# CDM Training Program Final Examination

15 July 2011

Prepared by: JICA Expert Team

Name: _____

Organization: _____

| TOTAL SCORE: | ／100 |
|---|---|
| Renewable energy | ／20 |
| Waste handling | ／20 |
| Energy Efficiency & Fuel switch | ／20 |
| Forest | ／20 |
| UNFCCC negotiation | ／20 |

## [1] Renewable Energy

Marks: ／20

[Q1] Select the appropriate option to fill the blank columns.

(1) (2)

$$KgCO_2 / kWh = tCO_2 / \boxed{\textbf{A}} \qquad 1MWh = \boxed{\textbf{B}}\ GWh$$

| A | | B | |
|---|---|---|---|
| [✓ ] | MWh | [ ] | 1,000 |
| [ ] | GWh | [ ] | 0.1 |
| [ ] | TJ | [✓ ] | 0.001 |

*[4 points: 2 points each]*

***[Guidance]***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | GWh | $10^3$ | MWh | $10^6$ | KWh | $10^9$ | Wh |
| $10^{-3}$ | GWh | 1 | MWh | $10^3$ | KWh | $10^6$ | Wh |
| $10^{-6}$ | GWh | $10^{-3}$ | MWh | 1 | KWh | $10^3$ | Wh |
| $10^{-9}$ | GWh | $10^{-6}$ | MWh | $10^{-3}$ | KWh | 1 | Wh |

(1)

$$\frac{kg\_CO2}{kWh} = \frac{1{,}000 \times kg\_CO2}{1{,}000 \times kWh} = \frac{ton\_CO2}{MWh}$$

1,000kg = 1ton

1,000kWh = 1MWh

(2) 1000MWh = 1 GWh ⇒ 1 MWh = 0.001 GWh

(3) $100kW \times 500hours = 50{,}000\ \boxed{\textbf{C}} = 50\ \boxed{\textbf{D}}$

| C | | D | |
|---|---|---|---|
| [✓ ] | kWh | [ ] | kWh |
| [ ] | MWh | [✓ ] | MWh |
| [ ] | GWh | [ ] | GWh |

*[2 points: 1 point each]*

(4) The following equation is a basic formula to calculate GHG emission reduction for the project which displace fuel by renewable energy.

| GHG Emission Reduction (tCO2) | = | Amount of Electricity (MWh) | × | Grid Emission Factor ( E / F ) | − | Project/Leakage Emission (tCO2) |
|---|---|---|---|---|---|---|

Unit check of the above equation:

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

| | | |
|---|---|---|
| [ ] | E: MWh | F: tCO2 |
| [✓ ] | E: tCO2 | F: MWh |
| [ ] | E: ton_fuel | F: tCO2 |
| [ ] | E: tCO2 | F: ton_fuel |

*[2 points]*

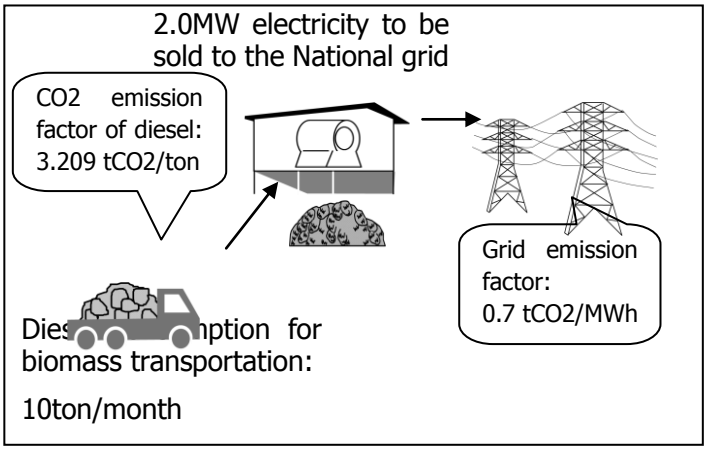
[Q2] Company B plans to generate power using saw dust for the purpose of selling the electricity to the grid. This project will reduce GHG emissions through replacing the grid electricity by renewable electricity. The details of the project are as follows:

| Item | Figure |
|---|---|
| Actual generation capacity of the power plant [MW] | 2.0 |
| Daily operating hours [hours] | 20 |
| Monthly operating days [days/month] | 25 |
| Seasonal operation: | Constant throughout the year |
| Grid emission factor [tCO2/MWh] | 0.70 |
| Diesel required for transportation of biomass [ton/month] | 10 |
| Emission factor of fossil fuel [tCO2/ton] | Diesel oil: 3.209 |

(1) How many hours does the plant operate annually?

(2) How much electricity to be sold to the grid annually? (100% of electricity generated is sold to the grid.)

(3) How much GHG emission is reduced annually by selling the electricity to the grid? [Baseline emissions]



(4) How much fossil fuel is required for biomass transportation annually?

(5) How much GHG is emitted annually through fossil fuel consumption by the project activity (transport of biomass)? [Project emissions]

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

***[Guidance]***

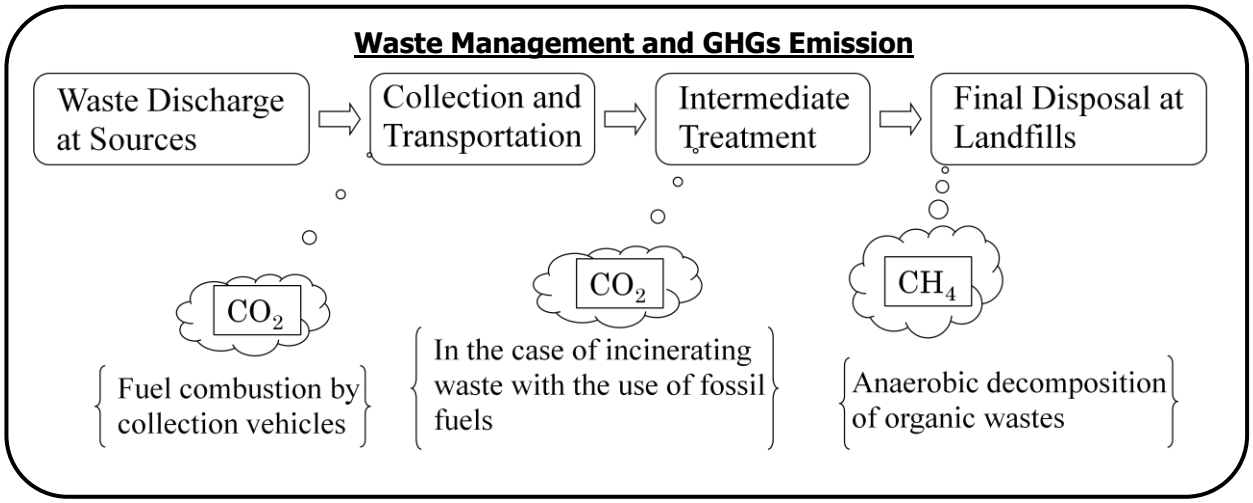
| ANSWER | |
|---|---|
| (1) | 20hours/day x 25days/month x 12monthyear<br>=6,000 [hours/year] |
| (2) | 2.0MW x 6,000 hours/year<br>=12,000 [MWh/year] |
| (3) | 12,000 MWh x 0.7 tCO2/MWh<br>=8,400 [tCO2/year] |
| (4) | 10ton/month x 12 months/year<br>=120 [ton/year] |
| (5) | 120 ton/year x 3.209 tCO2/year<br>=385.1 [tCO2/year] |
| (6) | 8,400 tCO2/year - 385.1 tCO2/y<br>=8,014.9 [tCO2/year] |

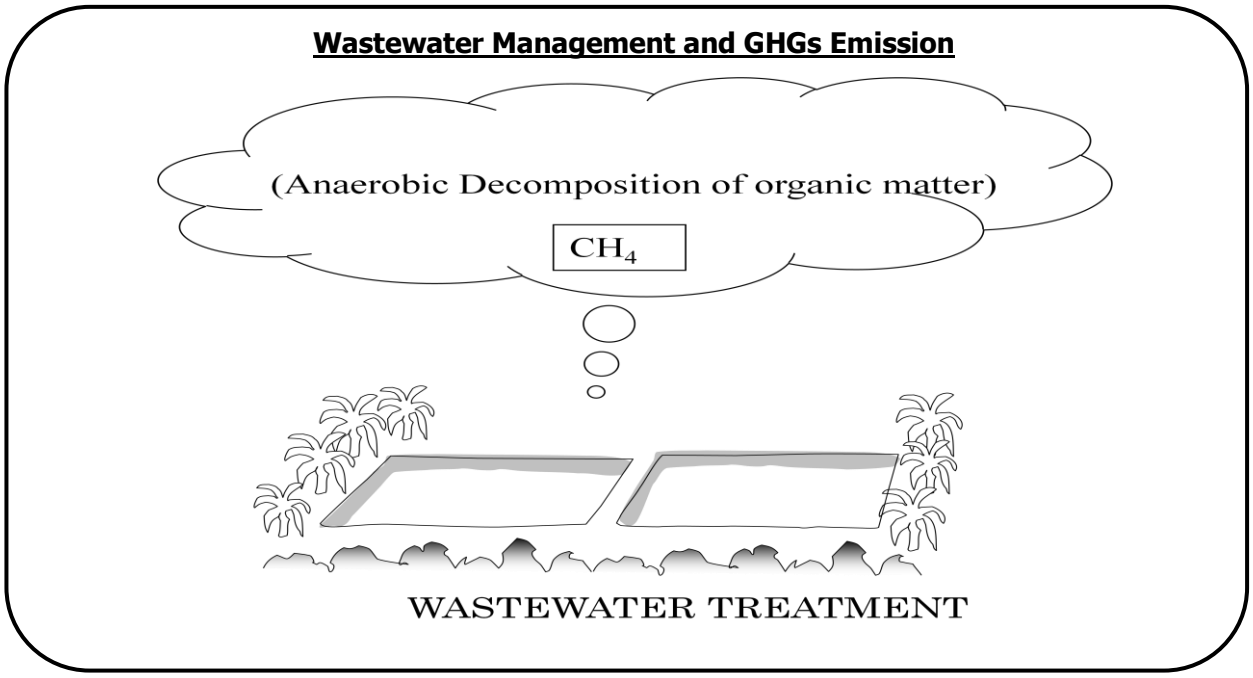
*[12 points: 2 points each]*

## [2] Waste Management/Handling CDM Project

Marks: ／20

[Q1] The figures below show the main sources of GHGs in waste and wastewater management processes. Fill the blank boxes in the figures below with the main GHGs emitted from each source. *[4 points: 1point each]*



[Q2] The table below outlines the basic methods of $CH_4$ emission reduction in waste/wastewater management process. Fill the blank columns with the appropriate methods of emission reduction. *[4 points: 1point each]*

| $CH_4$ emission source | Emission Reduction Methods | |
|---|---|---|
| Solid Waste/Wastewater Management | $CH_4$ capture | **Flaring (or Burning)** |
| | | **Direct heat use (or heat use)** |
| | | **Power generation** |
| | $CH_4$ emission avoidance/reduction by aerobic treatment of organic matter (Example: **Composting**) | |

[Q3] The sentences below explains the $CH_4$ emission from waste and key parameters in estimating the amount of $CH_4$ from waste. Fill in the blanks with appropriate word(s). *[2 points: 1point each]*

**$CH_4$ emission from waste**

- $CH_4$ is generated as a result of degradation of **organic compounds** under **anaerobic** condition.
- The time required for the waste to decay (half-life) is different among the types of waste.
- Part of $CH_4$ generated is oxidized in the cover of solid waste disposal ($CH_4$ oxidation by methanotrophic micro-organisms in cover soil.).

**Key Parameter in $CH_4$ emission**

- Degradable **organic compounds** in waste.
- Degree of **anaerobic** condition in waste (Methane Correction Factor: MCF)
- The time required for the waste to decay (decay rate)

Remarks:

- For answer ①, organic materials, matters, or waste is also considered correct.

[Q4] Estimate the amount of $CH_4$ emission from the waste management under the preconditions mentioned below *[10 points]*.

## PRECONDITIONS

### (1) Waste Amount and Composition

| Items | Preconditions | |
|---|---|---|
| The amount of waste disposed | | 100,000 tons/year |
| Waste composition by types (% by weight) | Paper/cardboard | 10% |
| | Textiles | 5% |
| | Food waste | 20% |
| | Wood | 5% |
| | Garden and park waste | 20% |
| | Inert waste | 40% |

### (2) Final Disposal (Landfill) method: unmanaged landfill with 3m depth.

### (3) Content of Degradable Organic Compounds (DOCs) and decay rate of DOCs by types of waste

| Type of Waste | Content of DOCs in the waste (% on weight basis) | Decay rate of DOCs in the first year (% on weight basis) |
|---|---|---|
| Paper/cardboard | 40% | 6.8% |
| Textiles | 24% | 6.8% |
| Food waste | 15% | 33.0% |
| Wood | 43% | 3.4% |
| Garden/park waste | 20% | 15.6% |
| Inert waste | 0% | 0% |

### (4) Methane ($CH_4$) Correction Factor (MCF) by types of landfills

| Type of landfills | MCF |
|---|---|
| Managed anaerobic | 1.0 |
| Managed semi-anaerobic | 0.5 |
| Unmanaged deep (>5m waste) and/or high waste table | 0.8 |
| Unmanaged shallow (<5m waste) | 0.4 |
| Uncategorized waste disposal | 0.6 |

**ESTIMATION METHODS**

Equation for estimating the $CH_4$ emission (in $CO_2$ equivalent) from waste landfill

$CH_4$ emission (in tonne $CO_2$e)
= 5.67 × MCF × (Total amount of DOCs decayed in the first year)

(Please use the blank below for your calculation)

(1) Amount of waste by types

| Type of Waste | Amount (tonne/year) |
|---|---|
| Paper/cardboard | 10,000 |
| Textiles | 5,000 |
| Food waste | 20,000 |
| Wood | 5,000 |
| Garden and park waste | 20,000 |
| Inert waste | 40,000 |

(2) Amount of DOCs decayed in the first year by types of waste

| Type of waste | Amount (tonne/year) | Content of DOCs (%) | Decay Rate (%) | Amount of DOCs decayed in the first year |
|---|---|---|---|---|
| Paper/cardboard | 10,000 | 40% | 6.8% | 272 |
| Textiles | 5,000 | 24% | 6.8% | 81.6 |
| Food waste | 20,000 | 15% | 33.0% | 990 |
| Wood | 5,000 | 43% | 3.4% | 73.1 |
| Garden/park waste | 20,000 | 20% | 15.6% | 624 |
| Inert waste | 40,000 | 0% | 0% | 0 |
| | | | **TOTAL** | **2,040.7** |

(3) Amount of $CH_4$ generated from the waste in the first year

5.67 × 0.4 × 2,040.7 = 4,628.~~3~~

| Answer | 4,628 Tonne $CO_2$ equivalent |
|---|---|

## [3] Energy Efficiency & Fuel Switch

Marks: ／20

[Q1] A food factory is changing halogen lamps in the factory and its warehouse to LED. The facility operates from 6AM and close at 6PM with 264 working days a year. Emission coefficient of electricity is 0.686 tCO2/MWh.

Specifications of an halogen lump and LED lumps are given as follows;

| Items | Value | Unit |
|---|---|---|
| Halogen lump | | |
| Power Consumption | 400 | W |
| Number of units | 137 | Units |
| LED lump | | |
| Power Consumption | 118 | W |
| Number of units | 83 | Units |

1-A: Calculate electricity consumption of halogen lamps.

1-B: Calculate electricity consumption of LED lamps.

1-C: Calculate CO2 reduction amount by changing from halogen to LED.

| ANSWER | |
|---|---|
| 1-A | 173,606.4 (kWh/year) |
| 1-B | 31,027.4 (kWh/year) |
| 1-C | 97.81 (tCO2) |

*[7 points: 2points for 1-A, 1-B, 3points for 1-C]*

***[Guidance]***

A. Calculate Hg lump's electricity consumption & CO2 Emissions.

400 (W/unit ) x 137 (units) x 12 (hours/day) x 264 (days)

= 173,606,400 (Wh/year)

= 173,606.4 (kWh/year)

173,606.4 (kWh/year) x 0.686 (tCO2/MWh)

= 173.61 (MWh/yaer) x 0.686 (tCO2/MWh)

= 119.1 (tCO2/year)

B. Calculate LED lump's electricity consumption & CO2 Emissions

118 (W/unit) x 83 (units) x 12 (hours/day) x 264 (days)

= 31,027,392 (Wh/year)

= 31,027.4 (kWh/year)

31,027.4 (kWh/year) x 0.686 (tCO2/MWh)

= 31.03 (MWh/year) x 0.686 (tCO2/MWh)

= 21.29 (tCO2/year)

C. Calculate reductions and savings.

Electricity Saving is;

173,606.4 (kWh/year) – 31.027.4(kWh/year)

= 142,579 (kWh)

119.1(tCO2/year) -21.29 (tCO2/year)

=97.81 (tCO2)

[Q2] The food factory runs 1.5 t of boiler to provide utility steam of the plant to cook and sterilization. The boiler runs from 6AM to 6PM including start up time. The facility runs 264 days last year. The project changes fuel of the boiler from furnace oil to natural gas to save fuel costs. According to the invoice, the facility bought 1,752 kl of furnace oil last year.

| Items | Value | Unit |
|---|---|---|
| Emission Factor | | |
| Furnace Oil | 3.084 | tCO2/kl |
| Natural Gas | 2.108 | kgCO2/Nm3 |
| Heat Value | | |
| Furnace Oil | 39.85 | GJ/kl |
| Natural Gas | 46.10 | MJ/Nm3 |

2-A: Calculate CO2 emissions from furnace oil consumption

2-B: Calculate an amount of natural gas to alternate furnace oil.

2-C: Calculate CO2 Emissions from an amount of natural gas derived from 2-B.

2-D: Calculate amount of CO2 reductions by changing fuel from furnace oil to natural gas.

| ANSWER | |
|---|---|
| 2-A | 5,403.17 (tCO2) |
| 2-B | 1,514.47 x10^3 (Nm^3) |
| 2-C | 3,192.50 (tCO2) |

| | |
|---|---|
| 2-D | 2,210.67(tCO2) |

*[10 points: 2 points for 2-A~2-C, 4 points for 2-D]*

***[Guidance]***

2-A. CO2 Emissions from furnace oil consumption

1,752 (kl) x 3.084 (tCO2/kl)

= 5,403.17 (tCO2)

2-B. Amount of Natural Gas required alternating Furnace Oil.

Heat energy supplied by furnace oil.

1,752 (kl) x 39.85 (GJ/kl)

= 69,817.2 (GJ)

Required natural gas to supply as same heat energy as furnace oil.

69,817.2 (GJ) ÷ 46.10 (MJ/Nm^3)

= 69,817.2 x 10^3 (MJ) ÷ 46.10 (MJ/Nm^3)

= 1,514.47 x10^3 (Nm^3)

2-C. CO2 emissions from natural gas consumption

1,514.47 x 10^3(Nm^3) x 2.108 (kgCO2/Nm^3)

= 3,192.50 x 10^3 (kgCO2)

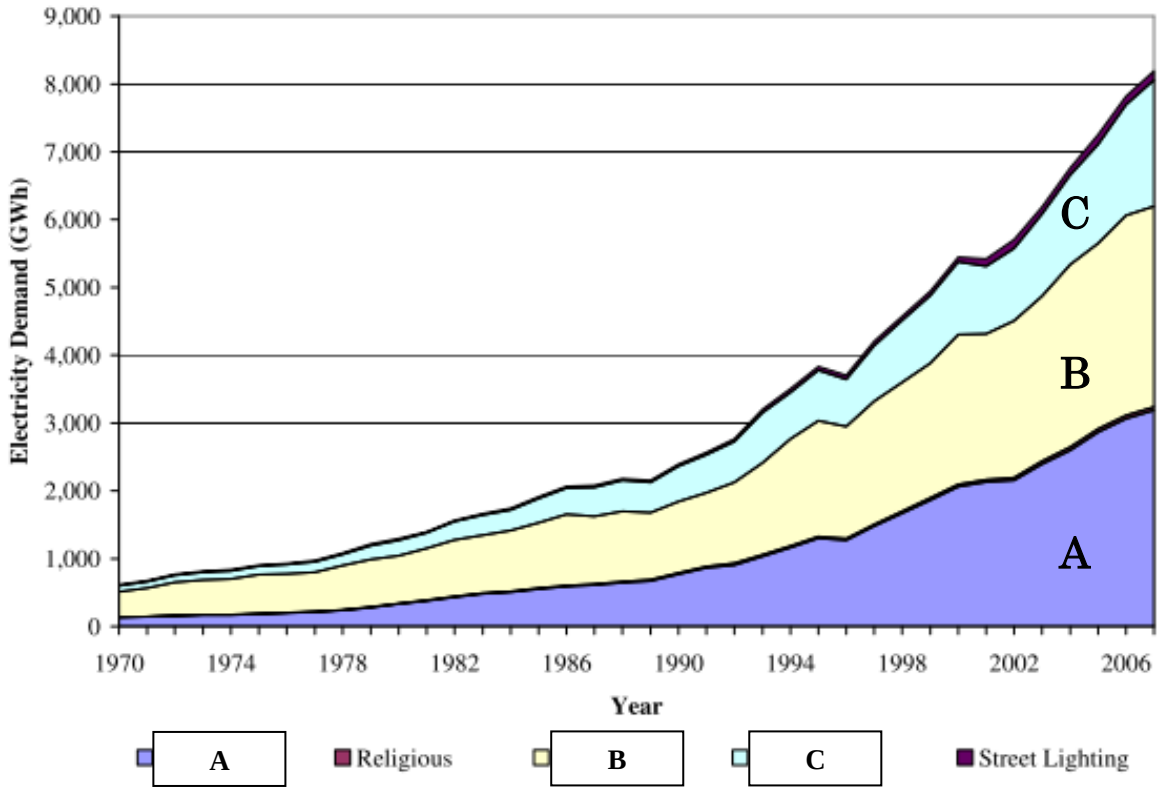
= 3,192.50 (tCO2)

2-D. Reduction Amount

5,403.17(tCO2) – 3,192.50 (tCO2) = 2,210.67(tCO2)

[Q3] Choose an appropriate category to represent proportions of the graph.

**Figure 5.4 – Electricity Demand by Consumer Category**




**Choices:**

① **Industrial**
② **Domestic**
③ **Commercial**

| ANSWER | |
|---|---|
| A | 2 |
| B | 1 |
| C | 3 |

*[3 points: 1 point each]*

| **[4] Afforestation Reforestation** | Marks: ／20 |
|---|---|

***[Guidance]***

*This was covered in section "A/R Definitions" (p6, 20 May, Afforestation Reforestation). From the definition, it is possible to understand that the A/R project must be an additional manmade activity, and it is a carbon sink project by growing trees. Therefore Biomass power generation projects, Natural regeneration projects, Status quo projects, Carbon Capture and Storage Projects are omitted from the CDM A/R candidates.*

[Q1] Select four projects that are Afforestation/Reforestation CDM from the following list of climate change mitigation projects. *[4 points: 1point each]*

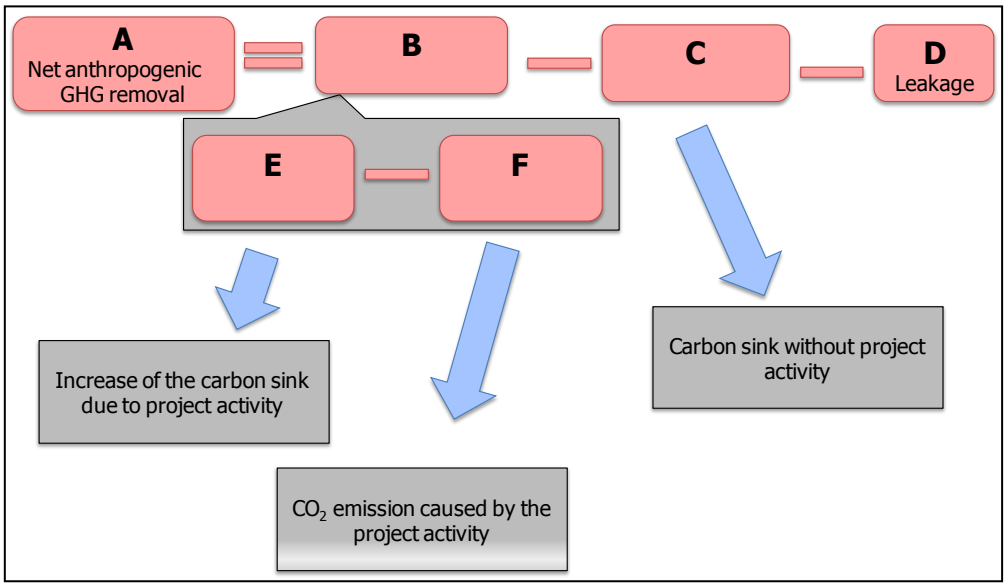
| | |
|---|---|
| [ ] | Biomass power generation project using forest residues |
| [ ] | Natural regeneration of trees without any human intervention |
| [ ✓ ] | Tree planting activities in the ex-farming land |
| [ ] | Status quo conservation and tree planting activities inside the national nature reserve |
| [ ✓ ] | Reforestation of the degraded grazing land |
| [ ✓ ] | Assisted natural regeneration of the degraded land with the help of the local farmers |
| [ ] | Carbon Capture and Storage in the ex-oil field |
| [ ✓ ] | Small Scale Cooperative Forestry Activity |

***[Guidance]***

*This was covered in section "A/R Methodology Basic Concept" (p17, 20 May, Afforestation Reforestation).*

[Q2] Following is the formula for the Afforestation/Reforestation carbon sink calculation. Fill in the correct alphabet to the table below containing the missing terms of the formula.

*[4 points: 1point each]*




| | |
|---|---|
| [ **A** ] | Net Anthropogenic GHG removal |
| [ **D** ] | Leakage |
| [ C ] | Baseline GHG removal by sink |
| [ B ] | Actual net GHG removal by sink |
| [ E ] | Total GHG removal by the project |
| [ F ] | Project Emission |

***[Guidance]***

*This was covered in section "Issue1: Non-permanence" (p12, 20 May, Afforestation Reforestation).*

*The non-permanence issue is the potential threat of release of $CO_2$ from the carbon sink.*

[Q3] Select one correct description of the "non-permanence issue" of the Afforestation/ Reforestation CDM *[4 points]*

| | |
|---|---|
| [ ] | It is considered to be generally more expensive and time consuming to monitor the activities of A/R CDM projects in comparison with energy-based CDM projects. This may be solved in the near future with the development of the remote sensing technology. |
| [ ✓ ] | Forest captures carbon, but it may be released once there is a forest fire, or if trees decay. Therefore there is no guarantee that the carbon will be stored inside the forest. |
| [ ] | The crediting period of the A/R CDM project is 30 years or 20years×2. With the current uncertainty of the post Kyoto agreement, it is difficult to conduct such long term projects. |
| [ ] | CER price always fluctuates. Therefore there is no guarantee that the price of the CER price will stay the same for the next 5 years, making it difficult to predict the revenue gained from the A/R CDM activities. |

***[Guidance]***

*This was covered in section "l-CER in detail" and "t-CER" (p4~7, 8 July, Afforestation Reforestation Review Session). The A/R CDM carbon credits are UNFCCC approved, therefore it could be used for the national emission reduction commitments; the credit expires; the buyer needs to obtain equivalent amount of CER after expiry of the credit; and the credit will be issued after post Kyoto regardless of the outcome of the post Kyoto negotiation.*

[Q4] Select either (A) or (B) which is the correct statement of the Afforestation/ Reforestation CDM carbon credit (l-CER and t-CER) *[4 points: 1point each]*

| | |
|---|---|
| [ A ] | (A) The credit can be used to offset the national emission reduction commitments<br>(B) The credit can only be used for voluntary purposes |
| [ A ] | (A) The credit has an expiry date<br>(B) The credit do not have any expiry date |
| [ A ] | (A) The CER buyer needs to obtain equivalent amount of CER upon end of the crediting period or end of the commitment period.<br>(B) There is no need for the CER buyer to obtain equivalent amount of CER upon end of the crediting period or end of the commitment period. |
| [ A ] | (A) The credit will be issued after 2012 even without post Kyoto agreement<br>(B) The credit will not be issued after 2012 unless there is a post Kyoto agreement |

***[Guidance]***

*This was covered in section "A/R Definition", "REDD"(p6 and p21, 20 May, Afforestation Reforestation) and "Credit Pooling Approach: VCS" (p9, July, Afforestation Reforestation Review Session). The carbon credit of A/R CDM expires, VCS projects uses buffer account for its carbon pooling approach, and carbon credits for REDD are issued for preventing deforestation. The remaining will be the voluntary projects which are often done for CSR purposes and cannot be used for national emission reduction commitment.*

[Q5] <A> is different types of forest related climate change mitigation projects. Please draw lines to connect "Mechanism" <A> with correct "Description of its carbon credit" <B>

*[4 points: 1point each]*

| <A>: Project | <B>: Description of the carbon credit |
|---|---|
| A/R CDM project | Certain percentage of carbon credit must be transferred to the buffer account |
| A/R VCS project (using carbon pooling approach) | The credit will be issued depending on how much forest has been prevented from deforestation in comparison with the reference scenario. |
| REDD project | The credit cannot be used for the Annex I commitment for now and most likely in the future as well. However the credits are often bought for the purpose of CSR or good will. |
| Voluntary Forestry Project | The carbon credit will expire during the end of the project or the end of the commitment period. |

## [5] Outcomes of COP/MOP and Post 2012 issues

Marks: ／20

[Q1] Check the CORRECT description (1 answer) about CDM Loan Scheme. *[4 points]*

| | |
|---|---|
| [ ] | CDM Loan Scheme agreed at the COP/MOP5 in Copenhagen, Denmark. |
| [ ] | Eligible for all Non-Annex I Parties, including LDCs and SIDS. |
| [✓] | Eligible only for fewer than 10 registered CDM project countries. |
| [ ] | Loan will cover for validation fee only. |

[Q2] Check the CORRECT description (1 answer) about CDM after 2012. *[4 points]*

| | |
|---|---|
| [ ] | Crediting period of all registered CDM projects will be expired at the end of the first commitment period of the Kyoto Protocol. |
| [ ] | CDM Executive Board will dissolve at the end of the first commitment period of the Kyoto Protocol. |
| [✓] | Certified Emission Reduction (CER) will be generated and issued after 2012. |
| [ ] | Certified Emission Reduction (CER) will be utilized for second commitment period of the Kyoto Protocol. |

[Q3] Read the following statements and select 'Correct' or 'Incorrect' in the box provided.

[Q3-1] There are several scenarios for Market Mechanism after 2012 presented by researchers and policy makers. CDM will not utilize at the most of the scenarios. *[12 points: 4points each]*

| | |
|---|---|
| [ ] | Correct |
| [✓] | Incorrect |

[Q3-2] Bangladesh, China and other developing country Parties submitted their views and opinions on New Market-based Mechanisms as follows:
Emission reduction commitments of the developed country Parties shall be achieved mainly through domestic actions. And Market-based Mechanisms could only play a supplementary role to achieve their commitments.

| | |
|---|---|
| [✓] | Correct |
| [ ] | Incorrect |

[Q3-3] The Government of Japan is promoting so-called "Bilateral Offset Credit Mechanism (BOCM)" to be introduced as a new financial assistance mechanism after 2012. Japan plans to provide technical and financial assistance to Non-Annex I countries entirely through this new scheme, not through CDM.

| | |
|---|---|
| [ ] | Correct |
| [✓] | Incorrect |