Renewable Energy Projects

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JICA Expert Team

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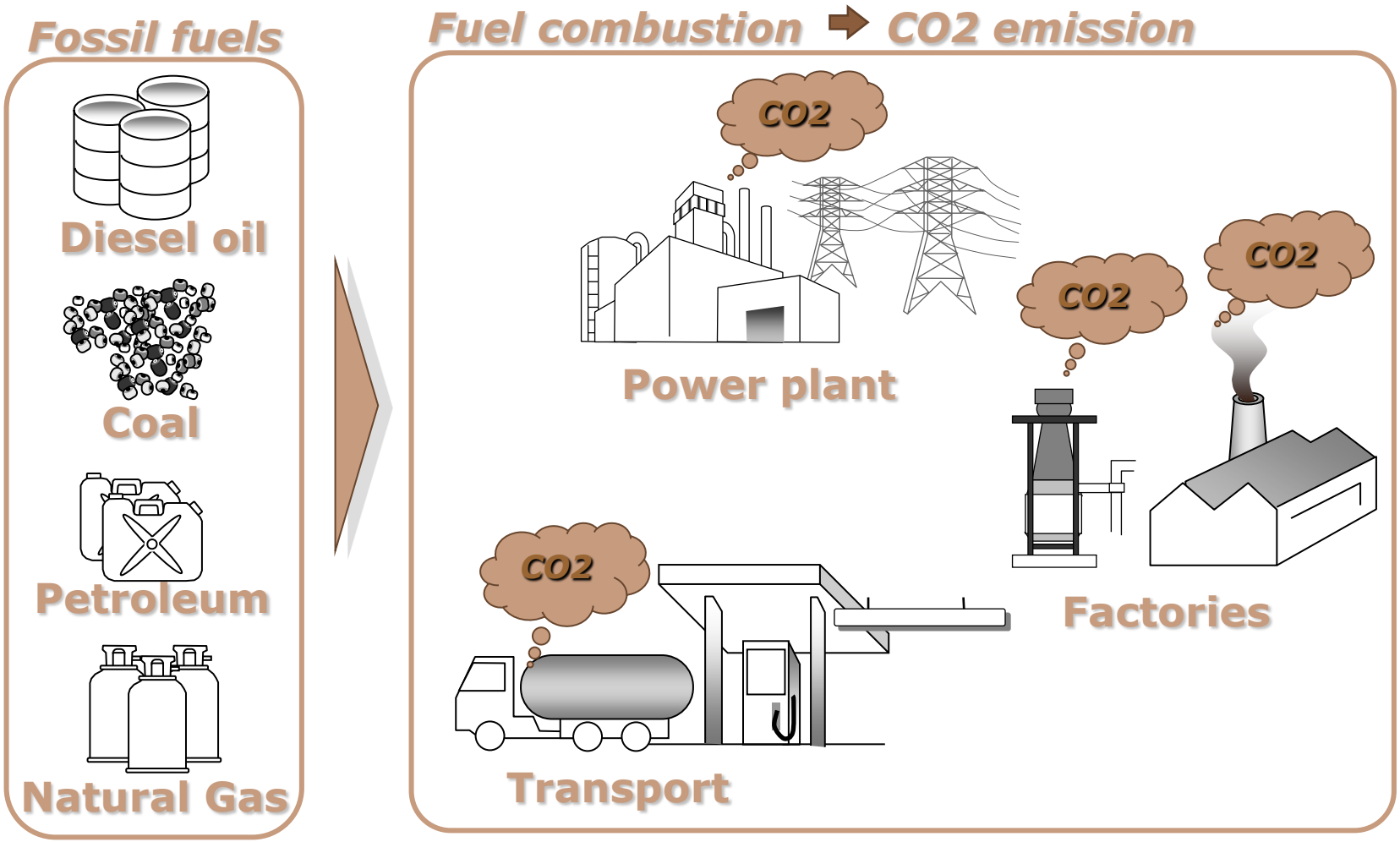
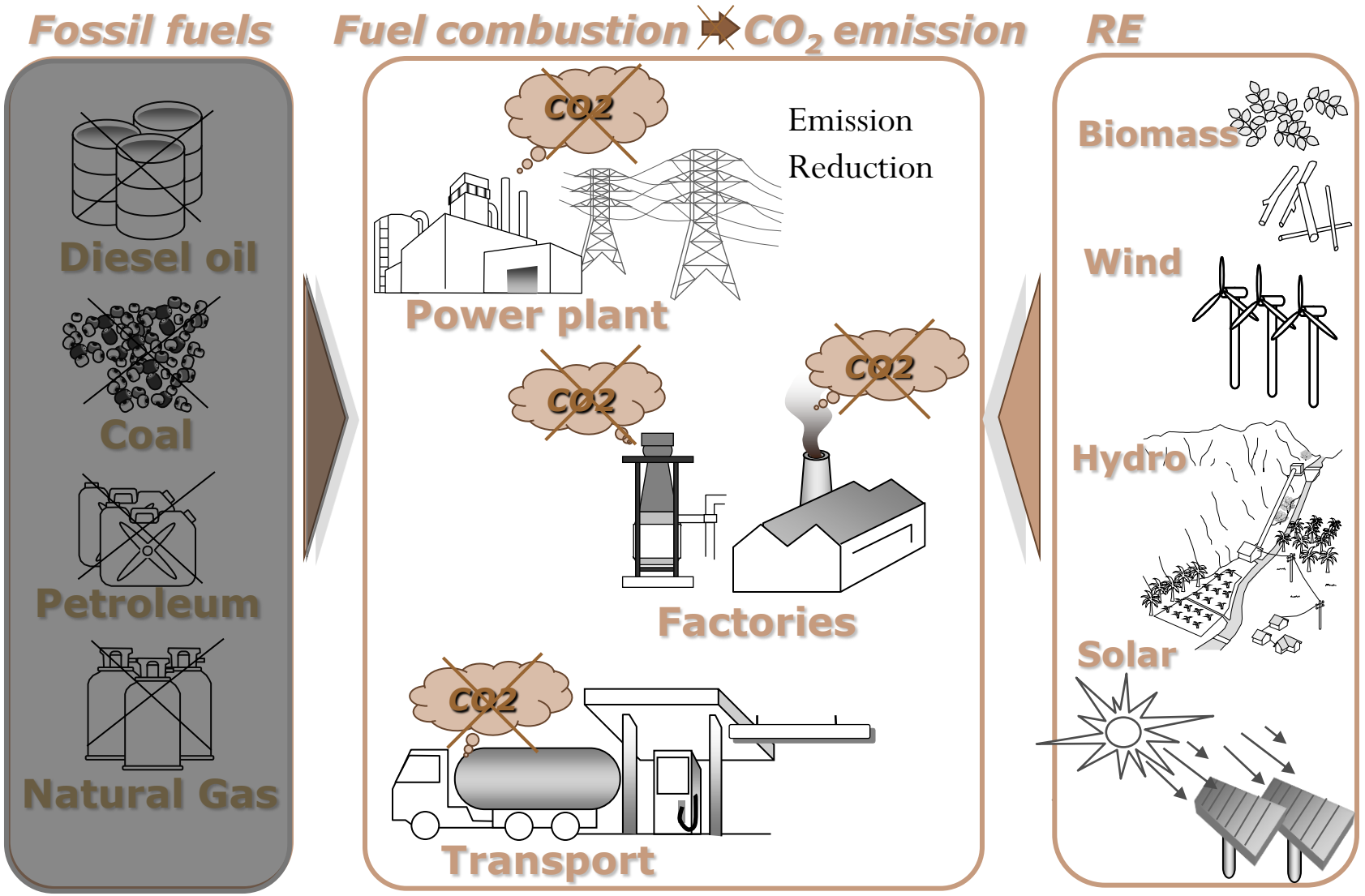
Contents

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



CO2 is emitted by combustion of fossil fuels

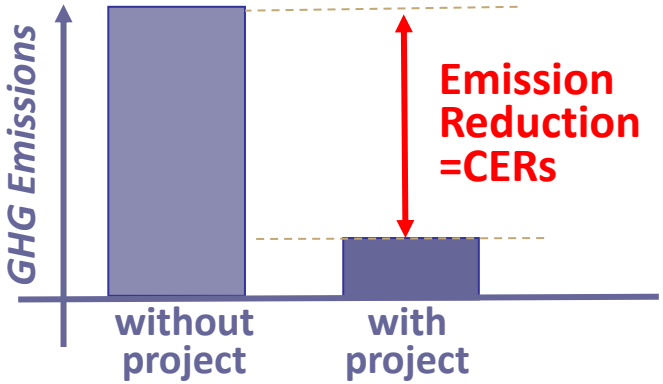
1. How emission reduction is achieved by RE Project (2)



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

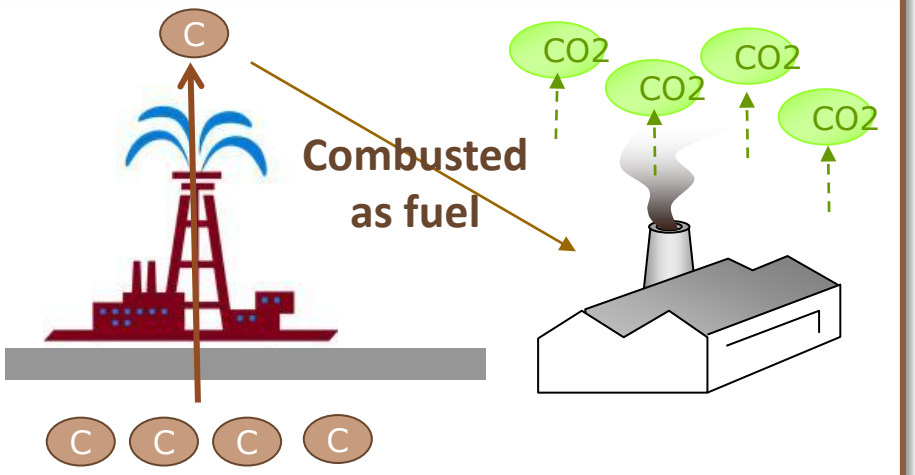
1. How emission reduction is achieved by RE Project (3) (Renewable Energy Sources)

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



1. How emission reduction is achieved by RE Project (4)

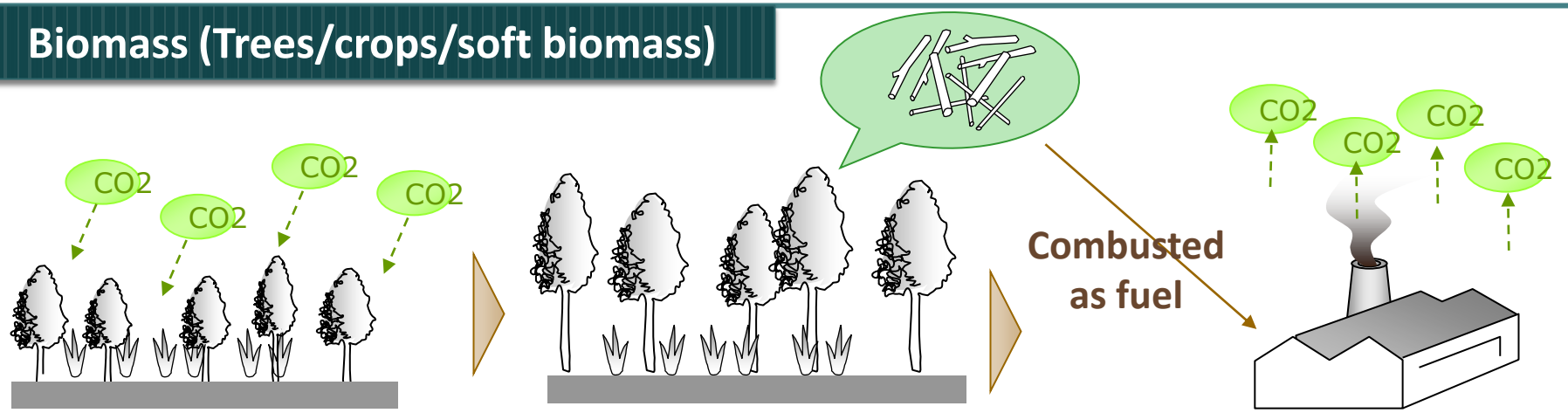
Fossil Fuel



Non-biomass (Wind/Hydro/Solar)

No CO2 Emissions!

Biomass (Trees/crops/soft biomass)



Carbon Neutral

(The emitted CO2 is absorbed by the air when plants grow and not increasing emissions)

1. How emission reduction is achieved by RE Project (5)

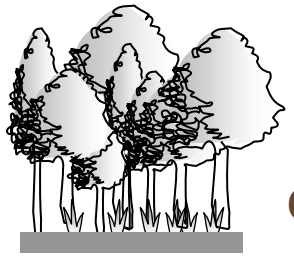
Project emissions, leakage emissions associated to project activities must be considered as CO2 emissions such as:

- **Project emissions associated to fossil fuel use (Fossil fuel & Electricity)**
- **Leakage emissions associated to biomass utilization**
  - **a. Leakage emissions associated to land use change**
  - **b. Leakage emissions associated to biomass production (chemical fertilizer use/vehicle use)**
  - **c. Leakage emissions associated to biomass competition**

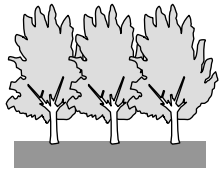
a. Leakage emissions associated to land use change

Destruction of forest

Forest

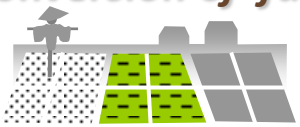


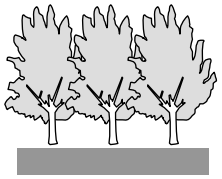
Gliricidia plantation



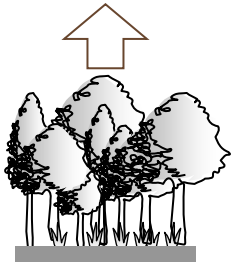
Carbon stock reduction (CO2 is emitted)

Conversion of farm (used) land





Gliricidia plantation

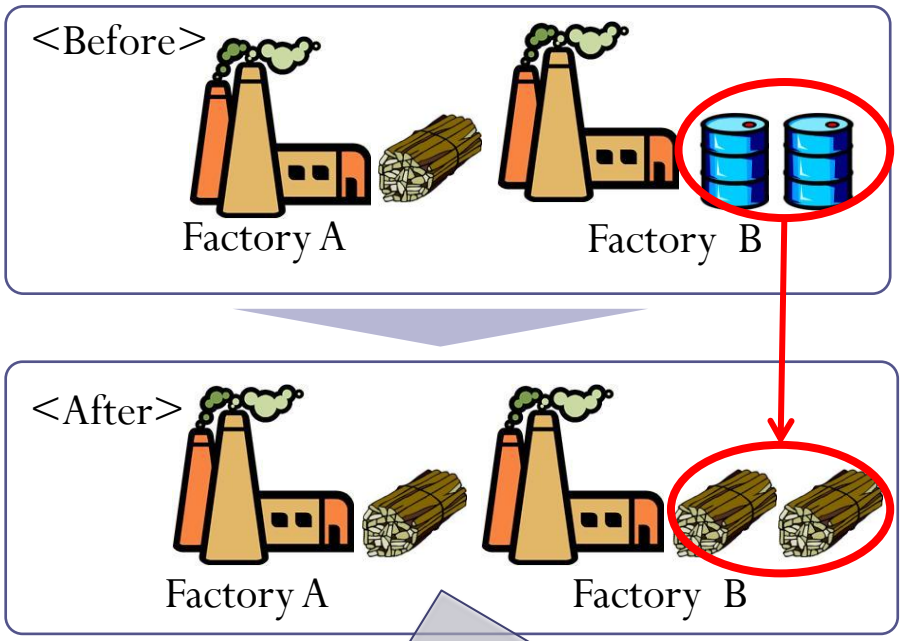


Carbon stock reduction by indirect land use change (CO2 is emitted)

c. Leakage emissions associated to biomass competition

Case A: Sufficient Supply of Biomass

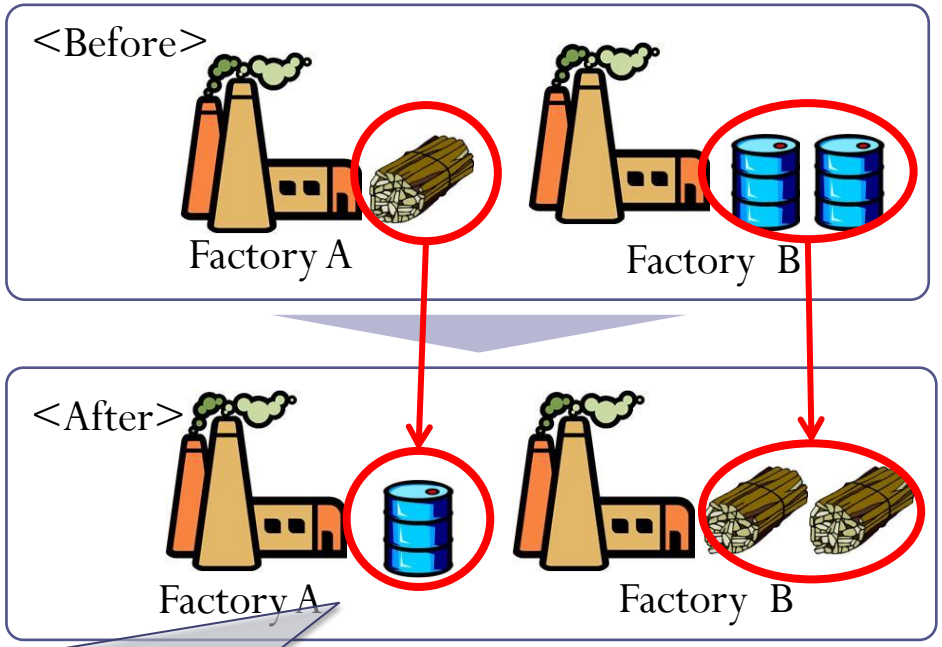
Available biomass in the collection boundary =



Emission reduction is achieved (No leakage)

Case B: Under Supply of Biomass

Available biomass in the collection boundary =



Factory A cannot get biomass fuel because of the competition caused by fuel conversion at Factory B. (leakage)

According to AM0042(Ver.2), if PP conduct biomass assessment and identify biomass availability within the collection boundary is more than 125% of the biomass demand, leakage does not need to be considered.

2. Potential and Policy Target of RE Project (1)

- Usage of RE energy

Electricity	Grid-connection, On site (by the user)
Thermal	Onsite (by the user)
Liquid fuel	(mainly for vehicle)

- RE sources and types of energy use

Source	Electricity	Heat	Liquid fuel
Biomass	✓	✓	✓ (plant oil)
Hydro/Wind	✓		
Solar	✓	✓	

2. Potential and Policy Target of RE Project (3)

- Policy Targets by SEA (electricity)

Yr	Conventional Hydrolytic	Maximum from Oil	Coal	Minimum from NCRE
1995	94%	6%	-	-
2000	45%	54%	-	1%
2005	36%	61%	-	3%
2010	42%	31%	20%	7%
2015	28%	8%	54%	10%

NCRE: non-conventional renewable energy

- Cumulative Renewable Energy Capacity Additions (MW)

Year	Biomass	Hydro	Wind	Other	Total	%Energy
2007	1	119	3		123	4
2008	11	155	3		169	4.5
2009	15	165	14		194	4.7
2010	15	200	34	1	250	6.4
2011	20	225	34	1	280	6.8
2012	20	280	35	1	336	9.1
2013	20	295	85	2	402	9.8
2014	30	310	85	2	427	9.9
2015	40	330	85	5	460	10

Source: (M/P&E, 2008)

2. Potential and Policy Target of RE Project (4)

- Purchasing tariff for NCRE by CEB

Technology	All inclusive rate for years 1-20
Mini-hydro	13.04 (LKR/kWh)
Mini-hydro – Local	13.32 (LKR/kWh)
Wind	19.43 (LKR/kWh)
Wind - Local	19.97 (LKR/kWh)
Biomass (Dendro)	20.70 (LKR/kWh)
Biomass (Agricultural & Industrial Waste)	14.53 (LKR/kWh)
Municipal Waste	22.02 (LKR/kWh)
Waste Heat Recovery	6.64 (LKR/kWh)

The Government has also recognised the need to elevate biomass as both a commercial crop as well as the third fuel option for electricity generation and has accordingly declared *Gliricedia sepium* as the fourth plantation crop after tea, rubber and coconut in 2005. Biofuels as an important constituent of the transport energy will be developed to take a 20 % share by 2020. (by SEA Website)

3. 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)

3. Basic Formula for Emission Reduction Calculation of RE project (2)

Project/ Leakage Emission [C]

- Electricity & fossil fuel consumption by the project facilities
- (biomass)Transportation of biomass resources
- (biomass)Leakage emission from biomass competition

Grid electricity

Emissions associated to grid electricity (tCO2/y) = **Electricity Consumption (MWh/y)** × **Emission factor of grid electricity (t_CO2/MWh)**

Fuel consumption

Emissions associated to fossil fuel consumption (tCO2/y) = **Fuel Consumption (t/y)** × **Net calorific value of fuel (TJ/t)** × **CO2 emission Factor (tCO2/TJ)**

Default value is available

3. Basic Formula for Emission Reduction Calculation of RE project (3)

Biomass transportation

Fuel consumption(t/y)

Emissions Associated to transportation (tCO2/y) = Number of trips (no.of trip/y) × Distance (round trip) (Km/trip) × Fuel Efficiency (L/km) × Specific Gravity of diesel (kg/L) ÷1000

× Net calorific value of fuel (TJ/t) × CO2 emission Factor of fuel (tCO2/TJ)

Default value is available

Leakage associated to biomass competition

Emissions associated to biomass competition (tCO2/y) = Quantity of biomass used by the project which cannot be ruled out from leakage calculation (t/y) × Net calorific value of Biomass fuel (MJ/kg) × CO2 emission Factor of most carbon intensive fuel (tCO2/TJ)

Biomass which cannot be proved the enough availability within the project boundary

3. Basic Formula for Emission Reduction Calculation of RE project (4)

Simplified formula for grid emission factor calculation:

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

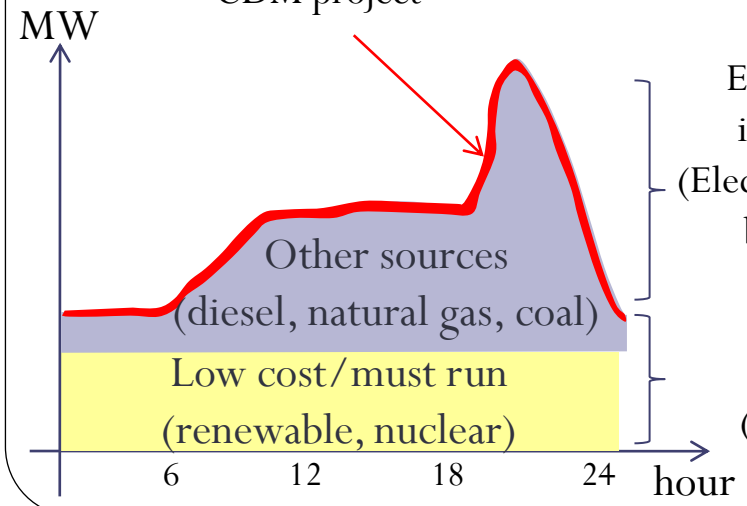
Reference:"Tool to calculate the emission factor for an electricity system"

- 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)

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

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



Electricity included in OM calculation (Electricity to be replaced by CDM project)

Electricity excluded from OM calculation (Electricity not affected by CDM project)

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

3. Basic Formula for Emission Reduction Calculation of RE project (6)

- Applicable CDM Approved Methodology for RE projects

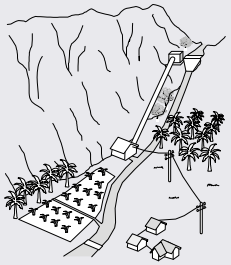
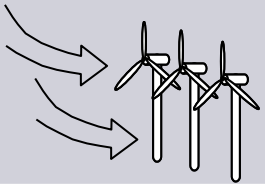
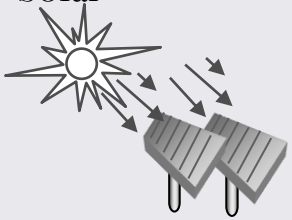
Category	Number	Title
Electricity	AM0019	Renewable energy project activities replacing part of the electricity production of one single fossil-fuel-fired power plant that stands alone or supplies electricity to a grid, excluding biomass projects
Electricity	AM0042	Grid-connected electricity generation using biomass from newly developed dedicated plantations
Electricity	ACM0002	Consolidated baseline methodology for grid-connected electricity generation from renewable sources
Electricity/ Thermal	ACM0006	Consolidated methodology for electricity and heat generation from biomass residues
Liquid fuel	ACM0017	Production of biodiesel for use as fuel
Electricity	ACM0018	Consolidated methodology for electricity generation from biomass residues in power-only plants

3. Basic Formula for Emission Reduction Calculation of RE project (7)

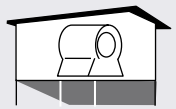
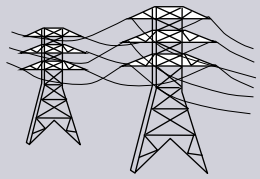
- Applicable Approved CDM Methodology for RE projects (Small Scale Methodology)

Category	No	Title
Electricity	I-A	Electricity generation by the user
	I-B	Mechanical energy for the user with or without electrical energy
Electricity	I-D	Grid connected renewable electricity generation
Electricity	I-F	Renewable electricity generation for captive use and mini-grid
Thermal/ Cogeneration	I-C	Thermal energy production with or without electricity
Thermal	I-E	Switch from non-renewable biomass for thermal applications by the user
Thermal	I-I	Biogas/biomass thermal applications for households/small users
Liquid fuel	I-G	Plant oil production and use for energy generation in stationary applications
Liquid fuel	I-H	Biodiesel production and use for energy generation in stationary applications
Liquid fuel	III-T	Plant oil production and use for transport applications

5. Important Factors of RE Projects (1) Non-Biomass

Project type	Important Factors for Project Planning	Risks (Manageable/Unmanageable)
Common	• Distance to national grid connecting point /users • Land ownership/tenure	• Natural disasters • Tariff policy/policy/trend
Hydro 	• Seasonal fluctuation of river flow • Units composition • Land tenure (relocation, fishery right, water concession, impacts on down stream stakeholders)	• Natural disasters (drought, land slide)
Wind 	• Wind intensity • Wind fluctuation • Arrangement of windmills	• Natural disasters (lightning)
Solar 	• Hours of sunshine • Sunshine intensity • Electricity or heat	• Theft

5. Important Factors of RE Projects (2) Biomass

Process	Important Factors for Project Planning	Risks (Manageable/Unmanageable)
Biomass Procurement 	•Enough amount of biomass should be assured (seasonal fluctuation) •Procurement cost: distance of transport, purchasing price (market fluctuation) • Each location of generation source(s), conversion site, national grid connecting point / users	• Fluctuation of the biomass market value • Lack of supply due to climate conditions • Natural factors (drought, extreme whether)
Conversion 	• Advantage and disadvantage of technology options (direct combustion, gasification, gas engine/turbine, steam generation, boiler) • Pre-treatment of biomass (water content)	
Utilization 	•In case of grid connection, larger scale may have advantage if enough biomass with reasonable price is assured (scale merit)	• Tariff policy/policy/trend

Summary

- Sri Lankan Government promotes RE utilization and business potential of renewable energy is high in Sri Lanka.
- RE basically contributes to reduce GHG emissions. There are opportunities to attain carbon credit through CDM or other mechanisms.
- For biomass project, project / leakage emissions need to be considered (Even if the project does not aim to obtain carbon credit, high emission project is considered less beneficial).
- Natural conditions are very important to assess feasibility of RE projects, but land issues and policy trend are also significant factors.
- For biomass CDM project, stable raw material supply is one of the most significant factors (price fluctuation, own plantation).

Thank you for your attention!