η_{EP} : Boiler efficiency

ws : Rate of total heat from boiler without the project to heat capacity with biomass residues

(2) Project Emission

In order to calculate project GHG emission, electricity consumption and supplemental fuel consumption from plants with biomass residues and fuel consumption for transporting biomass residues after the project starts must be measured. The measured consumption is multiplied by their respective emission factors.

$\boldsymbol{PE_y}$ = $PE_{elec,y}$ (Emision with electricity consumption) + $PE_{i,y}$ (Emision with fuel consumption)

$= (PC_y \times EF_{BL,y}) + (PC_{i,y} \times NCV_i \times COEF_i)$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission: GHG emission after the project starts ($t\text{-}CO_2/y$)
Input	PC_y	Electricity consumption after the project starts in year y (MWh/y)
	$EF_{BL,y}$	CO_2 emissions factor per electric power grid supply($t\text{-}CO_2/MWh$)
	$PC_{i,y}$	Fuel consumption i after the project starts in year y (kL, m^3, t etc./y)
	NCV_i	Net calorific value of fuel i (GJ/kL, m^3, t etc.)
	$COEF_i$	CO_2 emission factor of fuel i ($t\text{-}CO_2/TJ$)

4. Data Required for Estimation and Monitoring

Data Type		Description of Data	Data acquisition methods: Baseline Emissions: Before the Project Starts	Baseline Emissions: After Project Completion	Project Emissions: Before the Project Starts	Project Emissions: After Project Completion
Amount of electricity power supply with biomass residues(After : $EG_{PJ,y}$)		Amount of electricity power supply without the project(MWh/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
CO_2 emission factor(Before : $EF_{BL,y}$)	Either higher rate of factor in the case where the plant is currently owned or has plan to install private generating facilities					
	CO_2 emissions factor of electricity	Emissions factor of a typical power plants ($t\text{-}CO_2/MWh$)	Data availability is validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned ii) Published values in the target country			
	CO_2 emission factor in private generating facilities	CO_2 emission factor of every fuel type ($t\text{-}CO_2/TJ$)	Interview with power management entity			
	CO_2 emission factor supplying to the grid in the case where the plant is currently not owned or has no plan to install private generating facilities.					

(Continuation)

Data type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of heat with biomass residues (After： $HG_{PJ,y}$)		Amount of heat by the project activity (TJ/y)	Planned data	Measured data	(Not necessary because data is not involved in the calculation)	
CO_2 emission factor(Before：$EF_{heat,y}$)	Before：EF_{CO2}	CO_2 emission factor of the boiler fuel consumption without the project (t-CO_2/TJ)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)		(Not necessary because data is not involved in the calculation)	
	Heat efficiency (η_{EP})	Heat efficiency form boiler(%)	Data availability is validated in the following order: i) Unique data from interview with power management entity ii) Monitoring data of similar case			
	Heat ratio (*ws*)	Rate of total heat from boiler without the project to heat capacity with biomass residues	Heat capacity with biomass residues equal to heat capacity from boiler without the project The ratio is "1".			
Amount of electricity consumption by the project activity (After：$PC_{,y}$)		Amount of electricity consumption by the project activity (MWh/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Amount of fuel consumption by the project activity (After：$PC_{i,y}$)		Amount of fuel consumption by the project activity for every fuel type (kL/y、m^3/y、t/y)	(Not necessary because data is not involved in the calculation)		Planned data	Measured data
Other factors	Net calorific value of each fuel type (NCV_i)	net calorific value of each fuel type (GJ/kL, m^3,t)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Unique data from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-2, 3)			
	CO_2 emission factor of each fuel type($COEF_i$)	CO_2 emission factor of each fuel type (t-CO_2/TJ)				

5.Others

(1) Project Boundary

The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented and areas where biomass residues are generated.

(2) Leakage

Higher efficiency at fossil fuel fired power plants: the indirect emissions that potentially lead to leakage due to activities such as product manufacturing or materials transport. This corresponding emission is temporary and negligible considering the project scale. Therefore, it can be ignored.

Whereas cereal crops potential for biomass fuel by plantation are used instead of biomass residues, GHG emissions (from fertilization, transportation etc.) are calculated with plantation as leakage and subtracted from reduction (reduced emission by biomass residues).

(3) Reviewed methodologies and major differences

1) ACM0006 (Ver.11.1): Consolidated Methodology for Electricity and Heat Generation from Biomass Residues

【Differences】

・ In the reviewed methodology, the implementation of the project does not result in an increase of the processing capacity of raw materials such as sugar, rice, and lumber. The formula in this methodology excludes these conditions.

- Baseline emission in the reviewed methodology includes emissions from decayed and artificially fired biomass residues. However, the formula in this methodology excludes such emission because biomass residues are preserved under aerobic conditions to prevent the generation of methane¥.
- There are two ways to compute project emission from transporting biomass residues in the reviewed methodology. One is to compute from distance and transportation frequency, and the other is to compute from the quantity of fuel consumption. The latter is applied to the formula in this methodology for simplification.
- Project emission in the reviewed methodology includes methane emission from biomass residues, water discharge and production process of biogas. This corresponding emission is temporary and negligible compared to the project scale. Therefore, it can be ignored.
- GHG emissions may increase outside the project boundary because fossil fuel consumption and other emission sources may increase to compensate the biomass residues fuel which are moved to the project boundary. With regard to leakage, the reviewed methodology requires to prove that the above potential emission increase does not influence the emissions outside of the project boundary. However, the formula in this methodology excludes these conditions.

2) AMS-I.D.(Ver. 16.0): Grid Connected Renewable Electricity Generation

【Differences】

- Reviewed methodology is applied to power supply from renewable energy at 15 MW or less. However, the handbook does not restrict scale capacity.
- Baseline emission in the reviewed methodology is computed by multiplying the electricity supplied by the project activity, with the CO_2 emission factor of grid (*1). In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily.
- In the reviewed methodology, if the power plants are transferred from other projects or existing plants are transferred to other projects, leakage should be considered. However, this methodology excludes these conditions.
- GHG emissions may increase outside the project boundary because fossil fuel consumption or other emission sources may increase to compensate the biomass residues fuel which are moved to the project boundary. With regard to leakage, the reviewed methodology requires to prove that the potential increase in emission does not influence the emissions outside the project boundary. However, the formula in this methodology excludes these conditions.

*1: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM).

3) J-MRV001: Methodology for the Power and Heat Supply Projects using Biomass Residue (Revised on February 2011)

【Differences】

- Any of the methods on data acquisition can be selected from the reviewed methodology where several methods are available. However, this methodology clearly defines the selection priority.
- It is unclear that emissions from the transportation of biomass residues is included in the project emission of the reviewed methodology. However, the formula in this methodology includes emission generated by transportation.
- In the reviewed methodology, the CO_2 emission factor of the electricity is the average of all power plants in the target country. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily.

  The reviewed methodology excludes the leakage potential unless there are great influences. This methodology also excludes the leakage in the same manner.

Annex Table C-1 County-specific CO_2 emission factor of grid power (1)

Region	Country	Local Region	Carbon Emission Factor			Source ／ PDD Title	Registration Date	Carbon Emission Factor			Source ／ PDD Title	Registration Date
			OM[1]	BM[2]	CM[3]			OM[1]	BM[2]	CM[3]		
Published Values in the Target Country												
Asian and Oceanian	China	North China	1.007	0.780	0.894	China'sRegional Grid Baseline Emission Factors 2009 (Chinese Version), Department of Climate Change,NDRC http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=3840	2009/9/3	1.033	0.649	0.840	Institute for Global Environmental Strategies	2011/4/23
		North East Chine	1.129	0.724	0.927							
		East Chine	0.883	0.683	0.783							
		Central Chine	1.126	0.580	0.853							
		North West Chine	1.025	0.643	0.834							
		South Chine	0.999	0.577	0.788							
		Hainan Province	0.815	0.730	0.773							
	India	India	0.980	0.800	0.890	Baseline Carbon Dioxide Emission Database Version 6.0 - LATEST Central Electricity Authority, Ministry of Power, Government of India http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm	2010/3/11	1.009	0.598	0.906	Institute for Global Environmental Strategies	2011/4/9
		NEWNE	0.990	0.810	0.900							
		South	0.940	0.760	0.850							
	Indonesia	Sumatera	-	-	0.743	Baseline Emission Factor (Updated) http://dna-cdm.menlh.go.id/id/database/	2009/2/13	0.873	0.560	0.717	Institute for Global Environmental Strategies	2011/2/12
		JAMALI	-	-	0.891							
	Malaysia	Peninsular Malaysia	0.603	0.741	0.672	Study on Grid Connected Electricity Baselines in Malaysia Year:2008, CDM Baseline 2008(339KB), CDM Energy Secretariat http://cdm.eib.org.my/subindex.php?menu=9&submenu=85	2010/3/1	0.828	0.844	0.836	Institute for Global Environmental Strategies	2011/2/26
		Sarawak	0.813	0.837	0.825							
		Sabah	0.705	0.597	0.651							
Latin America and Caribbean	Argentina	Argentina	0.516	0.335	0.425	MODELO DE CALCULO DEL FACTOR DE EMISIONES DE CO2 DE LA RED, ARGENTINA DE ENERGIA ELECTRICA. A NO 2006. http://www.ambiente.gov.ar/?idarticulo=7362	2007/8/22	0.484	0.362	0.423	Institute for Global Environmental Strategies	2010/12/18
Kyoto Mechanisms												
Asian and Oceanian	Republic of Korea	—	0.682	0.393	0.610	3MW Shinan Wind power project	2010/4/18	0.682	0.394	0.610	Institute for Global Environmental Strategies	2011/2/4
	Mongol	—	1.050	1.070	1.060	Durgun hydropower project in Mongolia	2007/3/23	1.150	1.170	—	Institute for Global Environmental Strategies	2009
	Bangladesh	—	0.670	0.712	0.691	Composting of Organic Waste in Dhaka	2006/5/18	0.670	0.712	0.691	Institute for Global Environmental Strategies	2006/5/18
	Bhutan,India	—	1.160	0.850	1.004	Dagachhu Hydropower Project, Bhutan	2010/2/26	1.160	0.850	1.004	Institute for Global Environmental Strategies	2010/2/10
	Philippines	—	0.549	0.329	0.439	Republic Cement Corporation – Teresa Plant Waste Heat Recovery Project	2011/3/29	0.549	0.329	0.439	Institute for Global Environmental Strategies	2011/3/29
	Vietnam	—	0.635	0.502	0.568	Lao Cai - Lai Chau - Kontum Bundled Hydropower Project	2011/3/24	0.620	0.451	0.536	Institute for Global Environmental Strategies	2011/4/8
	Thailand	—	0.512	0.546	0.529	UB Tapioca Starch Wastewater Treatment Project	2011/3/22	0.507	0.554	0.530	Institute for Global Environmental Strategies	2011/4/9
	Sri Lanka	—	0.707	0.646	0.677	Adavikanda, Kuruwita Division Mini Hydro Power Project	2010/8/24	0.707	0.646	0.677	Institute for Global Environmental Strategies	2010/8/24
	Pakistan	—	0.724	0.242	0.483	Biogas-based Cogeneration Project at Shakarganj Mills Ltd., Jhang, Pakistan	2010/12/2	0.724	0.242	0.483	Institute for Global Environmental Strategies	2010/12/2
Central-Eastern Europe,Central Asia	United Arab Emirates	—	0.938	0.708	0.881	Abu Dhabi solar thermal power project, Masdar	2009/8/13	0.938	0.708	0.881	Institute for Global Environmental Strategies	2009/8/13
	Uzbekistan	—	-	-	0.617	Akhangaran Landfill Gas Capture Project in Tashkent	2009/12/19				Institute for Global Environmental Strategies	
	Israel	—	0.797	0.695	0.746	Evlayim Landfill Project	2011/2/12	0.797	0.695	0.746	Institute for Global Environmental Strategies	2011/2/12
Latin America and Caribbean	Brasil	—	0.487	0.078	0.282	CDM project of Moinho and Barracao Small Hydropower Plant	2010/1/11	0.291	0.078	0.184	Institute for Global Environmental Strategies	2011/1/12
	Columbia	—	0.469	0.237	0.353	Amaime Minor Hydroelectric Power Plant	2009/10/29	0.471	0.212	0.342	Institute for Global Environmental Strategies	2011/1/17
	Uruguay	—	0.338	0.181	0.259	Fray Bentos Biomass Power Generation Project (FBBP Project)	2008/5/8	0.580	0.733	0.618	Institute for Global Environmental Strategies	2011/1/29
	Bolivia	—	0.730	0.349	0.540	Conversion of existing open cycle gas turbine to combined cycle at Guaracachi power station, Santa Cruz, Bolivia	2010/4/13	0.730	0.349	0.540	Institute for Global Environmental Strategies	2010/4/13
	Argentina	—	0.510	0.347	0.429	Biogas recovery and Thermal Power production at CITRUSVIL Citric Plant in Tucumán, Argentina	2010/12/1					
	Chile	—	0.718	0.490	0.604	Trueno River Hydroelectric Power Plant	2011/4/1	0.718	0.490	0.604	Institute for Global Environmental Strategies	2011/4/9
	Costa Rica	—	0.485	0.098	0.388	Guanacaste Wind Farm	2011/2/11	0.485	0.098	0.388	Institute for Global Environmental Strategies	2011/2/11
	Honduras	—	0.629	0.559	0.594	Mezapa Small-Scale Hydroelectric Project	2011/2/8	0.629	0.559	0.594	Institute for Global Environmental Strategies	2010/3/8
	Ecuador	—	0.732	0.389	0.646	Landfill biogas extraction and combustion plant in El Inga I and II landfill (Quito, Ecuador)	2011/1/8	0.731	0.548	0.640	Institute for Global Environmental Strategies	2011/1/22
	Mexico	—	0.715	0.347	0.531	Alternative fuels and biomass project at Zapotiltic cement plant	2010/12/25	0.704	0.375	0.539	Institute for Global Environmental Strategies	2011/1/4
	Peru	—	0.720	0.480	0.600	Yanapampa Hydroelectric Power Plant	2010/12/18	0.720	0.480	0.600	Institute for Global Environmental Strategies	2010/12/18
	Dominican Republic	—	0.619	0.444	0.532	Bionersis project on La Duquesa landfill, Dominican Republic	2010/4/9	0.619	0.444	0.532	Institute for Global Environmental Strategies	2010/4/8
	El Salvador	—	0.716	0.718	0.717	El Chaparral Hydroelectric Project (El Salvador)	2010/3/1	0.716	0.718	0.717	Institute for Global Environmental Strategies	2010/3/1
Africa	Morocco	—	0.734	0.752	0.743	Essaouira wind power project	2005/10/29	0.734	0.752	0.743	Institute for Global Environmental Strategies	2005/10/29
	Kenya	—	0.710	0.480	0.600	Olkaria III Phase 2 Geothermal Expansion Project in Kenya	2010/3/4	0.761	0.426	0.594	Institute for Global Environmental Strategies	2010/12/4
	South Africa	—	0.990	1.050	1.020	Bethlehem Hydroelectric project	2009/10/8	0.990	1.050	1.020	Institute for Global Environmental Strategies	2010/10/26
	Uganda	—	0.569	0.677	0.623	Bugoye 13.0 MW Run-of-River Hydropower Project	2011/1/1	0.569	0.677	0.623	Institute for Global Environmental Strategies	2011/1/1
	Senegal	—	0.701	0.651	0.676	Energy efficiency improvement Project of CSS sugar mill	2010/12/28	0.701	0.651	0.676	Institute for Global Environmental Strategies	2010/12/28
	Nigeria	—	0.670	0.580	0.630	Municipal Solid Waste (MSW) Composting Project in Ikorodu, Lagos State	2010/12/15	0.670	0.580	0.630	Institute for Global Environmental Strategies	2010/12/15
	Egypt	—	0.557	0.428	0.525	Zafarana 8 - Wind Power Plant Project, Arab Republic of Egypt	2010/9/23	0.557	0.428	0.525	Institute for Global Environmental Strategies	2010/9/23
	Madagascar	—	0.518	0.579	0.548	Small-Scale Hydropower Project Sahanivotry in Madagascar	2010/8/28	0.518	0.579	0.548	Institute for Global Environmental Strategies	2010/8/28
	Rwanda	—	0.661	0.647	0.654	Rwanda Electrogaz Compact Fluorescent Lamp (CFL) distribution project	2010/5/30	0.661	0.647	0.654	Institute for Global Environmental Strategies	2010/5/30

Annex Table C-1 County-specific CO_2 emission factor of grid power (2)

Region	Country	Local Region	Carbon Emission Factor			Source ／PDD Title	Latest Year	Carbon Emission Factor			Source ／PDD Title	Registration Date
			OM[1]	BM[2]	CM[3]			OM[1]	BM[2]	CM[3]		
International Energy Agency												
Asian and Oceanian	Brunei	–	–	–	0.755	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cambodia	–	–	–	1.160	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Taiwan	–	–	–	0.650	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	North Korea	–	–	–	0.481	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Myanmar	–	–	–	0.285	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Nepal	–	–	–	0.003	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Singapore	–	–	–	0.531	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.502	0.411	–	Institute for Global Environmental Strategies	2010
	Fiji	–	–	–	–	–	–	0.660	0.650	0.656	Institute for Global Environmental Strategies	2005/10/1
	Papua New Guinea	–	–	–	–	–	–	0.704	0.653	0.679	Institute for Global Environmental Strategies	2006/5/29
Middle East	Bahrain	–	–	–	0.651	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Iran	–	–	–	0.582	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Iraq	–	–	–	0.812	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Jordan	–	–	–	0.589	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.675	0.551	0.613	Institute for Global Environmental Strategies	2009/12/11
	Kuwait	–	–	–	0.614	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Lebanon	–	–	–	0.705	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Oman	–	–	–	0.858	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Qatar	–	–	–	0.534	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Saudi Arabia	–	–	–	0.754	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Syria	–	–	–	0.613	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Yemen	–	–	–	0.636	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
Europe	Albania	–	–	–	0.014	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Bosnia and Herzegovina	–	–	–	0.928	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Bulgaria	–	–	–	0.489	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Croatia	–	–	–	0.341	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cyprus	–	–	–	0.759	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.846	0.735	0.818	Institute for Global Environmental Strategies	2010/2/7
	Gibraltar	–	–	–	0.757	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Macedonia	–	–	–	0.786	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.772	1.004	0.888	Institute for Global Environmental Strategies	2009/12/4
	Malta	–	–	–	0.849	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Romania	–	–	–	0.417	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Serbia	–	–	–	0.671	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Slovenia	–	–	–	0.329	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
Former Soviet Union	Armenia	–	–	–	0.165	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.535	0.398	0.437	Institute for Global Environmental Strategies	2009/7/10
	Azerbaijan	–	–	–	0.416	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Belarus	–	–	–	0.303	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Estonia	–	–	–	0.752	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Georgia	–	–	–	0.081	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	–	–	0.093	Institute for Global Environmental Strategies	2007/4/6
	Kazakhstan	–	–	–	0.439	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Kyrgyzstan	–	–	–	0.094	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Latvia	–	–	–	0.162	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Lithuania	–	–	–	0.114	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Moldova	–	–	–	0.468	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Russia	–	–	–	0.326	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Tajikistan	–	–	–	0.031	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Turkmenistan	–	–	–	0.795	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Ukraine	–	–	–	0.386	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
Latin America and Caribbean	Cuba	–	–	–	0.913	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.808	0.875	0.841	Institute for Global Environmental Strategies	2009/2/27
	Guatemala	–	–	–	0.336	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.811	0.468	0.640	Institute for Global Environmental Strategies	2008/12/23
	Haiti	–	–	–	0.480	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Jamaica	–	–	–	0.785	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.893	0.776	0.834	Institute for Global Environmental Strategies	2006/3/19
	Antilles	–	–	–	0.707	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Nicaragua	–	–	–	0.477	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.754	0.589	0.713	Institute for Global Environmental Strategies	2009/4/12
	Panama	–	–	–	0.273	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.713	0.503	0.660	Institute for Global Environmental Strategies	2009/2/23
	Trinidad and Tobago	–	–	–	0.687	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Venezuela	–	–	–	0.203	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Guyana	–	–	–	–	–	–	0.948	–	0.948	Institute for Global Environmental Strategies	2008/5/4

Annex Table C-1 County-specific CO_2 emission factor of grid power (3)

Region	Country	Local Region	Carbon Emission Factor			Source ／ PDD Title	Latest Year	Carbon Emission Factor			Source ／ PDD Title	Registration Date
			OM[1]	BM[2]	CM[3]			OM[1]	BM[2]	CM[3]		
International Energy Agency												
Africa	Algeria	—	—	—	0.596	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Angora	—	—	—	0.038	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Benin	—	—	—	0.697	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Botswana	—	—	—	1.789	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cameroon	—	—	—	0.230	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Congo	—	—	—	0.108	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cote d'Ivoire	—	—	—	0.449	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.713	0.661	0.687	Institute for Global Environmental Strategies	2010/11/25
	Eritrea	—	—	—	0.669	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Ethiopia	—	—	—	0.119	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Gabon	—	—	—	0.401	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Ghana	—	—	—	0.214	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Libya	—	—	—	0.885	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Morocco	—	—	—	0.718	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Mozambique	—	—	—	0.000	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Namibia	—	—	—	0.424	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Sudan	—	—	—	0.609	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Tanzania	—	—	—	0.242	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Togo	—	—	—	0.206	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Tunisia	—	—	—	0.522	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Zambia	—	—	—	0.003	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Zimbabwe	—	—	—	0.619	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Mali,Senegal,Mauritania	—	—	—	—	—	—	0.518	0.647	0.582	Institute for Global Environmental Strategies	2010/5/6

1) OM:Operating Margin Emission factor of existing plants
2) BM:Build Margin Emission factor of plants built recently
3) CM: Combined margin Average of emission factor of OM and BM

Annex Table C-2 IPCC default of Net calorific value (NCV_i) of each fuel type[1]

TABLE 1.2
DEFAULT NET CALORIFIC VALUES (NCVS) AND LOWER AND UPPER LIMITS OF THE 95% CONFIDENCE INTERVALS[1]

Fuel type English description		Net calorific value (TJ/Gg)	Lower	Upper
Crude Oil		42.3	40.1	44.8
Orimulsion		27.5	27.5	28.3
Natural Gas Liquids		44.2	40.9	46.9
Gasoline	Motor Gasoline	44.3	42.5	44.8
	Aviation Gasoline	44.3	42.5	44.8
	Jet Gasoline	44.3	42.5	44.8
Jet Kerosene		44.1	42.0	45.0
Other Kerosene		43.8	42.4	45.2
Shale Oil		38.1	32.1	45.2
Gas/Diesel Oil		43.0	41.4	43.3
Residual Fuel Oil		40.4	39.8	41.7
Liquefied Petroleum Gases		47.3	44.8	52.2
Ethane		46.4	44.9	48.8
Naphtha		44.5	41.8	46.5
Bitumen		40.2	33.5	41.2
Lubricants		40.2	33.5	42.3
Petroleum Coke		32.5	29.7	41.9
Refinery Feedstocks		43.0	36.3	46.4
Other Oil	Refinery Gas[2]	49.5	47.5	50.6
	Paraffin Waxes	40.2	33.7	48.2
	White Spirit and SBP	40.2	33.7	48.2
	Other Petroleum Products	40.2	33.7	48.2
Anthracite		26.7	21.6	32.2
Coking Coal		28.2	24.0	31.0
Other Bituminous Coal		25.8	19.9	30.5
Sub-Bituminous Coal		18.9	11.5	26.0
Lignite		11.9	5.50	21.6
Oil Shale and Tar Sands		8.9	7.1	11.1
Brown Coal Briquettes		20.7	15.1	32.0
Patent Fuel		20.7	15.1	32.0
Coke	Coke Oven Coke and Lignite Coke	28.2	25.1	30.2
	Gas Coke	28.2	25.1	30.2
Coal Tar[3]		28.0	14.1	55.0
Derived Gases	Gas Works Gas[4]	38.7	19.6	77.0
	Coke Oven Gas[5]	38.7	19.6	77.0
	Blast Furnace Gas[6]	2.47	1.20	5.00
	Oxygen Steel Furnace Gas[7]	7.06	3.80	15.0
Natural Gas		48.0	46.5	50.4
Municipal Wastes (non-biomass fraction)		10	7	18
Industrial Wastes		NA	NA	NA
Waste Oil[8]		40.2	20.3	80.0
Peat		9.76	7.80	12.5

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy Table1.2
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Annex Table C-3 IPCC default Co2 emission factors per electric grid power supply ($COEF_i$) of each fuel type[2]

TABLE 2.2
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Aviation Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Jet Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Jet Kerosene		r 71 500	69 700	74 400	r 3	1	10	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	r 3	1	10	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	r 3	1	10	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	r 3	1	10	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	r 3	1	10	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	r 1	0.3	3	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	r 1	0.3	3	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	r 3	1	10	0.6	0.2	2
Bitumen		80 700	73 000	89 900	r 3	1	10	0.6	0.2	2
Lubricants		73 300	71 900	75 200	r 3	1	10	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	r 3	1	10	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	r 3	1	10	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	r 1	0.3	3	0.1	0.03	0.3
Other Oil	Paraffin Waxes	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	White Spirit and SBP	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	Other Petroleum Products	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Anthracite		98 300	94 600	101 000	1	0.3	3	r 1.5	0.5	5
Coking Coal		94 600	87 300	101 000	1	0.3	3	r 1. 5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	1	0.3	3	r 1. 5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	1	0.3	3	r 1.5	0.5	5
Lignite		101 000	90 900	115 000	1	0.3	3	r 1. 5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	1	0.3	3	r 1. 5	0.5	5
Brown Coal Briquettes		97 500	87 300	109 000	n 1	0.3	3	r 1. 5	0.5	5
Patent Fuel		97 500	87 300	109 000	1	0.3	3	n 1. 5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	1	0.3	3	r 1. 5	0.5	5
Coke	Gas Coke	r 107 000	95 700	119 000	r 1	0.3	3	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 1	0.3	3	r 1. 5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	n 1	0.3	3	0.1	0.03	0.3
Derived Gases	Coke Oven Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Blast Furnace Gas	n 260 000	219 000	308 000	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	r 1	0.3	3	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	1	0.3	3	0.1	0.03	0.3

[2] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy Table2.2, Table2.3
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

TABLE 2.2 (CONTINUED)
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	30	10	100	4	1.5	15
Industrial Wastes		n 143 000	110 000	183 000	30	10	100	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	30	10	100	4	1.5	15
Peat		106 000	100 000	108 000	n 1	0.3	3	n 1.5	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	30	10	100	4	1.5	15
Solid Biofuels	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
Solid Biofuels	Other Primary Solid Biomass	n 100 000	84 700	117 000	30	10	100	4	1.5	15
Solid Biofuels	Charcoal	n 112 000	95 000	132 000	200	70	600	4	1.5	15
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
Liquid Biofuels	Biodiesels	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
Liquid Biofuels	Other Liquid Biofuels	n 79 600	67 100	95 300	r 3	1	10	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Gas Biomass	Sludge Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Gas Biomass	Other Biogas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n 100 000	84 700	117 000	30	10	100	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

TABLE 2.3
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Aviation Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Jet Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Jet Kerosene		71 500	69 700	74 400	r 3	1	10	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	r 3	1	10	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	r 3	1	10	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	r 3	1	10	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	r 3	1	10	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	r 1	0.3	3	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	r 1	0.3	3	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	r 3	1	10	0.6	0.2	2
Bitumen		80 700	73 000	89 900	r 3	1	10	0.6	0.2	2
Lubricants		73 300	71 900	75 200	r 3	1	10	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	r 3	1	10	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	r 3	1	10	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	r 1	0.3	3	0.1	0.03	0.3
Other Oil	Paraffin Waxes	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	White Spirit and SBP	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	Other Petroleum Products	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Anthracite		98 300	94 600	101 000	10	3	30	r 1.5	0.5	5
Coking Coal		94 600	87 300	101 000	10	3	30	r 1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	10	3	30	r 1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	10	3	30	r 1.5	0.5	5
Lignite		101 000	90 900	115 000	10	3	30	r 1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	10	3	30	r 1.5	0.5	5
Brown Coal Briquettes		n 97 500	87 300	109 000	n 10	3	30	n 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	10	3	30	r 1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	10	3	30	r 1.5	0.5	5
Coke	Gas Coke	r 107 000	95 700	119 000	r 1	0.3	3	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 10	3	30	n 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Coke Oven Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Blast Furnace Gas	n260 000	219 000	308 000	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	r 1	0.3	3	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	r 1	0.3	3	0.1	0.03	0.3

TABLE 2.3 (CONTINUED)
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	30	10	100	4	1.5	15
Industrial Wastes		n143 000	110 000	183 000	30	10	100	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	30	10	100	4	1.5	15
Peat		106 000	100 000	108 000	n 2	0.6	6	n 1.5	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	30	10	100	4	1.5	15
	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
	Other Primary Solid Biomass	n 100 000	84 700	117 000	30	10	100	4	1.5	15
	Charcoal	n 112 000	95 000	132 000	200	70	600	4	1.5	15
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Biodiesels	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Other Liquid Biofuels	n 79 600	67 100	95 300	r 3	1	10	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Sludge Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Other Biogas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n100 000	84 700	117 000	30	10	100	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

Annex Table C-4 Calculation of CO_2 emissions factor for electric power supplied in grid when values are not publicly available[3]

When CO_2 emissions factor is not publicly available for electric power supplied in grid, it should be calculated in the following formula using annual electric output, fuel seeds, annual fuel consumption, fuel unit heat output, and caloric CO_2 emissions factor of all grid-connected power plants in the target country.

$$EF_{BL,y} = \frac{\sum_{\mathrm{m}} EG_{m,y} \times EF_{m,y}}{\sum_{\mathrm{m}} EG_{m,y}}$$

m : all power plants in the target country

$EG_{m,y}$: total of annual electric output (transmission) of power plants m (MWh)

$EF_{m,y}$: CO_2 emissions factor per unit power output of power plants m (t-CO_2/ MWh)

$EF_{m,y}$ is calculated in the following formula.

$$EF_{m,y} = \frac{\sum_{\mathrm{i}} FC_{i,m,y} \times NCV_i \times COEF_i}{EG_{m,y}}$$

$FC_{i,m,,y}$: annual fuel consumption of power plants m (kL, m^3, t/y)

NCVi : unit heat output for fuel type i (GJ/kL, m^3, t)

COEFi : caloric CO_2 emissions factor for fuel type i (t-CO_2/TJ)

[3] UNFCCC :http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.0.pdf

Annex Table C-5 Calculation of leakage resulted from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution[4]

The following two emission sources shall be considered for leakage resulted from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution.

- Fugitive CH_4 emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity.
- In the case LNG is used in the project plant, CO_2 emissions from fuel combustion/ electricity consumption associated with the liquefaction, transportation, re-gasification, and compression into a natural gas transmission or distribution system.
- Thus, leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y}$$

LE_y : Leakage emissions during the year y (t-CO_2/y)

$LE_{CH4,y}$: Leakage emissions due to fugitive upstream CH_4 emissions in the year y (t-CO_2/y)

$LE_{LNG,CO2,y}$: Leakage emissions due to fossil fuel combustion/ electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into natural gas transmission or distribution system during the year y (t-CO_2/y)

$LE_{CH4,y}$ calculation

CH_4 leakage emissions associated with fuel production, one should multiply the quantity of natural gas consumed in the project by CH_4 emission factor for these upstream emissions, and subtract for fuel types which would be used in the absence of the project activity the fuel quantities multiplied by respective CH_4 emission factors.

$$LE_{CH4,y} = [FC_{PJ,y} \times NCV_{NG} \times EF_{NG,upstream,CH4} - \sum FC_{BL,i,y} \times NCV_i \times EF_{i,upstream,CH4}] \times GWP_{CH4}$$

$FC_{PJ,y}$: Natural gas quantity combusted in the all element processes during the year y (m^3)

NCV_{NG} : Average net calorific value of natural gas (GJ/ m^3)

$EF_{NG,upstream,CH4}$: Emission factor for upstream fugitive CH_4 emissions from production, transportation and distribution of natural gas (t-CH_4/PJ)

$FC_{BL,i,y}$: Quantity of fuel type i that would be combusted in the absence of the project activity in all element process (kL, t)

NCV_i : Average net calorific value of the fuel type i (GJ/kL, t)

$EF_{i,upstream,CH4}$: Emission factor for upstream fugitive CH_4 emissions from production of fuel type i (t-CH_4/PJ)

GWP_{CH4} : Global warming potential of CH_4 (－)

Data type	Description	Data acquisition method
Quantity of natural gas ($FC_{PJ,y}$)	Quantity of natural gas combusted in the all element processes in the year y (m^3)	This data is specific to the target country; data should be validated in the following order to use. i) Interview to parties concerned ii) Project design value
Average net calorific value (NCV_i)	Average net calorific value of natural gas (GJ/ m^3) Average net calorific value of fuel type i (GJ/kL, t)	Data specific to the target project should be used for calculation. Data should be validated in the following order to used. i) Project-specific data acquired through interview to electric power company ii) Publicized values in the target country iii) IPCC guideline, default values (see Annex Table C-2)
Emission factor for CH_4 leakage emissions ($EF_{i,upstream,CH4}$)	Emission factor for upstream CH_4 emissions from production, transportation and distribution (t-CH_4/PJ) Emission factor for upstream CH_4 emissions from production of fuel type i (t-CH_4/PJ)	See Annex Table C-6
Global warming potential	Global warming potential for CH_4 (－)	21

[4]UNFCCC:http://cdm.unfccc.int/filestorage/K/4/P/K4P3YG4TNQ5ECFNA8MBK2QSMR6HTEM/Consolidated%20methodology%20for%20industrial%20fuel%20switching%20from%20coal%20or%20petroleum%20fuels%20to%20natural%20gas.pdf?t=Sm98MTMwODYzODQ0Ni43Mg==|sIB62MGPb49uM001aAJzL50hppM=

$LE_{LNG,CO2,y}$ Calculation

CO_2 emissions from fuel combustion/ electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system should be calculated in the following formula by multiplying the quantity of natural gas combusted in the project by an appropriate emission factor.

$$LE_{LNG,CO2,y} = FC_{PJ,y} \times NCV_{LNG} \times EF_{upstream,LNG}$$

$FC_{PJ,y}$: Quantity of natural gas combusted in all element processes during the year y (m^3)

NCV_{LNG} : Average net calorific value for LNG (GJ/m^3)

$EF_{upstream,LNG}$: Emission factor for upstream CO_2 emissions due to fossil fuel combustion/ electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($t\text{-}CO_2/TJ$)

Data type	Description	Data acquisition method
Quantity of natural gas ($FC_{PJ,y}$)	Quantity of natural gas combusted in all element processes during the year y (m^3)	This data is specific to the target project. Data should be validated in the following order to use. i) Interview to parties concerned ii) Project design values
Average net calorific value (NCV_{LNG})	Average net calorific value for natural gas (GJ/ m^3)	Project-specific data/ information should be used for calculation preferably. Data should be validated in the following order to use. i) Project-specific data acquired through interview to electric power management entity. ii) Publicized values in the target country iii) Default values adopted in IPCC guideline (Annex C-2)
CO_2 emission factor for LNG ($EF_{upstream,LNG}$)	Emission factor for upstream CO_2 emissions from fossil fuel combustion/ electricity consumption associated with the liquefaction, transportation, re-gasification, and compression of LNG into a natural gas transmission or distribution system ($t\text{-}CO_2/TJ$)	Project-specific data/ information should be used for calculation preferably. If the data are hardly acquired from parties concerned, use the following default values (*1) for calculation. 6 ($t\text{-}CO_2/TJ$)

Source: Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas, UNFCCC （Translated by project team）

Sewerage, Urban Sanitation Sector

Sub-sector：

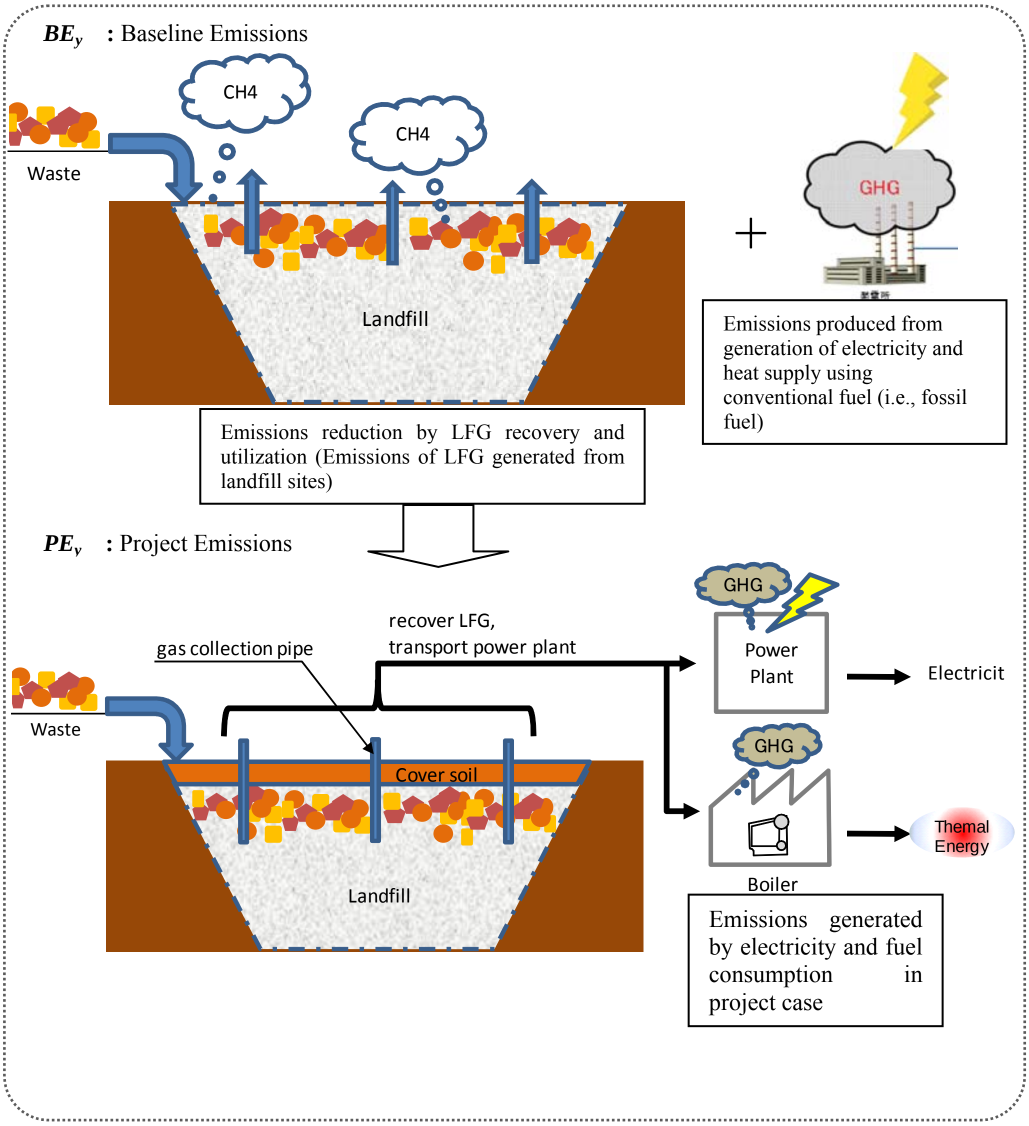
22. Landfill Disposal of Waste

23. Intermediate Treatment of Waste

24. Wastewater Treatment

25. Sewerage

1.Typical Project Outline	The project intends to reduce GHG emissions through recovery and utilization of landfill gas (LFG) generated from reclaimed or active landfill sites.
2.Applicability	○ The project should aim to recover LFG from anaerobic landfill, semi-aerobic landfill, etc. ○ The captured LFGs should be utilized for electricity and heat energy generation or flared. ○ The project should be implemented at reclaimed or active landfill sites.
3.Methodology on Emission Reduction	GHG emissions reduction through LFG recovery and utilization shall be determined as the difference between baseline emissions before project implementation (where methane in LFG is released to the atmosphere) and project emissions during LFG recovery operations. $$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$ ER_y : GHG emissions reduction in year 'y' achieved by the project (t-CO_2/y) BE_y : GHG emissions without LFG recovery in year 'y' (t-CO_2/y)(Baseline emission) PE_y : GHG emissions with LFG recovery and utilization for power generation in year 'y' (t-CO_2/y)(Project emission)



(1)Determination of baseline emission

The baseline emissions are comprised of uncaptured methane emitted to the atmosphere from landfill sites and the CO_2 emissions produced from generation of electric power, which with project activity will be replaced by electricity generated by LFG-fueled power plants.

$$\boldsymbol{BEy} = (MD_{PJ,y} - MD_{reg,y}) \times GWP_{CH4} + BE_{EN,y}$$

Type	Items	Description
Output	BE_y	Baseline Emissions: GHG emission from methane released to the atmosphere without LFG recovery (t- CO_2/y)
Input	$MD_{PJ,y}$	Methane (CH_4) recovered and destroyed after the project starts (t-CH_4/y) (≒CH_4 emission from landfill sites before the project starts)
	$MD_{reg,y}$	CH_4 quantity as required by National Regulations to be flared and combusted, before the project starts (t-CH_4/y) It shall be "0" where developing countries have very limited regulatory policies on CH_4 emissions.
	GWP_{CH4}	Methane Global Warming Potential (= 21 t-CO_2/t-CH_4)
	$BE_{EN,y}$	GHG emissions from generation of energy displaced by the project activity (t- CO_2/y)

Determination of $MD_{PJ,y}$

The $MD_{PJ,y}$ is computed from $LFG_{PJ,y}$, which is the combined emission quantities of LFG used for power generation, heat supply and decompose/combustion, modified by fraction CH_4 and CH_4 density, as shown in the following formula.

$$MD_{PJ,y}=LFG_{PJ,y}\times w_{Ch4,y}\times D_{CH4,y}$$

$LFG_{PJ,y}$: Total amount of LFG fed electricty generator and the boiler/air heater/heat generating equipment, the flare after the project starts(m^3)

$w_{Ch4,y}$: Fraction CH_4 in LFG recovered after the project starts(%)

$D_{CH4,y}$: Methane density(t-CH_4/m^3)

If the above data is not available during project planning process, the formula below can be used. CH_4 quantity from landfill (□ CH_4 quantity recovered and destroyed after the project started) shall be determined by monitoring the quantity of degradable organic carbon reclaimed in the landfill in consideration of decomposition rate.

$$MD_{PJ,y} = \Phi \times (1 - OX) \times \frac{16}{12} \times DOC_f \times MCF_p \times \sum_{x=1}^{y}\sum_{j}^{n} W_j \times DOC_j \times e^{-k_j(y-x)} \times (1 - e^{-k_j})$$

Φ : Model correction factor to account for model uncertainties

OX : Oxidation rate(-)

F : Fraction of CH_4 in LFG (-)

DOC_f : Fraction of degradable organic carbon (DOC) that can decompose (-)

MCF_p : CH_4 correction factor (-)

j : Waste type category (wood, paper, organics, fabric, yard waste)

W_j : Average annual quantity of the waste type j disposed in the SWDS before the project starts (t/y)

DOC_j : Fraction of degradable organic carbon (by weight) in the waste type j (-)

Wj shall be computed as follows:

$$W_j = W \times w_j$$

- W : Average annual quantity of the waste disposed in the SWDS before the project starts (t/y)
- w_j : Weight fraction of the waste type j in solid waste (weight basis)(%)

Determination of $MD_{reg,y}$

CH_4 quantity reduction by destroy and combustion, as required under National Regulations, before the project starts, shall be determined by multiplying the CH_4 quantity from landfill (MB_y) with the fraction of decomposed and combusted.

$$MD_{reg,y} = MD_{PJ,y} \times AF$$

- $MD_{PJ,y}$: CH_4 quantity recovered from landfill after the project started
- AF : CH_4 fraction required for flare and combustion under the National Regulations before the project starts (-) It shall be "0" where developing countries have very little regulation.

Determination of $BE_{EN,y}$

$BE_{EN,y}$ shall be determined by the quantity of electricity and thermal energy generated after the project started, and CO_2 baseline emission factors.

$$BE_{EN,y} = BE_{elec,y} + BE_{ther,y}$$

$$= EG_{d,y} \times CEF_d + \frac{Q_y}{\varepsilon_b \cdot NCV_{fuel}} \times EF_{fuel}$$

- $BE_{elec,y}$: Baseline emissions from electricity generated from utilizing LFG in the project activity and exported to the grid or displacing onsite/offsite fossil fuel (t-CO_2/y)
- $BE_{ther,y}$: Baseline emissions from thermal energy produced utilizing the LFG in the project activity displacing thermal energy from onsite/offsite fossil fuel-fueled boiler(t-CO_2/y)
- $EG_{d,y}$: Amount of electricity generated after the project starts(MWh/y)
- CEF_d : CO_2 emissions factor for the displaced electricity source in the project scenario (t-CO_2/MWh)
- Q_y : Amount of thermal energy generated after the project starts (TJ/y)
- ε_b : Energy efficiency of the boiler/air heater used in the absence of the project activity to generate the thermal energy(-) ε_b shall be "1" as conservative value.
- NCV_{fuel} : Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(GJ/kL, m^3, t, etc.)
- EF_{fuel} : Emission factor of the fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(t-CO_2/TJ)

(2)Project emission

The project emissions is comprised of the GHG emission from electricity and fuel consumption in the LFG recovery plants or power generating plants after the project starts as follows;

$$\boldsymbol{PE_y} = PE_{EC,y} + PE_{FC,j,y}$$

Type	Items	Description
Output	PE_y	GHG emission after the project start (t-CO_2/y)
Input	$PE_{EC,y}$	GHG emission from electricity consumption after the project started (t-CO_2/y)
	$PE_{FC,j,y}$	GHG emission from fossil fuel consumption after the project started (t-CO_2/y)

Determination of $PE_{EC,y}$

GHG emission from electric consumption after the project starts shall be calculated as follows:

$$PE_{EC,y} = EL_{PJ,y} \times EF_{PJ,y}$$

$EL_{PJ,y}$: Amount of electricity consumption after the project starts (MWh)

$EF_{PJ,y}$: CO_2 baseline emission factor per electric supply (t-CO_2/MWh)

Determination of $PE_{FC,j,y}$

GHG emission from fuel consumption after the project starts shall be calculated as follows:

$$PE_{FC,y} = \sum_i (FC_i \times NCV_i \times COEF_i)$$

FC_i : Amount of fuel consumption after the project starts (kL, m^3, t, etc./y)

NCV_i : Net calorific value of fuel i(GJ/kL、m^3、t etc.)

$COEF_i$: CO_2 emission factor per fuel (t-CO_2/TJ)

4.Data Required for Monitoring and Estimating Emission

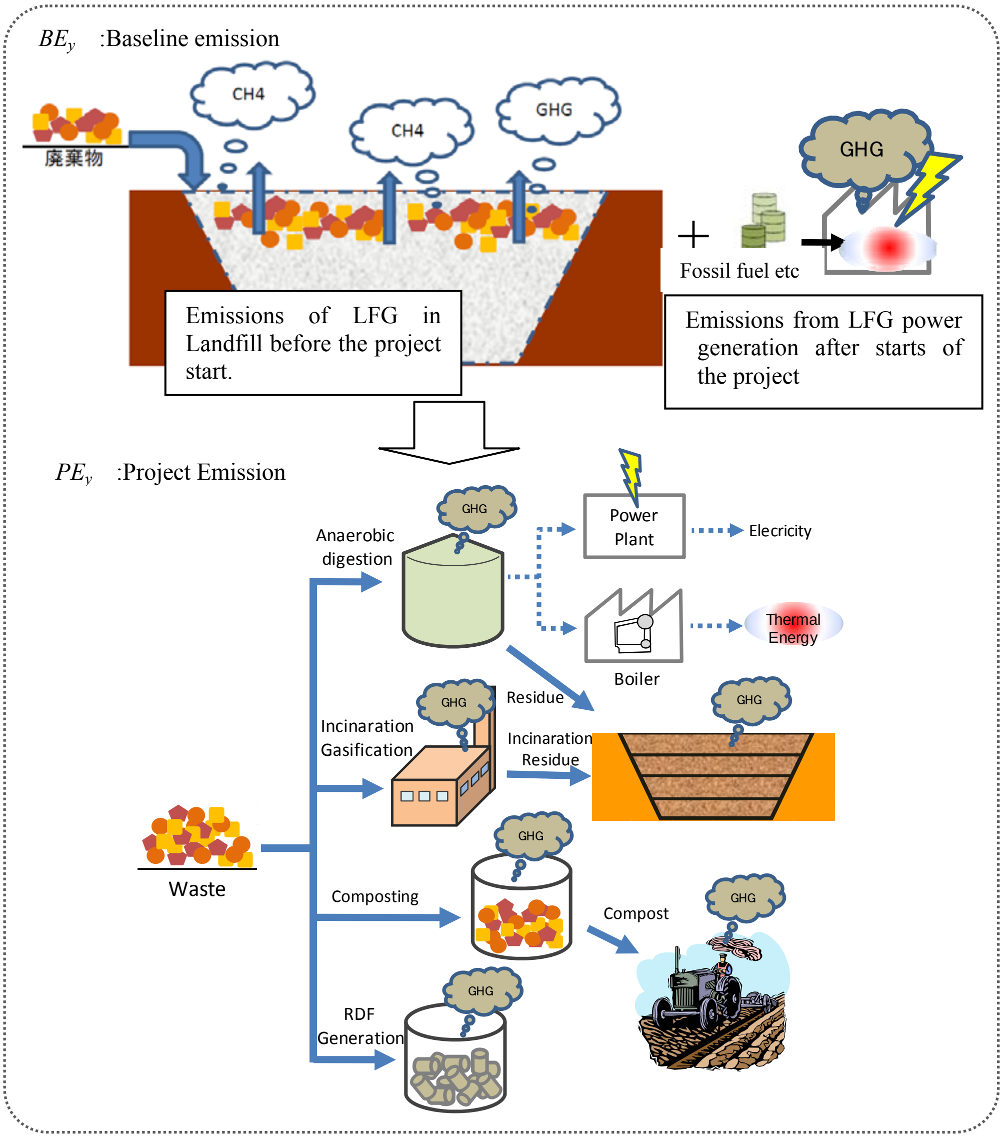
<table>
<tr><th colspan="2" rowspan="3">Data Type</th><th rowspan="3">Description of Data</th><th colspan="4">Data Acquisition Methods</th></tr>
<tr><th colspan="2">Baseline Emissions</th><th colspan="2">Project Emissions</th></tr>
<tr><th>Before the Project Starts</th><th>After Project Completion</th><th>Before the Project Starts</th><th>After Project Completion</th></tr>
<tr><td rowspan="3">Methane recovered and destroy</td><td>Quantity of LFG recovered and destroyed $LFG_{PJ,y}$</td><td>Quantity of LFG recovered and destroyed after the project starts（m^3）</td><td>Planned data</td><td>Monitoring data</td><td colspan="2" rowspan="11">(Not necessary because data is not involved in the calculation)</td></tr>
<tr><td>Average methane fraction of the LFG $w_{CH4,y}$</td><td>Average methane fraction of the LFG after the project starts（%）</td><td>Planned data</td><td>Monitoring data</td></tr>
<tr><td>Methane Density $D_{CH4,y}$</td><td>Methane density at temperature or pressure during recovery phase,（t-CH_4/m3）</td><td>Planned data</td><td>Monitoring data</td></tr>
<tr><td rowspan="8">Before: $MD_{PJ,y}$</td><td>Model correction factor to account for model uncertainties Φ</td><td>Model correction factor to account for model uncertainties（-）</td><td colspan="2">0.9
（default data of Methodological tool, "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"(ver.05)）</td></tr>
<tr><td>Decomposition rate of degradable organic carbon oxidation OX</td><td>oxidation rate（-）</td><td colspan="2">Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost.
Use 0 for other types of solid waste disposal sites
(IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table3.2)</td></tr>
<tr><td>Fraction of methane in LFG F</td><td>Fraction of methane in LFG from landfill（-）</td><td colspan="2">0.5
(IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)</td></tr>
<tr><td>Fraction of degradable organic carbon that can decompose, DOC_f</td><td>Fraction of degradable organic carbon (DOC) that can decompose（-）</td><td colspan="2">0.5
（2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste）</td></tr>
<tr><td>Methane correction factor, MCF_p</td><td>Methane correction factor（-）</td><td colspan="2">IPCC default data（Refer to Appendix D-1）</td></tr>
<tr><td>Fraction of degradable organic carbon in the waste type j, DOC_j</td><td>Fraction of degradable organic carbon (by weight) in the waste type j (-)</td><td colspan="2">Data availability is validated in the following order:
i) Data unique to the national or areas
ii) IPCC default data（Refer to Appendix D-2）</td></tr>
<tr><td>Decay rate k_j</td><td>Decay rate of waste j（-）</td><td colspan="2">Data availability is validated in the following order:
i) Data unique to the national or areas
ii) IPCC default data（Refer to Appendix D-3）</td></tr>
<tr><td>Average annual quantity of the waste, W</td><td>Average annual quantity of the waste disposed in the SWDS（t/y）</td><td colspan="2">Data availability is validated in the following order:
i) Data from interview with landfill managers
ii) Planned data from the landfill capacity potential</td></tr>
</table>

(Continuation)

Data Type		Description of Data	Data Acquisition Methods			
			Baseline emissions		Project emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Before : $MD_{PJ,y}$ (Contin-uation)	Composition rate of waste j in(weight basis), w_j	Composition rate of waste j in solid waste (weight basis)(%)	Data availability is validated in the following order: i) Data from interview with landfill managers ii) Data unique to the national or areas iii) IPCC default data（Refer to Appendix D-4）	Monitoring data	(Not necessary because data is not involved in the calculation)	
Emission displaced by electricity and thermal energy generation	Amount of electricity generated $EG_{d,y}$	The quantity of electricity generated after the project starts (MWh)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	
	Baseline CO_2 emission factor CEF_d (= $EF_{PJ,y}$)	Emission factor of the typical power plant (t-CO_2/MWh)	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. 1. Interview to the electric power management entity concerned 2. Published values in the target country			
	Quantity of thermal energy produced Q_y	The quantity of thermal energy generated after the project start (TJ/y)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	
	Net calorific value NCV_{fuel} (= NCV_i)	Net calorific value according to fuel seed (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Refer to Appendix D-6.7)			
Before : $BE_{EN,y}$	CO_2 emission factor EF_{fuel} ($COEF_i$)	CO_2 emission factor per fuel seed (t-CO_2/TJ)				
Electricity consumption (After : $EL_{PJ,y}$)		Electricity consumption after the project start (MWh/y)	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data
Fuel consumption (After : FC_i)		Fuel consumption after the project start (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data

6.Other data	(1)Project boundary The project boundary is the site where the project activity is being done, where the gas is captured and destroyed/used. (2)Leakage Project activity could lead to the following leakages: Construction of power plants, replacement of facility: the indirect emissions potentially leading to leakage due to activities such as product manufacturing or materials transport in consideration of Life Cycle Assessment, LCA of disposal of waste at a solid waste disposal site. The contribution of this emission is relatively small and negligible compared with the GHG emission reduction after the project starts. This formula ignores the leakage because ACM0001 methodology also ignores it. (3) Reference methodology and differences 1)ACM 0001(Ver.11) : Consolidated baseline and monitoring methodology for landfill gas project activity ・This formula partially simplifies the formula used in the methodology "ACM 0001". ・ In the reviewed methodology, in the case of using the electricity generated by captive power plant, the emissions factor of electricity is the default date "0.8 CO_2/MWh" or determined by generating efficiency and CO_2 emission factor of fuel and etc. In the case of using the grid electricity, the emission factor is calculated by the CDM methodology "Tool to calculate the Emission Factor for an electricity system" In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate simlply. ・Leakage is ignored in the formula of the reference methodology as well as in this formula. 2)AMS-III.G.(Ver.6.0) : Landfill methane recovery 【Differences】 ・ Baseline emission in the reviewed methodology is computed by or the CO_2 emission factor of grid (*1). In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・Emission from the transport of the existing or new facilities is considered as the leakage in the reference methodology. This formula however excludes this condition. *1: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM) in the CDM methodology "Tool to calculate the Emission Factor for an electricity system". 3)AM0025（Ver.10) : Avoided emissions from organic waste through alternative waste treatment processes 【Differences】 ・ The formula in the reference methodology is applied for the waste which will be reclaimed; however, this formula is applied for the waste which has been reclaimed. ・ In the reviewed methodology, in the case of using the grid electricity generated by heat power plant, the CO_2 emission factor of the electricity is "0.8 CO_2/MWh" as the default date. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ The formula in the reference methodology is applied for composting, LFG capture, and flaring, gasification and solid fuel. This formula is applied for only LFG captured and power generation. ・ In the reviewed methodology, the leakage is composed of emissions from traffic increased, emissions from the incineration residues, emissions from the end-user of the sustainable biomass and emissions from residual waste from anaerobic digester, gasifier, and processing/combustion of RDF/stabilized biomass or compost in case it is disposed of in landfills. In this methodology, the

	leakage is only emissions from residual waste from anaerobic digester, gasifier, and processing/combustion of RDF/stabilized biomass or compost in case it is disposed of in landfills. 4) CCX : Landfill Methane Offset 【Differences】 ・The formula in the reference methodology is applied to calculate the GHG emissions reduction only after the project started. This formula is applied to calculate the GHG emission reduction for both before and after the project starts. ・The formula of CCX for the quantity of captured methane after the project starts determines quantity of captured methane by the quantity of captured methane and fraction methane in LFG in the reference methodology. This formula determines the quantity of captured methane by quantity of captured methane, fraction methane in LFG and methane density at recovery. 5) Climate Action Reserve : Landfill Project Protocol (ver2.1)-Collecting and Destroying Methane from Landfill sites 【Differences】 ・ The formula in the reference methodology is applied to calculate the GHG emission reductions only after the project starts. This formula is applied to calculate the GHG emission reduction for both before and after the project start.

1.Typical Project Outline	The project intends to reduce the GHG emissions without disposing in landfill but by waste treatment such as composting or anaerobic digestion etc.
2.Applicability	This methodology addresses project activities where fresh waste (i.e. the organic matter present in new domestic, commercial waste, organic industrial waste and municipal solid waste), originally intended for land filling is treated either through one or a combination of the following processes: composting, gasification, anaerobic digestion, RDF processing/thermal treatment without incineration, and incineration.
3.Methodology on Emission Reduction	GHG emission reduction through the waste treatment (composting, gasification, anaerobic digestion, RDF processing/thermal treatment without incineration, and incineration) shall be determined as the difference between baseline emissions before the project starts where methane in LFG is vented to atmospheres and project emissions after the project starts. $ERy\ =BEy - PEy\quad (t\text{-}CO_2/y)$ ER_y :GHG emissions reduction in year y achieved by the project (t-CO_2/y) BE_y : GHG emission without waste treatment in year "y" (t-CO_2/y)(Baseline emission) PE_y : GHG emission with waste treatment in year "y" (t-CO_2/y)(Project emission) 

(Continuation)

(1)Determination of baseline emission

Baseline emission is comprised of GHG emissions which the methane produced in the landfill in the absence of the project activity and GHG emissions from generation of energy displaced by the project activity.

$$BE_y = MB_y - MD_{reg,y} + BE_{EN,y}$$

Type	Items	Description
Output	BE_y	Baseline emission: GHG emission from CH_4 released into the atmosphere before the project starts which the waste treatment is installed (t-CO_2/y)
Input	MB_y	GHG emission from methane produced in landfill before the project starts (t-CO_2/y)
	$MD_{reg,y}$	GHG emission reduction of methane destroyed by national regulation before the project starts(t-CO_2/y) This shall be "0" where developing countries have a very few regulation.
	$BE_{EN,y}$	GHG emissions from generation of energy displaced by the project activity (t- CO_2/y)

Determination of $MD_{BL,y}$

Quantity of methane produced in landfill before the project starts shall be determined by monitoring the quantity of degradable organic carbon (DOC) that can decompose in landfill from the data below in consideration of the decay rate for organic waste.

$$MB_y = \phi \times (1 - OX) \times \frac{16}{12} \times F \times DOC_f \times MCF_p \times GWP_{CH4} \times \sum_{x=1}^{y} \sum_{j}^{n} \left\{ W_{j,x} \times DOC_j \times e^{-k_j (y-x)} \times (1 - e^{-k_j}) \right\}$$

- ϕ : Model correction factor to account for model uncertainties(-)
- OX : Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
- F : Fraction of methane in the biogas (volume fraction) (-)(=0.5)
- DOC_f : Fraction of degradable organic carbon (by weight) that can decompose
- MCF_p :CH_4 correction factor
- j : Classification of waste(wood, papre, organic, fabric, yard waste)
- $W_{j,y}$: Amount of organic waste type j prevented from disposal in the disposal site (t/y)
- DOC_j : Fraction of degradable organic carbon (by weight) in the waste type j
- k_j : Decay rate for the waste type j
- GWP_{CH4} : Methane global warming potential (t-CO_2/t-CH_4) (=21)

$W_{j,y}$ shall be calculated as follow;

$$W_{j,y} = W_y \times w_j$$

- W_y :Weight of organic waste prevented from disposal in the disposal site (t/y)
- w_j :Weight fraction of the waste type j in solid waste (weight basis)(%)

(Continuation)

Determination of $MD_{reg,y}$

CH_4 quantity reduction by decomposition and combustion by national regulation before the project starts shall be determined by multiplying the CH_4 quantity from landfill (MB_y) with the fraction of methane combusted.

$$MD_{reg,y} = MB_y \times AF$$

MB_y : GHG emission from methane from landfill before the project starts (t-CO_2/y)

AF : CH_4 fraction with combustion by national regulation before the project starts (-) It shall be "0" where developing countries have a very few regulation.

Determination of $BE_{EN,y}$

$BE_{EN,y}$ shall be determined by the quantity of electricity and thermal energy generation after the project starts and CO_2 baseline emission factors.

$$BE_{EN,y} = BE_{elec,y} + BE_{ther,y}$$

$$= EG_{d,y} \times CEF_d + \frac{Q_y}{\varepsilon_b \cdot NCV_{fuel}} \times EF_{fuel}$$

$BE_{elec,y}$: Baseline emissions from electricity generated from utilizing biogas in the project activity and exported to the grid or displacing onsite/offsite fossil fuel (t-CO_2/y)

$BE_{ther,y}$: Baseline emissions from thermal energy produced utilizing biogas in the project activity displacing thermal energy from onsite/offsite fossil fuel-fueled boiler(t-CO_2/y)

$EG_{d,y}$: Amount of electricity generated after the project starts(MWh/y)

CEF_d : CO_2 emissions factor for the displaced electricity source in the project scenario (t-CO_2/MWh)

Q_y : Amount of thermal energy generated after the project starts (TJ/y)

ε_b : Energy efficiency of the boiler/air heater used in the absence of the project activity to generate the thermal energy(-)ε_b shall be "1" as conservative value.

NCV_{fuel} : Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(GJ/kL, m^3, t, etc.)

EF_{fuel} : Emission factor of the fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(t-CO_2/TJ)

(Continuation)

(2)Project emission

GHG emission from electricity and fuel consumption at water recycling facilities and other emissions, after the project starts, shall be determined as follows:

$$PE_y = PE_{elec,y} + PE_{fuel,on\text{-}site,y} + PE_{e,y} + PE_{a,y} + PE_{g,y} + PE_{r,y} + PE_{i,y} + PE_{w,y}$$

Type	Items	Description
Output	PE_y	GHG emission after the project starts ($t\text{-}CO_2/y$)
Input	$PE_{elec,y}$	GHG emission from electricity consumption after the project starts($t\text{-}CO_2/y$)
	$PE_{FC,y}$	GHG emission from fossil fuel consumption after the project starts ($t\text{-}CO_2/y$)
	$PE_{c,y}$*	GHG emission during the composting process after the project starts ($t\text{-}CO_2/y$) If CH_4 produced in the composting process is recovered and destroyed by energy generation or flare after the project starts, this term shall be neglected.
	$PE_{a,y}$*	GHG emission from the anaerobic digestion process after the project starts ($t\text{-}CO_2/y$) If CH_4 produced in the anaerobic digestion process is recovered and destroyed by energy generation or flare after the project starts, this term shall be neglected.
	$PE_{g,y}$*	GHG emission from the gasification process after the project starts ($t\text{-}CO_2/y$)
	$PE_{r,y}$*	GHG emission from the combustion of RDF after the project starts ($t\text{-}CO_2/y$)
	$PE_{i,y}$*	GHG emissions from waste incineration after the project starts ($t\text{-}CO_2/y$)
	$PE_{w,y}$	GHG emissions from wastewater treatment after the project starts ($t\text{-}CO_2/y$)

*：Only the parameters related to the project is calculated. If not, parameter is “0”.

Determination of $E_{EC,y}$

GHG emission from electricity consumption after the project starts is calculated using the following formula.

$$PE_{EC,y} = EL_{PJ,y} \times EF_{PJ,y}$$

$EL_{PJ,y}$: Quantity of electricity consumption in facilities on site after the project start (MWh)

$EF_{PJ,y}$: Carbon emissions factor for electricity generation ($t\text{-}CO_2/MWh$)

Determination of $PE_{FC,y}$

GHG emission from fuel consumption after the project starts is calculated using the following formula.

$$PE_{FC,y} = \sum_i \left(FC_i \times NCV_i \times COEF_i \right)$$

FC_i : Quantity of fuel *i* consumed on site (kL, m^3, t etc./y)

NCV_i : Net calorific value of fuel *i* (GJ/kL, m^3, t, etc.)

$COEF_i$: CO_2 emissions factor of fuel *i* ($t\text{-}CO_2/TJ$)

Determination of $PE_{c,y}$

GHG emission from composting after the project starts is calculated using the following formula.

$$PE_{c,y} = Q_{c,y} \times (EF_{c,N2O} \times GWP_{N2O} + EF_{c,CH4} \times GWP_{CH4})$$

$Q_{c,y}$: Quantity of organic waste composted(t/y)
$EF_{c,N2O}$: Emission factor for N_2O emissions from the composting process (t-N_2O/t-waste)
GWP_{N2O} : Global Warming Potential of N_2O(t-CO_2/t-N_2O)
$EF_{c,CH4}$: Emission factor for CH_4 emissions from the composting process(t-CH_4/t-waste)
GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

Determination of $PE_{a,y}$

At the project planning, GHG emission from anaerobic digestion process after the project start shall be determined with the following formula.

$$PE_{a,y} = Q_{a,y} \times EF_{a,CH4} \times GWP_{CH4}$$

$Q_{a,y}$: Amount of organic waste fed into anaerobic digestion(t/y)
$EF_{a,y,CH4}$: Emission factor for CH_4 emissions from the anaerobic digestion(t-CH_4/t-waste)
GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

At the monitoring process, GHG emission shall be determined with the following formula.

$$PE_{a,y} = SG_{a,y} \times MC_{CH4,a,y} \times GWP_{CH4}$$

$SG_{a,y}$: Total volume of stack gas from anaerobic digestion(m^3/y)
$MC_{CH4,a,y}$: Monitored content of CH_4 in the stack gas from anaerobic digestion(t-CH_4/m^3)
GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

Determination of $PE_{g,y}$（$PE_{r,y}$、$PE_{j,y}$ are caluculated in the same way.)

GHG emission from gasification after the project starts shall be determined with the following formula.

$$PE_{g,y} = PE_{g,f,y} + PE_{g,s,y}$$

$PE_{g,f,y}$: Fossil-based waste CO_2 emissions from gasification(t-CO_2/y)
$PE_{g,s,y}$: N_2O and CH_4 emissions from the final stacks from gasification,(t-CO_2/y)

$PE_{g,f,y}$ shall be determined with the following formula.

$$PE_{g,y} = \Sigma A_i \times CCW_i \times FCF_i \times EF_i \times 44/12$$

A_i : Amount of waste type i fed into the gasifier (t/y)
CCW_i : Fraction of carbon content in waste type i(-)
FCF_i : Fraction of fossil carbon in total carbon of waste type i(-)
EF_i : Combustion efficiency for waste(-)
i : Waste type (t-CO_2/t-C)

(Continuation)

$PE_{g,s,y}$ shall be determined using the following formula.

1) At the time of project planning

$$PE_{g,s,y} = Q_{BIO,y} \times (EF_{N2O} \times GWP_{N2O} + EF_{CH4} \times GWP_{CH4}) \times 10^{-3}$$

$Q_{BIO,y}$: Amount of waste gasified (t/y)

EF_{N2O} : Emission factor for N_2O emissions from combustion(kg-N_2O/t)

EF_{CH4} : Emission factor for CH_4 emissions from combustion(kg-CH_4/t)

GWP_{N2O} : Global Warming Potential of N_2O(t-CO_2/t-N_2O)

GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

2) At the time of monitoring

$$PE_{g,s,y} = SG_{g,y} \times MC_{N2O,g,y} \times GWP_{N2O} + SG_{g,y} \times MC_{CH4,g,y} \times GWP_{CH4}$$

$SG_{g,s,y}$: Total volume of stack gas from(m^3/y)

$MC_{N2O,g,y}$: Monitored content of nitrous oxide in the stack gas from gasification(t-N_2O/m^3)

$MC_{CH4,g,y}$: Monitored content of methane in the stack gas from from gasification(t-CH_4/m^3)

GWP_{N2O} : Global Warming Potential of nitrous oxide(t-CO_2/t-N_2O)

GWP_{CH4} : Global Warming Potential of methane(t-CO_2/t-CH_4)

Determination of $PE_{w,y}$

GHG emission from CH_4 in wastewaterafter the project start shall be determined with the following formula.

$$PE_{w,y} = Q_{COD,y} \times P_{COD,y} \times B_0 \times MCF_d \times GWP_{CH4}$$

$Q_{COD,y}$: Amount of wastewaster treated anaerobically or released untreated from the project activity(m^3/y)

$P_{COD,y}$: Chemical Oxygen Demand (COD) of wastewaster(t-COD/m^3)

B_0 : Maximum methane producing capacity(t-CH_4/t-COD)

MCF_d : Methane correction factor(-)

GWP_{CH4} : Global Warming Potential of methane(t-CO_2/t-CH_4)

4.Data Required for Monitoring and Estimating Emission

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Methane produced in landfill before the project before : MB_y	Model correction factor Φ	Model correction factor to account for model uncertainties (-)	0.9 (default data of Methodological tool "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"(ver.05))		(Not necessary because data is not involved in the calculation)	
	oxidation rate OX	oxidation rate (-)	Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal sites (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table3.2)			
	Fraction of methane in LFG F	Fraction of methane in LFG from landfill (-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
	Fraction of degradable organic carbon that can decompose DOC_f	Fraction of degradable organic carbon (DOC) that can decompose (-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
	Methane correction factor MCF_p	Methane correction factor (-)	IPCC default data (Refer to Appendix D-1)			
	Fraction of degradable organic carbon DOC_j	Fraction of degradable organic carbon in the waste type j (-)	Data availability is validated in the following order: i) Data unique to the national or areas ii) IPCC default data (Refer to Appendix D-2)			
	Decay rate k_j	Decay rate for the waste type j (-)	Data availability is validated in the following order: i) Data unique to the national or areas ii) IPCC default data (Refer to Appendix D-3)			
	Total amount of organic waste (W_y)	Total amount of organic waste prevented from disposal in the fandfill saite (t/y)	Data availability is validated in the following order: i) Data unique to the national or areas ii) IPCC default data (Refer to Appendix D-4)			
	Weight fraction of waste type j (w_j)	Weight fraction of waste type j (%)	Data availability is validated in the following order: i) Data unique to the national or areas ii) IPCC default data (Refer to Appendix D-5)	Monitoring data		

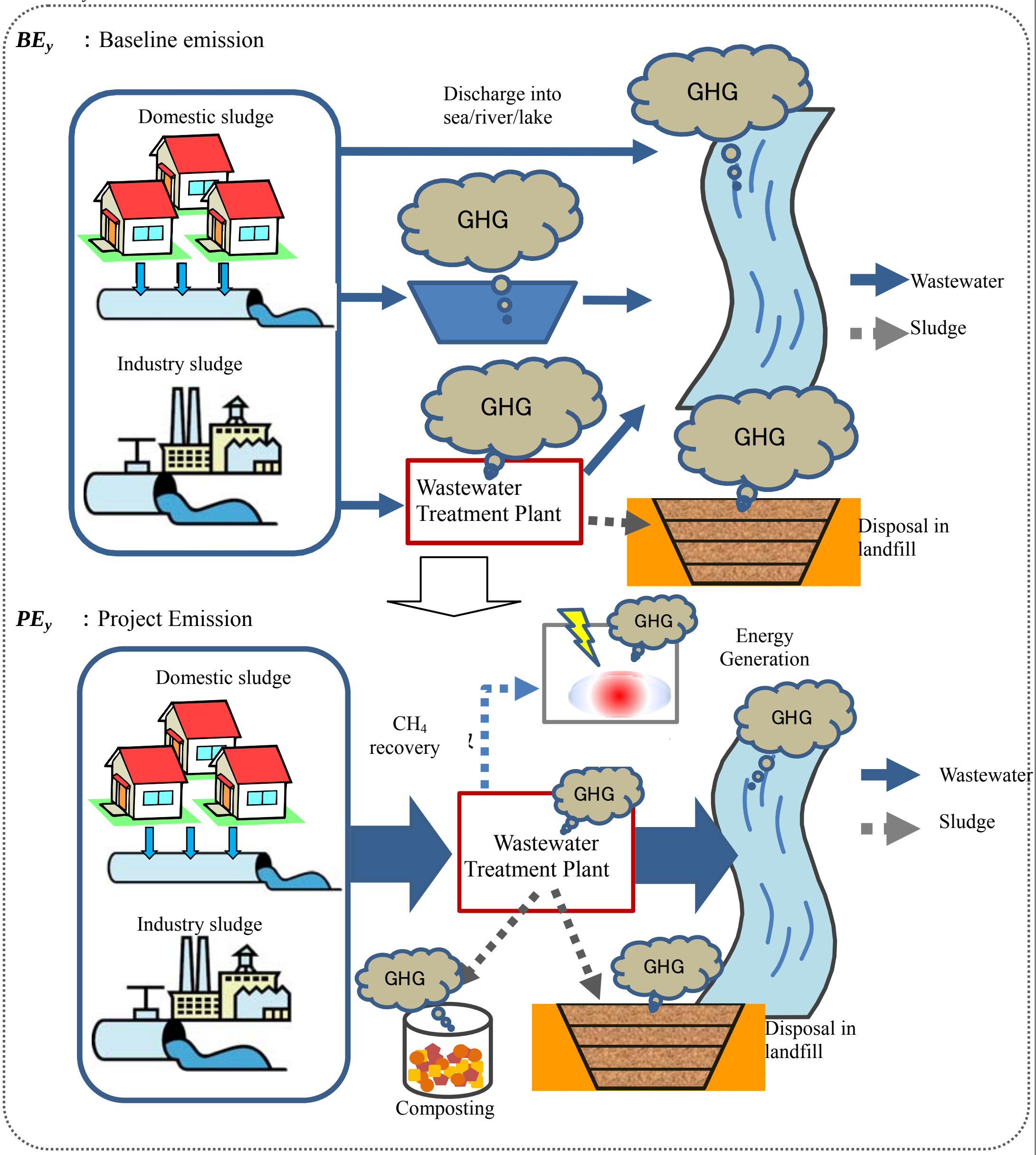
(Continuation)

Data Type		Description of Data	Data Acquisition Methods: Baseline Emissions: Before the Project Starts	Data Acquisition Methods: Baseline Emissions: After Project Completion	Data Acquisition Methods: Project Emissions: Before the Project Starts	Data Acquisition Methods: Project Emissions: After Project Completion
Emission displaced by electricity and thermal energy generation before : $BE_{EN,y}$	Amount of electricity generated $EG_{d,y}$	The quantity of electricity generated after the project start (MWh)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	(Not necessary because data is not involved in the calculation)
	Baseline CO_2 emission factor CEF_d ($=EF_{PJ,y}$)	Emission factor of the typical power plant (t-CO_2/MWh)	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned Published values in the target country	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned Published values in the target country	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned Published values in the target country	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned Published values in the target country
	Quantity of thermal energy generated Q_y	The quantity of thermal energy generated after the project starts (TJ/y)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	(Not necessary because data is not involved in the calculation)
	Net calorific value NCV_{fuel} ($=NCV_i$)	Net calorific value according to fuel seed (GJ/kL, m^3・t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Refer to Appendix D-7,8)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Refer to Appendix D-7,8)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Refer to Appendix D-7,8)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Refer to Appendix D-7,8)
	CO_2 emission factor EF_{fuel} ($COEF_i$)	CO2 emission factor per fuel seed (t-CO2/TJ)				
Electricity consumption (After : $EL_{PJ,y}$)		Electricity consumption after the project start (MWh/y)	(Not necessary because data is not involved in the calculation)	(Not necessary because data is not involved in the calculation)	Planned data	Monitoring data
Fuel consumption (After : FC_i)		Fuel consumption after the project start (kL, m^3・t etc./y)	(Not necessary because data is not involved in the calculation)	(Not necessary because data is not involved in the calculation)	Planned data	Monitoring data
Emission from composting process after: $PE_{c,y}$	Quantity of organic waste composted($Q_{c,y}$)	Quantity of organic waste composted(t)	(Not necessary because data is not involved in the calculation)	(Not necessary because data is not involved in the calculation)	Planned data	Monitoring data
	N_2O emission factor($EF_{c,N2O}$)	N_2O emission factor for composting process(tN2O/t waste)			0.043 (default data methodology"AM0025")	0.043 (default data methodology"AM0025")
	CH_4 emission factor($EF_{c,CH4}$)	CH_4 emission factor for composting process(t-CH_4/t-waste)			(Refer to Appendix D-9)	(Refer to Appendix D-9)
Emission from anaerobic digestion after : $PE_{a,y}$	Quantity of organic waste ($Q_{a,y}$)	Quantity of organic waste fed into anaerobic digestion (t/y)	(Not necessary because data is not involved in the calculation)	(Not necessary because data is not involved in the calculation)	Planned data	Monitoring data
	CH_4 emission factor ($EF_{a,CH4}$)	CH_4 emission factor for anaerobic digestion (t-CH_4/t-waste)			(Refer to Appendix D-9)	(Not necessary because data is not involved in the calculation)
	Total volume of stack gas ($SG_{a,y}$)	Total volume of stack gas from anaerobic digestion (m^3/y)			(Not necessary because data is not involved in the calculation)	Monitoring data
	Monitored content of CH_4 ($MC_{CH4,a,y}$)	Monitored content of CH_4 in the stack gas from anaerobic digestion (t-CH_4/m^3)			(Not necessary because data is not involved in the calculation)	Monitoring data

(Continuation)

Data Type		Description of Data	Data Acquisition Methods: Baseline Emissions: Before the Project Starts	Baseline Emissions: After Project Completion	Project Emissions: Before the Project Starts	Project Emissions: After Project Completion
Emission from Gasification process After: $PE_{g/r/i,y}$	Amount of waste type i (A_i)	Amount of waste type i fed into the gasifier (t/y)	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data
	Fraction of carbon content (CCW_i)	Fraction of carbon content in waste type i (-)			IPCC Guideline default data (Refer to Appendix D-2)	Monitoring data
	Fraction of fossil carbon (FCF_i)	Fraction of fossil carbon in total carbon of waste type i (-)			IPCC Guideline default data (Refer to Appendix D-2)	Monitoring data
	Combustion efficiency (EF)	Combustion efficiency for waste (-)			1 (default data of IPCC Guidelines Vol.5 Waste)	Monitoring data
	Amount of waste ($Q_{BIO,y}$)	Amount of waste gasified (t/y)			Planned data	(Not necessary because data is not involved in the calculation)
	N_2O emission factor (EF_{N2O})	N_2O emission factor for waste combustion (kg-N_2O/t)			IPCC Guideline default data (Refer to Appendix D-11)	(Not necessary because data is not involved in the calculation)
	CH_4 emission factor (EF_{CH4})	CH_4 emission factor for waste combustion (kg-CH_4/t)			IPCC Guideline default data (Refer to Appendix D-12)	(Not necessary because data is not involved in the calculation)
	Total volume of stack gas ($SG_{g/r/i,y}$)	Total volume of stack gas from gasification (m^3/y)			(Not necessary because data is not involved in the calculation)	Monitoring data
	Monitored content of N_2O (MC_{N2O})	Monitored content of N_2O in the stack gas from gasification (t-N_2O/m_3)			(Not necessary because data is not involved in the calculation)	Monitoring data
	Monitored content of CH_4 (MC_{CH4})	Monitored content of CH_4 in the stack gas from gasification (t-CH_4/m_3)			(Not necessary because data is not involved in the calculation)	Monitoring data
Emission from wastewater treatment process after : $PE_{w,y}$	Amount of wastewater ($Q_{COD,y}$)	Amount of wastewater after the project starts (m^3/y)	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data
	COD (t-COD/m^3)	Chemical Oxygen Demand (COD) of wastewater (t-COD/m^3)			Planned data	Monitoring data
	Maximum CH_4 producing capacity (B_0)	Maximum CH_4 producing capacity (t-CH_4/t-COD)			0.265 (IPCC Guideline default data)	
	CH_4 correction factor (MCF_d)	CH_4 correction factor for the wastewater treatment process (-)			Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) National default ii) IPCC Guideline default data (Refer to Appendix D-10)	

5.Others	(1)Project boundary The project boundary is the site where the project activity is being done and where the waste is treated or disposed. (2)Leakage The project activity could lead to the following leakages: Construction of treatment plants: the indirect emissions potentially lead to leakage due to activities such as product manufacturing or materials transport. This respective emission is temporary and negligible considering the scale of the project. Therefore, it can be ignored. (3)Reference methodology and differences 1) AM0025(Ver.12):Avoided emissions from organic waste through alternative waste treatment processes ・This formula partially simplifies that used in the methodology “AM0025”. 【Differences】 ・In the reviewed methodology, the CO_2 emission factor of the electricity is the default data “0.8 CO_2/MWh” . In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・Leakage is ignored in the formula of the reference methodolgy, same with this formula. 2) AMS-III.F(Ver.10.0): Avoidance of methane emissions through composting. 【Differences】 ・The formula in the reference methodology is applied only for composting as waste treatment, after the project starts. This formula is applied for composting, gasfication, anerobic digestion, and RDF processing/thermal treatment without incineration, and incineration. ・Transportation of compost generated after the project starts is considered in the calculation of the project emission in the referenced method. This formula however excludes these conditions. ・GHG emission from transferring the facilities from other places or vice versa is considered as the leakage in the referenced methodology. On the other hand, this formula excludes these conditions.

1.Typical Project Outline	The project intends to reduce GHG emission by improving the living condition and reducing CH_4 from sewer water from the houses or factories, through wastewater treatment.
2.Applicability	○ The project should be applied where the sewer water or sludge treatment system before the project starts, run under aerobic condition or anerobic condition or treatment system does not run. ○ The project should be applied where the sewer water or sludge treatment system after the project starts should run under aerobic condition or anerobic condition.
3.Methodology on Emission Reduction	GHG emission reduction shall be determined as the difference between baseline emissions before the project starts without wastewater treatment, and the project emissions with wastewater treatment after the project starts. $$ER_y = BE_y - PE_y \quad (t\text{-}CO_2/y)$$ ER_y :GHG emissions reduction in year y achieved by the project ($t\text{-}CO_2/y$) BE_y : GHG emission without wastewater treatment in year y ($t\text{-}CO_2/y$)(Baseline emission) PE_y : GHG emission with wastewater treatment in year y ($t\text{-}CO_2/y$)(Project emission) 

(Continuation)

(1)Determination of baseline emission

Baseline emission shall be equivalent to the summation of the following items:

・GHG emissions from electricity or fuel consumption on site
・GHG emissions of the wastewater treatment system
・GHG emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake
・GHG emissions from anaerobic decay of the final sludge in wastewater treatment

$$\boldsymbol{BE_y} = BE_{EC,y} + BE_{FC,y} + BE_{ww,t,y} + BE_{s,t,y} + BE_{ww,d,y} + BE_{s,f,y} + BE_{EN}$$

Type	Items	Description
Output	$\boldsymbol{BE_y}$	Baseline emission: GHG emission from CH_4 released into the atmosphere before the project starts where the sludge treatment is installed or revised (t-CO_2/y)
Input	$BE_{EC,y}$	GHG emissions from electricity consumption on site before the project starts (t-CO_2/y)
	$BE_{FC,y}$	GHG emissions from fuel consumption on site before the project starts(t-CO_2/y)
	$BE_{ww,t,y}$	GHG emissions of the wastewater treatment system before the project starts (t-CO_2/y)
	$BE_{ww,d,y}$	GHG emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake before the project starts(t-CO_2/y)
	$BE_{s,t,y}$	GHG emissions of the sludge treatment system before the project starts(t-CO_2/y)
	$BE_{s,f,y}$	GHG emissions from anaerobic decay of the final sludge in wastewater treatment before the project starts (t-CO_2/y) If the sludge is controlled, combusted, and disposed in a landfill with biogas recovery, or used for soil application before the project, this term shall be neglected.
	$BE_{EN,y}$	GHG emissions from generation of energy displaced by the project activity (t- CO_2/y)

<u>*Determination of $BE_{EC,y}$*</u>

GHG emissions from electricity consumption on site shall be determined by multiplying fuel comsumption with CO_2 emission factor.

$$BE_{EC,y} = EL_{BL,y} \times EF_{BL,y}$$

$EL_{BL,y}$: Quantity of electricity consumption on site before the project start (MWh/y)
$EF_{BL,y}$: Carbon emissions factor for electricity generation (t-CO_2/MWh)

<u>*Determination of $BE_{FC,y}$*</u>

GHG emissions from fuel consumption on site shall be determined by multiplying fuel comsumption with net calorificvalue of fuel and CO_2 emission factor.

$$BE_{FC,y} = \sum_i (FC_{BL,i} \times NCV_i \times COEF_i)$$

$FC_{BL,i}$: Quantity of fuel *i* consumed on site before the project(kL, m^3, t etc./y)
NCV_i : Net calorific value of fuel *i*(GJ/kL,m^3,t etc.,)
$COEF_i$: CO_2 emissions factor of fuel *i*(t-CO_2/TJ)

3.Methodology on Emission Reduction (Continuation)

Determination of $BE_{ww,t,y}$

GHG emissions of the wastewater treatment system before the project starts shall be determined by multiplying the volume of wastewater treated in the system, by the COD removed through the treatment process, CH_4 producing capacity, and global warming potential.

$$BE_{ww,y}=Q_{ww,t,BL,y}\times COD_{r,BL,y}\times MCF_{ww,BL}\times B_{0,ww}\times UF_{BL}\times GWP_{CH4}$$

$Q_{ww,t,BL,y}$: Volume of wastewater treated in wastewater treatment system before the project starts (m^3/y)

$COD_{r,BL,y}$: Chemical oxygen demand removed by the wastewater treatment system before the project starts (t-COD/m^3)

$MCF_{ww,BL}$: CH4 correction factor for the wastewater treatment system before the project starts

$B_{o,ww}$: CH4 producing capacity of the wastewater (kg-CH_4/kg-COD)

UF_{BL} : Model correction factor to account for model uncertainties (-)(=0.94)

GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

Determination of $BE_{s,t,y}$

GHG emissions of the sludge treatment system before the project stasrts shall be determined by the volume of sludge, CH_4 correction factor for the sludge treatment system, degradable organic content of the untreated sludge, fraction of DOC dissimilated to biogas, model correction factor, fraction of CH_4 in biogas, etc.

$$BE_{s,t,y}=S_{BL,y}\times MCF_{s,t,BL}\times DOC_s\times UF_{BL}\times DOC_F\times 16/12\times GWP_{CH4}$$

$S_{BL,y}$: Amount of dry matter in the sludge that would have been treated by the sludge treatment system (t/y)

$MCF_{s,t,BL}$: CH_4 correction factor for the sludge treatment system before the project starts (-)

DOC_s : Degradable organic content of the untreated sludge generated (dry basis)(-)

UF_{BL} : Model correction factor to account for model uncertainties (-)

DOC_F : Fraction of DOC dissimilated to biogas (-)

F : Fraction of CH_4 in biogas (-)

GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

If the baseline wastewater treatment system is different from the treatment system in the project scenario, the sludge generation rate (amount of sludge generated per unit of COD removed) in the baseline may differ significantly from that of the project scenario. Therefore, for these cases, the monitored values of the amount of sludge generated during the credited period will be used to estimate the amount of sludge generated in the baseline, as follows:

$$S_{BL,y} = S_{PJ,y}\times\frac{SGR_{BL}}{SGR_{PJ}}$$

$S_{PJ,y}$: Amount of dry matter in the sludge treated by the sludge treatment system after the project started(t)

SGR_{BL} : Sludge generation ratio of the wastewater treatment plant before the project starts (t-dry matter in sludge/t-COD removed)

SGR_{PJ} : Sludge generation ratio of the wastewater treatment plant after the project starts (t-dry matter in sludge/t-COD removed)

(Continuation)	**Determination of $BE_{ww,d,y}$** GHG emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake shall be determined by the volume of wastewater discharged, COD of the wastewater, CH_4 correction factor based on discharge pathway, etc. $BE_{ww,d,y} = Q_{ww,d,BL,y} \times GWP_{CH4} \times B_{0,ww} \times UF_{BL} \times COD_{ww,d,BL,y} \times MCF_{ww,BL,}$ $Q_{ww,d,BL,}$: Volume of treated or untreated wastewater discharged (m^3) $B_{o,ww}$: CH_4 producing capacity of the wastewater (kg-CH_4/kg-COD) UF_{BL} : Model correction factor to account for model uncertainties (-) (=0.94) $COD_{ww,d,BL,y}$: Chemical oxygen demand of the treated and untreated wastewater discharged into sea, river or lake before the project starts (t/m^3) $MCF_{ww,BL,d}$: CH_4 correction factor based on discharge pathway before the project starts (-) GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4) **Determination of $BE_{s,f,y}$** GHG emissions from anaerobic decay of the final sludge shall be determined considering the volume of the final sludge, degradable organic content of the final sludge, CH_4 correction factor of the disposal site, degradable organic content of the final sludge, fraction of DOC dissimilated to biogas model correction factor, fraction of CH_4 in biogas, etc. $BE_{s,f,y} = S_{f,BL,y} \times DOC_s \times UF_{BL} \times MCF_{s,BL,f} \times DOC_F \times F \times 16/12 \times GWP_{CH4}$ $S_{f,BL,y}$: Amount of dry matter in the final sludge generated by the baseline wastewater treatment system (t/y) DOC_s : Degradable organic content of the final sludge generated (dry basis)(-) $MCF_{s,BL,f}$: CH_4 correction factor of the disposal site that receives the sludge before the poject starts UF_{BL} : Model correction factor to account for model uncertainties (-) DOC_F : Fraction of DOC dissimilated to biogas (-) F : Fraction of CH_4 in biogas (-) GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

Determination of $BE_{EN,y}$

$BE_{EN,y}$ shall be determined by the quantity of electricity and thermal energy generation after the project starts and CO_2 baseline emission factors.

$$BE_{EN,y} = BE_{elec,y} + BE_{ther,y}$$
$$= EG_{d,y} \times CEF_d + \frac{Q_y}{\varepsilon_b \cdot NCV_{fuel}} \times EF_{fuel,b}$$

$BE_{elec,y}$: Baseline emissions from electricity generated from utilizing biogas in the project activity and exported to the grid or displacing onsite/offsite fossil fuel (t-CO_2/y)

$BE_{ther,y}$: Baseline emissions from thermal energy produced utilizing the biogas in the project activity displacing thermal energy from onsite/offsite fossil fuel-fueled boiler(t-CO_2/y)

$EG_{d,y}$: Amount of electricity generated after the project starts(MWh/y)

CEF_d : CO_2 emissions factor for the displaced electricity source in the project scenario (t-CO_2/MWh)

Q_y : Amount of thermal energy generated after the project starts (TJ/y)

ε_b : Energy efficiency of the boiler/air heater used in the absence of the project activity to generate the thermal energy(-) εb shall be “1” as conservative value.

NCV_{fuel} : Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(GJ/kL, m^3, t, etc.)

$EF_{fuel,b}$: Emission factor of the fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(t-CO_2/TJ)

(Continuation)

(2)Project emission

Project emission shall be equivalent to the summation of the following items:

・GHG emission from electric or fuel consumption after the project starts
・GHG emissions of the wastewater treatment system after the project starts
・GHG emissions from the sludge treatment systems after the project starts
・GHG emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake
・GHG emissions from anaerobic decay of the final sludge in wastewater treatment after the project starts

$$PEy = PE_{EC,y} + PE_{FC,y} + PE_{ww,t,y} + PE_{s,t,y} + PE_{ww,d,y} + PE_{s,f,y}$$

Type	Items	Description
Output	PE_y	Project emission: GHG emission from CH_4 released into the atmosphere before the project starts, where the wastewater treatment is installed or revised (t-CO_2/y)
Input	$PE_{EC,y}$	GHG emission from electric consumption after the project starts (t-CO_2/y)
	$PE_{FC,y}$	GHG emission from fossil fuel consumption after the project starts (t-CO_2/y)
	$PE_{ww,t,y}$	GHG emissions of the wastewater treatment system after the project starts (t-CO_2/y) If CH_4 produced in the wastewater treatment system is recovered and destroyed by energy generation or flare after the project starts, this term shall be neglected.
	$PE_{s,t,y}$	GHG emissions from the sludge treatment systems after the project starts (t-CO_2/y) If CH_4 produced in the sludge treatment system is recovered and destroyed by energy generation or flare after the project starts, this term shall be neglected.
	$PE_{ww,d,y}$	GHG emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake after the project starts (t-CO_2/y)
	$PE_{s,f,y}$	GHG emissions from anaerobic decay of the final sludge in wastewater treatment after the project starts (t-CO_2/y) If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application after the project starts, this term shall be neglected.

Determination of $E_{EC,y}$

GHG emission from electricity consumption after the project starts is calculated from the following formula.

$$PE_{EC,y} = EL_{PJ,y} \times EF_{PJ,y}$$

$EL_{PJ,y}$: Quantity of electricity consumption in facilities on site after the project starts (MWh/y)
$EF_{PJ,y}$: Carbon emissions factor for electricity generation (t-CO_2/MWh)

Determination of $PE_{FC,y}$

GHG emission from fuel consumption after the project starts is calculated from the following formula.

$$PE_{FC,y} = \sum_i \left(FC_{PJ,y} \times NCV_i \times COEF_i \right)$$

$FC_{PJ,i}$: Quantity of fuel *i* consumed on site (kL, m^3, t, etc./y)
NCV_i : Net calorific value of fuel *i* (GJ/kL, m^3, t, etc.)
$COEF_i$: CO_2 emissions factor of fuel (t-CO_2/TJ)

(Continuation)	***Determination of $PE_{ww,t,y}$***

GHG emissions of the wastewater treatment system after the project starts shall be determined by multiplying the volume of wastewater treated,by the COD removed through the treatment, CH_4 producing capacity, and by the Global Warming Potential.

$$PE_{ww,y}=Q_{ww,t,PJ,y}\times COD_{r,PJ,y}\times MCF_{ww,t,y}\times B_{0,ww}\times UF_{PJ}\times GWP_{CH4}$$

- $Q_{ww,t,PJ,,y}$: Volume of wastewater treated in wastewater treatment system after the project starts (m^3/y)
- $COD_{r,PJ,y}$: Chemical oxygen demand removed by the wastewater treatment system after the project (t-COD/m^3)
- $MCF_{ww,PJ}$: CH_4 correction factor for the wastewater treatment system after the project starts
- $B_{o,ww}$: CH_4 producing capacity of the wastewater (kg-CH_4/kg-COD)
- UF_{PJ} : Model correction factor to account for model uncertainties (-)(=1.12)
- GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

Determination of $PE_{s,t,y}$

GHG emissions of the sludge treatment system after the project shall be determined by multiplying the volume of the sludge, by CH_4 correction factor for the sludge treatment system, degradable organic content of the untreated sludge, fraction of DOC dissimilated to biogas, model correction factor, fraction of CH_4 in biogas, etc.

$$PE_{s,t,y}=S_{PJ,y}\times MCF_{s,t,PJ}\times DOC_s\times UF_{PJ}\times DOC_F\times F\times 16/12\times GWP_{CH4}$$

- $S_{PJ,y}$: Amount of dry matter in the treated sludge by the sludge treatment system after the project (t/y)
- $MCF_{s,t,PJ}$: CH_4 correction factor of the disposal site that receives the sludge after the poject (-)
- DOC_s : Degradable organic content of the final sludge generated (dry basis)(-)
- UF_{PJ} : Model correction factor to account for model uncertainties (-)
- DOC_F : Fraction of DOC dissimilated to biogas (-)
- F : Fraction of CH_4 in biogas (-)
- GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

In case sludge is composted, $BE_{s,t,y}$ shall be determined from the following formula.。

$$PE_{s,t,y}=S_{PJ,y}\times EF_C\times GHP_{CH4}$$

- $S_{PJ,y}$: Amount of dry matter in the treated sludge by the sludge treatment system after the project (t/y)
- EF_C : CH_4 emission factor for composting sluge (t-CH_4/t-sludge)
- GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

Determination of $PE_{ww,d,y}$

GHG emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake after the project starts shall be determined by multiplying the volume of the wastewater discharged, COD of the wastewater, CH_4 correction factor based on discharge pathway, etc.

$$PE_{ww,d,y} = Q_{ww,d,PJ,y}\times GWP_{CH4}\times B_{0,ww}\times UF_{PJ}\times COD_{ww,d,PJ,y}\times MCF_{ww,PJ,d}$$

- $Q_{ww,d,PJ,y}$: Volume of treated or untreated wastewater discharged (m^3/y)
- UF_{PJ} : Model correction factor to account for model uncertainties (-) (=0.94)
- $COD_{ww,d,PJ,y}$: Chemical oxygen demand of the treated wastewater discharged into sea, river or lake after the project starts (t/m^3)
- $MCF_{ww,PJ,d}$: CH_4 correction factor based on discharge pathway after the project starts (-)
- GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)
- Bo,ww : CH_4 producing capacity of the wastewater (kg-CH_4/kg-COD)

(Continuation)	<u>*Determination of $PE_{s,f,y}$*</u> GHG emissions from anaerobic decay of the final sludge after the project starts shall be determined by multiplying the volume of thefinal slidge, degradable organic content of the final sludge, CH_4 correction factor of the disposal site, degradable organic content of the final sludge, fraction of DOC dissimilated to biogas model correction factor, fraction of CH_4 in biogas, etc. $$PE_{s,f,y} = S_{f,PJ,y} \times DOC_s \times UF_{PJ} \times MCF_{s,PJ,f} \times DOC_F \times F \times 16/12 \times GWP_{CH4}$$ $S_{f,PJ,y}$: Amount of dry matter in the final sludge generated by wastewater treatment systems after the project (t) $MCF_{s,PJ,f}$: CH_4 correction factor of the disposal site that receives the final sludge after the project (-) UF_{PJ} : Model correction factor to account for model uncertainties (-) DOC_s : Degradable organic content of the final sludge generated (dry basis)(-) DOC_F : Fraction of DOC dissimilated to biogas (-) F : Fraction of CH_4 in biogas (-) GWP_{CH4} : Global Warming Potential of CH_4 (t-CO_2/t-CH_4)

4.Data Required for Monitoring and Estimating Emission

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Emission by energy consumption and generation	Quantity of electricity consumption (before：$EL_{BL,y}$) (after：$EL_{PJ,y}$)	Quantity of electricity consumption on site （MWh/y）	Monitoring data	Monitoring data	Planned data	Monitoring data
	Baseline CO_2 emission factor $EF_{BL,y}$ ＝CEF_d (＝$EF_{PJ,y}$)	Emission factor of the typical power plant (t-CO_2/MWh)	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned Published values in the target country			
	Quantity of fuel consumption on site (before：$FC_{BL,i}$) (after：$FC_{PJ,i}$)	Fuel consumption after the project starts (kL, m^3, t etc/y)	Monitoring data	Monitoring data	Planned data	Monitoring data
	Net calorific value NCV_i （=NCV_{fuel})	Net calorific value according to fuel seed (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) National default ii) IPCC Guideline default data（Refer to Appendix D-7,8）			
	CO_2 emission factor ($COEF_i$)	CO_2 emission factor per fuel seed （t-CO_2/TJ)				
Emission from wastewater treatment process before: $BE_{ww,t,y}$ before: $PE_{ww,t,y}$	Volume of wastewater (before：$Q_{ww,t,BL,y}$) (after：$Q_{ww,t,PJ,y}$)	Volume of wastewater tereated in the wastewater teratment system （m^3/y)	Monitoring data	Monitoring data	Planned data	Monitoring data
	COD (before：$COD_{r,BL,y}$) (after：$COD_{r,PJ,y}$)	COD of the wastewater inflow to the treatment system （t-COD/m^3）	Monitoring data	Monitoring data	Planned data	Monitoring data
	CH_4 correction factor (before：$MCF_{ww,BL}$) (after：$MCF_{ww,PJ}$)	CH_4 correction factor for the wastewater treatment system （-)	IPCC Guideline default data（Refer to Appendix D-10）			
	CH_4 producing capacity ($B_{o,ww}$)	CH_4 producing capacity of the wastewater （kg-CH_4/kg-COD）	Domestic sludge：0.25 （IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste）			
Emission from sludge treatment process before：$BE_{s,t,y}$ after：$PE_{s,t,y}$	Amount of dry matter in the sludge (before：$S_{BL,y}$) (after：$S_{PJ,y}$)	Amount of dry matter in the sludge treated（t）	Monitoring data	Monitoring data	Planned data	Monitoring data
	Degradable organic content (DOC_s)	Degradable organic content of the untreated sludge generated (dry basis)(-)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) National default ii) IPCC Guideline default data（Refer to Appendix D-14）			
	CH_4 correction factor (before:$MCF_{s,t,BL}$) (after:$MCF_{s,t,PJ}$)	CH_4 correction factor for the sludge treatment system（-）	IPCC Guideline default data（Refer to Appendix D-10）			
	Fraction of DOC dissimilated (DOC_F)	Fraction of DOC dissimilated to biogas (-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
	Fraction of CH_4 (F)	Fraction of CH_4 in biogas（-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			

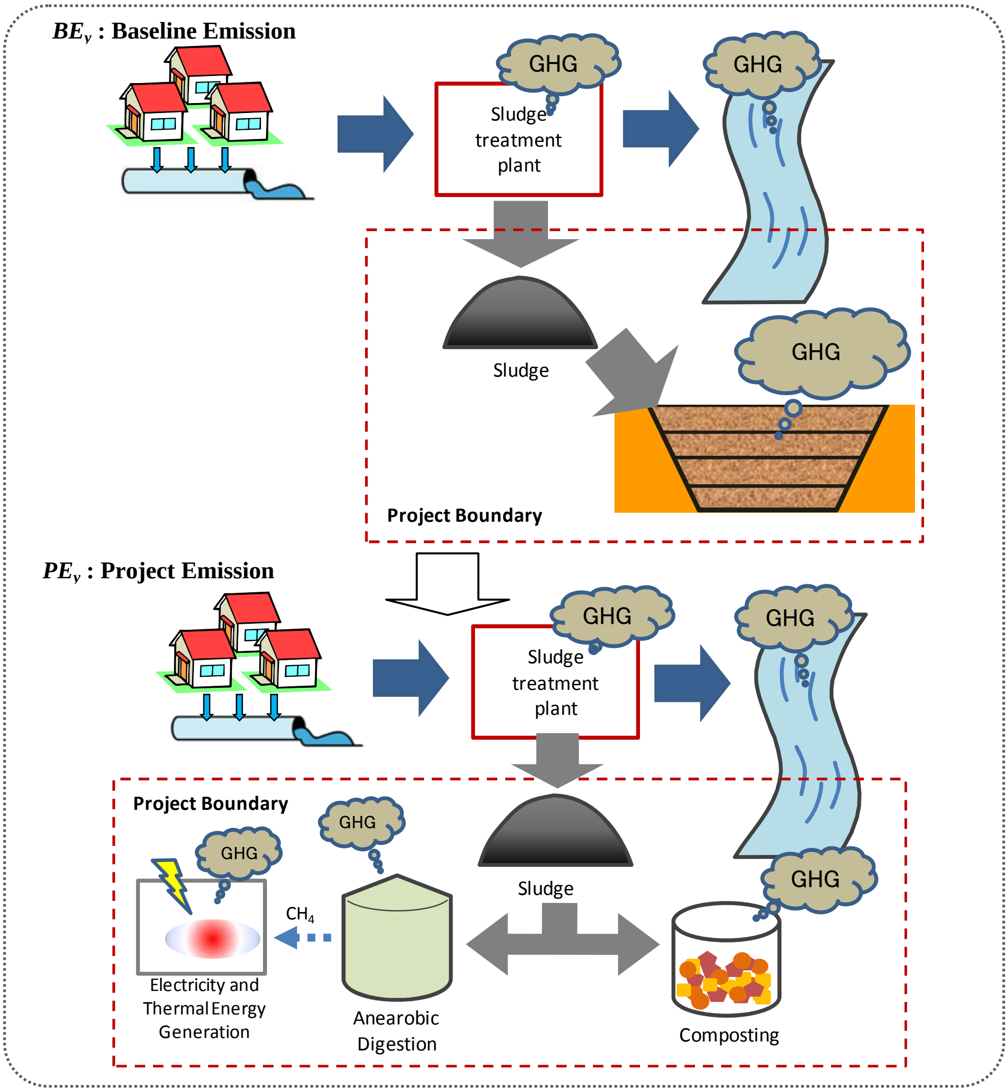
(Continuation)

Data Type		Description of Data	Data Acquisition Methods: Baseline Emissions – Before the Project Starts	Baseline Emissions – After Project Completion	Project Emissions – Before the Project Starts	Project Emissions – After Project Completion
Emission from sludge treatment process before : $BE_{s,t,y}$ after : $PE_{s,t,y}$	Amount of the treated sludge($S_{PJ,y}$)	Amount of dry matter in the treated sludge by the sludge treatment system after the project start s(t)	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data
	Sludge generation ratio of the wastewater treatment plant(before : SGR_{BL}) (after : SGR_{PJ})	Sludge generation ratio of the wastewater treatment plant before the project starts (t-sludge/t-COD removed)	Monitoring data	Monitoring data	Planned data	Monitoring data
	CH_4 emission factor for composting sludge (EF_C)	CH_4 emission factor for composting sludge (t-CH_4/t-sludge)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) Planned data of the sludge treatment plant ii) National default iii) IPCC Guideline default data(Refer to Appendix D-8)			
Emision on discharge pathway before: $BE_{ww,d,y}$ after: $PE_{ww,d,y}$	Volume of wastewater discharged (before : $Q_{ww,d,BL,y}$) (after : $Q_{ww,d,PJ,y}$)	Volume of treated or untreated wastewater discharged(m^3/y)	Monitoring data	Monitoring data	Planned data	Monitoring data
	CH_4 producing capacity ($B_{o,ww}$)	CH_4 producing capacity of the wastewater (kg-CH_4/kg-COD)	Domestic sludge : 0.25 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
	COD of the treated wastewater discharged (before : $COD_{ww,d,BL,y}$) (after : $COD_{ww,d,PJ,y}$)	COD of the treated wastewater discharged into sea, river or lake(t/m^3)	Monitoring data	Monitoring data	Planned data	Monitoring data
	CH_4 correction factor (before : $MCF_{ww,BL,d}$) (after : $MCF_{ww,PJ,d}$)	CH_4 correction factor based on discharge pathway(-)	IPCC Guideline default data(Refer to Appendix D-10)			
Emission by decay of the final sludg before : $BE_{s,f,y}$ after : $PE_{s,f,y}$	Amount of the final sludge (before : $S_{f,BL,y}$) (after : $S_{f,PJ,y}$)	Amount of dry matter in the final sludge generated by wastewater treatment (t)	Monitoring data	Monitoring data	Planned data	Monitoring data
	Degradable organic content(DOC_s)	Degradable organic content of the untreated sludge generated (dry basis)(-)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project: i) National default ii) IPCC Guideline default data（Refer to Appendix D-14）			
	CH4 correction factor (before : $MCF_{s,BL,f}$) (after : $MCF_{s,PJ,f}$)	CH_4 correction factor of the disposal site that receives the final sludge(－)	IPCC Guideline default data（Refer to Appendix D-1）			
	Fraction of DOC dissimilated (DOC_F)	Fraction of DOC dissimilated to biogas (-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
	Fraction of CH_4 (F)	Fraction of CH_4 in biogas(-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
Model correction factor (before : UF_{BL}) (after : UF_{PJ})		Model correction factor to account for model uncertainties (-)	0.94 (Default data of FCCC/SBSTA/2003/10/Add.2)		1.06 (Default data of FCCC/SBSTA/2003/10/Add.2)	
Global Warming Potential GWP_{CH4}		Global Warming Potential of CH4 (-)	21 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
Global Warming Potential GWP_{N2O}		Global Warming Potential of N_2O (-)	310 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
Before: $BE_{EN,y}$	Amount of electricity generation, $EG_{elec,y}$	Amount of electricity generation(MWh/y)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	
	Amount of thermal energy supply, Q_y	Amount of thermal energy supply(TJ/y)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	

5.Others	<u>(1)Project boundary</u> The project boundary is the site where project activity is being done and where the wastes are reclaimed or treated. <u>(2)Leakage</u> Project activity could lead to the following leakages: Construction of treatment plant: the indirect emissions potentially lead to leakage due to activities such as product manufacturing or materials transport. This respective emission is temporary and its constituent value is almost negligible considering the project scale. Therfore, it can be ignored. <u>(3)Reference Methodology and Differences</u> 1) AMS III.H(Ver.16):Methane recovery in wastewater treatment ・ This formula pratically simplifies the formula used in the methodology "AMS III.H". 【Differences】 ・ In the reviewed methodology, when using the grid electric power only the CO_2 emission factor of the electricity will be chosen from alternatives that the grid average value calculated by the CDM Methodology "Tool to calculate the Emission Factor for an electricity system" or one of some default values. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ GHG emission from transporting the facilities to other places or transporting the existing facilities to other places is considered as leakage in the reference methodology. ・ GHG emission from methane incineration, flare incompleteness and biomass strain under anerobic condition after the project started is considered as leakage in the reference methodology. 2) AMS-III.I(Ver.8.0): Avoidance of methane production in wastewater treatment facilities through modification of the process from anaerobic systems to aerobic systems. 【Differences】 ・ Baseline emission in the reviewed methodology is computed by or the CO_2 emission factor of grid (*1). In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ The formula in the reference method is quite limited and applied to anerobic treatment before and aerobic after the project starts. This formula as well is applied for both aerobic and anerobic treatment before and after the project starts. ・ GHG emission from transporting the facilities to other places or transporting the existing facilities to other places is considered as leakage in the reference methodology. *1: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM) in the CDM methodology "Tool to calculate the Emission Factor for an electricity system". 3)ACM0014(Ver. 04.1.0):Mitigation of greenhouse gas emissions from treatment of industrial wastewater 【Differences】 ・ In the reference methodology, the GHG emission contributed by CH_4 in treating wastewater is not considered because the biogas from the treatment of wastewater after the project starts is expected to be disposed by flaring, power generation or thermal treatment. This formula does not limit the type of biogas treatment in wastewater treatment but considers the GHG emission from CH_4 in wastewater treatment process. ・ In the case of connecting the captive power plant, the emission factor of electricity, the smaller one between the emission factor of electricity generated by captive power plant and that of the grid electricity is adopted. The emission factor of the grid electric power is calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM. In this methodology, emissions factor of electricity

	is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ Though the reference methodology expects the condition where the final sludge after treatment should be disposed definitely under aerobic condition and although it does not consider the GHG emission the final sludge decay, this formula does not limit the type of treatment for final sludge and consider GHG emission for final sludge decay. 4)AM0080(Ver01):Mitigation of GHG emissions through treatment of wastewater in aerobic wastewater treatment plants 【Differences】 ・ The reference methodology considers the GHG emission from sludge transportation after the project starts and GHG emission from N_2O in sludge treatment after the project starts. This formula however excludes these conditions. ・ In the reviewed methodology, when using the grid electric power only the CO_2 emission factor of the electricity will be chosen from alternatives that the grid average value calculated by the "Tool to calculate the Emission Factor for an electricity system" for CDM or some default values. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily.

1.Typical Project Outline	The project intends to reduce the GHG emissions by suppressing CH_4 from the sewage sludge decay, through composting the sewage sludge.
2.Applicability	○ This methodology addresses the case where the sewage sludge is decayed under the anerobic condition, and CH_4 is generated before the project starts. ○ This methodology addresses the case where the sewage sludge is composted and generated compost is used under the aerobic condition after the project starts. ○ This methodology addresses both cases where wastewater is recycled or not in composting the sewage sludge after the project starts.
3.Methodology on Emission Reduction	GHG emission reduction with composting of the sewage sludge or anaerobic digestion of the sewage sludge and biogas utilization shall be determined as the difference between baseline emission before the project starts where decay is not composted, and emissions after the project starts. $ERy = BEy - PEy \quad (t\text{-}CO_2/y)$ ER_y :GHG emissions reduction in year" y" achieved by the project ($t\text{-}CO_2/y$) BE_y : GHG emission without composting the sewage sludge decay in year "y" ($t\text{-}CO_2/y$) (Baseline emission) PE_y : GHG emission with composting the sewage sludge decay in year "y" ($t\text{-}CO_2/y$) (Project emission)



(Continuation)

(1)Determination of baseline emission

Baseline emission shall be determined by the summation of the following:

・GHG emission from the sewage sludge decay before the project starts

・Baseline emissions from generation of energy displaced by the project activity

$$BEy = BE_{CH4,S,y} - MD_{reg,y} + BE_{ww,y}$$

Type	Items	Description
Output	BE_y	Baseline emission： GHG emission from methane released into the atmosphere before the project starts ($t\text{-}CO_2/y$)
Input	$BE_{CH4,S,y}$	Baseline emissions for CH_4 generation potential of decay of sludge ($t\text{-}CO_2/y$)
	$MD_{reg,y}$	Amount of CH_4 that would have to be captured and combusted to comply with the prevailing regulations ($t\text{-}CO_2/y$)
	$BE_{EN,y}$	GHG emissions from generation of energy displaced by the project activity ($t\text{-}CO_2/y$)

Determination of $BE_{CH4,S,y}$

Baseline emissions or CH_4 generation potential of decay of sludge shall be determined by multiplying the volume of the sludge by CH_4 correction factor of the disposal site, degradable organic content of the untreated sludge, fraction of DOC dissimilated to biogas, model correction factor, fraction of CH_4 in biogas, and methane global warming potential.

$$BE_{CH4,S,y} = S_{PJ,y} \times DOC_s \times MCF_S \times DOC_F \times F \times UF_{BL} \times 16/12 \times GWP_{CH4}$$

$S_{PL,y}$: Amount of sludge treated after the poject starts (dry basis)(t/y)

DOC_s : Degradable organic content of the untreated sludge (dry basis)(-)

MCF_S : CH_4 correction factor of the disposal site that receives the sludge before the poject starts (-)

DOC_F : Fraction of DOC dissimilated to biogas(-)

F : Fraction of CH_4 in biogas(-)

UF_{BL} : Model correction factor to account for model uncertainties(-)

GWP_{CH4} : Methane global warming potential(-)(＝21)

Determination of $\boldsymbol{MD_{reg,y}}$

$BE_{EN,y}$ shall be determined by multiplying the amount of electricity produced using biogas after the project starts (MWh/y) and heat supply (TJ/y), with respective CO_2 emission factor before connecting to the grid.

$$MD_{reg,y} = BE_{CH4,S,y} \times AF$$

$BE_{CH4,S,y}$: GHG emission from the sewage sludge decay before the project starts ($t\text{-}CO_2/y$)。

AF : CH_4 fraction with combustion by national regulation before the project starts (-)
It shall be "0" where developing countries have a very few regulation.

(Continuation)	*Determination of $BE_{EN,y}$* $BE_{EN,y}$ shall be determined by the quantity of electricity and thermal energy generation after the project starts and CO_2 baseline emission factors. $$BE_{EN,y} = BE_{elec,y} + BE_{ther,y} = EG_{d,y} \times CEF_d + \frac{Q_y}{\varepsilon_b \cdot NCV_{fuel}} \times EF_{fuel}$$ $BE_{elec,y}$: Baseline emissions from electricity generated from utilizing biogas in the project activity and exported to the grid or displacing onsite/offsite fossil fuel ($t\text{-}CO_2/y$) $BE_{ther,y}$: Baseline emissions from thermal energy produced utilizing the biogas in the project activity displacing thermal energy from onsite/offsite fossil fuel-fueled boiler($t\text{-}CO_2/y$) $EG_{d,y}$: Amount of electricity generated after the project starts(MWh/y) CEF_d : CO_2 emissions factor for the displaced electricity source in the project scenario ($t\text{-}CO_2/MWh$) Q_y : Amount of thermal energy generated after the project starts (TJ/y) ε_b : Energy efficiency of the boiler/air heater used in the absence of the project activity to generate the thermal energy(-) εb shall be “1” as conservative value. NCV_{fuel} : Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity(GJ/kL, m^3, t, etc.) EF_{fuel} : Emission factor of the fuel, as identified through the baseline identification procedure, used in the boiler/air heater to generate the thermal energy in the absence of the project activity($t\text{-}CO_2/TJ$)

(Continuation)

(2)Project emission

Project emission shall be determined by the summation of the following:

・GHG emission from electric and fuel consumption after the project starts

・GHG emission with compositng the sewage sludge after the project starts

$$\boldsymbol{PEy} \quad = \quad PE_{EC,y} + PE_{FC,y} + PE_{C,y}$$

Type	Items	Description
Output	$\boldsymbol{PE_y}$	Project emission: GHG (t-CO_2/y)
Input	$PE_{EC,y}$	GHG emission from electric consumption after the project starts (t-CO_2/y)
	$PE_{FC,y}$	GHG emission from fossil fuel consumption after the project starts (t-CO_2/y)
	$PE_{C,y}$	GHG emission with composting the sewage sludge after the project starts (t-CO_2/y)

Determination of $PE_{EC,y}$

GHG emission from electricity consumption after the project starts is calculated using the following formula.

$$PE_{EC,y} = EL_{PJ,y} \times EF_{PJ,y}$$

$EL_{PJ,y}$: Quantity of electricity consumption on site(MWh)

$EF_{PJ,y}$: Carbon emissions factor for electricity generation (t-CO_2/MWh)

Determination of $PE_{FC,y}$

GHG emission from fuel consumption after the project starts is calculated using the following formula.

$$PE_{FC,y} = \sum_i (FC_i \times NCV_i \times COEF_i)$$

FC_i : Quantity fuel consumption on site(kL, m^3, t etc./y)

NCV_i : Net calorific value of fuel i(GJ/kL,m^3,t etc.,)

$COEF_i$: CO_2 emissions factor of fuel (t-CO_2/TJ)

Determination of $PE_{C,y}$

GHG emission with composting the sewage sludge after the project starts shall be determined by multyplying the quantity of sludge by the CH_4 emission factor and global warming potential.

$$PE_{C,y} = S_{PJ,y} \times EF_C \times GHP_{CH4}$$

$S_{PJ,y}$:Amount of sludge composted after the project starts (dry base)(t/y)

EF_C : Emission factor for CH_4 emissions from the composting process (t-CH_4/t-sludge)

GWP_{CH4} : Global Warming Potential of CH_4 (-)(=21)

4.Data Required for Monitoring and Estimating Emission

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Amount of sludge ($S_{PL,y}$)		Amount of sludge treated after the poject(dry basis) (t/y)	Planned data	Monitoring data	Planned data	Monitoring data
Emission from untreated sludge decay Before: $BE_{CH4,S,y}$	Degradable organic content (DOC_s)	Degradable organic content of the untreated sludge(weight basis) (-)	Data availability is validated in the following order: i) Data unique to the national or areas ii) IPCC default data (Refer to Appendix D-13)		(Not necessary because data is not involved in the calculation)	
	CH_4 correction factor (bofore : MCF_S)	CH_4 correction factor of the disposal site that receives the sludge (-)	IPCC default data (Refer to Appendix D-1)			
	Fraction of DOC dissimilated (DOC_F)	Fraction of DOC dissimilated to biogas (-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
	Fraction of CH_4 in biogas (F)	Fraction of CH_4 in biogas (-)	0.5 (IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
Emissions from generation of energy displaced by the project activity Before: $BE_{EN,y}$	Amount of electricity produced using biogas ($EG_{d,y}$)	The quantity of LFG power supply after the project start (MWh/y)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	
	Baseline CO_2 emission factor CEF_d (= $EF_{PJ,y}$)	Emission factor of the typical power plant (t-CO_2/MWh)	Data availability should be validated in the following order in selecting the typical power plant and obtaining CO_2 emissions factor specific to the target. i) Interview to the electric power management entity concerned ii) Published values in the target country			
	Quantity of thermal energy produced Q_y	The quantity of thermal energy produced after the project starts (TJ/y)	Planned data	Monitoring data	(Not necessary because data is not involved in the calculation)	
	Net calorific value NCV_{fuel} (= NCV_i)	Net calorific value according to fuel seed (GJ/kL, m^3, t etc.)	Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Refer to Appendix C-6,7)			
	CO2 emission factor EF_{fuel} ($COEF_i$)	CO2 emission factor per fuel seed (t-CO2/TJ)				
Model correction factor (before : UF_{BL})		Model correction factor to account for model uncertainties (-)	0.94 (default data of "FCCC/SBSTA/2003/10/Add.2")		(Not necessary because data is not involved in the calculation)	

(Continuation)

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Emission for electricity consumption after : $PE_{EC,y}$	Quantity of electricity consumption（after : $EL_{PJ,y}$）	Quantity of Electricity consumption after the project starts（MWh/y）	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data
Emission for fuel consumption after : $PE_{FC,y}$	Quantity of fuel consumption on site（after : $FC_{PJ,i}$）	Fuel consumption after the project starts (kL, m^3, t etc./y)	(Not necessary because data is not involved in the calculation)		Planned data	Monitoring data
Emission from composting process after : $PE_{C,y}$	CH_4 emission factor（EF_C）	CH_4 emissions factor from the composting process(dry basis) (t-CH_4/t-sludge)	(Not necessary because data is not involved in the calculation)		Data availability is validated in the following order because it is preferably calculated using data and information unique to the project. i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data（Refer to Appendix D-7,8）	
Global Warming Potential GWP_{CH4}		Global Warming Potential of CH_4（-）	21 Default data of “2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste”			

5.Others	(1)Project boundary The project boundary is the site where project activity is being done and where the wastewater and sludge are treated. . (2)Leakage Project activity could lead to the following leakages: Construction of composting plant: the indirect emissions potentially lead to leakage due to activities such as product manufacturing or materials transport. This respective emission is temporary and negligible considering the project scale and therefore it can be ignored. (3)Reference methodology and differences 1) AMS-III.F(Ver.10.0): Avoidance of methane emissions through composting 【Differences】 ・ The formula in the reference methodology is applied for manure as the CH_4 generating factor (raw materials for composting) before the project starts. This formula is only applied to sewage sludge. ・ The formula in the reference methodology considers the generated compost transportation, sewer water discharge, GHG emission from decay in compost or residual waste after the project start for the project emission. This formula is only applied to sewage sludge. ・ Baseline emission in the reviewed methodology is computed by or the CO_2 emission factor of grid (*1). In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ GHG emission from transporting the facilities to other places or vice versa is considered as the leakage in the reference methodology. This formula however excludes this condition. *1: CO_2 emission factor of grid is a combined margin (CM) computed by the combination of operating margin (OM) and build margin (BM) in the CDM methodology "Tool to calculate the Emission Factor for an electricity system". 2) AM0025(Ver.12):Avoided emissions from organic waste through alternative waste treatment processes 【Differences】 ・ The formula in the reference methodology is applied for organic waste in general as the CH_4 generating factor (raw materials for composting) before the project starts. This formula is only applied to sewage sludge. ・ In the reviewed methodology, in the case of using the grid electricity generated by heat power plant, the CO_2 emission factor of the electricity is "0.8 CO_2/MWh" as the default date. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ The formula in the reference methodology is applied to the methane capture, flare treatment, power generation, heat supply, incineration, RDF processing and composting as the measures to generate CH_4 by decay and to reduce emission. This formula however is only applied for composting. ・ GHG emission from transportation increase and decay in residual waste is considered as the leakage in the reference methodology. On the other hand, this formula excludes this condition. 3) AM0039(Ver. 02)Methane emissions reduction from organic wastewater and bioorganic solid waste using co-composting 【Differences】 ・ GHG emission from N_2O generation a transportation of generated compost, wastewater discharge, decay in residual waste or compost after the project starts is considered in the calculation of the project emission. This formula however excludes these conditions. ・ In the reviewed methodology, in the case of connecting to the grid the CO_2 emission factor of the electricity is calculated by the "Tool to calculate the Emission Factor for an electricity system" for

	CDM. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. 4) AMS III.H(Ver.16):Methane recovery in wastewater treatment 【Differences】 ・ The formula in the reference methodology includes wastewater treatment in project boundary while this formula excludes this. ・ In the reviewed methodology, when using the grid electric power only the CO_2 emission factor of the electricity will be chosen from alternatives that the grid average value calculated by the CDM Methodology “Tool to calculate the Emission Factor for an electricity system” or one of some default values. In this methodology, emissions factor of electricity is defined as the emission factor of one or two typical power plants existing in the gird to calculate easily. ・ GHG emission from transporting the facilities to other places or vice versa is considered as the leakage in the reference methodology. This formula however excludes this condition.

Annex Table D-1 Default data for MCF_p[1]

TABLE 3.1 SWDS CLASSIFICATION AND METHANE CORRECTION FACTORS (MCF)	
Type of Site	**Methane Correction Factor (MCF) Default Values**
Managed – anaerobic [1]	1.0
Managed – semi-aerobic [2]	0.5
Unmanaged [3] – deep (>5 m waste) and /or high water table	0.8
Unmanaged [4] – shallow (<5 m waste)	0.4
Uncategorised SWDS [5]	0.6

[1] **Anaerobic managed solid waste disposal sites**: These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.

[2] **Semi-aerobic managed solid waste disposal sites**: These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system.

[3] **Unmanaged solid waste disposal sites – deep and/or with high water table**: All SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 metres and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.

[4] **Unmanaged shallow solid waste disposal sites**; All SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres.

[5] **Uncategorised solid waste disposal sites**: Only if countries cannot categorise their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used.

Sources: IPCC (2000); Matsufuji *et al.* (1996)

Souces：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table3.1

[1] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

Annex TableD-2 Default data for CCW_i, FCF_i,DOC_j [2]

TABLE 2.4
DEFAULT DRY MATTER CONTENT, DOC CONTENT, TOTAL CARBON CONTENT AND FOSSIL CARBON FRACTION OF DIFFERENT MSW COMPONENTS

MSW component	Dry matter content in % of wet weight [1]	DOC content in % of wet waste		DOC content in % of dry waste		Total carbon content in % of dry weight		Fossil carbon fraction in % of total carbon	
	Default	Default	Range	Default	Range [2]	Default	Range	Default	Range
Paper/cardboard	90	40	36 - 45	44	40 - 50	46	42 - 50	1	0 - 5
Textiles [3]	80	24	20 - 40	30	25 - 50	50	25 - 50	20	0 - 50
Food waste	40	15	8 - 20	38	20 - 50	38	20 - 50	-	-
Wood	85 [4]	43	39 - 46	50	46 - 54	50	46 - 54	-	-
Garden and Park waste	40	20	18 - 22	49	45 - 55	49	45 - 55	0	0
Nappies	40	24	18 - 32	60	44 - 80	70	54 - 90	10	10
Rubber and Leather	84	(39) [5]	(39) [5]	(47) [5]	(47) [5]	67	67	20	20
Plastics	100	-	-	-	-	75	67 - 85	100	95 - 100
Metal [6]	100	-	-	-	-	NA	NA	NA	NA
Glass [6]	100	-	-	-	-	NA	NA	NA	NA
Other, inert waste	90	-	-	-	-	3	0 - 5	100	50 - 100

[1] The moisture content given here applies to the specific waste types before they enter the collection and treatment. In samples taken from collected waste or from e.g., SWDS the moisture content of each waste type will vary by moisture of co-existing waste and weather during handling.

[2] The range refers to the minimum and maximum data reported by Dehoust *et al*., 2002; Gangdonggu, 1997; Guendehou, 2004; JESC, 2001; Jager and Blok, 1993; Würdinger *et al*., 1997; and Zeschmar-Lahl, 2002.

[3] 40 percent of textile are assumed to be synthetic (default). Expert judgement by the authors.

[4] This value is for wood products at the end of life. Typical dry matter content of wood at the time of harvest (that is for garden and park waste) is 40 percent. Expert judgement by the authors.

[5] Natural rubbers would likely not degrade under anaerobic condition at SWDS (Tsuchii et al., 1985; Rose and Steinbüchel, 2005).

[6] Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common.

Souces：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table2.4

[2] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf

Annex TableD-3 Default data for k_j[3]

TABLE 3.3
RECOMMENDED DEFAULT METHANE GENERATION RATE (*k*) VALUES UNDER TIER 1

(Derived from *k* values obtained in experimental measurements, calculated by models, or used in greenhouse gas inventories and other studies)

Type of Waste		Climate Zone*							
		Boreal and Temperate (MAT ≤ 20°C)				Tropical[1] (MAT > 20°C)			
		Dry (MAP/PET < 1)		Wet (MAP/PET > 1)		Dry (MAP < 1000 mm)		Moist and Wet (MAP ≥ 1000 mm)	
		Default	Range[2]	Default	Range[2]	Default	Range[2]	Default	Range[2]
Slowly degrading waste	Paper/textiles waste	0.04	0.03[3,5] – 0.05[3,4]	0.06	0.05 – 0.07[3,5]	0.045	0.04 – 0.06	0.07	0.06 – 0.085
	Wood/ straw waste	0.02	0.01[3,4] – 0.03[6,7]	0.03	0.02 – 0.04	0.025	0.02 – 0.04	0.035	0.03 – 0.05
Moderately degrading waste	Other (non – food) organic putrescible/ Garden and park waste	0.05	0.04 – 0.06	0.1	0.06 – 0.1[8]	0.065	0.05 – 0.08	0.17	0.15 – 0.2
Rapidly degrading waste	Food waste/Sewage sludge	0.06	0.05 – 0.08	0.185[4]	0.1[3,4] – 0.2[9]	0.085	0.07 – 0.1	0.4	0.17 – 0.7[10]
Bulk Waste		0.05	0.04 – 0.06	0.09	0.08[8] – 0.1	0.065	0.05 – 0.08	0.17	0.15[11] – 0.2

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table3.3

[3] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

Annex TableD-4 Default data for W_y[4]

TABLE 2.1
MSW GENERATION AND TREATMENT DATA - REGIONAL DEFAULTS

Region	MSW Generation Rate[1, 2, 3] (tonnes/cap/yr)	Fraction of MSW disposed to SWDS	Fraction of MSW incinerated	Fraction of MSW composted	Fraction of other MSW management, unspecified[4]
Asia					
Eastern Asia	0.37	0.55	0.26	0.01	0.18
South-Central Asia	0.21	0.74	-	0.05	0.21
South-East Asia	0.27	0.59	0.09	0.05	0.27
Africa[5]	0.29	0.69	-	-	0.31
Europe					
Eastern Europe	0.38	0.90	0.04	0.01	0.02
Northern Europe	0.64	0.47	0.24	0.08	0.20
Southern Europe	0.52	0.85	0.05	0.05	0.05
Western Europe	0.56	0.47	0.22	0.15	0.15
America					
Caribbean	0.49	0.83	0.02	-	0.15
Central America	0.21	0.50	-	-	0.50
South America	0.26	0.54	0.01	0.003	0.46
North America	0.65	0.58	0.06	0.06	0.29
Oceania[6]	0.69	0.85	-	-	0.15

[1] Data are based on weight of wet waste.

[2] To obtain the total waste generation in the country, the per-capita values should be multiplied with the population whose waste is collected. In many countries, especially developing countries, this encompasses only urban population.

[3] The data are default data for the year 2000, although for some countries the year for which the data are applicable was not given in the reference, or data for the year 2000 were not available. The year for which the data are collected, where available, is given in the Annex 2A.1.

[4] Other, unspecified, includes data on recycling for some countries.

[5] A regional average is given for the whole of Africa as data are not available for more detailed regions within Africa.

[6] Data for Oceania are based only on data from Australia and New Zealand.

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table2.1

[4] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf

Annex TableD-5　Default data for w_j[5]

TABLE 2.3
MSW COMPOSITION DATA BY PERCENT - REGIONAL DEFAULTS

Region	Food waste	Paper/cardboard	Wood	Textiles	Rubber/leather	Plastic	Metal	Glass	Other
Asia									
Eastern Asia	26.2	18.8	3.5	3.5	1.0	14.3	2.7	3.1	7.4
South-Central Asia	40.3	11.3	7.9	2.5	0.8	6.4	3.8	3.5	21.9
South-Eastern Asia	43.5	12.9	9.9	2.7	0.9	7.2	3.3	4.0	16.3
Western Asia & Middle East	41.1	18.0	9.8	2.9	0.6	6.3	1.3	2.2	5.4
Africa									
Eastern Africa	53.9	7.7	7.0	1.7	1.1	5.5	1.8	2.3	11.6
Middle Africa	43.4	16.8	6.5	2.5		4.5	3.5	2.0	1.5
Northern Africa	51.1	16.5	2	2.5		4.5	3.5	2	1.5
Southern Africa	23	25	15						
Western Africa	40.4	9.8	4.4	1.0		3.0	1.0		
Europe									
Eastern Europe	30.1	21.8	7.5	4.7	1.4	6.2	3.6	10.0	14.6
Northern Europe	23.8	30.6	10.0	2.0		13.0	7.0	8.0	
Southern Europe	36.9	17.0	10.6						
Western Europe	24.2	27.5	11.0						
Oceania									
Australia and New Zealand	36.0	30.0	24.0						
Rest of Oceania	67.5	6.0	2.5						
America									
North America	33.9	23.2	6.2	3.9	1.4	8.5	4.6	6.5	9.8
Central America	43.8	13.7	13.5	2.6	1.8	6.7	2.6	3.7	12.3
South America	44.9	17.1	4.7	2.6	0.7	10.8	2.9	3.3	13.0
Caribbean	46.9	17.0	2.4	5.1	1.9	9.9	5.0	5.7	3.5

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table2.3

[5] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf

Annex TableD-6 County-specific CO_2 emission factor of grid power

Unit：t-CO2/MWh

Region	Country	Local Region	Carbon Emission Factor OM[1]	BM[2]	CM[3]	Source ／ PDD Title	Registration Date	Carbon Emission Factor OM[1]	BM[2]	CM[3]	Source ／ PDD Title	Registration Date
Published Values in the Target Country												
Asian and Oceanian	China	North China	1.007	0.780	0.894	China'sRegional Grid Baseline Emission Factors 2009 (Chinese Version), Department of Climate Change,NDRC http://cdm.ccchina.gov.cn/english/NewsInfo.asp?NewsId=3840	2009/9/3	1.033	0.649	0.840	Institute for Global Environmental Strategies	2011/4/23
		North East Chine	1.129	0.724	0.927							
		East Chine	0.883	0.683	0.783							
		Central Chine	1.126	0.580	0.853							
		North West Chine	1.025	0.643	0.834							
		South Chine	0.999	0.577	0.788							
		Hainan Province	0.815	0.730	0.773							
	India	India	0.980	0.800	0.890	Baseline Carbon Dioxide Emission Database Version 6.0 - LATEST Central Electricity Authority, Ministry of Power, Government of India http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm	2010/3/11	1.009	0.598	0.906	Institute for Global Environmental Strategies	2011/4/9
		NEWNE	0.990	0.810	0.900							
		South	0.940	0.760	0.850							
	Indonesia	Sumatera	-	-	0.743	Baseline Emission Factor (Updated) http://dna-cdm.menlh.go.id/id/database/	2009/2/13	0.873	0.560	0.717	Institute for Global Environmental Strategies	2011/2/12
		JAMALI	-	-	0.891							
	Malaysia	Peninsular Malaysia	0.603	0.741	0.672	Study on Grid Connected Electricity Baselines in Malaysia Year:2008, CDM Baseline 2008(339KB), CDM Energy Secretariat http://cdm.eib.org.my/subindex.php?menu=9&submenu=85	2010/3/1	0.828	0.844	0.836	Institute for Global Environmental Strategies	2011/2/26
		Sarawak	0.813	0.837	0.825							
		Sabah	0.705	0.597	0.651							
Latin America and Caribbean	Argentina	Argentina	0.516	0.335	0.425	MODELO DE CALCULO DEL FACTOR DE EMISIONES DE CO2 DE LA RED, ARGENTINA DE ENERGIA ELECTRICA. A NO 2006. http://www.ambiente.gov.ar/?idarticulo=7362	2007/8/22	0.484	0.362	0.423	Institute for Global Environmental Strategies	2010/12/18
Kyoto Mechanisms												
Asian and Oceanian	Republic of Korea	ー	0.682	0.393	0.610	3MW Shinan Wind power project	2010/4/18	0.682	0.394	0.610	Institute for Global Environmental Strategies	2011/2/4
	Mongol	ー	1.050	1.070	1.060	Durgun hydropower project in Mongolia	2007/3/23	1.150	1.170	ー	Institute for Global Environmental Strategies	2009
	Bangladesh	ー	0.670	0.712	0.691	Composting of Organic Waste in Dhaka	2006/5/18	0.670	0.712	0.691	Institute for Global Environmental Strategies	2006/5/18
	Bhutan,India	ー	1.160	0.850	1.004	Dagachhu Hydropower Project, Bhutan	2010/2/26	1.160	0.850	1.004	Institute for Global Environmental Strategies	2010/2/10
	Philippines	ー	0.549	0.329	0.439	Republic Cement Corporation - Teresa Plant Waste Heat Recovery Project	2011/3/29	0.549	0.329	0.439	Institute for Global Environmental Strategies	2011/3/29
	Vietnam	ー	0.635	0.502	0.568	Lao Cai - Lai Chau - Kontum Bundled Hydropower Project	2011/3/24	0.620	0.451	0.536	Institute for Global Environmental Strategies	2011/4/8
	Thailand	ー	0.512	0.546	0.529	UB Tapioca Starch Wastewater Treatment Project	2011/3/22	0.507	0.554	0.530	Institute for Global Environmental Strategies	2011/4/9
	Sri Lanka	ー	0.707	0.646	0.677	Adavikanda, Kuruwita Division Mini Hydro Power Project	2010/8/24	0.707	0.646	0.677	Institute for Global Environmental Strategies	2010/8/24
	Pakistan	ー	0.724	0.242	0.483	Biogas-based Cogeneration Project at Shakarganj Mills Ltd., Jhang, Pakistan	2010/12/2	0.724	0.242	0.483	Institute for Global Environmental Strategies	2010/12/2
Central-Eastern Europe,Central Asia	United Arab Emirates	ー	0.938	0.708	0.881	Abu Dhabi solar thermal power project, Masdar	2009/8/13	0.938	0.708	0.881	Institute for Global Environmental Strategies	2009/8/13
	Uzbekistan	ー	-	-	0.617	Akhangaran Landfill Gas Capture Project in Tashkent	2009/12/19				Institute for Global Environmental Strategies	
	Israel	ー	0.797	0.695	0.746	Evlayim Landfill Project	2011/2/12	0.797	0.695	0.746	Institute for Global Environmental Strategies	2011/2/12
Latin America and Caribbean	Brasil	ー	0.487	0.078	0.282	CDM project of Moinho and Barracao Small Hydropower Plant	2010/1/11	0.291	0.078	0.184	Institute for Global Environmental Strategies	2011/1/12
	Columbia	ー	0.469	0.237	0.353	Amaime Minor Hydroelectric Power Plant	2009/10/29	0.471	0.212	0.342	Institute for Global Environmental Strategies	2011/1/17
	Uruguay	ー	0.338	0.181	0.259	Fray Bentos Biomass Power Generation Project (FBBP Project)	2008/5/8	0.580	0.733	0.618	Institute for Global Environmental Strategies	2011/1/29
	Bolivia	ー	0.730	0.349	0.540	Conversion of existing open cycle gas turbine to combined cycle at Guaracachi power station, Santa Cruz, Bolivia	2010/4/13	0.730	0.349	0.540	Institute for Global Environmental Strategies	2010/4/13
	Argentina	ー	0.510	0.347	0.429	Biogas recovery and Thermal Power production at CITRUSVIL Citric Plant in Tucumán, Argentina	2010/12/1					
	Chile	ー	0.718	0.490	0.604	Trueno River Hydroelectric Power Plant	2011/4/1	0.718	0.490	0.604	Institute for Global Environmental Strategies	2011/4/9
	Costa Rica	ー	0.485	0.098	0.388	Guanacaste Wind Farm	2011/2/11	0.485	0.098	0.388	Institute for Global Environmental Strategies	2011/2/11
	Honduras	ー	0.629	0.559	0.594	Mezapa Small-Scale Hydroelectric Project	2011/2/8	0.629	0.559	0.594	Institute for Global Environmental Strategies	2010/3/8
	Ecuador	ー	0.732	0.389	0.646	Landfill biogas extraction and combustion plant in El Inga I and II landfill (Quito, Ecuador)	2011/1/8	0.731	0.548	0.640	Institute for Global Environmental Strategies	2011/1/22
	Mexico	ー	0.715	0.347	0.531	Alternative fuels and biomass project at Zapotiltic cement plant	2010/12/25	0.704	0.375	0.539	Institute for Global Environmental Strategies	2011/1/4
	Peru	ー	0.720	0.480	0.600	Yanapampa Hydroelectric Power Plant	2010/12/18	0.720	0.480	0.600	Institute for Global Environmental Strategies	2010/12/18
	Dominican Republic	ー	0.619	0.444	0.532	Bionersis project on La Duquesa landfill, Dominican Republic	2010/4/9	0.619	0.444	0.532	Institute for Global Environmental Strategies	2010/4/8
	El Salvador	ー	0.716	0.718	0.717	El Chaparral Hydroelectric Project (El Salvador)	2010/3/1	0.716	0.718	0.717	Institute for Global Environmental Strategies	2010/3/1
Africa	Morocco	ー	0.734	0.752	0.743	Essaouira wind power project	2005/10/29	0.734	0.752	0.743	Institute for Global Environmental Strategies	2005/10/29
	Kenya	ー	0.710	0.480	0.600	Olkaria Ⅲ Phase 2 Geothermal Expansion Project in Kenya	2010/3/4	0.761	0.426	0.594	Institute for Global Environmental Strategies	2010/12/4
	South Africa	ー	0.990	1.050	1.020	Bethlehem Hydroelectric project	2009/10/8	0.990	1.050	1.020	Institute for Global Environmental Strategies	2010/10/26
	Uganda	ー	0.569	0.677	0.623	Bugoye 13.0 MW Run-of-River Hydropower Project	2011/1/1	0.569	0.677	0.623	Institute for Global Environmental Strategies	2011/1/1
	Senegal	ー	0.701	0.651	0.676	Energy efficiency improvement Project of CSS sugar mill	2010/12/28	0.701	0.651	0.676	Institute for Global Environmental Strategies	2010/12/28
	Nigeria	ー	0.670	0.580	0.630	Municipal Solid Waste (MSW) Composting Project in Ikorodu, Lagos State	2010/12/15	0.670	0.580	0.630	Institute for Global Environmental Strategies	2010/12/15
	Egypt	ー	0.557	0.428	0.525	Zafarana 8 - Wind Power Plant Project, Arab Republic of Egypt	2010/9/23	0.557	0.428	0.525	Institute for Global Environmental Strategies	2010/9/23
	Madagascar	ー	0.518	0.579	0.548	Small-Scale Hydropower Project Sahanivotry in Madagascar	2010/8/28	0.518	0.579	0.548	Institute for Global Environmental Strategies	2010/8/28
	Rwanda	ー	0.661	0.647	0.654	Rwanda Electrogaz Compact Fluorescent Lamp (CFL) distribution project	2010/5/30	0.661	0.647	0.654	Institute for Global Environmental Strategies	2010/5/30

Annex TableD-6 County-specific CO_2 emission factor of grid power（2）

Unit：t-CO2/MWh

Region	Country	Local Region	Carbon Emission Factor OM[1]	BM[2]	CM[3]	Source ／ PDD Title	Latest Year	Carbon Emission Factor OM[1]	BM[2]	CM[3]	Source ／ PDD Title	Registration Date
International Energy Agency												
Asian and Oceanian	Brunei	―	―	―	0.755	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cambodia	―	―	―	1.160	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Taiwan	―	―	―	0.650	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	North Korea	―	―	―	0.481	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Myanmar	―	―	―	0.285	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Nepal	―	―	―	0.003	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Singapore	―	―	―	0.531	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.502	0.411	―	Institute for Global Environmental Strategies	2010
	Fiji	―	―	―	―	―	―	0.660	0.650	0.656	Institute for Global Environmental Strategies	2005/10/1
	Papua New Guinea	―	―	―	―	―	―	0.704	0.653	0.679	Institute for Global Environmental Strategies	2006/5/29
Middle East	Bahrain	―	―	―	0.651	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Iran	―	―	―	0.582	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Iraq	―	―	―	0.812	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Jordan	―	―	―	0.589	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.675	0.551	0.613	Institute for Global Environmental Strategies	2009/12/11
	Kuwait	―	―	―	0.614	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Lebanon	―	―	―	0.705	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Oman	―	―	―	0.858	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Qatar	―	―	―	0.534	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Saudi Arabia	―	―	―	0.754	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Syria	―	―	―	0.613	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Yemen	―	―	―	0.636	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
Europe	Albania	―	―	―	0.014	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Bosnia and Herzegovina	―	―	―	0.928	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Bulgaria	―	―	―	0.489	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Croatia	―	―	―	0.341	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cyprus	―	―	―	0.759	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.846	0.735	0.818	Institute for Global Environmental Strategies	2010/2/7
	Gibraltar	―	―	―	0.757	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Macedonia	―	―	―	0.786	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.772	1.004	0.888	Institute for Global Environmental Strategies	2009/12/4
	Malta	―	―	―	0.849	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Romania	―	―	―	0.417	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Serbia	―	―	―	0.671	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Slovenia	―	―	―	0.329	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
Former Soviet Union	Armenia	―	―	―	0.165	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.535	0.398	0.437	Institute for Global Environmental Strategies	2009/7/10
	Azerbaijan	―	―	―	0.416	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Belarus	―	―	―	0.303	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Estonia	―	―	―	0.752	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Georgia	―	―	―	0.081	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	―	―	0.093	Institute for Global Environmental Strategies	2007/4/6
	Kazakhstan	―	―	―	0.439	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Kyrgyzstan	―	―	―	0.094	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Latvia	―	―	―	0.162	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Lithuania	―	―	―	0.114	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Moldova	―	―	―	0.468	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Russia	―	―	―	0.326	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Tajikistan	―	―	―	0.031	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Turkmenistan	―	―	―	0.795	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Ukraine	―	―	―	0.386	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
Latin America and Caribbean	Cuba	―	―	―	0.913	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.808	0.875	0.841	Institute for Global Environmental Strategies	2009/2/27
	Guatemala	―	―	―	0.336	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.811	0.468	0.640	Institute for Global Environmental Strategies	2008/12/23
	Haiti	―	―	―	0.480	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Jamaica	―	―	―	0.785	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.893	0.776	0.834	Institute for Global Environmental Strategies	2006/3/19
	Antilles	―	―	―	0.707	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Nicaragua	―	―	―	0.477	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.754	0.589	0.713	Institute for Global Environmental Strategies	2009/4/12
	Panama	―	―	―	0.273	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.713	0.503	0.660	Institute for Global Environmental Strategies	2009/2/23
	Trinidad and Tobago	―	―	―	0.687	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Venezuela	―	―	―	0.203	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Guyana	―	―	―	―	―	―	0.948	―	0.948	Institute for Global Environmental Strategies	2008/5/4

Annex TableD-6　County-specific CO_2 emission factor of grid power（3）

Unit：t-CO2/MWh

Region	Country	Local Region	Carbon Emission Factor			Source ／ PDD Title	Latest Year	Carbon Emission Factor			Source ／ PDD Title	Registration Date
			OM[1]	BM[2]	CM[3]			OM[1]	BM[2]	CM[3]		
International Energy Agency												
Africa	Algeria	－	－	－	0.596	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Angora	－	－	－	0.038	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Benin	－	－	－	0.697	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Botswana	－	－	－	1.789	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cameroon	－	－	－	0.230	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Congo	－	－	－	0.108	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Cote d'Ivoire	－	－	－	0.449	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008	0.713	0.661	0.687	Institute for Global Environmental Strategies	2010/11/25
	Eritrea	－	－	－	0.669	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Ethiopia	－	－	－	0.119	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Gabon	－	－	－	0.401	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Ghana	－	－	－	0.214	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Libya	－	－	－	0.885	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Morocco	－	－	－	0.718	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Mozambique	－	－	－	0.000	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Namibia	－	－	－	0.424	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Sudan	－	－	－	0.609	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Tanzania	－	－	－	0.242	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Togo	－	－	－	0.206	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Tunisia	－	－	－	0.522	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Zambia	－	－	－	0.003	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Zimbabwe	－	－	－	0.619	IEA "CO2 EMISSIONS FROM FUEL CONBUSTION, 2010 EDITION"	2008					
	Mali,Senegal,Mauritania	－	－	－	－	－	－	0.518	0.647	0.582	Institute for Global Environmental Strategies	2010/5/6

1) OM:Operating Margin　Emission factor of existing plants
2) BM:Build Margin　Emission factor of plants built recently
3) CM: Combined margin　Average of emission factor of OM and BM

Annex TableD-7 Default data for NCV_i[6]

TABLE 1.2
DEFAULT NET CALORIFIC VALUES (NCVS) AND LOWER AND UPPER LIMITS OF THE 95% CONFIDENCE INTERVALS [1]

Fuel type English description		Net calorific value (TJ/Gg)	Lower	Upper
Crude Oil		42.3	40.1	44.8
Orimulsion		27.5	27.5	28.3
Natural Gas Liquids		44.2	40.9	46.9
Gasoline	Motor Gasoline	44.3	42.5	44.8
	Aviation Gasoline	44.3	42.5	44.8
	Jet Gasoline	44.3	42.5	44.8
Jet Kerosene		44.1	42.0	45.0
Other Kerosene		43.8	42.4	45.2
Shale Oil		38.1	32.1	45.2
Gas/Diesel Oil		43.0	41.4	43.3
Residual Fuel Oil		40.4	39.8	41.7
Liquefied Petroleum Gases		47.3	44.8	52.2
Ethane		46.4	44.9	48.8
Naphtha		44.5	41.8	46.5
Bitumen		40.2	33.5	41.2
Lubricants		40.2	33.5	42.3
Petroleum Coke		32.5	29.7	41.9
Refinery Feedstocks		43.0	36.3	46.4
Other Oil	Refinery Gas [2]	49.5	47.5	50.6
	Paraffin Waxes	40.2	33.7	48.2
	White Spirit and SBP	40.2	33.7	48.2
	Other Petroleum Products	40.2	33.7	48.2
Anthracite		26.7	21.6	32.2
Coking Coal		28.2	24.0	31.0
Other Bituminous Coal		25.8	19.9	30.5
Sub-Bituminous Coal		18.9	11.5	26.0
Lignite		11.9	5.50	21.6
Oil Shale and Tar Sands		8.9	7.1	11.1
Brown Coal Briquettes		20.7	15.1	32.0
Patent Fuel		20.7	15.1	32.0
Coke	Coke Oven Coke and Lignite Coke	28.2	25.1	30.2
	Gas Coke	28.2	25.1	30.2
Coal Tar [3]		28.0	14.1	55.0
Derived Gases	Gas Works Gas [4]	38.7	19.6	77.0
	Coke Oven Gas [5]	38.7	19.6	77.0
	Blast Furnace Gas [6]	2.47	1.20	5.00
	Oxygen Steel Furnace Gas [7]	7.06	3.80	15.0
Natural Gas		48.0	46.5	50.4
Municipal Wastes (non-biomass fraction)		10	7	18
Industrial Wastes		NA	NA	NA
Waste Oil [8]		40.2	20.3	80.0
Peat		9.76	7.80	12.5

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy Table1.2

[6] IPCC: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Annex TableD-8 Default data for $COEF_i$[7]

TABLE 2.2
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Aviation Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Jet Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Jet Kerosene		r 71 500	69 700	74 400	r 3	1	10	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	r 3	1	10	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	r 3	1	10	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	r 3	1	10	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	r 3	1	10	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	r 1	0.3	3	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	r 1	0.3	3	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	r 3	1	10	0.6	0.2	2
Bitumen		80 700	73 000	89 900	r 3	1	10	0.6	0.2	2
Lubricants		73 300	71 900	75 200	r 3	1	10	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	r 3	1	10	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	r 3	1	10	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	r 1	0.3	3	0.1	0.03	0.3
Other Oil	Paraffin Waxes	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	White Spirit and SBP	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	Other Petroleum Products	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Anthracite		98 300	94 600	101 000	1	0.3	3	r 1.5	0.5	5
Coking Coal		94 600	87 300	101 000	1	0.3	3	r 1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	1	0.3	3	r 1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	1	0.3	3	r 1.5	0.5	5
Lignite		101 000	90 900	115 000	1	0.3	3	r 1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	1	0.3	3	r 1.5	0.5	5
Brown Coal Briquettes		97 500	87 300	109 000	n 1	0.3	3	r 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	1	0.3	3	n 1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	1	0.3	3	r 1.5	0.5	5
Coke	Gas Coke	r 107 000	95 700	119 000	r 1	0.3	3	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 1	0.3	3	r 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	n 1	0.3	3	0.1	0.03	0.3
Derived Gases	Coke Oven Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Blast Furnace Gas	n 260 000	219 000	308 000	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	r 1	0.3	3	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	1	0.3	3	0.1	0.03	0.3

[7] IPCC: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

TABLE 2.2 (CONTINUED)
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	30	10	100	4	1.5	15
Industrial Wastes		n 143 000	110 000	183 000	30	10	100	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	30	10	100	4	1.5	15
Peat		106 000	100 000	108 000	n 1	0.3	3	n 1.5	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	30	10	100	4	1.5	15
Solid Biofuels	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
Solid Biofuels	Other Primary Solid Biomass	n 100 000	84 700	117 000	30	10	100	4	1.5	15
Solid Biofuels	Charcoal	n 112 000	95 000	132 000	200	70	600	4	1.5	15
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
Liquid Biofuels	Biodiesels	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
Liquid Biofuels	Other Liquid Biofuels	n 79 600	67 100	95 300	r 3	1	10	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Gas Biomass	Sludge Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Gas Biomass	Other Biogas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n 100 000	84 700	117 000	30	10	100	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy Table2.2

TABLE 2.3

DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION

(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	r 3	1	10	0.6	0.2	2
	Aviation Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
	Jet Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Jet Kerosene		71 500	69 700	74 400	r 3	1	10	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	r 3	1	10	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	r 3	1	10	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	r 3	1	10	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	r 3	1	10	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	r 1	0.3	3	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	r 1	0.3	3	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	r 3	1	10	0.6	0.2	2
Bitumen		80 700	73 000	89 900	r 3	1	10	0.6	0.2	2
Lubricants		73 300	71 900	75 200	r 3	1	10	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	r 3	1	10	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	r 3	1	10	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	r 1	0.3	3	0.1	0.03	0.3
	Paraffin Waxes	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
	White Spirit and SBP	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
	Other Petroleum Products	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Anthracite		98 300	94 600	101 000	10	3	30	r 1.5	0.5	5
Coking Coal		94 600	87 300	101 000	10	3	30	r 1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	10	3	30	r 1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	10	3	30	r 1.5	0.5	5
Lignite		101 000	90 900	115 000	10	3	30	r 1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	10	3	30	r 1.5	0.5	5
Brown Coal Briquettes		n 97 500	87 300	109 000	n 10	3	30	n 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	10	3	30	r 1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	10	3	30	r 1.5	0.5	5
	Gas Coke	r 107 000	95 700	119 000	r 1	0.3	3	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 10	3	30	n 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
	Coke Oven Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
	Blast Furnace Gas	n260 000	219 000	308 000	r 1	0.3	3	0.1	0.03	0.3
	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	r 1	0.3	3	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	r 1	0.3	3	0.1	0.03	0.3

TABLE 2.3 (CONTINUED)
DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION
(kg of greenhouse gas per TJ on a Net Calorific Basis)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	30	10	100	4	1.5	15
Industrial Wastes		n143 000	110 000	183 000	30	10	100	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	30	10	100	4	1.5	15
Peat		106 000	100 000	108 000	n 2	0.6	6	n 1.5	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	30	10	100	4	1.5	15
	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
	Other Primary Solid Biomass	n 100 000	84 700	117 000	30	10	100	4	1.5	15
	Charcoal	n 112 000	95 000	132 000	200	70	600	4	1.5	15
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Biodiesels	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Other Liquid Biofuels	n 79 600	67 100	95 300	r 3	1	10	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Sludge Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Other Biogas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n100 000	84 700	117 000	30	10	100	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy Table2.3

Annex TableD-9 Default data for $EF_{c,CH4}$ 、 $EF_{a,CH4}$[8]

TABLE 4.1
DEFAULT EMISSION FACTORS FOR CH_4 AND N_2O EMISSIONS FROM BIOLOGICAL TREATMENT OF WASTE

Type of biological treatment	CH_4 Emission Factors ($g CH_4/kg$ waste treated)		N_2O Emission Factors ($g N_2O/kg$ waste treated)		Remarks
	on a dry weight basis	on a wet weight basis	on a dry weight basis	on a wet weight basis	
Composting	10 (0.08 - 20)	4 (0.03 - 8)	0.6 (0.2 - 1.6)	0.3 (0.06 - 0.6)	Assumptions on the waste treated: 25-50% DOC in dry matter, 2% N in dry matter, moisture content 60%. The emission factors for dry waste are estimated from those for wet waste assuming a moisture content of 60% in wet waste.
Anaerobic digestion at biogas facilities	2 (0 - 20)	1 (0 - 8)	Assumed negligible	Assumed negligible	

Sources: Arnold, M.(2005) Personal communication; Beck-Friis (2002); Detzel *et al.* (2003); Petersen *et al.* 1998; Hellebrand 1998; Hogg, D. (2002); Vesterinen (1996).

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table4.1

8 IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_4_Ch4_Bio_Treat.pdf

Annex TableD-10 Default data for *MCF*[9]

TABLE 6.3
DEFAULT MCF VALUES FOR DOMESTIC WASTEWATER

Type of treatment and discharge pathway or system	Comments	MCF [1]	Range
Untreated system			
Sea, river and lake discharge	Rivers with high organics loadings can turn anaerobic.	0.1	0 – 0.2
Stagnant sewer	Open and warm	0.5	0.4 – 0.8
Flowing sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH_4 from pump stations, etc)	0	0
Treated system			
Centralized, aerobic treatment plant	Must be well managed. Some CH_4 can be emitted from settling basins and other pockets.	0	0 – 0.1
Centralized, aerobic treatment plant	Not well managed. Overloaded.	0.3	0.2 – 0.4
Anaerobic digester for sludge	CH_4 recovery is not considered here.	0.8	0.8 – 1.0
Anaerobic reactor	CH_4 recovery is not considered here.	0.8	0.8 – 1.0
Anaerobic shallow lagoon	Depth less than 2 metres, use expert judgment.	0.2	0 – 0.3
Anaerobic deep lagoon	Depth more than 2 metres	0.8	0.8 – 1.0
Septic system	Half of BOD settles in anaerobic tank.	0.5	0.5
Latrine	Dry climate, ground water table lower than latrine, small family (3-5 persons)	0.1	0.05 – 0.15
Latrine	Dry climate, ground water table lower than latrine, communal (many users)	0.5	0.4 – 0.6
Latrine	Wet climate/flush water use, ground water table higher than latrine	0.7	0.7 – 1.0
Latrine	Regular sediment removal for fertilizer	0.1	0.1

[1] Based on expert judgment by lead authors of this section.

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste Table6.3

[9] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf

Annex TableD-11 Default data for EF_{N2O}[10]

TABLE 5.6 DEFAULT N_2O EMISSION FACTORS FOR DIFFERENT TYPES OF WASTE AND MANAGEMENT PRACTICES			
Type of waste	**Technology / Management practice**	**Emission factor ($g\ N_2O$ / t waste)**	**weight basis**
MSW	continuous and semi-continuous incinerators	50	wet weight
MSW	batch-type incinerators	60	wet weight
MSW	open burning	150	dry weight
Industrial waste	all types of incineration	100	wet weight
Sludge (except sewage sludge)	all types of incineration	450	wet weight
Sewage sludge	incineration	990	dry weight
		900	wet weight
Source: Expert judgement by lead authors of this chapter of *2006 Guidelines*			

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste, Table5.6

Annex TableD-12 Default data for EF_{CH4}[11]

TABLE 5.3 CH_4 EMISSION FACTORS FOR INCINERATION OF MSW		
Type of incineration/technology		**CH_4 Emission Factors (kg/Gg waste incinerated on a wet weight basis)**
Continuous incineration	stoker	0.2
	fluidised bed Note1	~0
Semi-continuous incineration	stoker	6
	fluidised bed	188
Batch type incineration	stoker	60
	fluidised bed	237
Note 1: In the study cited for this emission factor, the measured CH_4 concentration in the exhaust air was lower than the concentration in ambient air. Source: Greenhouse Gas Inventory Office of Japan, GIO 2004.		

Sources：2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste, Table5.3

[10] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_5_Ch5_IOB.pdf
[11] IPCC:http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_5_Ch5_IOB.pdf

Annex TableD-13　Tool to determine leakage for intermediate treatment of waste[12]

Emissions from residual waste from anaerobic digester, gasifier, and processing/combustion of RDF/stabilized biomass or compost in case it is disposed of in landfills as leakage of intermediate treatment shall be calculated as follows:

$$L_{r,y} = S_{LE} \times MB_{r,y}$$

$L_{r,y}$: leakage emissions from the residual waste from the anaerobic digester, the gasifier, the processing/combustion of RDF/stabilized biomass, or compost in case it is disposed of in landfills in year y

S_{LE} : Fraction of the residual waste under anaerobic condition in total residual the waste (-)

$MB_{r,y}$: CH_4 puroduced in landfill in case all the residual waste is under anaerobic condition (t-CO_2/y)

S_{LE} shall be calculated as follows:

$$S_{LE} = S_{OD,LE} / S_{LE,total}$$

$S_{OD,LE}$: number of samples per year with an oxygen deficiency (i.e. oxygen content below 10%)

$S_{LE,total}$: total number of samples taken per year, where Stotal should be chosen in a manner that ensures the estimation of Sa with 20% uncertainty at a 95% confidence level

$MB_{r,y}$ shall be calculated as follws:

$$MB_{r,y} = \Phi \times (1-OX) \times \frac{16}{12} \times F \times DOC_f \times MCF_p \times GWP_{CH4} \times \sum_{x=1}^{y} \sum_{i}^{n} \left\{ A_{i,x} \times DOC_j \times e^{-\frac{k}{y-x}} \times \left(1-e^{-kj}\right) \right\}$$

$A_{i,y}$: Quantity of the residual waste (t)

i : Waste type

Refer to above tool to determine MB_y for information and data acquisition methods of the other parameters.

Source:AM0025 (Ver.12) : Avoided emissions from organic waste through alternative waste treatment processes, UNFCCC

Annex TableD-14　Default data for DOC_S

Sludge type		Default DOC(-)	
		Wet matter	Dry matter
Domestic sludge		0.05	0.50
Industrial sludge	Rough default	0.09	0.35
	Pulp and paper industry	-	0.27
	Food industry	-	0.30
	Chemical industry	-	0.52

Sources : 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste(summarized by)

[12] UNFCCC:
http://cdm.unfccc.int/filestorage/9/W/V/9WVIN7Z06A8UGLFPO4Y51BDMJ23QXT/EB55_repan04_AM0025_ver12.pdf?t=RXd8MTMwODg3OTMyNC4y|aDzPHqXGfi2kTBVlitVZTAMDI0w=

Annex TableD-15 CDM project registered on Sewer and Urban Sanitation Sector[13]

Landfill Disposal of Waste

unit: $t\text{-}CO_2/y$

Title of the project activity	Type of Treatment	Volume of Waste in landfill (t/y)	Estimation of project activity emissions	Methane emissions	Estimation of baseline emissions	Estimation of leakage	Estimation of overall emission reductions	Total number of crediting years
Taman Beringin Integrated Landfill Management Project, Kuala Lumpur, Malaysia.	Flare	3,934,665	6,229	59,316	64,723	0	53,090	10
Luoyang Landfill Site LFG Recovery to Electricity Project	Electricity generation	9,352,800	0	95,163	103,715	0	103,715	10
Landfill biogas extraction and combustion plant in El Inga I and II landfill	Flare, Electricity generation	9,766,255	141,495	349,825	355,430	0	213,935	7

Intermediate Treatment of Waste

unit: $t\text{-}CO_2/y$

Title of the project activity	Type of Treatment	Volume of Waste (t/y)	Estimation of project activity emissions	Methane emissions	Estimation of baseline emissions	Estimation of leakage	Estimation of overall emission reductions	Total number of crediting years
Composting of organic waste in Wuzhou	Composting	84,701	2,530		64,723	0	41,880	7
Municipal Solid Waste (MSW) Composting Project in Urumqi, China	Composting	219,000	4,214		22,818	2,539	16,065	7
Huzhou Municipal Solid Waste Incineration for Power Generation Project	Incineration , Electricity generation	266,000	42,788		135,425	7,239	85,398	10
Chengdu Luodai Municipal Solid Waste Incineration Project	Incineration , Electricity generation	400,000	83,111		189,105	7,964	98,030	7

Wastewater treament

unit: $t\text{-}CO_2/y$

Title of the project activity	Type of Treatment	Volume of Wastewater (m3/y)	Estimation of project activity emissions	Methane emissions	Estimation of baseline emissions	Estimation of leakage	Estimation of overall emission reductions	Total number of crediting years
Methane recovery and utilization through organic wastewater treatment in Malaysia	anaerobic treatment, Flare	288,000	7,651		64,723	0	43,152	7
NHR Co-Composting Project	Heat/Electricity Generation and Flare on existing anaerobic treatment system	165,529	6,944		54,600	0	47,655	7

Sewerage

unit: $t\text{-}CO_2/y$

Title of the project activity	Type of Treatment	Volume of Sludge (t/y)	Estimation of project activity emissions	Methane emissions	Estimation of baseline emissions	Estimation of leakage	Estimation of overall emission reductions	Total number of crediting years
Introduction of the recovery and combustion of methane in the existing sludge treatment system of the Cañaveralejo Wastewater Treatment Plant of EMCALI in Cali, Colombia	Digestion, Energy Generation, Flare on existing treatment system	1,884,371	8,090		64,723	0	56,633	10

Sources : UNFCCC HP（http://cdm.unfccc.int/Projects/projsearch.html）

[13] UNFCCC:http://cdm.unfccc.int/Projects/projsearch.html

References

Forest and Natural Resources Conservation Sector(1.2)

- AR-AM0002(ver3.0)：Restoration of degraded lands through afforestation/reforestation
- AR-AM0007(ver5.0)：Afforestation and Reforestation of Land Currently Under Agricultural or Pastoral Use
- J-VER003(ver3.2)：Increase of CO_2 absorption through forestation activities
- The Carbon Assessment Tool for Afforestation Reforestation(CAT-AR)
- The Carbon Assessment Tool for Sustainable Forest Management (CAT-SFM)
- WB Methodology of BioCarbonFund"Methodology for Estimating Reductions of GHG Emissions from Mosaic Deformation" (Proposed)

Traffic and Transportation Sector(3.4.5.6)

- AM0031(ver3.1.0)：Methodology for Bus Rapid Transit Projects
- ACM0016(ver2.0)：Baseline Methodology for Mass Rapid Transit Projects
- AMS-III-U(ver1.0)：Cable Cars for Mass Rapid Transit Projects

Energy Conservation (Industry) Sector(7.8.9)

- AMS-II.C.(ver13.0)：Demand-side energy efficiency activities for specific technologies
- AMS-II.D.(ver12.0)：Energy efficiency and fuel switching measures for industrial facilities
- J-MRV002: Methodologies for energy efficiency project (Revised on February 2011)
- ACM0012(ver4.0.0)：Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects
- AM0024(ver02.1)：Baseline methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants
- ACM0013(ver4.0.0)：Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology
- AMS-III.Q(ver4.0)：Waste Energy Recovery (gas/heat/pressure) Projects
- J-MRV003: Methodology for waste energy recovery and utilization project (Revised on February 2011)
- ACM0009(ver3.2):Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas
- AMS-III.B.(ver15.0):Switching fossil fuels
- AMS-III.AN(ver2.0)：Fossil fuel switch in existing manufacturing industries

Energy Sector(10.11.12.13.14.15.16)

- ACM0009(ver3.2):Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas
- AMS-III.B.(ver15.0):Switching fossil fuels
- AMS-III.AN(ver2.0)：Fossil fuel switch in existing manufacturing industries
- ACM0012(ver4.0.0)：Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects
- AM0048(ver03)：New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels
- ACM0011(ver2.2): Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation
- AM0061(ver2.1)：Methodology for rehabilitation and/or energy efficiency improvement in existing power plants
- AM0062(ver2.0)：Energy efficiency improvements of a power plant through retrofitting turbines
- ACM0013(ver02)：Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology
- AMS-II.B.(ver9.0): Supply side energy efficiency improvements – generation
- J-MRV004: Methodology for the projects to introduce a low-carbon power generation technologies at fossil fuel-fired power (Revised on February 2011)
- AM0067(ver02)：Methodology for installation of energy efficient transformers in a power distribution grid
- AMS-II.A(ver10)：Supply side energy efficiency improvements – transmission and distribution
- AMS-I.A(ver14.0)：Electricity generation by the user
- AM0019(ver2.0)：Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects
- AMS-I.D.(ver16.0)：Grid connected renewable electricity generation
- AMS-I.F.(ver1.0)：Renewable electricity generation for captive use and mini-grid

Renewable Energy(17.18.19.20.21)

- ACM0002(ver12.1)：Consolidated baseline methodology for grid-connected electricity generation from renewable sources
- AM0019(ver2.0)：Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects
- AMS-I.F.(ver1.0)：Renewable electricity generation for captive use and mini-grid
- J-VER　E015(ver2.0)：Substitution of grid electric power with small scale hydropower
- ACM0006(ver11.1)：Consolidated methodology for electricity and heat generation from biomass residues
- AMS-I.D.(ver16.0)：Grid connected renewable electricity generation
- J-MRV001: Methodology for the power and heat supply projects using biomass residue (Revised on February 2011)

Sewerage, Urban Sanitation(22.23.24.25)

- ACM 0001(Ver.11)：Consolidated baseline and monitoring methodology for landfill gas project activity
- Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site(Ver.05.1.0)
- ASM-III.G.(Ver.6.0)：Landfill methane recovery
- AM0025(Ver.12)：Avoided emissions from organic waste through alternative waste treatment processes
- CCX：Landfill Methane Offset
- Climate Action Reserve：Landfill Project Protocol(ver3.0)-Collecting and Destroying Methane from Landfills
- ACM0014（Ver.0.4.1.0）：Mitigation of greenhouse gas emissions from treatment of industrial wastewater
- AM0080（ver01）：Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants
- AMS-III.F(Ver.10.0): Avoidance of methane emissions through composting
- AM0039(Ver. 02)Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting
- AMS III.H(Ver.16)：Methane recovery in wastewater treatment
- AMS-III.I(Ver.8.0): Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems