Renewable Energy CDM Projects (Review Session)

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JICA Expert Team

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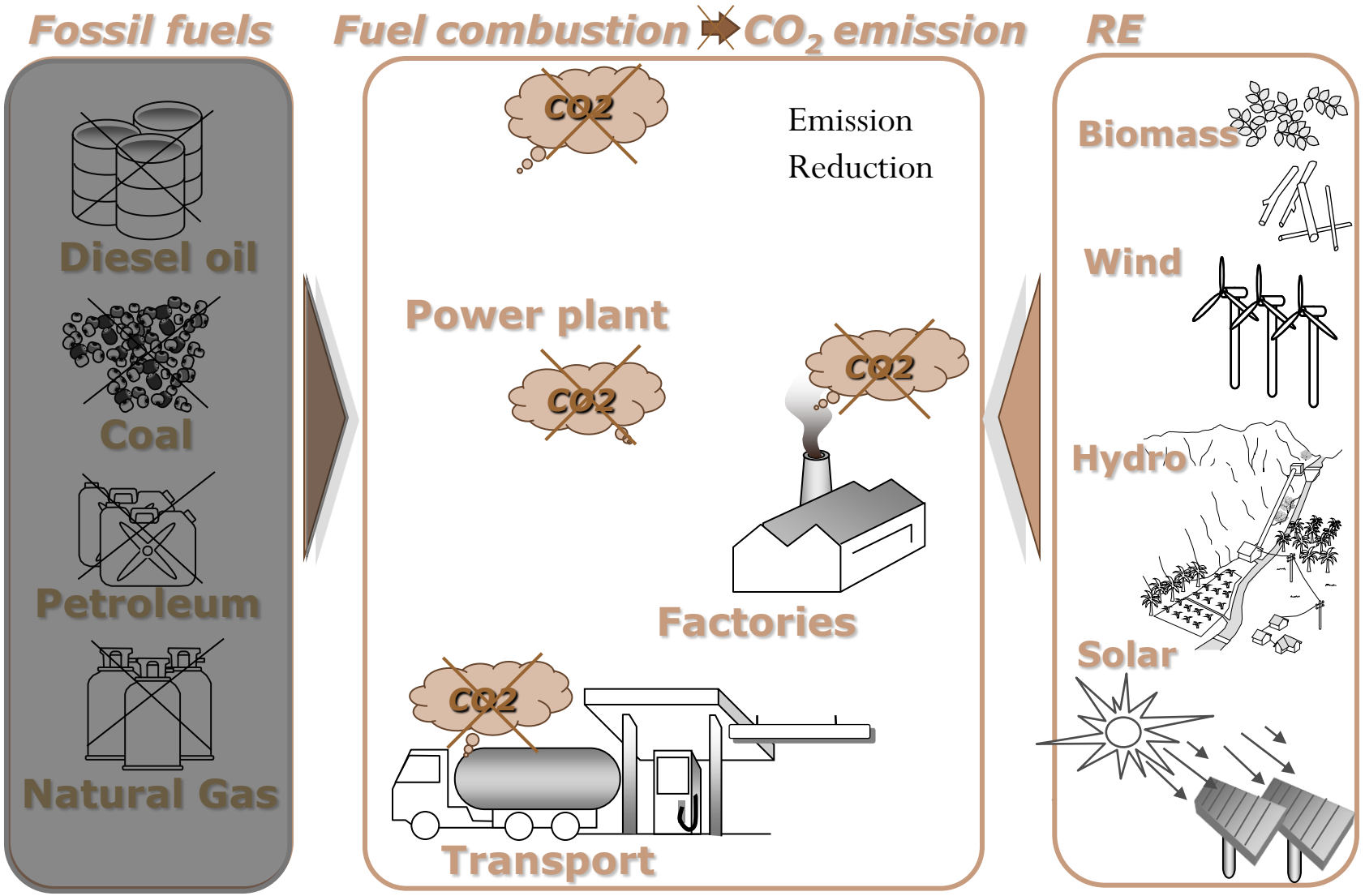
Summary of the Lecture of Renewable Energy

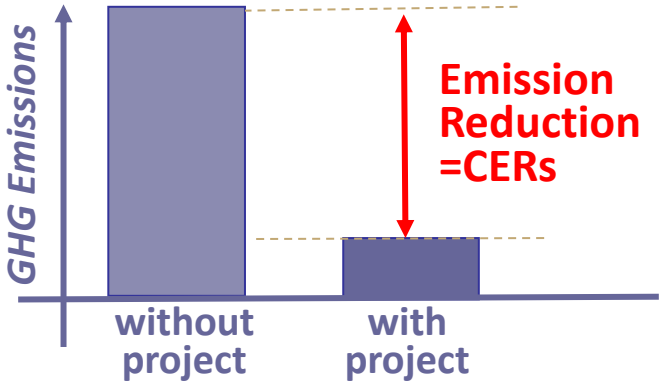
1. How emission reduction is achieved by RE Project (2)



RE reduces GHG emissions by reducing the use of fossil fuel.

2. Energy Source of Renewable Energy

- **Non-biomass:**
  - **Wind**
  - **Hydro**
  - **Solar**
  - **Others (geothermal & wave etc)**
- **Biomass:**
  - **Residue biomass (wood residue, rice husk, bagasse & garbage etc)**
  - **Energy crops (gliricidia, jatropha etc)**



5. Basic Formula for Emission Reduction Calculation of RE project (1)

- **Basic formula**

GHG Emission Reduction by RE project (tCO2) = Amount of energy to be replaced [A] × Emission factor of energy to be replaced [B] − Project/ Leakage Emission [C]

1) Grid electricity replacement

= [A] Amount of electricity (MWh) × [B] Grid emission factor [tCO2/MWh]

Unit Check

$$MWh \times \frac{tCO2}{MWh} = tCO2$$

2) Replacement of Electricity Generated On-site

= [A] Amount of fuel used for electricity generation (ton_fuel) × [B] Emission factor of fuel used for electricity generation [tCO2/ton_fuel]

$$Ton \times \frac{tCO2}{Ton} = tCO2$$

- Emission from on-site electricity and fossil fuel consumption in the project scenario
- Emission from transportation (for biomass)
- Emission from biomass competition (for biomass)

6. Calculation of Grid Emission Factor (2)

Simplified formula for grid emission factor calculation:

Grid Emission Factor in year y [tCO2/MWh] =

$$\frac{\textit{Total } CO_2 \textit{ emission from all the power plants that are connected to the grid in year y if the CDM project activity did not take place [tCO2/y]}}{\textit{Total MWh of electricity produced by all the power plants that are connected to the grid in year y if the CDM project activity did not take place [MWh/y]}}$$

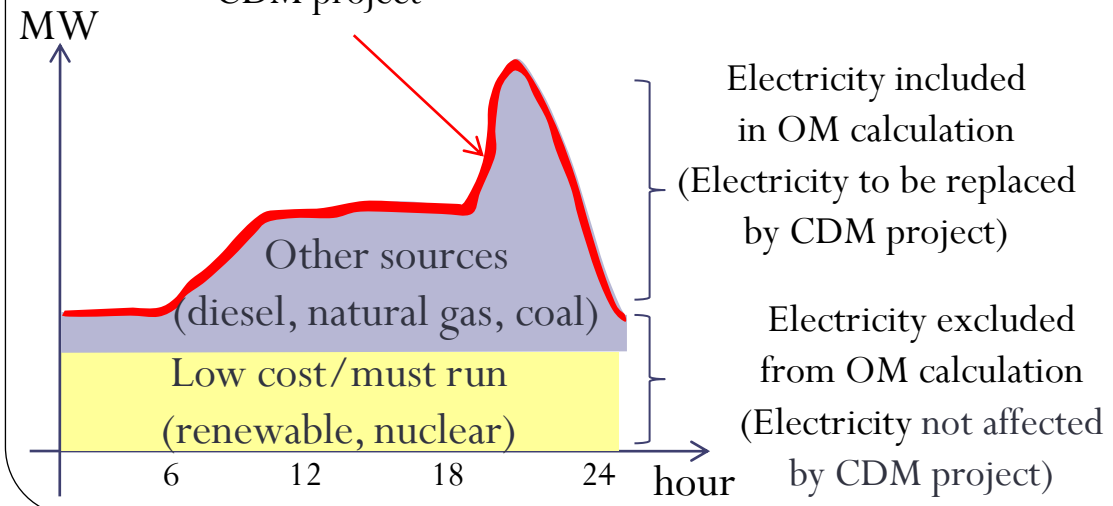
Reference:"Tool to calculate the emission factor for an electricity system"

- Grid Emission Factor is necessary for:
  - Renewable energy project that displaces grid electricity
  - Energy efficiency projects that reduces the use of the grid electricity
  - Projects using grid electricity in the project scenario (project emissions)
- Currently, all the registered Sri Lankan CDM projects requires grid emission factor data.
- Grid Emission Factor: 0.65~0.73 tCO2/MWh
  (National official figure is under preparation, Currently, PP has to calculate by themselves)

6. Calculation of Grid Emission Factor (3) Essential Terminologies

Terminology	Explanation
Operating Margin (OM)	Emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity.
Built Margin (BM)	Emission factor of the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity.
Combined Margin (CM)	Weighted average of OM & BM of the electricity system.
Low-cost/must-run resources	Power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid.

OM



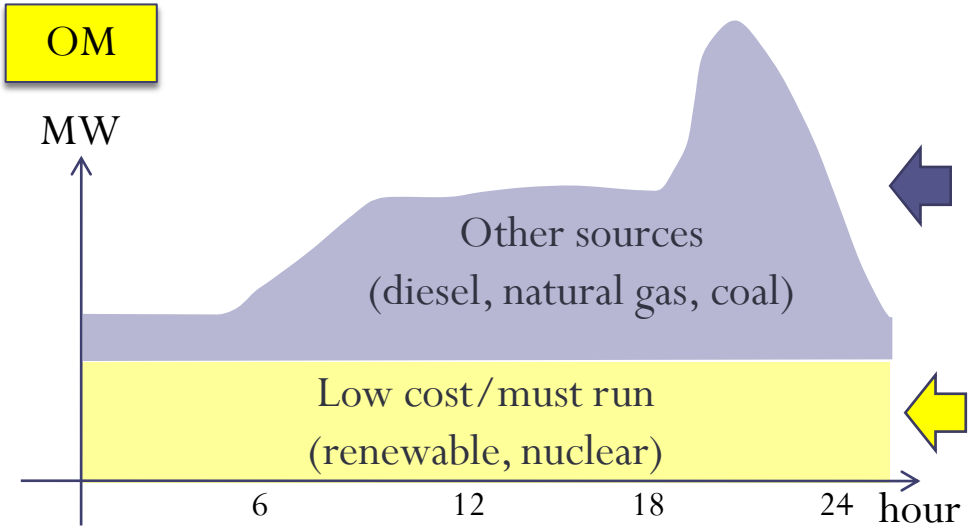
BM

The set of power capacity additions in the electricity system that comprise 20% of the system generation (MWh) and that have been built most recently

The set of 5 power units that have been built most recently

6. Calculation of Grid Emission Factor (3) Essential Terminologies

OM



Emission is calculated based on the emission factor of each fuel used for power generation

Considered as 0(zero) emission in CDM calculation

Emission factor of each fuel

Fuel Type	Net Calorific Value (TJ/t) [a]	CO2 Emission Factor(tCO2/TJ) [b]	Oxidation factor [c]	CO2 emission factor(tCO2/t) [a]*[b]*[c]
Furnace Oil	0.041	77.4	1.0	**3.173**
Gas/Diesel Oil	0.0433	74.1	1.0	**3.209**
Naphtha	0.0456	73.3	1.0	**3.342**
Residual Oil	0.041	77.4	1.0	**3.173**
Source	Energy Data 2007, SEA	2006 IPCC Guidelines for National GHG Inventories, vol.2		

Grid Electricity factor for CDM project

Grid Emission Factor: 0.65~0.73 tCO2/MWh
(National official figure is under preparation,
Currently, PP has to calculate by themselves)

Grid emission factor for existing electricity consumers is not the same

Calculation Exercise

Non-biomass, Biomass

1. Calculation Exercise: Biomass(1)

- Company B has a CDM project plan with the following details:
  - Biomass power generation project selling the electricity to CEB
  - The biomass to be used is saw dust and rice husk
  - Net electricity generation operation rate: 1.0 MW
  - Daily operating hours: 20 hours
  - Monthly operating days: 25 days
  - Seasonal operation: operation is constant
  - Grid emission factor: 0.70 kgCO2/kWh
  - Furnace oil required for operation of the new plant: 5ton/month
  - Diesel required for transportation of biomass: 10 ton/month
  - Emission factor of fossil fuel is shown as below:

Fuel Type	CO2 emission coefficient (tCO2/t)
Furnace Oil	3.173
Diesel Oil	3.209

(Question)
How much emission reduction is expected by this project activity?

1. Calculation Exercise: Biomass(2)

Step1
- How many hours does the plant operate annually?

Step2
- How much electricity to be sold to the grid annually?

Step3
- How much GHG emission is reduced annually by selling the electricity to the grid? [baseline emission]

Step4
- How much fossil fuel is required for operating the plant annually?
- How much fossil fuel is required for biomass transportation annually?
- How much fossil fuel is required by the project activity ?

Step5
- How much GHG is emitted annually through fossil fuel consumption by the project activity? [project emission]

Step6
- How much GHG emission is reduced annually by the project activity? [Emission reduction]

1. Calculation Exercise: Biomass(3)

Step1

- How many hours does the plant operate annually?

- Daily operating hours: 20 hours
- Monthly operating days: 25 days
- Seasonal operation: operation is constant

Annual operation hours

$$20\frac{hours}{day}\times 25\frac{days}{month}\times 12\frac{month}{year}=6{,}000\frac{hour}{year}$$

Unit Check

$$\frac{hours}{day}\times\frac{days}{month}\times\frac{month}{year}=\frac{hour}{year}$$

1. Calculation Exercise: Biomass(4)

Step2

- How much electricity to be sold to the grid annually?

- Annual operation hour: 6,000 hours/y
- Electricity generation operation rate: 1.0 MW

Amount of electricity to be sold to the grid

6,000 hours/year × 1.0MW = **6,000 MWh/y**

Unit Check

$$\frac{hour}{year} \times MW = \frac{MWh}{year}$$

1. Calculation Exercise: Biomass(5)

Step3

- How much GHG emission is reduced annually by selling the electricity to the grid? [baseline emission]

- Amount of electricity to be sold to the grid annually: 6,000 MWh/y
- Grid emission factor: 0.70 kgCO2/kWh

Baseline emission (tCO2/y)	=	**Amount of Electricity (MWh/y)**	×	**Grid emission factor (tCO2/MWh)**
	=	6,000 MWh/y	×	0.70 tCO2/MWh
	=	**4,200 tCO2/y**		

Unit Check

$$\frac{kg}{kWh} = \frac{1000 \times kg}{1000 \times kWh} = \frac{t}{MWh}$$

$$\frac{MWh}{year} \times \frac{t\_CO2}{MWh} = \frac{t\_CO2}{MWh}$$

1. Calculation Exercise: Biomass(6)

Step4

- How much fuel is required for operating the plant annually?
- How much fuel is required for biomass transportation annually?

- Furnace oil required for operation of the new plant: 5ton/month
- Diesel required for transportation of biomass: 10ton/month

On-site fossil fuel consumption

5 ton/month × 12 months/year = 60 ton/year

Fossil fuel consumption for biomass transport

10 ton/month × 12 months/year = 120 ton/year

Unit Check

$$\frac{ton}{Month} \times \frac{Month}{Year} = \frac{ton}{Year}$$

1. Calculation Exercise: Biomass(7)

Step5

- How much GHG is emitted annually through fossil fuel consumption by the project activity? [project emission]

- Furnace oil required for operation of the new plant: 60ton/year
- Diesel required for transportation of biomass: 120ton/year

Emission associated to on-site fossil fuel consumption

60 t/year × 3.173 tCO2/t
= 190.4 tCO2/y

Emission associated to biomass transport

120 t/year × 3.209 tCO2/t
= 385.1 tCO2/y

Project emissions

190.4 tCO2/y + 385.1 tCO2/y = 575.5 tCO2/y

Fuel Type	Net Calorific Value (TJ/t)	Effective CO2 emission factor (tCO2/TJ)	Oxidation factor	CO2 emission coefficient (tCO2/t)
	(a)	(b)	(c)	(a)*(b)*(c)
Furnace Oil	0.041	77.4	1.0	3.173
Gas/Diesel Oil	0.0433	74.1	1.0	3.209
Naphtha	0.0456	73.3	1.0	3.342
Residual Oil	0.041	77.4	1.0	3.173
Source	Energy Data 2007	2006 IPCC Guidelines for National GHG Inventories, Volume 2: Energy, Table 1.4		

1. Calculation Exercise: Biomass(8)

Step6

- How much GHG emission is reduced annually by the project activity? [Emission reduction]

- Baseline emissions: 4,200 tCO2/year
- Project emissions: 575.5 tCO2/year

Emission reduction (tCO2/y)	=	**Baseline emission (tCO2/y)**	-	**Project emission (tCO2/y)**
	=	4,200 tCO2/y	-	575.5 tCO2/y
	=	3,624.5 tCO2/y		

Answer:

3,624.5 tCO2/y

2. Calculation Exercise: Mini-hydro power(1)

- Company A has a CDM project plan with the following details:
  - New mini-hydro power plant project selling the power to CEB
  - Capacity: 1.1 MW
  - Expected operation: (dry season) 0.6MW, (wet season)1.1MW
  - 0.1MW of generated electricity is required for operating the mini-hydro plant
  - Daily operating hours: 24 hours
  - Monthly operating days: 25 days
  - Season: (dry season) 4 months, (wet season) 8 months
  - Grid emission factor: 0.70 kgCO2/kWh

(Question)
How much emission reduction is expected by this project activity?

2. Calculation Exercise: Mini-hydro power(2)

Step1

- How many hours does the plant operate in dry season?
- How many hours does the plant operate in wet season?

Step2

- How much electricity to be sold to the grid in dry season?
- How much electricity to be sold to the grid in wet season?

Step3

- How much is the total electricity to be sold to the grid annually?

Step4

- How much GHG emission is reduced annually by the project?

2. Calculation Exercise: Mini-hydro power(3)

Step1

- How many hours does the plant operate in dry season?
- How many hours does the plant operate in wet season?

- Daily operating hours: 24 hours
- Monthly operating days: 25 days
- Season: (dry season) 4 months, (wet season) 8 months

Dry season:

24 hours/day × 25days/month × 4 months/y = **2,400 hours/y**

Wet season:

24 hours/day × 25days/month × 8 months/y = **4,800 hours/y**

2. Calculation Exercise: Mini-hydro power(4)

Step2

- How much electricity to be sold to the grid in dry season?
- How much electricity to be sold to the grid in wet season?

- Operating hours in each season: (Dry) 2,400 hours, (Wet) 4,800hours
- Expected operation: (dry season) 0.6MW, (wet season) 1.1MW
- Electricity requirement by the plant: 0.1MW

Amount of electricity to be sold to the grid can be obtained by operation ratio (MW) times number of operating hours.

Dry season:

2,400 hours/y × (0.6 MW －0.1MW) = **1,200 MWh/y**

Wet season:

4,800 hours/y × (1.1 MW －0.1MW) = **4,800 MWh/y**

2. Calculation Exercise: Mini-hydro power(5)

Step3

- How much electricity to be sold to the grid annually?

- Amount of electricity to be sold to the grid in dry season: 1,200 MWh/y
- Amount of electricity to be sold to the grid in wet season: 4,800 MWh/y

Annual Electricity	=	**Electricity (Dry season)**	+	**Electricity (Wet season)**
	=	1,200 MWh/y	+	4,800 MWh/y
	=	**6,000 MWh/y**		

2. Calculation Exercise: Mini-hydro power(6)

Step4

- How much emission is reduced annually by the project?

- Amount of electricity to be sold to the grid annually: 6,000 MWh/y
- Grid emission factor: 0.70 kgCO2/kWh

Emission Reduction (tCO2/y)	=	Amount of Electricity (MWh/y)	×	Grid emission factor (tCO2/MWh)
	=	6,000 MWh/y	×	0.70 tCO2/MWh
	=	**4,200 tCO2/y**		

Emission Reduction = Baseline emission − Project emission
= 4,200 tCO2/y − 0 tCO2/y
= 4,200 tCO2/y

Answer:
4,200 tCO2/y