**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 03 - in effect as of: 28 July 2006**

**CONTENTS**



**Annexes**

## SECTION A. General description of project activity

### A.1. Title of the project activity:

The title of the project activity: LFG Collection & Utilization Project in Ipoh
Version number: 01
Date: 18/1/2011

### A.2. Description of the project activity:

The Landfill is located in the northeast of Ipoh City, Perak State, Malaysia.
The landfill site has a total area of 40 ha and receives approximately 220,000 tons per year of domestic and non-hazardous industrial waste by open-dumping. LTC ALAM BERSIH S/B (hereinafter, LT) operates the landfill, including collection and transportation of municipal solid waste (hereinafter, MSW). But, the new landfill site is planed to open and this existing one may be closed soon. And now, the LFG is not collected (Atmospheric release).
The project involves the installation of a gas collection pipeline system, a gas pumping system, a flaring system and gas engine generators. The recovery volume of landfill gas (Methane gas only) in 2013, the first year of the proposed project, is estimated to be approximately 4,000 tons / year .The gas engines will combust landfill gas, which contains nearly 50% of methane, to produce electricity and export it to the grid.
The project is intended to play an important role in the safety closure of the landfill site by eliminating the emission of landfill gas and prevent odd smell from spreading. The project is consistent with the criteria mentioned in the ninth Malaysian Plan and its Mid-Term Review by Economic Planning Unit in Malaysia on performance for sustainable development for CDM project in Malaysia.
The project is expected to contribute to;
►Destruction of methane by collecting landfill gas formed inside the accumulated waste in the landfill site.
►Reduction of carbon dioxide emitter by replacing electricity generated from fossil fuel.

### A.3. Project participants:

**Table 1: Project participants**

| Name of Party involved ((host) indicates a host Party) | Private and/or public entity (ies) project participants (as applicable) | Kindly indicate if the party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Malaysia (host) | LTC ALAM BERSIH S/B (LT) | No |
| Japan | To be determined | No |

**A.4. Technical description of the project activity:**

**A.4.1. Location of the project activity:**

**A.4.1.1. Host Party(ies):**

Malaysia

**A.4.1.2. Region/State/Province etc.:**

Perak State

**A.4.1.3. City/Town/Community etc.:**

Ipoh City

**A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):**

The project activity will take place at the landfill site located in Kampung Lim Tang in Ipoh City. Ipoh city is the capital of Perak State, in the northern part of West Malaysia. Ipoh City is about 200 km to the north of Kuala Lumpur. The latitudes and longitudes of the project site are given below:
Latitude: 4° 39’ 37″ N
Longitude: 101° 09’ 16″ E



**Figure1: Map of Malaysia and Ipoh City**

### A.4.2. Category(ies) of project activity:

Sectoral scope 13: Waste handling and disposal.
Landfill gas recovery and conversion to electricity.

### A.4.3. Technology to be employed by the project activity:

The project will involve proven technology and hardware for the recovery, collection and pumping landfill gas (LFG) and power generation using the gas. In addition, since gas recovery volume is essential to the project viability, optimization of gas recovery well arrangements in the disposed waste is made by applying a newly developed method based on the site investigation.
The facilities proposed for the project consist of an LFG recovery system, an LFG punping system, and LFG flareing system as shown in Figure 2. The detail of each system follows.

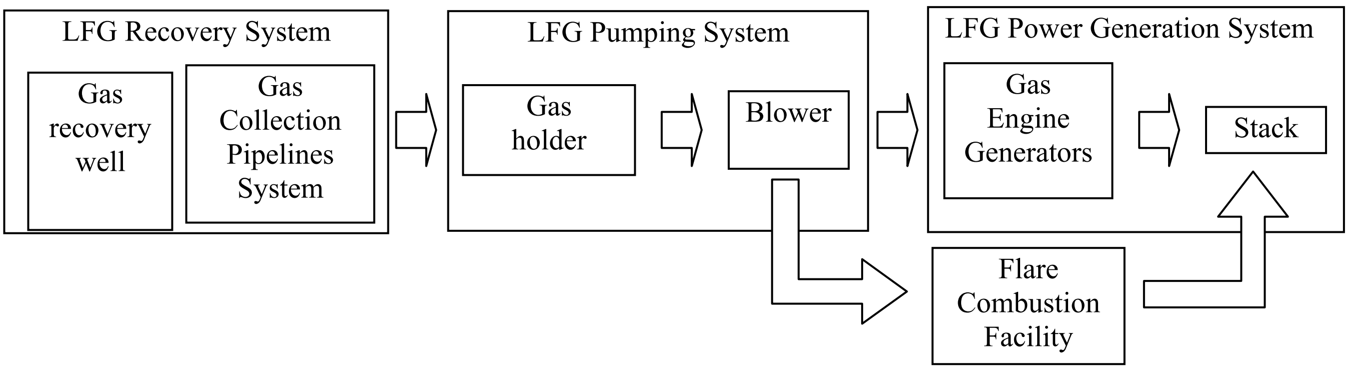


**Figure 2: Overview flowchart of the LFG facility**

**LFG recovery system**
It is noted that a critical factor that controls methane gas emissions is a covering layer of the landfill surface as well as recovery wells. In order to maximize the methane gas recovery, the landfill area of the project will be covered with dense soil of thickness more than 0.5m.
In the LFG recovery system, LFG is collected through gas recovery wells located at the landfill area and delivered to LFG flaring system and power generation system by LFG collection pipelines.

**LFG pumping system**
The LFG pumping system consists of blowers with appropriate control system, which pumps and brings LFG to the power generation system at the optimal rate and quality. In addition, in the case of maintenance of a gas engine, etc., the LFG is leaded to flare combustion equipment.

**LFG power generation system**
Gas engine generators combust the gas as fuel and generate electricity. All the electric power generated by the facility after its in-house consumption is sold to Tenaga Nasional Berhad (TNB), a regional power generator and distributor.

**Flare combustion facility**
The flare combustion facility burns excessive LFG beyond the gas engine capacity and collected LFG

during maintenance (inspection and malfunction) of the gas engine generators.

**Facilities in summary**
In summary, the following components are installed in the LFG recovery, storage and power generation

facilities:
►Vertical wells with perforated pipes
►Horizontal pipeline system conveying the collected LFG
►A blower
►Flare combustion facility
►Gas engine generators
►Step-up transformers
►Transmission line to the grid
►Monitoring equipment.
The employed technology is environmentally sound, because almost no alteration is added to the present state of the landfill site except boring the vertical holes of small size.

**A.4.4. Estimated amount of emission reductions over the chosen crediting period:**

**Table 2: Estimation of emission reduction**

| Year | Annual estimation of emission reductions in tons of CO2e |
|---|---|
| 2013 | 91,505 |
| 2014 | 74,316 |
| 2015 | 61,789 |
| 2016 | 52,481 |
| 2017 | 45,415 |
| 2018 | 39,927 |
| 2019 | 35,562 |
| **Total estimated reductions (tons of CO2e)** | 400,995 |
| **Total number of years in first crediting period** | 7 |
| **Annual average estimated reductions, first crediting period (tons of CO2e)** | 57,285 |

**A.4.5. Public funding of the project activity:**

This project will not receive any national or international funding for the development of the proposed project

## SECTION B. Application of a baseline and monitoring methodology

### B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

ACM0001 - Version 11 "Consolidated baseline methodology for landfill gas project activities",– Revision to the approved consolidated baseline methodology.

"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site - Version 4
"Tool to determine project emissions from flaring gases containing methane"
"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" Version 2
"Tool for the demonstration and assessment of additionality" Version 5.2
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" Version 1
"Tool to calculate the emission factor for an electricity system" Version 2

### B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

ACM 0001 is applicable to landfill gas capture project activities, where the baseline scenario is partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; and/or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy);
c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodology AM0053.

The project activity corresponds to situations a) and b): the collected landfill gas will be flared and used to produce electricity, thus ACM0001 is applicable for this project.

### B.3. Description of the sources and gases included in the project boundary:

ACM 0001 defines the project boundary as the site of the project activity where the gas is captured and destroyed/used.
In addition, since the renewable electricity exported by the project would have been generated by power generation sources connected to the grid, the project boundary includes all these power generation sources.

The gases and sources relevant to the Project are listed in the following table.

**Table 3: The Greenhouse Gases included in or excluded from the Project Boundary**

| | Source | Gas | Included? | Justification / Explanation |
|---|---|---|---|---|
| Baseline | Emissions from decomposition of waste at the landfill site | $CO_2$ | No | $CO_2$ emissions from the decomposition of organic waste are not accounted. |
| | | $CH_4$ | Yes | The major source of emissions in the baseline |
| | | $N_2O$ | No | $N_2O$ emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative. |
| | Emissions from electricity consumption | $CO_2$ | Yes | Electricity is consumed from the grid in the baseline scenario. |
| | | $CH_4$ | No | Excluded for simplification. This is conservative. |
| | | $N_2O$ | No | Excluded for simplification. This is conservative. |
| | Emissions from thermal energy generation | $CO_2$ | No | Thermal energy generation is not included in the project activity |
| | | $CH_4$ | No | Excluded for simplification. This is conservative. |
| | | $N_2O$ | No | Excluded for simplification. This is conservative. |
| Project Activity | On-site fossil fuel consumption due to the project activity other than for electricity generation | $CO_2$ | No | No on-site fossil fuel consumption. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | Emissions from on-site electricity use | $CO_2$ | Yes | Important emission source. |
| | | $CH_4$ | No | Excluded for simplification. This emission source is assumed to be very small. |
| | | $N_2O$ | No | Excluded for simplification. This emission source is assumed to be very small. |

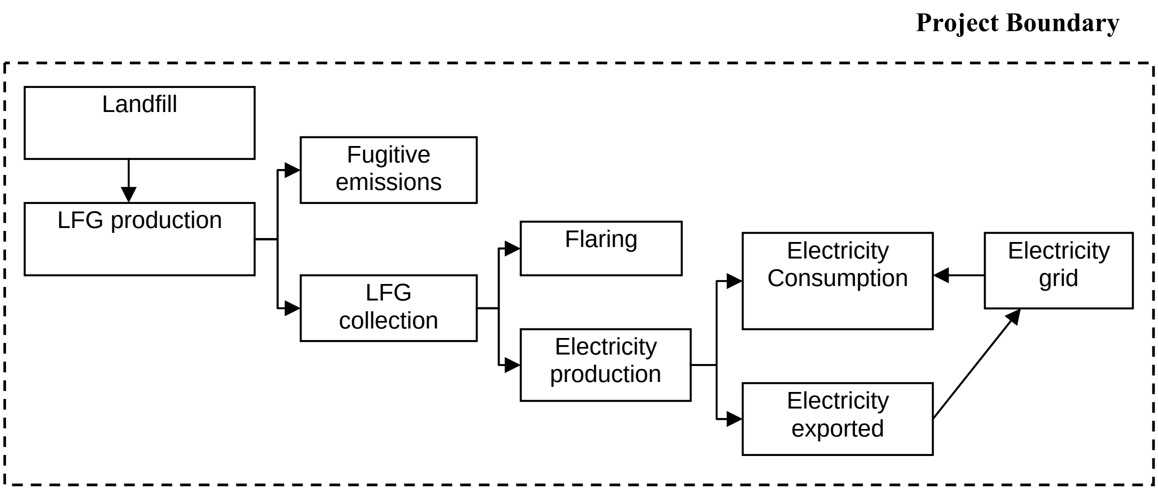


**Figure 3: Project boundary of the proposed project**

| **B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:** |
|---|

According to the approved methodology ACM0001, the baseline scenario of the project activity is defined as the following procedures, using the "Tool for the demonstration and assessment of additionality (version 5.2)"

**STEP 1: Identification of alternative scenarios**

***Sub-step 1a. Define alternatives to the project activity:***
Alternatives for the disposal/treatment of the waste in the absence of the project activity, i.e. the relevant scenario for estimating baseline methane emissions, to be analysed include:

LFG1. The project activity (i.e. capture of landfill gas and its flaring and/or use) undertaken without being registered as a CDM project activity;

LFG2. Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odd smell concerns.

Since the project activity also includes LFG for generation of electricity for export to a grid, realistic and credible alternatives for power generation should also be separately determined as below:

P1: Power generated from landfill gas undertaken without being registered as CDM project activity;
P2: Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3: Existing or construction of a new on-site or off-site renewable based cogeneration plant;

P4: Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
P5: Existing or construction of a new on-site or off-site renewable based captive power plant;
P6: Existing and/or new grid-connected power plants.

As the project activity does not aim at producing heat for nearby industries or on-site use, existing or construction of a cogeneration plant is not part of the baseline scenario. Also there is no existing nor construction plan for fossil fuel based or renewable based cogeneration plant nearby. Hence alternatives P2 and P3 are not taken into consideration in identification of baseline scenario.

Similarly, there is no existing on-site or off-site renewable based captive power plant. The government of Malaysia encourages development on renewable energy, however, currently this kind of renewable projects have not been implemented yet. Furthermore, Renewable sources other than LFG are not economically feasible for the project site; therefore P5 is not a realistic and credible scenario.

As a grid connection already exists on the landfill site, construction of a new onsite fossil fuel fired captive power plant is not as economically competitive as purchasing power from the grid, and not realistic alternatives to the Project activity. Furthermore, the power needs at the landfill site are minimal and therefore do not justify the construction of a new fossil fuel fired captive power plant, Thus, alternatives P4 can be discarded.

***Sub-step 1b. Consistency with mandatory laws and regulations***

Currently, in Malaysia, there are no national or regional regulatory requirements to collect and/or burn landfill gas. Hence alternative LFG 1 and LFG2 are in compliance with national laws and regulations. P1 complies with all laws and regulations but is not required by laws and regulations. P6 complies with all laws and regulations

**STEP 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.**

The baseline for the energy source is the electricity generated by the power plants connected to Malaysian National Grid, which is mainly consist of fossil fuel based power plants (coal and gas), as well as renewable based power plants (hydro). This grid covers whole Peninsula Malaysia, and there is no restriction of baseline fuel to be used.

As described above, plausible alternative scenarios for the Project are LFG1, LFG2 for LFG utilization and P1, P6 for power generation.

**STEP 3: Investment analysis**

If power generated from LFG is undertaken without being registered as CDM project activity (P1), this is not a viable alternative because of the low electricity tariff in Malaysia. In Malaysia, the tariff of sale of electricity to the only national power supplier, Tenaga National Malaysia, is low. The current sale price of 21 Malaysia sen per KWh (US $0.07) is not attractive to project owner in view of the capital investment of US $ 3 millions and uncertainty of the landfill gas production. Even when combined with Scenario

LFG1, the IRR is determined to be negative, let alone when combined with Scenario LFG2. Therefore, it can be clearly stated that scenario P1 is economically unattractive, and shall also be excluded from further consideration.

Scenario LFG1 requires installation of LFG collection system in the landfill site, and all necessary expenses to develop and implement the proposed project activity would be additional cost for the project owner. Furthermore, if LFG was just flared without being utilized to generate electricity, the Project would not be able to obtain additional income, thus LFG1 is not financially attractive. Therefore, LFG1 cannot be realistic alternative, and thus can be eliminated from consideration as baseline scenario.

Based on the above analysis, P1 and LFG1 can be discarded from the possible baseline scenarios. Hence, LFG2 (atmospheric release of the landfill gas) and P6 (electricity obtained from the Grid) are the only remaining credible and plausible scenarios, and have been identified as the baseline scenario.

**B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):**

The additionality of the project activity is demonstrated and assessed using the “Tool for the demonstration and assessment of additionality” Version. 05.2.

**Serious Consideration of CDM**

Annex 46 of EB 41 requires the serious consideration of the benefits to be demonstrated by a) the awareness of CDM by project participant prior to the project activity start date and b) parallel action having been taken for the registration of the project as CDM activity along with the implementation of the project. This proposed project falls under a).

The following chronology demonstrates the efforts taken by the project proponent in validation.

| Date | Description of Events | Description of Evidence |
|---|---|---|
| August 2008 | Outline of the project as a CDM explained to LT | Minutes of meeting |
| November 2008 | Waste composition and aerobic treatment process tested toward CDM development by LT | Test report |
| August 2009 | CDM FS financed by GEC began with full assistance by LT | Contract |
| August 2010 | CDM procedures financed by GEC began with full assistance by LT | Contract |
| October 2010 | Validation contract with DOE | Contract with DOE |
| January 2013 | Project to start | |

**Step 1. Identification of alternatives to the project activity consistent with current laws and Regulations**

In line with the applied methodology ACM0001, realistic and credible alternatives available for the disposal/treatment of the waste in the absence of the project activity are identified as follows, and all are in compliance with the mandatory laws and regulations that are set by the Government of Malaysia.

Scenario1 (LFG2 + P6): Atmospheric release of LFG, no capture based on legislation, etc. (Maintenance of status quo);
Scenario2 (LFG1 + P6): The proposed activity is undertaken without being registered as a CDM project activity, capturing the LFG and combusting by flaring;
Scenario3 (LFG1 + P1): Power generated from LFG undertaken without being registered as a CDM project activity.

**Step 2: Investment analysis**

The purpose of this step is to determine whether the proposed Project activity is financially less attractive than other alternatives without revenues from the sale of CERs. The investment analysis was implemented in the following steps:

***Sub-step 2a. Determine appropriate analysis method***
The Project generates income from its electricity sales, in addition to the expected CDM revenue. Consequently, Option I (Simple Cost Analysis) is not appropriate. Option II (Investment Comparison Analysis) is also not appropriate as there is no comparable investment alternative at the proposed landfill sites available to the project proponent. Option III (Benchmark Analysis) is therefore deemed as the most appropriate analysis method.

***Sub-step 2b. Option III. Apply benchmark analysis***
The IRR was chosen as the relevant financial indicator for the Project, and the benchmark is Base Lending Rate issued by Bank Negara Malaysia which is 6.27 %[1]. (Issued December, 2010)

***Sub-step 2c. Calculation and comparison of financial indicators:***
The IRR of the proposed project without CDM revenue (Scenario 3: LFG1 and P1) and with CDM revenue are calculated using the parameters listed in the following tables.

| Item | Description |
|---|---|
| Project Period | 7 years |
| Waste Amount | No change during the project (600t/d) |
| Amount of Loans | None |
| Inflation Rate | 1.70% (as of 2010)[2] |

[1] Bank Negara Malaysia, "Monthly Statistical Bulletin November 2010", 2.1 Interest Rates , http://www.bnm.gov.my/index.php?ch=109&pg=294&mth=11&yr=2010&eId=box1

| | |
|---|---|
| Salary Increment Rate | 4.10 %[3] |
| Corporate Tax | 25%[4] |
| Depreciation Period | 7 years |

| Expense | | Notes |
|---|---|---|
| Initial Investment | 13,000,000 RM | Equipment expenditure and civil work & earthworks |
| O&M Cost | 782,726 RM/year | Electricity cost, Labour cost, maintenance & repair cost, etc. |
| Expense Total (7 years) | 20,967,000 RM | |
| Income | | |
| CER Sales (7years) | 16,102,800 RM | 40 RM/tCO2 |
| Electricity Sales (7years) | 9,822,498 RM | 0.21 RM/kWh |
| Income Total (7 years) | 25,481,263 RM | CER sales + Electricity Sales - SOP-Admin & SOP-Adaptation |
| Project IRR (7years) | | |
| With CER | 10.94 % | |
| Without CER | negative | |

As shown in the table above, the project IRR is negative without CER. With the additional revenue from sale of carbon credits from CDM, the IRR increases to acceptable rates. This clearly indicates that an investment barrier exists in the projects implementation and the project is unattractive without CER revenue.

***Sub-step 2d. Sensitivity analysis:***
The purpose of sensitivity analysis is to examine whether the conclusion regarding the financial/ economic attractiveness is robust to reasonable variations in the critical assumptions.

The critical assumptions include:

i. Changes in investment cost
ii. Changes in O&M cost (maintenance & repair cost, electricity cost, labour cost, etc.)
iii. Changes in revenue from electricity sales

These parameters were selected as being the most likely to fluctuate over time due to external factors. The results of the sensitivity analysis are as given below:

| Parameters | IRR (7 years) | | |
|---|---|---|---|
| | Base Case | Increase by 10% | Decrease by 10% |
| Investment Cost | Negative | Negative | Negative |

[2] Department of Statistics Malaysia Official Website, Consumer Price Index Malaysia December 2010 (Updated: 19/01/2011)
[3] Kelly Service, Inc., Employment Outlook and Salary Guide 2010/11
[4] Malaysia Industrial Development Authority (MIDA) Website, Invest in Malaysia

| | | | |
|---|---|---|---|
| O&M Cost | Negative | Negative | Negative |
| Revenue from electricity sales | Negative | Negative | Negative |

As is evident in the table, even with the decreased expense and increased income, the IRR of the project is negative.

Thus, the sensitivity analysis reveals that even with significant changes in various parameters, the project IRR is negative or lower than the benchmark rates. Therefore, the project is additional and is not a business as usual scenario. The project can become financially attractive only with the CDM benefit.

**Step 3. Barrier analysis**

According to the "Tool for the demonstration and assessment of additionality", the project developer could choose between Step 2 and Step3. As Step 2 shows already that there is a high financial barrier Step3 will not be described any further.

**Step 4: Common practice analysis**

***Sub-step 4a. Analyze other activities similar to the proposed project activity:***
Currently, LFG collection project is not carried out on landfill sites in Malaysia, except those developed under CDM. The common method for waste disposal is open dumps and landfills, though there are few landfills engineered and having gas venting or collection systems. Thus prevailing practice in Malaysia is free venting of LFG.

Although the government of Malaysia encourages the development of renewable energy, there is no obligation for landfill operators to promote productive use of LFG for heat or electricity generation. In addition, because of high Initial investment, utilization of LFG for electricity generation project without CDM benefit has no profitability as an independent project. Taking into consideration its technical difficulty and no financial feasibility, capturing and utilization of LFG is not attractive for project developer. Consequently, collection and utilization of LFG has not been practiced in Malaysia besides the CDM projects.

***Sub-step 4b. Discuss any similar options that are occurring:***
As stated in sub-step 4a, there are no similar options commonly occurring in the Host country. The common practice in Malaysia is disposal of waste in the landfill without the capture of LFG, and capture and utilization of LFG is difficult without additional incomes and investment.

In conclusion, the proposed project activity is economically unattractive, and it will not be implemented without the incentive provided by the CDM. Therefore, the proposed project activity is additional.

**B.6. Emission reductions:**

**B.6.1. Explanation of methodological choices:**

The emission reductions resulting from the capture and combustion of methane are calculated in accordance with ACM0001 "Consolidated baseline methodology for landfill gas project activities" Version 11.

**1. Baseline emissions**

The baseline emissions are calculated as follows:

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \quad (1)$$

As the proposed project activity does not include a thermal energy component, equation can be modified for simplification.

$$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y} \quad (2)$$

Where:

$BE_y$ :Baseline emissions in year y ($tCO_2e/yr$)

$MD_{project,y}$ :The amount of methane that would have been destroyed/combusted during the year, in tons of methane ($tCH_4$) in project scenario

$MD_{BL,y}$ :The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tons of methane ($tCH_4$)

$GWP_{CH4}$ :Global Warming Potential value for methane for the first commitment period is 21 $tCO_2e/tCH_4$

$EL_{LFG,y}$ :Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh)

$CEF_{elec,BL,y}$ :CO2 emissions intensity of the baseline source of electricity displaced, in $tCO_2e$/ MWh.

**(1) Amount of methane that would have been destroyed/combusted during the year y in the absence of the project due to regulatory and/or contractual requirements ($MD_{BL,y}$)**

The amount of methane that would have been destroyed/combusted during the year y in the absence of the project due to regulatory and/or contractual requirements is calculated as follows:

$$MD_{BL,y} = MD_{project,y} * AF \quad (3)$$

Where:

AF :Adjustment Factor

ACM0001 provides the guidance on how to estimate AF. AF should be considered in cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements or is undertaken for other reasons, the ratio of the destruction efficiency of the baseline system to the destruction efficiency of the system used in the project activity shall be used. For the proposed project, there is no contractual requirement. As explained before, the flaring and treatment of LFG are not widely enforced and the common practice in Malaysia remains venting LFG. Therefore, AF is zero. Then $MD_{BL,y}$ is 0.

**(2) Methane destroyed by the project activity ($MD_{project,y}$)**

The amount of methane that would have been destroyed/combusted during year y is calculated as follows since there are neither thermal energy generation nor LFG feeding to pipeline:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} \quad (4)$$

Where:
$MD_{flared,y}$ :Quantity of methane destroyed by flaring ($tCH_4$)
$MD_{electricity,y}$ :Quantity of methane destroyed by generation of electricity ($tCH_4$)

The amount of methane destroyed/combusted by flaring is calculated as:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (5)$$

Where:
$LFG_{flare,y}$ :Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters ($m^3$)
$w_{CH4,y}$ :Average methane fraction of the landfill gas as measured during the year and expressed as fraction ($m^3CH_4/m^3LFG$)
$D_{CH4}$ :Methane density expressed in tons of methane per cubic meter of methane ($tCH_4/m^3CH_4$)
*At standard temperature and pressure (0℃、 1.013 bar), the density of methane is 0.0007168 $tCH_4/m^3CH_4$
$PE_{flare,y}$ :Project emissions from flaring of the residual gas stream in year y ($tCO_2e$) determined following the procedure described in the ”Tool to determine project emissions from flaring gases containing Methane”. If methane is flared through more than one flare, the $PE_{flare,y}$ shall be determined for each flare using the tool

Determination of $PE_{flare,y}$ :
Project emissions from flaring will be calculated and monitored according to the procedures described in the “Tool to determine project emissions from flaring gases containing methane”, using the 90 % default value for the methane destruction efficiency of the flare.

$PE_{flare,y}$ is calculated as follows:

$$PE_{flare,y} = \Sigma_{(h = 1 \sim 8760)} TM_{RG,,h} * (1 - \eta_{flare,h}) * GWP_{CH4} /1000 \quad (6)$$

Where:
$TM_{RG,h}$ :Mass flow rate of methane in the residual gas in the hour h (kg/h)
$\eta_{flare,h}$ :Flare efficiency in hour h

The quantity of methane destroyed by generation of electricity is calculated using the following equation:

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4} \quad (7)$$

Where:

$LFG_{electricity,y}$ :Quantity of landfill gas fed into electricity generator ($m^3$)

$w_{CH4,y}$ :Average methane fraction of the landfill gas as measured during the year and expressed as fraction ($m^3CH_4/m^3LFG$)

$D_{CH4}$ :Methane density expressed in tons of methane per cubic meter of methane ($tCH_4/m^3CH_4$)
*At standard temperature and pressure (0℃、1.013 bar), the density of methane is 0.0007168 $tCH_4/m^3CH_4$

<u>Ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tons of methane</u>

The ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tons of methane, will be done with the latest version of the approved "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", considering the following additional equation:

$$MD_{project,y} = BE_{CH4,\ SWDSy} / GWP_{CH4} \quad (8)$$

Where: $BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year y ($tCO_2e$), calculated as per the "*Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*.

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-kj \cdot (y-x)} \cdot \left(1-e^{-kj}\right) \quad (9)$$

Where:

| | |
|---|---|
| $MB_y$ | is $BE_{CH4,SWDS,y}$ ($tCO_2e/yr$) |
| $BE_{CH4,SWDS,y}$ | is the methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year *y* ($tCO_2e/yr$) |
| $\varphi$ | is the model correction factor to account for model uncertainties (0.9) |
| $f$ | is the fraction of methane captured at the SWDS and flared, combusted or used in another manner |
| $GWP_{CH4}$ | is the Global Warming Potential (GWP) of methane, valid for the relevant commitment period |
| $OX$ | is the oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste) |
| $F$ | is the fraction of methane in the SWDS gas (volume fraction) (0.5) |
| $DOC_f$ | is the fraction of degradable organic carbon (DOC) that can decompose |
| $MCF$ | is the methane correction factor |
| $W_{j,x}$ | is the amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons) |

| | |
|---|---|
| $DOC_j$ | is the fraction of degradable organic carbon (by weight) in the waste type *j* |
| $k_j$ | is the decay rate for the waste type *j* |
| $j$ | is the waste type category (index) |
| $x$ | is the year during the crediting period: *x* runs from the first year of the first crediting period (*x*=1) to year *y* for which avoided emissions are calculated (*x*=*y*) |
| $y$ | is the year for which methane emissions are calculated |

$$W_{j,x} = W_x \times \frac{\sum_{n=1}^{z} P_{n,j,x}}{z} \qquad (10)$$

Where:

| | |
|---|---|
| $W_{j,x}$ | is the amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons) |
| $W_x$ | is the total amount of organic waste prevented from disposal in year *x* (tons) |
| $P_{n,j,x}$ | is the weight fraction of the waste type *j* in the sample *n* collected during the year *x* |
| $z$ | is the number of samples collected during the year *x* |

Once $BE_{CH4,SWDS,y}$ is calculated according to the Tool, a collection efficiency is applied to this value in order to reflect the fact that no all methane generated is actually captured by the collection system. The collection efficiency value should consider the physical conditions of this landfill as well as the capping material used to cover the waste, but those parameters are already addressed by the formula used to calculated $BE_{CH4,SWDS,y}$. Therefore, according to the manufacture, a collection efficiency is a reasonable factor to use, as it reflects only the efficiency of the system itself (incl. pipes, blower, etc…)

**2. Project emissions**

The project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} \qquad (11)$$

Where:

| | |
|---|---|
| $PE_{EC,y}$ | :project emissions from electricity consumption by the project activity during the year y ($tCO_2e/yr$) |
| $PE_{FC,y}$ | :project emissions from heat consumption by the project activity during the year y ($tCO_2e/yr$) |

**(1) Project emissions from electricity consumption**

Determination of $PE_{EC,y}$ is done with the approved "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", using the following equation;

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1 + TDL_y) \quad (12)$$

$EC_{PJ,y}$ :Quantity of electricity consumed in the project activity during the year y (MWh)
$EF_{grid,y}$ :Emission factor for the grid in year y($tCO_2e/MWh$)
$TDL_y$ :Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

**(2) Project emissions from heat consumption**

As the only fossil fuel to be used will be diesel, project emissions from fuel combustion is calculated using the following equation:

$$PE_{FC,j,y} = FC_{diesel,y} * COEF_{diesel,y} \quad (13)$$

Where:
$FC_{diesel,y}$ :Quantity of diesel combusted during the year y
COEF :$CO_2$ emission coefficient of diesel during the year y

**3. Leakage emissions:**

No leakage effects need to be accounted under this methodology.

**4. Emission reductions**

According to methodology ACM0001 version 11 the greenhouse gas emission reductions achieved by the project activity during a given year "y" ($ER_y$) shall be estimated as follows:

$$ER_y = BE_y – PE_y \quad (14)$$

Where:
$ER_y$ : Emission reductions in year y ($tCO_2e/yr$)
$BE_y$ : Baseline emission in year y ($tCO_2e/yr$)
$PE_y$ : Project emission in year y ($tCO_2e/yr$)

**B.6.2. Data and parameters that are available at validation:**

| **Data / Parameter:** | **Regulatory requirements relating to landfill gas** |
|---|---|
| Data unit: | -- |
| Description: | Regulatory requirements relating to landfill gas |
| Source of data used: | National legislation and mandatory regulations |
| Value applied: | 0 % |

| | |
|---|---|
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The information will be recorded annually, to be used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Changes to regulation should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). |
| Any comment: | |

| **Data / Parameter:** | **$GWP_{CH4}$** |
|---|---|
| Data unit: | $tCO_2e/tCH_4$ |
| Description: | Global warming potential of $CH_4$ |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| Value applied: | 21 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | 21 for the first commitment period. |
| Any comment: | |

| **Data / Parameter:** | **$D_{CH4}$** |
|---|---|
| Data unit: | $tCH_4/m^3CH_4$ |
| Description: | Methane Density |
| Source of data used: | The methodology |
| Value applied: | See Annex3 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 $tCH_4/m^3CH_4$ |
| Any comment: | |

| **Data / Parameter:** | **$\eta_{flare,h}$** |
|---|---|
| Data unit: | - |
| Description: | Flare efficiency in the hour h |
| Source of data used: | “Tool to determine project emissions from flaring gases containing methane” |
| Value applied: | 90 % |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Default value as per “Tool to determine project emissions from flaring gases containing methane”. |
| Any comment: | As and when the entire equipment for continuous measurement of the methane destruction efficiency of the flare will be installed, the actual flare efficiency |

| | |
|---|---|
| | will be monitored continuously *ex-post*, and the default vale will no longer be used. |

| **Data / Parameter:** | $\mathbf{BE_{CH4,SWDS,y}}$ |
|---|---|
| Data unit: | $tCO_2e/yr$ |
| Description: | Methane generation from the landfill in the absence of the project activity at year y |
| Source of data used: | Calculated as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. |
| Value applied: | See Annex3 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*. |
| Any comment: | |

| **Data / Parameter:** | $\varphi$ |
|---|---|
| Data unit: | - |
| Description: | Model correction factor to account for model uncertainties of the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | 0.9 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | |
| Any comment: | |

| **Data / Parameter:** | $f$ |
|---|---|
| Data unit: | - |
| Description: | Fraction of methane captured at the SWDS and flared, combusted or used in another manner |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | 0 |
| Justification of the choice of data or description of measurement methods and procedures actually | Already accounted for as AF (Adjustment Factor) |

| | |
|---|---|
| applied : | |
| Any comment: | |

| **Data / Parameter:** | ***OX*** |
|---|---|
| Data unit: | - |
| Description: | Oxidation Factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) |
| Source of data used: | Assessed according to site visit and the "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | 0.1 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The site for the proposed project activity is a managed solid waste disposal site that is covered with soil. |
| Any comment: | |

| **Data / Parameter:** | ***F*** |
|---|---|
| Data unit: | - |
| Description: | Fraction of methane in the SWDS gas (volume fraction) |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | 0.5 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | A default value recommended by the IPCC. |
| Any comment: | |

| **Data / Parameter:** | $DOC_f$ |
|---|---|
| Data unit: | - |
| Description: | Fraction of degradable organic carbon (DOC) that can decompose |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | 0.5 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | A default value recommended by the IPCC. |
| Any comment: | |

| **Data / Parameter:** | ***MCF*** |
|---|---|

| | |
|---|---|
| Data unit: | - |
| Description: | Methane correction factor |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | 1.0 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Value applied for anaerobic managed solid waste disposal sites.– It has controlled placement of waste. Waste directed to specific deposition area and will include : (i) cover material and, (ii) mechanical compacting |
| Any comment: | |

| **Data / Parameter:** | ***$DOC_j$*** |
|---|---|
| Data unit: | - |
| Description: | Fraction of degradable organic carbon (by weight) in the waste type *j* |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |
| Value applied: | Following values are applied for each waste type *j* according to the values provided in the "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site". |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per the "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site". |
| Any comment: | |

| Waste Type *j* | $DOC_j$ (% wet waste) | $DOC_j$ (% dry waste) |
|---|---|---|
| Food | 15 | 38 |
| Garden | 20 | 49 |
| Wood and Straw | 43 | 50 |
| Paper | 40 | 44 |
| Textile | 24 | 30 |
| Disposable nappies | 24 | 30 |

| **Data / Parameter:** | ***$k_j$*** |
|---|---|
| Data unit: | - |
| Description: | Decay rate for the waste type j |
| Source of data used: | "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site" |

| | |
|---|---|
| Value applied: | Following values are applied for each waste type *j* according to the values provided in the "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site". The conditions for the project site is tropical (MAT>20℃) and wet (MAP>1000mm), and the decomposition of waste is very fast (Rapidly degrading). |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per the "Tool to determine the methane emissions avoided from dumping waste at a solid waste disposal site". |
| Any comment: | |

| Waste Type *j* | Tropical (MAT>20℃)<br>Wet (MAP>1000mm) |
|---|---|
| Food | 0.4 |
| Garden | 0.17 |
| Wood and Straw | 0.035 |
| Paper | 0.07 |
| Textile | 0.07 |
| Disposable nappies | 0.17 |

| **Data / Parameter:** | **$TDL_y$** |
|---|---|
| Data unit: | % |
| Description: | Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site. |
| Source of data used: | "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" |
| Value applied: | 10% |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per Annual Report published by TNB |
| Any comment: | |

| **Data / Parameter:** | **$EF_{grid,BL}$** |
|---|---|
| Data unit: | $tCO_2e/MWh$ |
| Description: | The emission factor for the grid in year y |
| Source of data used: | Calculated as per the *"Tool to calculate emissions factor for an electric system"*. |
| Value applied: | 0.684 |

| | |
|---|---|
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Calculated based on the "*Tool to calculate the emission factor for an electricity system*" (*Version 1.1*)", as demonstrated in the "Study on Grid Connected Electricity Baselines in Malaysia: 2006 & 2007" (Version 2.0) published by the Malaysia Energy Centre in December 2008. |
| Any comment: | |

### B.6.3. Ex-ante calculation of emission reductions:

***Baseline emissions***

Baseline emission is calculated using the equation (2).

$BE_y = (MD_{project,y} – MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y}$

Ex-ante estimation of $MD_{project,y}$ is done using the following calculation:

$MD_{project,y} = BE_{CH4,\ SWDSy} * \varepsilon_{PR,y} / GWP_{CH4}$ (15)

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-kj \cdot (y-x)} \cdot (1-e^{-kj})$$

Where:

| | |
|---|---|
| $MB_y$ | is $BE_{CH4,SWDS,y}$ ($tCO_2e$/yr) |
| $BE_{CH4,SWDS,y}$ | is the methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year *y* ($tCO_2e$/yr) |
| $\varphi$ | is the model correction factor to account for model uncertainties (0.9) |
| $f$ | is the fraction of methane captured at the SWDS and flared, combusted or used in another manner |
| $GWP_{CH4}$ | is the Global Warming Potential (GWP) of methane, valid for the relevant commitment period |
| $OX$ | is the oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste) |
| $F$ | is the fraction of methane in the SWDS gas (volume fraction) (0.5) |
| $DOC_f$ | is the fraction of degradable organic carbon (DOC) that can decompose |
| $MCF$ | is the methane correction factor |
| $W_{j,x}$ | is the amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons) |
| $DOC_j$ | is the fraction of degradable organic carbon (by weight) in the waste type *j* |
| $k_j$ | is the decay rate for the waste type *j* |
| $j$ | is the waste type category (index) |
| $x$ | is the year during the crediting period: *x* runs from the first year of the first crediting period (*x*=1) to year *y* for which avoided emissions are calculated (*x*=*y*) |
| $y$ | is the year for which methane emissions are calculated |

$$W_{j,x} = W_x \times \frac{\sum_{n=1}^{z} P_{n,j,x}}{z} \quad (16)$$

Where:

| | |
|---|---|
| $W_{j,x}$ | is the amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons) |
| $W_x$ | is the total amount of organic waste prevented from disposal in year *x* (tons) |
| $P_{n,j,x}$ | is the weight fraction of the waste type *j* in the sample *n* collected during the year *x* |
| $z$ | is the number of samples collected during the year *x* |

| $\varphi$ | $f$ | $GWP_{CH4}$ | $OX$ | $F$ | $DOC_f$ | $MCF$ |
|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - |
| 0.9 | 0 | 21 | 0.1 | 0.5 | 0.5 | 1.0 |

| Waste type *j* | $P_{n,j,x}$ | $DOC_j$ | $k_j$ |
|---|---|---|---|
| | % | % | 1/yr |
| Food | 36 | 0.15 | 0.4 |
| Garden | 8 | 0.20 | 0.17 |
| Wood and Straw | 6 | 0.43 | 0.035 |
| Paper | 14 | 0.40 | 0.07 |
| Textiles | 3 | 0.24 | 0.07 |
| Plastics, other inert | 32 | - | - |

| Year x | $W_x$ | Year x | $W_x$ |
|---|---|---|---|
| | tons/yr | | tons/yr |
| 2003 | 219,000 | 2013 | 0 |
| 2004 | 219,000 | 2014 | 0 |
| 2005 | 219,000 | 2015 | 0 |
| 2006 | 219,000 | 2016 | 0 |
| 2007 | 219,000 | 2017 | 0 |
| 2008 | 219,000 | 2018 | 0 |
| 2009 | 219,000 | 2019 | 0 |
| 2010 | 219,000 | | |

| | |
|---|---|
| 2011 | 219,000 |
| 2012 | 219,000 |

The waste composition considered for the calculations is a result of investigation made in 2009 by Midac CO., LTD. The references are attached under the "Waste composition analysis" section in Annex 3.

| year | $BE_{CH4, SWDS,y}$ | $MD_{project,y}$ | $MD_{BL,y}$ | $EL_{LFG,y}$ | $EL_{LFG,y}*CEF_{elec,BL,y}$ | BE |
|---|---|---|---|---|---|---|
| | $tCO_2e/yr$ | $tCH_4/yr$ | $tCH_4/yr$ | MWh | $tCO_2e/yr$ | $tCO_2e/yr$ |
| | A | $B=A*\varepsilon_{PR,y}/21$ | C | D | E | B*21+E |
| 1 | 105,178 | 4,007 | 0 | 10,775 | 7,370 | 91,512 |
| 2 | 85,591 | 3,261 | 0 | 8,554 | 5,851 | 74,323 |
| 3 | 71,315 | 2,717 | 0 | 6,935 | 4,743 | 61,796 |
| 4 | 60,709 | 2,313 | 0 | 5,732 | 3,921 | 52,488 |
| 5 | 52,657 | 2,006 | 0 | 4,819 | 3,296 | 45,422 |
| 6 | 46,403 | 1,768 | 0 | 4,110 | 2,811 | 39,933 |
| 7 | 41,429 | 1,578 | 0 | 3,546 | 2,425 | 35,569 |
| Total | 463,281 | 17,649 | 0 | 44,470 | 30,417 | 401,043 |
| $\varepsilon_{PR,y}$ = 80%, CEF = 0.684 | | | | | | |

***Project emissions***

$PE_y = PE_{EC,y} + PE_{FC,y}$

| $PE_y$ | $PE_{EC,y}$ | $PE_{FC,y}$ |
|---|---|---|
| $tCO_2e/yr$ | $tCO_2e/yr$ | $tCO_2e/yr$ |
| 6.8 | 6.837 | 0 |

***Project emissions from electricity consumption ($PE_{EC,y}$)***

$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1 * TDL_y)$

| $PE_{EC,y}$ | $EC_{PJ,y}$ | $EF_{grid,y}$ | $TDL_{,y}$ |
|---|---|---|---|
| $tCO_2e/yr$ | MWh | $tCO_2e/MWh$ | % |
| 6.8 | 9.09 | 0.684 | 10 |

***Project emissions from heat consumption ($PE_{FC,y}$)***

There is no consumption of fossil fuel for heat in the project activity. Thus, $PE_{FC,y} = 0$.

***<u>Leakage</u>***

According to ACM0001, no leakage effects need to be accounted for this method.

***Emission Reduction***

$$ER_y = BE_y - PE_y - L_y \quad (17)$$

**B.6.4 Summary of the ex-ante estimation of emission reductions:**

**Table 4: Ex-ante estimation of emission reductions**

| **Year** | **Estimation of project emissions** ($tCO_2e/yr$) | **Estimation of baseline emissions** ($tCO_2e/yr$) | **Estimation of leakage** ($tCO_2e/yr$) | **Estimation of overall emission reductions** ($tCO_2e/yr$) |
|---|---|---|---|---|
| 2013 | 6.8 | 91,512 | 0 | 91,505 |
| 2014 | 6.8 | 74,323 | 0 | 74,316 |
| 2015 | 6.8 | 61,796 | 0 | 61,789 |
| 2016 | 6.8 | 52,488 | 0 | 52,481 |
| 2017 | 6.8 | 45,422 | 0 | 45,415 |
| 2018 | 6.8 | 39,933 | 0 | 39,927 |
| 2019 | 6.8 | 35,569 | 0 | 35,562 |
| **Total** (tons of $CO_2e$) | 47.9 | 401,042 | 0 | 400,995 |

**B.7. Application of the monitoring methodology and description of the monitoring plan:**

**B.7.1 Data and parameters monitored:**

*(Copy this table for each data and parameter)*

| | |
|---|---|
| **Data / Parameter:** | **$LFG_{total,y}$** |
| Data unit: | $Nm^3$ |
| Description: | Total amount of landfill gas captured at Normal Temperature and Pressure |
| Source of data to be used: | Continuous measured by flow meter |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | IPCC FOD method is adopted to calculate the theoretically generated LFG, and the recovery efficiency of the proposed project is estimated to be 80 % |
| Description of measurement methods and procedures to be applied: | Measured by a flow meter. Data to be aggregated monthly and yearly<br>Data will be automatically and continuously monitored and recorded. |
| QA/QC procedures to be applied: | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| Any comment: | |

| **Data / Parameter:** | **$LFG_{flare,y}$** |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Total amount of landfill gas flared at Normal Temperature and Pressure |
| Source of data to be used: | Continuous measured by flow meter |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | - |
| Description of measurement methods and procedures to be applied: | Measured by a flow meter. Data to be aggregated monthly and yearly<br>Data will be automatically and continuously monitored and recorded. |
| QA/QC procedures to be applied: | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| Any comment: | |

| **Data / Parameter:** | **$LFG_{electricity,y}$** |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Total amount of landfill gas combusted in power plant at Normal Temperature and Pressure |
| Source of data to be used: | Continuous measured by flow meter |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | - |
| Description of measurement methods and procedures to be applied: | Measured by a flow meter. Data to be aggregated monthly and yearly<br>Data will be automatically and continuously monitored and recorded. |
| QA/QC procedures to be applied: | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| Any comment: | |

| **Data / Parameter:** | **$PE_{flare,y}$** |
|---|---|
| Data unit: | $tCO_2e/yr$ |
| Description: | Project emissions from flaring of the residual gas stream in year y |
| Source of data to be used: | Calculated as per the “Tool to determine project emissions from flaring gases containing Methane”. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 3,143 tCO2e for the first credit period calculated as per the “Tool to determine project emissions from flaring gases containing Methane”. |

| | |
|---|---|
| Description of measurement methods and procedures to be applied: | As per the "Tool to determine project emissions from flaring gases containing Methane". |
| QA/QC procedures to be applied: | As per the "Tool to determine project emissions from flaring gases containing Methane". |
| Any comment: | |

| **Data / Parameter:** | $\mathbf{w_{CH4}}$ |
|---|---|
| Data unit: | $m^3CH_4$ / $m^3LFG$ |
| Description: | Methane fraction in the landfill gas |
| Source of data to be used: | Continuous measurement by gas analyzer for CH4 content in LFG |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0.5 |
| Description of measurement methods and procedures to be applied: | Measured by continuous gas quality analyser.<br>The gas quality will be continuously recorded through the data logger.<br>Measurement will be mad on a dry basis. |
| QA/QC procedures to be applied: | The gas analyser will be subject to regular maintenance, and a testing and calibration regime in accordance with manufacturer specifications to ensure accuracy. |
| Any comment: | |

| **Data / Parameter:** | $\boldsymbol{\varepsilon_{PR,y}}$ |
|---|---|
| Data unit: | - |
| Description: | Efficiency of landfill gas collection and flaring system |
| Source of data to be used: | Site information |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 80 % |
| Description of measurement methods and procedures to be applied: | The coefficients have only been set for the ex-ante estimation of emission reductions based on the contributing disposal areas during each year. |
| QA/QC procedures to be applied: | |
| Any comment: | |

| **Data / Parameter:** | $\mathbf{T_t,T_f,T_e}$ |
|---|---|
| Data unit: | ℃ |

| | |
|---|---|
| Description: | Temperature of the landfill gas at the proximity of each flow meter, including;<br>• Total (t)<br>• at each flare (f)<br>• at each engine(e) |
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | - |
| Description of measurement methods and procedures to be applied: | Measured continuously by a flow meter which measures the temperature, pressure and flow meter.<br>Data will continuously be registered through a data logger.<br>Measured to determine the density of methane $D_{CH4}$.<br>No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing landfill gas volumes in normalized cubic meters or when using mass flow meter.<br>Data to be aggregated monthly and yearly.<br>Archived data will be kept during the crediting period and two years after. |
| QA/QC procedures to be applied: | Measuring instruments will be subjected to a regular maintenance and testing regime in accordance to appropriate national/international standards. |
| Any comment: | |

| **Data / Parameter:** | **$P_t$, $P_f$, $P_e$** |
|---|---|
| Data unit: | Pa |
| Description: | Pressure of the landfill gas near each flow meter:<br>• Total (t)<br>• at each flare (f)<br>• at each engine(e) |
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | - |
| Description of measurement methods and procedures to be applied: | Measured continuously by a flow meter which measures the temperature, pressure and flow meter.<br>Data will continuously be registered through a data logger.<br>Measured to determine the density of methane $D_{CH4}$.<br>No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing landfill gas volumes in normalized cubic meters or when using mass flow meter.<br>Data to be aggregated monthly and yearly.<br>Archived data will be kept during the crediting period and two years after. |

| | |
|---|---|
| QA/QC procedures to be applied: | Measuring instruments will be subjected to a regular maintenance and testing regime in accordance to appropriate national/international standards. |
| Any comment: | |

| | |
|---|---|
| **Data / Parameter:** | **$EL_{LFG}$** |
| Data unit: | MWh |
| Description: | Net amount of electricity generated using LFG. |
| Source of data to be used: | Measured by the electricity meter |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | The total net amount is estimated at 44,470 MWh within the first crediting period based on the ex-ante calculation. |
| Description of measurement methods and procedures to be applied: | Measured continuously with an electricity meter. |
| QA/QC procedures to be applied: | The meter will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier to ensure accuracy. |
| Any comment: | Required to estimate the emission reductions from electricity generation from LFG. |

| | |
|---|---|
| **Data / Parameter:** | **$CEF_{elec,BL,y}$** |
| Data unit: | tCO2/MWh |
| Description: | Carbon emission factor of electricity |
| Source of data to be used: | Calculated as per “Tool to calculate the emission factor for an electricity system” |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0.684<br>Calculated based on the “*Tool to calculate the emission factor for an electricity system*” (*Version 1.1*)”, as demonstrated in the “Study on Grid Connected Electricity Baselines in Malaysia: 2006 & 2007” (Version 2.0) published by the Malaysia Energy Centre in December 2008. |
| Description of measurement methods and procedures to be applied: | The $CEF_{elec,BL,y}$ will be calculated according to the equations from the “Tool to calculate the emission factor for an electricity system”, based on fuel consumption and electricity generation data for plants connected to the grid. |
| QA/QC procedures to be applied: | To be re-calculated with release of the latest grid data. |
| Any comment: | |

| | |
|---|---|
| **Data / Parameter:** | **Operation of the energy plant** |
| Data unit: | Hours |
| Description: | Operation of the energy plant |

| | |
|---|---|
| Source of data to be used: | Project participants |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | - |
| Description of measurement methods and procedures to be applied: | On site measurement of the operating hours of the energy Data will be recorded annually. |
| QA/QC procedures to be applied: | The counter will be checked as per manufacturer recommendation. |
| Any comment: | This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational. |

| **Data / Parameter:** | **$PE_{EC,y}$** |
|---|---|
| Data unit: | tCO2e/yr |
| Description: | Project emissions from electricity consumption by the project activity during the year y |
| Source of data to be used: | Calculated from the electricity imported from the grid and the emission factor from the grid($EF_{grid,y}$), according to the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | |
| Description of measurement methods and procedures to be applied: | As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" |
| QA/QC procedures to be applied: | As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" |
| Any comment: | |

| **Data / Parameter:** | **$MG_{PR,y}$** |
|---|---|
| Data unit: | $tCH_4$ |
| Description: | Amount of methane generated during year y of the project activity |
| Source of data to be used: | Calculated |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | |
| Description of | Estimated using the actual amount of waste disposed in the landfill as per the |

| | |
|---|---|
| measurement methods and procedures to be applied: | latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" |
| QA/QC procedures to be applied: | As per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" |
| Any comment: | |

### B.7.2. Description of the monitoring plan:

The monitoring plan for this project activity includes all monitoring requirements following the procedures set by ACM0001 ver.11. The monitoring will be based on direct and continuous measurement of the amount of LFG captured and destroyed at the flare platform or sent for generating electricity.

The overall monitoring plan can be illustrated in the figure below:

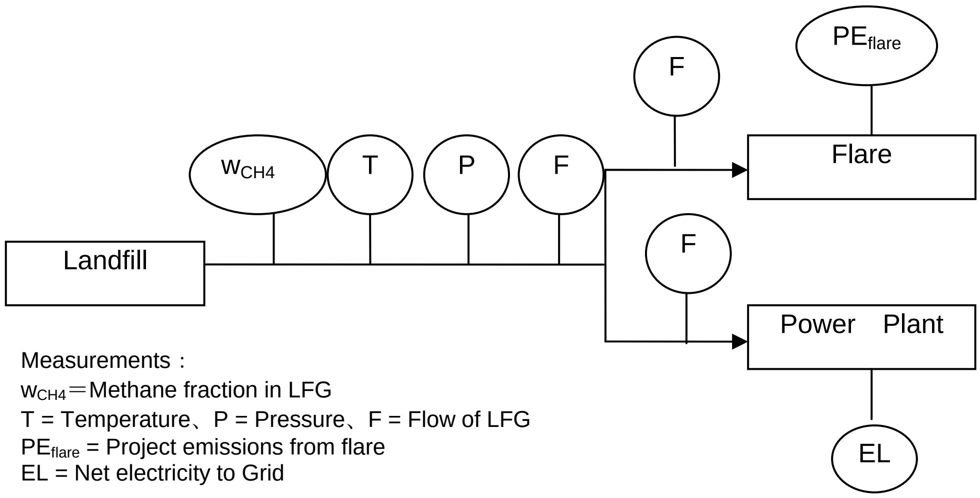


**Figure 4: Schematic diagram of monitoring plan**

Relevant regulations on LFG project activities shall be monitored and updated upon renewal of each crediting period. Changes to regulations will be converted to the amount of methane that would have been destroyed/ combusted during the year in the absence of the project activity ($MD_{BL,y}$).

All data will be converted and stored by electronic format and cross checked with the original data. The data and calculation result will be managed by the Special Purpose Company (SPC) that will be established for project implementation. The various data and calculation results will be verified by a DOE yearly for the issuance of CER's.

| | Items | Responsible Organization | Description |
|---|---|---|---|
| 1 | Monitoring Planning | SPC | Training will be done for the O/M team for the good understanding of the monitoring plan and the actual monitoring methods. |
| 2 | Monitoring | SPC or outsourced | All data will be stored by paper and electronic files. |
| 3 | Monitoring of Regulation | SPC or outsourced | Periodical reports will be made |
| 4 | Calibration of Monitoring Equipments | Authorized entity | Calibration record will be kept by the SPC |

**B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):**

Kaoru Nakajima
Yachiyo Engineering Co., Ltd.
2-18-12 Nishiochiai
Shinjuku-ku
Tokyo Japan
Telephone: +81-3-5906-0212
E-mail: ko-nakajima@yachiyo-eng.co.jp

Katsuyoshi Takahashi
Technomodesty Co., Ltd.
866-6 Yokura
Katori City
Chiba Japan
Telephone: +81-478-58-1347
E-mail: technomodesty@yahoo.com

## SECTION C. Duration of the project activity / crediting period

### C.1. Duration of the project activity:

#### C.1.1. Starting date of the project activity:

The project is expected to start from January 2013 (1/1/2013).

#### C.1.2. Expected operational lifetime of the project activity:

21years.

### C.2. Choice of the crediting period and related information:

#### C.2.1. Renewable crediting period:

##### C.2.1.1. Starting date of the first crediting period:

1/1/2013

##### C.2.1.2. Length of the first crediting period:

7 years.

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

Not applicable.

##### C.2.2.2. Length:

Not applicable.

## SECTION D. Environmental impacts

### D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>

The project might have some environmental impacts such as air pollution, noise and vibration, etc. which may occur along with construction and operation of the facility. However, the project's overall impact on environment will be small, and be reduced to minimum by implementation of project.

Negative impacts that may occur on environment during construction and operation include as follows;

<Construction>
- Air pollution, through the use of fossil fuel on vehicles required for transportation of construction materials, and machinery required for construction.
- Generation of noise and vibration to some extent, due to material transportation, number of worker increase, installing of facilities, etc.
- Generation of the waste due to the construction work

<Operation>
- Generation of noise and vibration due to facility operation

These negative impacts shall be reduced by taking the appropriate mitigation measures. In addition, all the potential negative impacts were taken into account in the environmental management plan which was developed in accordance with the Environmental Impact Assessment System defined by the Law on Environmental Protection.

Positive environmental impacts of the project activity are as follows;

- Efficient use of methane gas contribute to mitigation of GHG emission to the atmosphere
- LFG as renewable energy sources – cleaner fuel that replaces fossil fuel based grid power
- Diminishing of the odor problem
- Improvement of landfill's stability
- Mitigation of fire / explosions risk in the landfill

**D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:**

There are no significant negative environmental impacts resulting from the project activity.

In Malaysia, environmental impact assessment is required for activities prescribed under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 Environmental impact assessment is required in the case of construction of new landfill site. The present project of capturing, combusting and flaring of landfill gases is not a prescribed activity and there is no need to conduct any environmental impact assessment for this project.

## SECTION E. Stakeholders' comments

>>

**E.1. Brief description how comments by local stakeholders have been invited and compiled:**

This project is to establish LFG recovery and power generation system on the existing landfill site. Thus, the local stakeholders in the project area include;

1. Ministry of Natural Resources and Environment (NRE) – NRE is the DNA in Malaysia.
2. Perak State Government – The project site is located in Perak State.

3. Ipoh City Council – The project site is located in Ipoh City, Perak State.
4. LEE TUCK CONSTRUCTION SDN.BHD. (LT) – LT is the local counterpart company in Malaysia in this project and in charge of collection of MSW and management of the existing landfill.
5. Neighborhood inhabitants – There are no immediate inhabitants, but there are some living comparatively close.

The project participants have heard comments from NRE, Perak State, Ipoh City, LT, and Neighborhood inhabitants. At that time, the general plans on project activities including applied methodologies, project scale, implementation structures, schedule, etc. were also explained.

**E.2. Summary of the comments received:**

Since this project will contribute to improving the waste management in Ipoh City, as well as reducing the GHG emission through the combustion of LFG, all the stakeholders welcomed the project activities and expressed their support for the implementation of project in Ipoh City.

Major comments from stakeholders are as follows;

1. Ministry of Natural Resources and Environment (NRE) – NRE officers in charge mentioned that there are some CDM projects in Malaysia, but not so much in the “Waste handling and disposal” category. The most popular category is concerning “Biomass”. As they positively accept technical support through CDM project in Malaysia, it would be fine to get technical support also in this project.
2. Perak State – The presentation about CDM project (for Ipoh City) was taken place in Ipoh City office on August, 2009. The officer expects that this project will be carried on in close cooperation with Ipoh City.
3. Ipoh City – The presentation about CDM project (for Ipoh City) was taken place in Ipoh City office on August, 2009. The mayor showed a favorable understanding of this project, on the other hand, he suggested there is a competitor on this matter.
4. LT – LT wants the technical support for waste management as well as this project.
5. Neighborhood inhabitants – At the moment, they don’t have big problems except for odor. After explained the outline of this project, many inhabitants want to positively go ahead with it because it will make the environment better.

**E.3. Report on how due account was taken of any comments received:**

At present, the project has not received any claims from local stakeholders to obstruct its implementation.

**Annex 1**

**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

| | |
|---|---|
| Organization: | LTC ALAM BERSIH S/B |
| Street/P.O.Box: | 129-B, JALAN KAMPAR |
| Building: | |
| City: | 30250 IPOH |
| State/Region: | PERAK |
| Postcode/ZIP: | |
| Country: | MALAYSIA |
| Telephone: | +605-2547129 |
| FAX: | +605-2417334 |
| E-Mail: | leetuck@pd.jaring.my |
| URL: | |
| Represented by: | LEE TUCK |
| Title: | president |
| Salutation: | Mr. |
| Last name: | TUCK |
| Middle name: | |
| First name: | LEE |
| Department: | |
| Mobile: | |
| Direct FAX: | +805-2417334 |
| Direct tel: | +805-2547129 |
| Personal e-mail: | |

| | |
|---|---|
| Organization: | |
| Street/P.O.Box: | |
| Building: | |
| City: | |
| State/Region: | |
| Postcode/ZIP: | |
| Country: | |
| Telephone: | |
| FAX: | |
| E-Mail: | |
| URL: | |
| Represented by: | |
| Title: | |
| Salutation: | |
| Last name: | |
| Middle name: | |
| First name: | |
| Department: | |

| | |
|---|---|
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal e-mail: | |

## Annex 2

### INFORMATION REGARDING PUBLIC FUNDING

**NO APPLICABLE. THE PROJECT WILL BE PRIVATELY FUNDED AND WILL NOT INVOLVE ANY PUBLIC FUNDING OR OFFICIAL DEVELOPMENT ASSISTANCE (ODA).**

# Annex 3

## BASELINE INFORMATION

### 1. Waste composition analysis

### (1) Composition of incoming waste

Composition of incoming waste in the plant used in baseline emission estimation was determined based on the result of waste composition analysis conducted by Midac Co., Ltd. in 2009. The results and outline of the composition analysis are as described below;

**Table 3-1: Basic condition on the analysis**

| | |
|---|---|
| Date | 23/11/2009 ~ 27/11/2009 |
| Place | Existing landfill in Ipoh City |
| Objective | 1. Understanding the waste composition installed to the landfill<br>2. Understanding the recyclables |
| Volume of waste | 50 tons/day |
| Origin of waste | The waste is originated from Household, Shop, and Market, the ratio of each item is 70%, 25%, and 5%. |

**Table 3-2: Average composition of the incoming waste in the plant**

| Waste Type | Tons/day | % |
|---|---|---|
| Food | 18 | 36 |
| Garden | 4 | 8 |
| Wood and Straw | 3 | 6 |
| Paper | 7 | 14 |
| Textile | 1.5 | 3 |
| Others | 16 | 32 |
| Plastics | 8.1 | 16.2 |
| Glass | 0.9 | 1.8 |
| Steel | 0.95 | 1.9 |
| Aluminium | 0.05 | 0.1 |
| Nappies | 5.45 | 10.9 |
| Other inert | 0.7 | 1.4 |

### (2) Composition of wastes before/after composting

Based on the survey results, composition of compost waste used in calculation of leakage emission is determined as shown in the table below. (Only includes organic wastes because recyclables have been taken out by sorting) as follows:

**Table 3-3: Composition of wastes before/after composting**

| | Before Composting | | After composting | |
|---|---|---|---|---|
| | **Ton/day** | **%** | **Ton/day** | **%** |
| Food | 18 | 53% | 7.2 | 51% |
| Garden | 4 | 12% | 1.6 | 12% |
| Wood and Straw | 3 | 9% | 1.2 | 9% |
| Paper | 7 | 21% | 3.1 | 22% |
| Textile | 1.5 | 4% | 0.6 | 4% |
| Others | 0.2 | 1% | 0.2 | 2% |

## 2. Calculation of Emission Factor

The electricity consumed on-site is purchased from the TNB national grid of Peninsula Malaysia. The emission factor of the grid is calculated according to "Tool to calculate the emission factor for an electricity system (Version02)". The latest available baseline electricity data was obtained from the Final Report for the Study on Grid Connected Electricity Baselines in Malaysia (Year 2006 - 2007) published by the Malaysia Energy Centre (PTM) in December 2008.

In accordance to the above mentioned tool, the following six steps were applied:

***Step 1: Identify the relevant electric power system***

There are 3 electricity grid system in Malaysia, namely, the Peninsula Malaysia national grid operated by the Tenaga Negara Berhad, the Sarawak State grid operated by Sarawak Energy Corporation and Sabah State grid operated by Sabah Electricity Supply Berhad (SESB). The electricity supply to the Ipoh City is imported from the national grid of Peninsular Malaysia.

***Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)***

Option 1, "only grid power plants are included in the calculation" was chosen for this project.

***Step 3: Select an operating margin (OM) method***

Since the low-cost/must-run resources constitute less than 50% of total grid generation on average of the five most recent years, the calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on "Simple OM" method.

***Step 4: Calculate the operating margin emission factor according to the selected method***

The simple OM emission factor is calculated as the generation-weighted average $CO_2$ emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system in Peninsula Malaysia, not including low-cost / must-run power plants/ units.

The Simple OM is calculated based on the net electricity generation and a $CO_2$ emission factor of each power unit (Option A), using the following formula.

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OM,y}$ :Simple operating margin $CO_2$ emission factor in year $y$ ($tCO_2$/MWh)

$EG_{m,y}$ : Net quantity of electricity generated and delivered to the grid by power unit $m$ in year $y$ (MWh)

$FE_{EL,m,y}$ : $CO_2$ emission factor of power unit $m$ in year $y$ ($tCO_2$/MWh)

$m$ : All power units serving the grid in year $y$ except low-cost /must-run power units

$y$ : Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)

The Simple OM is calculated using the data of all operation fossil fuel fired power plants generating electricity to the grid for the years 2005, 2006 and 2005.

Simple Operating Margin for Peninsular Malaysia for 2007

| Years | Generation (GWh) | $CO_2$ Emission (tonnes) | Baselines (tCO2/MWh) |
|---|---|---|---|
| 2007 | 89,241 | 56,409,586 | 0.632 |
| 2006 | 85,421 | 51,809,152 | 0.607 |
| 2005 | 82,605 | 49,150,332 | 0.595 |
| **Average Operating Margin for 3 years** | | | **0.611** |

***Step 5: Identify the group of power units to be included in the build margin (BM)***

The sample group of power units "m" used to calculate the build margin consists of the set of (a) five power units that have been built most recently. The source of data is from Energy Commission of Malaysia, as shown in the table below.

The total output generated by these 5 plants in 2007 is 33,206,840 MWh, resulting in 35% (i.e. more than 20% as stipulated by the "Tool to calculate the emission factor for an electricity system") of the total system generation in Peninsular Malaysia (90,950,000 MWh).

| Name of Power Plants/ Fuel Types | Year of Operation | Type | Capacity (MW) | Total Generation (MWh) | CO2 Emission (tCO2) |
|---|---|---|---|---|---|
| 1. SKS Prai Power Station | 2002 | Gas & Distillate | 350 | 2,483,310 | 1,049,809 |
| 2. Panglima Power Station | 2003 | Gas & Distillate | 720 | 5,419,930 | 2,186,230 |
| 3. Janamanjung Power Station | 2003 | Coal | 2070 | 11,248,290 | 11,363,743 |
| 4. Tuanku Jaafar Power Station | 2005 | Gas & Distillate | 714 | 5,759,730 | 2,361,373 |
| 5. Tanjung Bin Power Station | 2006/2007 | Coal | 1400 | 8,295,580 | 8,184,319 |
| **Total** | | | | **33,206,840** | **25,145,474** |

In terms of vintage of data, Option 1 is chosen, in which, for the first credit period, the build margin emission factor ex-ante is calculated based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

***Step 6: Calculate the build margin emission factor***

The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units *m* during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,OM,y}$ :Build margin $CO_2$ emission factor in year $y$($tCO_2$/MWh)

$EG_{m,y}$ : Net quantity of electricity generated and delivered to the grid by power unit $m$ in year $y$ (MWh)

$FE_{EL,m,y}$ : $CO_2$ emission factor of power unit $m$ in year $y$ ($tCO_2$/MWh)

$m$ : Power units included in the build margin

$y$ : Most recent historical year for which power generation data is available

The total CO2 emission from the 5 power plants is calculated to be 25,145,474 tons CO2. Therefore the Build Margin for Peninsular Malasysia is calculated as follows;

$EF_{grid,OM,y}$ = 25,145,474 tonne CO2 / 33,206,840 MWh = **0.757 tonnes of CO2/MWh**

***Step 7: Calculate the combined margin emissions factor***

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \cdot w_{OM} + EF_{grid,BM,y} \cdot w_{BM}$$

Where:

$EF_{grid,OM,y}$ :Build margin $CO_2$ emission factor in year *y*($tCO_2$/MWh)
$EF_{grid,OM,y}$ :Simple operating margin $CO_2$ emission factor in year *y* ($tCO_2$/MWh)
$w_{OM}$ :Weighting of operating margin emissions factor (%)
$w_{BM}$ :Weighting of build margin emissions factor (%)

The recommended values applied for $w_{OM}$ and $w_{BM}$ is both at 0.5 for the first crediting period.

Thus, the calculations are as below:

$EF_{grid,CM,y}$ = 0.611 * 0.5 + 0.757 * 0.5 = **0.684 $tCO_2$/MWh**

## 3. IRR Spread Sheet

IRR for basic scenario (7 years)

| Total Project Cost | -13,000,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,726 | 2,773 | 2,820 | 2,868 | 2,916 | 2,966 | 3,016 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,726** | **798,913** | **815,492** | **832,476** | **849,878** | **867,708** | **885,979** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,262,666 | 1,796,256 | 1,456,308 | 1,324,701 | 1,132,950 | 984,039 | 865,578 |
| **Total revenue from project activities (RM/year)** | | **2,262,666** | **1,796,256** | **1,456,308** | **1,324,701** | **1,132,950** | **984,039** | **865,578** |
| Depreciation | | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 |
| EBIT (Revenue - Expenses-Depreciation) | | *-377,203* | *-859,799* | *-1,216,327* | *-1,364,918* | *-1,574,070* | *-1,740,811* | *-1,877,544* |
| Loss carried forward | | *-377,203* | *-1,237,002* | *-2,453,329* | *-3,818,248* | *-5,392,318* | *-7,133,130* | *-9,010,674* |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -377,203 | -859,799 | -1,216,327 | -1,364,918 | -1,574,070 | -1,740,811 | -1,877,544 |
| Free Cash Flow | -13,000,000 | 1,479,940 | 997,343 | 640,816 | 492,225 | 283,072 | 116,331 | -20,401 |
| **IRR (7 years) without CDM** | **-34.55%** | | | | | | | |

IRR for initial cost +10%

| Total Project Cost | -14,300,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,726 | 2,773 | 2,820 | 2,868 | 2,916 | 2,966 | 3,016 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,726** | **798,913** | **815,492** | **832,476** | **849,878** | **867,708** | **885,979** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,262,666 | 1,796,256 | 1,456,308 | 1,324,701 | 1,132,950 | 984,039 | 865,578 |
| **Total revenue from project activities (RM/year)** | | **2,262,666** | **1,796,256** | **1,456,308** | **1,324,701** | **1,132,950** | **984,039** | **865,578** |
| Depreciation | | 2,042,857 | 2,042,857 | 2,042,857 | 2,042,857 | 2,042,857 | 2,042,857 | 2,042,857 |
| EBIT (Revenue - Expenses-Depreciation) | | *-562,917* | *-1,045,514* | *-1,402,041* | *-1,550,633* | *-1,759,785* | *-1,926,526* | *-2,063,259* |
| Loss carried forward | | *-562,917* | *-1,608,431* | *-3,010,472* | *-4,561,105* | *-6,320,889* | *-8,247,415* | *-10,310,674* |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -562,917 | -1,045,514 | -1,402,041 | -1,550,633 | -1,759,785 | -1,926,526 | -2,063,259 |
| Free Cash Flow | -14,300,000 | 1,479,940 | 997,343 | 640,816 | 492,225 | 283,072 | 116,331 | -20,401 |
| **IRR (7 years) without CDM** | **-36.42%** | | | | | | | |

## IRR for initial cost -10%

| Total Project Cost | -11,700,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,726 | 2,773 | 2,820 | 2,868 | 2,916 | 2,966 | 3,016 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,726** | **798,913** | **815,492** | **832,476** | **849,878** | **867,708** | **885,979** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,262,666 | 1,796,256 | 1,456,308 | 1,324,701 | 1,132,950 | 984,039 | 865,578 |
| **Total revenue from project activities (RM/year)** | | **2,262,666** | **1,796,256** | **1,456,308** | **1,324,701** | **1,132,950** | **984,039** | **865,578** |
| Depreciation | | 1,671,429 | 1,671,429 | 1,671,429 | 1,671,429 | 1,671,429 | 1,671,429 | 1,671,429 |
| EBIT (Revenue - Expenses-Depreciation) | | -191,489 | -674,085 | -1,030,613 | -1,179,204 | -1,388,356 | -1,555,097 | -1,691,830 |
| Loss carried forward | | -191,489 | -865,574 | -1,896,186 | -3,075,391 | -4,463,747 | -6,018,844 | -7,710,674 |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -191,489 | -674,085 | -1,030,613 | -1,179,204 | -1,388,356 | -1,555,097 | -1,691,830 |
| Free Cash Flow | -11,700,000 | 1,479,940 | 997,343 | 640,816 | 492,225 | 283,072 | 116,331 | -20,401 |
| **IRR (7 years) without CDM** | **-32.38%** | | | | | | | |

## IRR for O&M cost +10%

| Total Project Cost | -13,000,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,999 | 3,050 | 3,102 | 3,154 | 3,208 | 3,262 | 3,318 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,999** | **799,190** | **815,774** | **832,763** | **850,169** | **868,004** | **886,281** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,262,666 | 1,796,256 | 1,456,308 | 1,324,701 | 1,132,950 | 984,039 | 865,578 |
| **Total revenue from project activities (RM/year)** | | **2,262,666** | **1,796,256** | **1,456,308** | **1,324,701** | **1,132,950** | **984,039** | **865,578** |
| Depreciation | | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 |
| EBIT (Revenue - Expenses-Depreciation) | | -377,476 | -860,077 | -1,216,609 | -1,365,205 | -1,574,362 | -1,741,108 | -1,877,846 |
| Loss carried forward | | -377,476 | -1,237,552 | -2,454,161 | -3,819,366 | -5,393,728 | -7,134,836 | -9,012,682 |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -377,476 | -860,077 | -1,216,609 | -1,365,205 | -1,574,362 | -1,741,108 | -1,877,846 |
| Free Cash Flow | -13,000,000 | 1,479,667 | 997,066 | 640,534 | 491,938 | 282,781 | 116,035 | -20,703 |
| **IRR (7 years) without CDM** | **-34.58%** | | | | | | | |

## IRR for O&M cost -10%

| Total Project Cost | -13,000,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,454 | 2,495 | 2,538 | 2,581 | 2,625 | 2,669 | 2,715 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,454** | **798,635** | **815,210** | **832,190** | **849,586** | **867,411** | **885,678** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,262,666 | 1,796,256 | 1,456,308 | 1,324,701 | 1,132,950 | 984,039 | 865,578 |
| **Total revenue from project activities (RM/year)** | | **2,262,666** | **1,796,256** | **1,456,308** | **1,324,701** | **1,132,950** | **984,039** | **865,578** |
| Depreciation | | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 |
| EBIT (Revenue - Expenses-Depreciation) | | -376,930 | -859,522 | -1,216,045 | -1,364,632 | -1,573,779 | -1,740,515 | -1,877,243 |
| Loss carried forward | | -376,930 | -1,236,453 | -2,452,498 | -3,817,129 | -5,390,908 | -7,131,423 | -9,008,665 |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -376,930 | -859,522 | -1,216,045 | -1,364,632 | -1,573,779 | -1,740,515 | -1,877,243 |
| Free Cash Flow | -13,000,000 | 1,480,212 | 997,621 | 641,098 | 492,511 | 283,364 | 116,628 | -20,100 |
| **IRR (7 years) without CDM** | **-34.53%** | | | | | | | |

IRR for revenue from electricity sales + 10%

| Total Project Cost | -13,000,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,726 | 2,773 | 2,820 | 2,868 | 2,916 | 2,966 | 3,016 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,726** | **798,913** | **815,492** | **832,476** | **849,878** | **867,708** | **885,979** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,488,933 | 1,975,882 | 1,601,939 | 1,457,171 | 1,246,245 | 1,082,443 | 952,136 |
| **Total revenue from project activities (RM/year)** | | **2,488,933** | **1,975,882** | **1,601,939** | **1,457,171** | **1,246,245** | **1,082,443** | **952,136** |
| Depreciation | | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 |
| EBIT (Revenue - Expenses-Depreciation) | | -150,936 | -680,174 | -1,070,696 | -1,232,448 | -1,460,775 | -1,642,408 | -1,790,987 |
| Loss carried forward | | -150,936 | -831,110 | -1,901,806 | -3,134,255 | -4,595,030 | -6,237,438 | -8,028,424 |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -150,936 | -680,174 | -1,070,696 | -1,232,448 | -1,460,775 | -1,642,408 | -1,790,987 |
| Free Cash Flow | -13,000,000 | 1,706,206 | 1,176,969 | 786,447 | 624,695 | 396,367 | 214,735 | 66,156 |
| **IRR (7 years) without CDM** | **-27.49%** | | | | | | | |

IRR for revenue from electricity sales -10%

| Total Project Cost | -13,000,000 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| Maintenance & Repair cost | | 580,000 | 589,860 | 599,888 | 610,086 | 620,457 | 631,005 | 641,732 |
| Electricity cost | | 2,726 | 2,773 | 2,820 | 2,868 | 2,916 | 2,966 | 3,016 |
| Labour cost | | 120,000 | 124,920 | 130,042 | 135,373 | 140,924 | 146,702 | 152,716 |
| Others | | 80,000 | 81,360 | 82,743 | 84,150 | 85,580 | 87,035 | 88,515 |
| **Total Expenses (RM/year)** | | **782,726** | **798,913** | **815,492** | **832,476** | **849,878** | **867,708** | **885,979** |
| **Revenue from CER** | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Revenue from electricity sales (RM) | | 2,036,399 | 1,616,630 | 1,310,677 | 1,192,231 | 1,019,655 | 885,635 | 779,020 |
| **Total revenue from project activities (RM/year)** | | **2,036,399** | **1,616,630** | **1,310,677** | **1,192,231** | **1,019,655** | **885,635** | **779,020** |
| Depreciation | | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 | 1,857,143 |
| EBIT (Revenue - Expenses-Depreciation) | | -603,470 | -1,039,425 | -1,361,958 | -1,497,388 | -1,687,365 | -1,839,215 | -1,964,102 |
| Loss carried forward | | -603,470 | -1,642,895 | -3,004,852 | -4,502,241 | -6,189,606 | -8,028,822 | -9,992,924 |
| Income TAX | 25% | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nett Income (EBIT - income tax) | | -603,470 | -1,039,425 | -1,361,958 | -1,497,388 | -1,687,365 | -1,839,215 | -1,964,102 |
| Free Cash Flow | -13,000,000 | 1,253,673 | 817,718 | 495,185 | 359,754 | 169,777 | 17,927 | -106,959 |
| **IRR (7 years) without CDM** | **#NUM!** | | | | | | | |

## Annex 4

## MONITORING INFORMATION

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