Project design document form for CDM project activities

(Version 08.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor in Malaysia
Version number of the PDD	Version 19.0
Completion date of the PDD	02/09/2016
Project participant(s)	KUB-Berjaya Enviro Sdn. Bhd. (KBE)
Host Party	Malaysia
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	ACM 0001, version 8 [1] Consolidated baseline and monitoring methodology for landfill gas project activities
Sectoral scope(s) linked to the applied methodology(ies)	13: Waste handling and disposal
Estimated amount of annual average GHG emission reductions	237,207 tCO_2e

1 The ACM 0001 - *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8) is no longer valid and is not available for download in UNFCCC. The version has been replaced with Version 8.1.

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

KUB-Berjaya Enviro Sdn. Bhd. (KBE) is the developer responsible for the construction, operation, management and maintenance of the Bukit Tagar sanitary landfill and its facilities. This sanitary landfill is located at Bukit Tagar, Mukim Sg. Tinggi, Hulu Selangor District in the State of Selangor. KBE is expected to conclude a concession agreement with the Malaysian Government in 2008 to operate and maintain this landfill for the next 30 years.

The Bukit Tagar sanitary landfill occupies a 700 acres footprint and is surrounded by a buffer zone of 1000 hectares of palm oil plantations. The landfill has been in operation since 1 April 2005 and is designed to receive up to an average of 3,000 tons of solid waste per day for at least 40 years. To date, the landfill received on average of 2,000 tons of municipal solid waste (MSW) per day from Kuala Lumpur City and the Selayang District in the State of Selangor.

The landfill is being developed in phases. The first cell involved the operation of the cell known as the "advance cell", which commenced in April 2005 and was completed in November 2007. A total of approximately 1,430,000 metric tons of municipal solid waste was disposed in this cell. A new cell known as Phase 1 is currently in use and is expected to receive up to 3.7 million tons of MSW over the following 3 to 4 years. Both these phases are included in this project, as well as any future phases to be developed.

Landfill gas consisting of mainly methane (CH_4) is generated due to the anaerobic degradation of solid waste in Bukit Tagar sanitary landfill. Currently, landfill gas (consisting Green House Gases such as CH_4) is passively vented from the Bukit Tagar Sanitary landfill to the atmosphere. There are no regulations or specific requirement by the Malaysian Government requiring the collection, flaring and/or utilization of landfill gas.

The landfill cells are designed according to standards required for fully engineered sanitary landfill (Level 4 under United States Environmental Protection Agency (USEPA) standard). A complete cell lining system (see Figure 1 overleaf for detail) is applied with compacted clay, High Density Poly Ethylene (HDPE) liners, geo-textile and fabric membranes, gravel and clay layers to ensure separation of waste from the ground and proper drainage of leachate. The liner system is applied to create an impermeable leachate and gas flow barrier to protect the land of being contaminated.

Recognising the potential of capturing and utilising landfill gas, KBE hereby propose a project that entails the collection and utilization of landfill gas for power generation as well as flaring the excess gas (as opposed to direct emission of landfill gas to the atmosphere). The renewable power generated from the landfill gas, will be utilised on-site (for flaring and power generation only) to replace the existing power supply from grid that is mainly fossil fuel based. Excess power generated from the landfill gas (in addition to those consumed on-site) may be generated and sold to the grid, leading to further reduction of greenhouse gases emission.

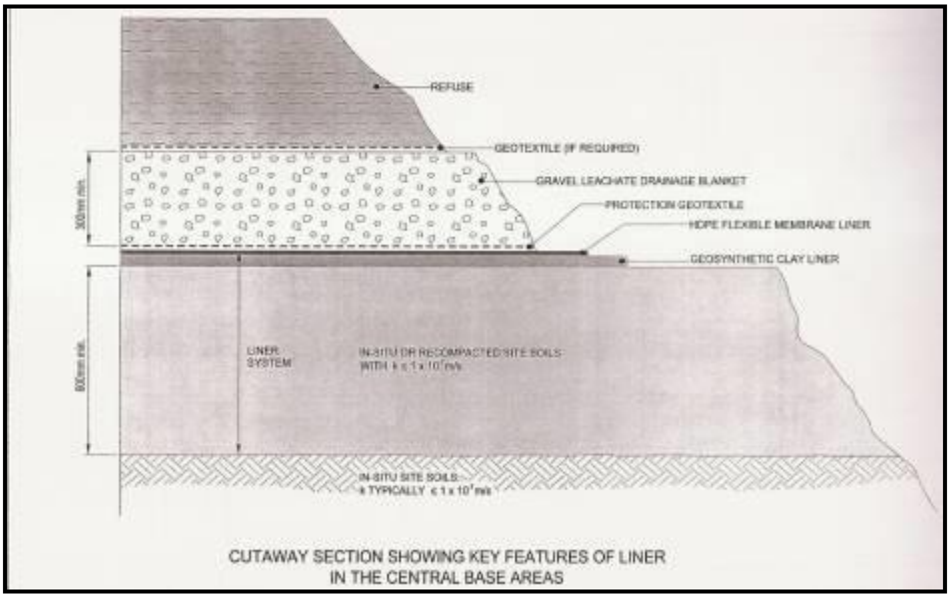


Figure 1: Cross section of Bukit Tagar Sanitary Landfill Liner System

(Source: KUB-Berjaya Environ Sdn Bhd, 2008)

The project will involve the following gas piping works:

- Installation of vertical HDPE gas extraction pipes (perforated) at regular interval period;
- Connection of vertical pipes by horizontal HDPE pipes; and
- Complete sealing of existing passive venting pipes;

Gas extraction from the currently operating Phase 1 cell will be initiated while the cell is being filled. Horizontal extraction pipes in addition to vertical pipes will be installed to fully extract methane gas generated.

With the implementation of the landfill gas recovery system, the daily operation of the landfill will not be affected. The working face (where waste is actually disposed daily) of the landfill will be kept to minimal. Under regular landfill operations, waste will be compacted and daily earth cover applied to maintain hygiene and prevent odour.

Leachate management and treatment at Bukit Tagar is an important aspect for landfill gas extraction. With proper leachate drainage system already in placed, leachate interference to the landfill gas extraction is not foreseen to be a problem. The collected leachate is treated extensively through a series of treatment processes in the following order:

- anaerobic holding ponds for leachate storage and aging;
- aerobic treatment using sequential batch reactor lagoons provides main biological treatment;
- dissolved air flotation (DAF) tank for removal of suspended solids and colloidal particles;
- sequence of reed beds to absorb residues in the treated leachate and maximize the treatment standard;
- finally irrigated to natural vegetation within the project sites rather than discharges to nearby rivers.

Apart from reducing methane (as a Greenhouse Gas with a Global Warming Potential of 21), the implementation of this landfill gas recovery and utilization project will also reduce the effects of air pollution on surrounding environments and minimize the risks of an explosion due to the concentration of accumulated landfill gas. This project is in line with the “Zero discharge” policy of KBE in striving to develop Bukit Tagar Sanitary Landfill into the role model of modern sanitary

landfill in Malaysia. The generation of renewable energy from the captured landfill gas will inevitably contribute to the nation's renewable energy drive. This project is also in line with the Malaysian National Energy Policy where it specifically supports the following strategies laid out in the Malaysian Ninth Malaysian Plan[2]:

- *"(iii) Reducing high dependence of petroleum products by increasing the use of alternative fuels"*
- *"(iv) Promoting greater use of renewable energy for power generation and by industries"*

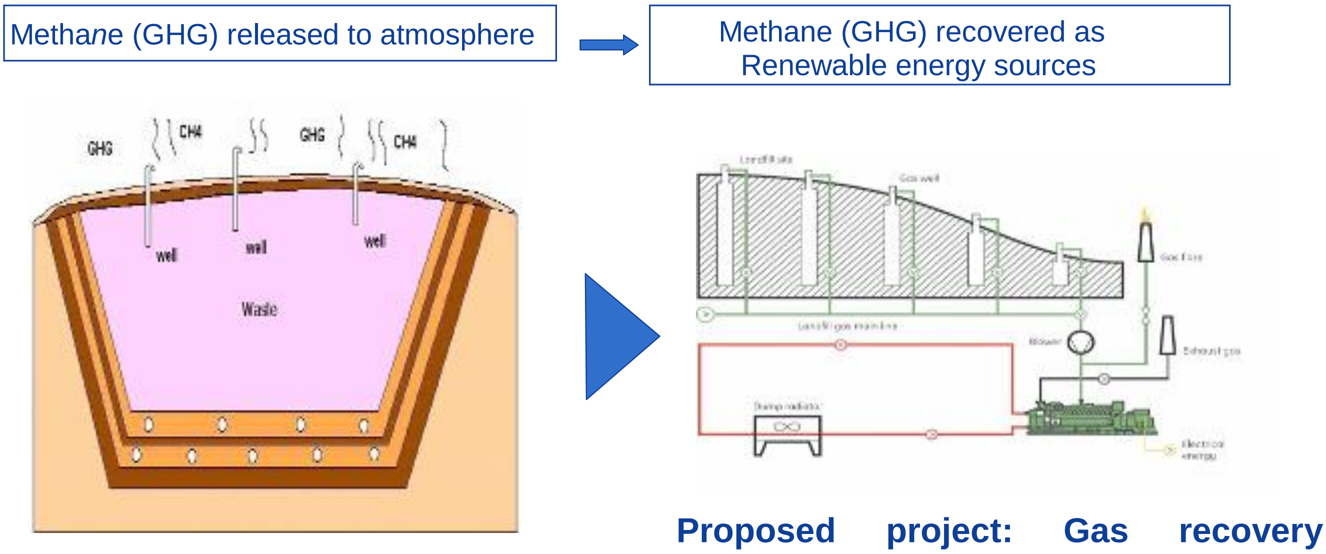
On economic implications of the project, the implementation of the project will lead to an increase in employment opportunities and contribute to the local economy, especially in the form of foreign investment for local technological support and contractors.

On the social aspects, the improvement of the local environment due to the reduction of harmful landfill gases otherwise released to the atmosphere will improve the working environment for the workers on-site as well as for the health of surrounding community.

All the above positive impacts will contribute to the overall sustainable development of Malaysia.

It has been proposed that flaring of the landfill gas will be commissioned in March 2009. Grid connected power generation would be further assessed and is expected to start in 2011.

The project activity, as opposed to the current situation, can be illustrated in the schematic below:



Present situation: Passive venting

Proposed project: Gas recovery utilisation on site and Utilisation

Figure 2: Proposed landfill gas recovery and utilisation

Source: Own Illustration & Jenbacher Catalouge (http://www.ge-energy.com)

[2] Pusat Tenaga Malaysia. (2006). Malaysia CDM Information Handbook. Pg 31.

An assessment of how this project will comply with the Malaysian National Criteria for CDM projects was done. The summarized results are presented below:

Comparison of Project with the Malaysia National CDM Criteria

National CDM Criteria in Malaysia	**Conditions for this Project**
Criterion 1: Contribute to Sustainable Development in Malaysia	Improve local environment (air quality, reduce health risk) Supports renewable energy policy
Criterion 2: Must involve Annex 1 (developed countries) parties	Buyer : Japan Carbon Finance Ltd (Japanese) Technology: Gas Con/Q2 A/S (Denmark)
Criterion 3: Must involve technology transfer or improvement of technology	Transfer of technology from overseas & improvement of technology from existing venting
Criterion 4: Must fulfill International CDM conditions	LFG recovery is voluntary and this project fulfills all conditions outlined by the CDM Executive Board
Criterion 5: Ability of Project Developer to undertake project	KBE Sdn Bhd is a local incorporated company, Jointed Venture by two public listed companies in the KLSE (Malaysian Stock Market)

A.2. Location of project activity

A.2.1. Host Party

Malaysia

A.2.2. Region/State/Province etc.

State of Selangor

A.2.3. City/Town/Community etc.

Mukim Sg. Tinggi, District of Hulu Selangor

A.2.4. Physical/Geographical location

The project location (landfill) is situated approximately 5 km West of the Bukit Tagar Interchange along the North-South Expressway and 40 km from central Kuala Lumpur. The landfill is easily accessible by expressway and a dedicated Bukit Tagar interchange has been developed for the access from the North-South Expressway. The landfill is situated in a leased agricultural land, surrounded by hectares of oil palm plantations and rubber trees.

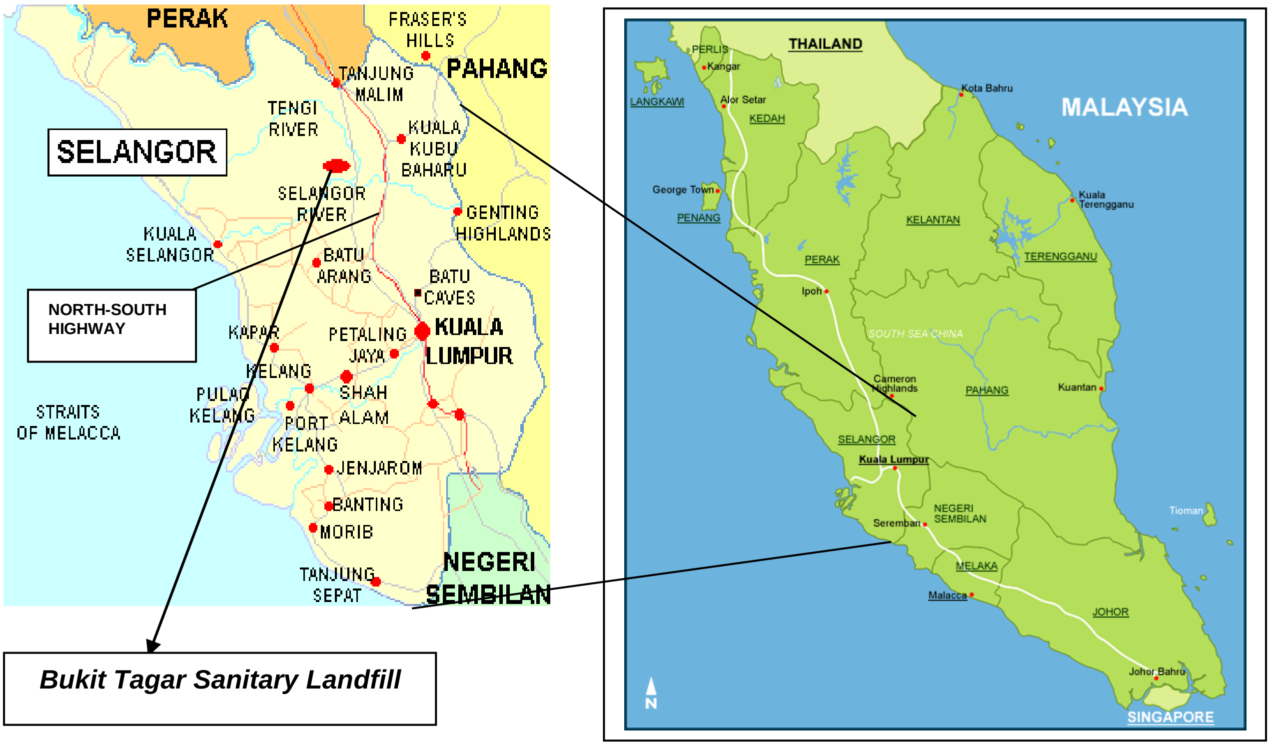


Figure 3: Location of Selangor State and Bukit Tagar Sanitary Landfill

The specific geographical coordinates of the Bukit Tagar Landfill is:

Latitude	**Longitude**	**Description**
3^{0} 30' 168''	101^{0} 28' 428''	North
3^{0} 29' 07''	101^{0} 28' 452''	South
3^{0} 29' 46''	101^{0} 28' 20''	West
3^{0} 29' 69''	101^{0} 29' 268''	East

A.3. Technologies and/or measures

Overall, the landfill gas technology and design will be sourced from developed countries since it is not readily available locally. The technology[3], which will be applied and transferred into this project, has been implemented and proven in Europe. The technology is currently been commissioned at Seelong landfill (another CDM project that has been registered by CDM Executive Board) in the State of Johor, Malaysia.

The gas extraction (collection) system to be applied includes a containerised landfill gas pumping and control unit, supplied by a series of new vertical landfill gas wells. The system is designed based on a modular concept whereby expansion of the extraction system can be done in stages as the landfill develops. Two imported gas blowers with a total maximum capacity of approximately 2500 m^3/hr will be used.

The landfill gas recovered will be utilised to generate electricity as follows:

[3] The final negotiation and signing of contract is expected to be finalised by April 2008.

Connection and Sell to TNB National Grid (by 2011):

Sale of energy to the grid will be further assessed and considered. KBE intends to apply for the Malaysian Small Renewable Energy Power Programme (SREP). Possibilities to supply power to nearby energy consumers (when they become available) would also be considered.

When Phase 1 is completed, KBE plans to sell 2 MW to the TNB grid. The first gas engine (installed capacity of 1.2MW) was commissioned in 2011 and the second gas engine (1MW export capacity) is expected to be implemented by 2013.

KBE has applied to the Energy Commission of Malaysia for 2 MW grid export in 2009 under the Small Renewable Energy Programme. The official approval was granted via a letter dated 11 January 2010, informing that the application was approved but the maximum capacity acceptable by the grid operator TNB is capped at 1 MW instead.

Due to such limitation, KBE was unable to implement the 2 MW in the same time and therefore request a notification change to delay the 1 MW to be implemented in 2013 instead of 2011. The notification of changes was approved on 9 May 2012 by the CDM Executive Board.

Upon commencement of the extraction of LFG in Phase 2 and with the additional gas expected, KBE intends to generate an additional of approximately 3MW and upload to the grid by year 2013, making the total grid upload capacity from the site to approximately 4MW. KBE has re-applied and got the approval of approximately 3MW export under the new Renewable Energy Act 2010. With the increase of power generation approximately 3MW to be uploaded to the grid, KBE has requested 2nd notification of changes and was approved by UNFCCC on 09 September 2013.

Based on the declared annual availability and estimated operating hours, an additional approximately 1.5MW is commissioned on 26 October 2015 and hence, the total grid upload capacity expected is about 5.5MW.

In addition to the new gas engines, an additional pipeline and flare system equipped with skid mounted LFG gas blower will be implemented to handle any excess LFG captured which is expected to be commissioned at the beginning of year 2014. The cost for the additional LFG transfer pipe is included in the financial analysis. Other expected cost (for example the flare system) is not included in the existing financial analysis for conservativeness. The 3rd flare is planned to be installed by the end of 2014. However, in 2014, there is a decision made by the management to not implementing the 3rd flare. Hence, the cost for the additional LFG transfer pipe has been excluded in the financial analysis.

On site utilisation for flaring and gas engines (by 2011):

Power generated from landfill gas will be utilized for the project activity (flaring and gas engine), replacing the grid power which will be used otherwise (baseline). Power utilized by project activity (flaring and gas engine) will not be claimed during the crediting period.

There are three existing diesel generator sets at the Bukit Tagar site with the following capacity and efficiency:

- 100 kW – 85%
- 120 kW – 85%

- 750 kW – 85%

These engines were put in placed before the grid power was available. With grid power available, the generators have been used as back-up generators in the landfill operation where the remaining operational lifetime is expected to be more than 15years.

Upon the implementation of power generation from landfill gas, the power required to operate the project activities will be sourced internally from the gas engines and backed up by grid power. The three existing diesel generator sets will only be used as back up for landfill operation.

There is another diesel generator which will be used as backup for project activities during the power failure of the grid. The specification for the backup diesel generator is described as below:

Name	Perkins
Series	2500
Generator Output	500 kVA
Output Voltage	415 V

A high accuracy gas analyser and data logging system will be installed to monitor the flow, gas composition and temperature of the gas extraction system. The gas analyser will also be imported.

Overall, technological transfer is expected from this project to both KBE as well as the local office of the technological provider in Malaysia. The successful transfer will also ensure the system can be monitored and sustained in future.

Details of the components are further described below:

Wells and Piping

Well heads will be complete with well piping and will be constructed by drilling, and inserting a gravel filter material surrounding a HDPE perforated filter pipe. The dimension of the chosen filter pipe will allow various types of pumping equipment to be installed in case leachate problems are detected.

Since the Advance Phase has been closed, vertical wells will be installed for gas extraction. A different design with a combination of vertical and horizontal wells is planned for Phase I. This design is considered more efficient than the vertical wells for installation at operating landfills that are still currently being operated (for example Phase I in Bukit Tagar).

Each of the well heads will be equipped with a measuring and regulating string consisting of a measuring point and a regulating valve. The measuring point is used to sample gas quality with a portable gas analyzer. In addition, the measuring string allows the use of a portable gas velocity instrument, giving the possibility of obtaining the yield of each well independently. The production of gas in each well can then be optimized by regulating the flow on the well control valve.

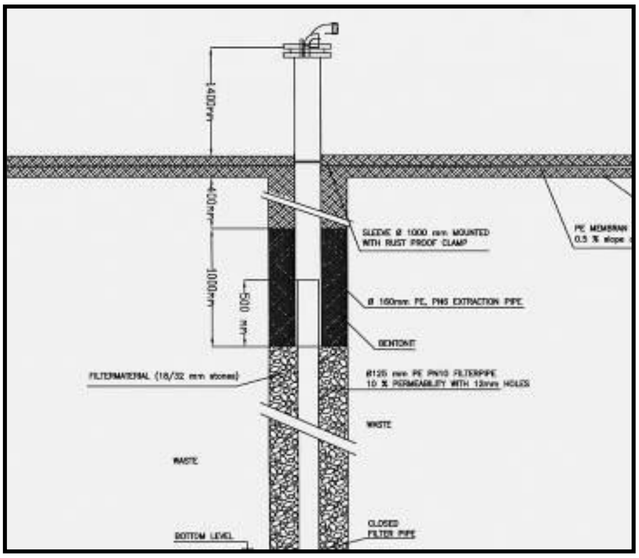


Figure 4: Schematic drawing of a "telescopic" vertical extraction well
(Source: Gas Con A/S / Q2 Engineering Sdn Bhd)

LFG Blower / Flare

The landfill gas booster blower to be installed is known as a twin lobe roots blower. Its total capacity amounts to a maximum of 2500Nm^3/h will be capable of delivering a differential pressure of 250 mbar as well as being suitable for vacuum duty. The blowers are coupled to allow the use of one burner while the other is being serviced, thus maximizing the utilization time of the total system.

Two enclosed flares with a destruction ratio of at least 99% and a retention time of more than 0.3 second at temperatures exceeding 1000°C is installed at the landfill to destruct the landfill gas that is not consumed by the gas engine generator. The flare is delivered together with a pumping unit on a skid to be placed in the open air. The excess gas will be burned in an enclosed type of flare fitted onto the pumping system. The flare will have the ability to burn the total capacity to prevent emission if a grid failure or any other event that will force the engines to be turned off. The 3rd flare is planned to be installed by the end of 2014. However, there is a decision made by the management to discontinue the 3rd flare.

Figure 5: High temperature enclosed methane flare to be installed
(Source: Fairyland Environmental Technology, 2008)

Gas Treatment

Primary pre-treatment of gas represent the first stage in reducing the amount of contaminants in the landfill gas and typically employs simple physical process operations. The main contaminants removed or reduced are condensate and particulates. The removal of these contaminants will prolong the lifetime of the gas engine. These technologies have been in use for many years and

are now a relatively standard element of active landfill gas management plants. The same also applies to the Biogas Filter System which is capable of a 2000m³ per hour flow rate to be installed in on-site the gas vents.

Gas Engine Energy Power Plants

The gas is transformed into electricity by combustion gas engines. Its design and stationary engine concept ensure excellent component durability and a service life of 60,000 operating hours before the first major overhaul.

Power generated will be for sale to the national grid and consumed for project activity (flaring and gas engine). This will involve applying for necessary license and reaching agreement with the Tenaga National Berhad (TNB) – the largest electricity utility in Malaysia.

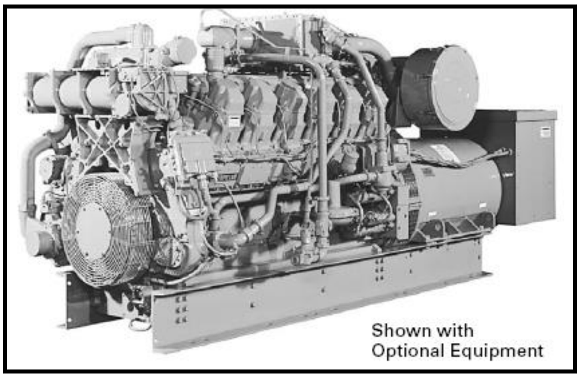


Figure 6: Illustration of Standard Landfill Gas Engine

(Source: Caterpillar Official Website, 2008)

Gas Analyzer and Data Logging System

The gas analyzing system is a multi-functional environmental monitoring equipment that can monitor up to 14 different measurement and data logging channels. Data from the logging system is presented on a local screen and stored in a local PC-unit with a possibility for external communication via GSM. Data can be downloaded directly from the inbuilt data logger to an external PC, or transmitted via GSM modem. The system will be equipped with probes for accurate measurement of Methane, Carbon Dioxide, Oxygen, atmospheric pressure, LFG-line pressure and/or velocity. Temperature sensors on the gas side will also record, report and display values relating to flare operation. Monitoring of the correct functioning of the flaring system will be provided by a continuous logging system which examines the operational parameters of the flare. The details of the gas analyzer will be discussed in the monitoring section below.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (host)	KUB-Berjaya Enviro Sdn. Bhd. (KBE) (Private)	No

A.5. Public funding of project activity

This project will be fully funded by KUB-Berjaya Enviro Sdn. Bhd. (Non-Annex 1 private entity) and will not involve any public funding or Official Development Assistance (ODA) diversion.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

This project will apply the following approved methodology (AM) and tools:

ACM0001: *"Consolidated baseline and monitoring methodology for landfill gas project activities -Version 8".*

The methodology also draws upon the following applicable tools in the case of this project:

- "Tool for the demonstration and assessment of additionality" *(Version 4.0)*;
- "Tool to determine project emissions from flaring gases containing methane" *(EB 28 Annex 13)*;
- "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*(Version 2);*
- "Tool to calculate the emission factor for an electricity system: *(Version 01)-EB 35 Annex 32;* and
- "Tool to calculate project emissions from electricity consumption" *(Version 1)*

"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (*Version 2*)

B.2. Applicability of methodology and standardized baseline

ACM0001 (Version 8), a consolidated approved methodology for landfill gas projects is most applicable and appropriate to this project which involves recovering and utilisation of landfill gas.

The applicability of this methodology is relevant to this project since the baseline scenario is the total atmospheric release of methane and the project activities (as described in A.2 above) include the situation where the captured gas is flared as well as used to produce energy (electricity).

In addition, the applicability under the relevant tools mentioned is also met as demonstrated below:

Table 1: Applicability of the relevant tools in the Bukit Tagar project

Tool	Applicability	This Project (Bukit Tagar)
"Tool for the demonstration and assessment of additionality" *(Version 04)*	Project requiring step by step approach to demonstrate additionality.	Yes, applicable to this project for demonstrating additionality.
"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"	Solid waste disposal site where waste would be dumped can be clearly identified.	Yes, waste disposal is clearly visible as seen the photos attached in Annex 3.
	Not applicable to hazardous waste.	The landfill only accepts non-hazardous municipal and industrial waste (means of verification: EIA report of the landfill).
"Tool to determine project emissions from flaring gases containing methane"	Residual gas stream to be flared contains methane, carbon monoxide & hydrogen.	Yes, the residual gas stream consists mainly of methane, followed by traced amount of carbon monoxide & hydrogen.
	Residual gas stream to be	Yes, the gas is generated from

Tool	Applicability	This Project (Bukit Tagar)
	flared to be obtained from decomposition of organic material.	landfilling of waste consisting of organic matter (See Annex 3 for waste composition).
"Tool to calculate the emission factor for an electricity system: *(Version 01)-EB 35 Annex 12.*	Project activity results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	Electricity generated from the project will replace electricity supplied by the grid to the project activity (flaring and gas engine).
"Tool to calculate project emissions from electricity consumption" *(Version 1)*	Consumption of electricity by the proposed CDM project activity	This applies to this project before the installation of gas engine. Power from grid will be utilised for the extraction and flaring in 2008. When the gas engine is in operation, only project activity (flaring and gas engine) from grid based power consumption by the project will be substituted.
"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 2)	Consumption of fossil fuel by the proposed CDM project activity	Yes. The diesel generator sets will only be used as back up during power failure of grid.

B.3. Project boundary

The project boundary is illustrated below:

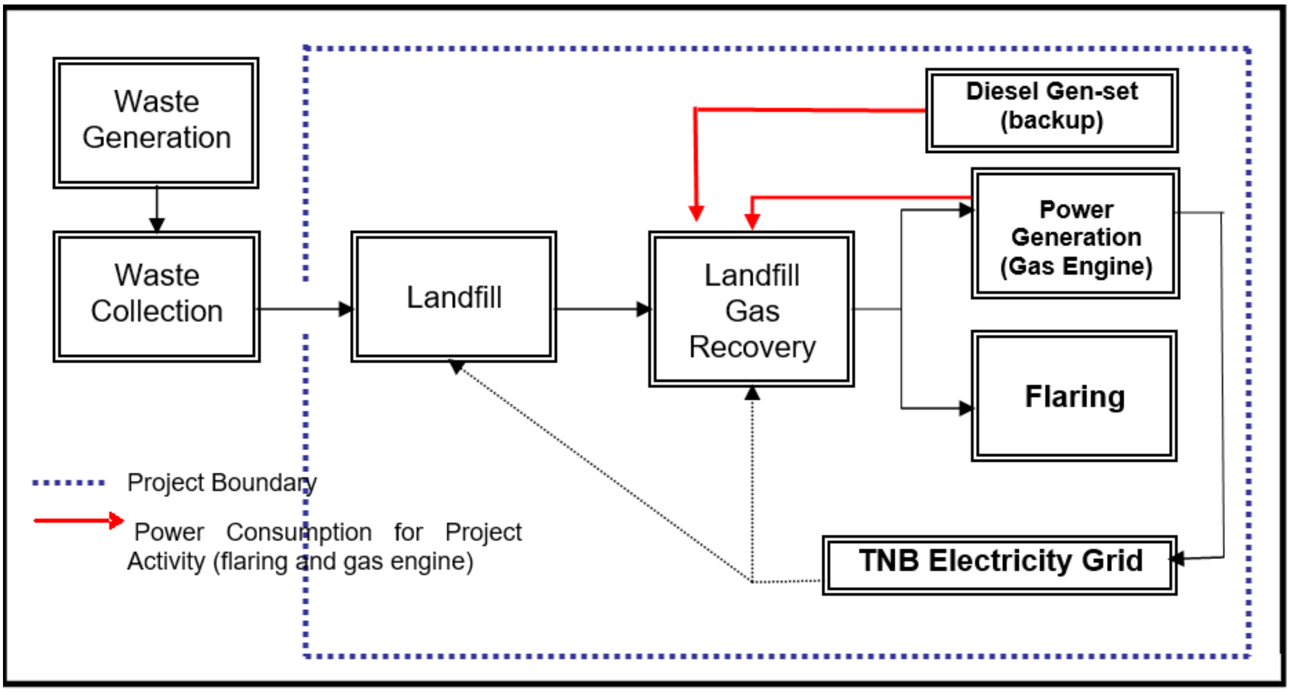


Figure 7: Project Boundary of Bukit Tagar CDM Project

Note: Deleted the arrow for power generation (gas engine) own power consumption to landfill

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the landfill site	CO_2	Yes	Landfill gas released to the atmosphere
		CH_4	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		N_2O	No	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	Yes	Electricity consumption from the grid
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project scenario	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	Applicable.
		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	Electricity consumed by project prior to the installation of landfill gas based power plants.
		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 flaring of Methane	CO_2	No	CO_2 emissions from the combustion of methane from the organic waste are not accounted.
		CH_4	Yes	Emissions of methane can be important source of project emissions
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

Note: Electricity generated is used for project activity (gas extraction, flaring and gas engines). The export of electricity is not expected to take place before 2011.

B.4. Establishment and description of baseline scenario

According to ACM0001, Step 1of the latest version of "*Tool for the demonstration and assessment of additionality (Version 04")* was used to identify all realistic and credible baseline alternatives for this project.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Step 1 a. Define alternatives to the project activity:

The project activity involves the recovery and utilisation of landfill gas on an existing landfill. Alternative scenarios were identified with the following main considerations:

- These scenarios must be available options to the project participants;
- Current regulation on gas management in landfills in Malaysia (national, regional and local level considered).

Outcome of Step 1a:

Table 3: The alternative scenarios for <u>landfill gas management</u> are:

LFG 1	Continuation of the current scenario whereby landfill gas consisting of methane is passively vented and not recovered.
LFG 2	Landfill gas is recovered for flaring without CDM
LFG 3	Landfill gas is recovered for power generation and flaring without CDM. Power generation is utilised for on-site consumption (landfill operation) only.
LFG 4	Landfill gas is recovered for power generation and flaring without CDM. Power generation is utilised for on-site consumption (landfill operation) as well as sold to grid.
LFG 5	Landfill gas is recovered for thermal energy generation and flaring without CDM.

Table 4: The alternative scenarios for <u>electricity generation</u> are:

P 1	Use power generated from landfill gas undertaken without being registered as CDM project activity
P 2	Use an existing or construct a new on-site or off-site fossil fuel fired cogeneration plant.
P 3	Use an existing or construct a new on-site or off-site renewable based cogeneration plant.
P 4	Use an existing or construct a new on-site or off-site fossil fuel fired captive power plant.
P 5	Use an existing or construct a new on-site or off-site renewable based captive power plant.
P 6	Use existing and/or new grid-connected power plants

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

<u>Landfill Gas Management</u>

Most relevant laws related to this project (landfill & landfill gas management) in Malaysia would include:

<u>Federal (National) Laws</u>

- The Solid Waste and Public Cleansing Management Act 2007 (Act 672) – expected to be in force April 2008;
- Environmental Quality Act 1974 (Act 127) and subsidiary legislations;

<u>State and Local Laws</u>

- Local Government Act 1976 (171) and subsidiary legislations;
- Street, Drainage and Building Act 1974 (Act 133) and subsidiary legislations;

The Solid Waste and Public Cleansing Management Act 2007 were passed by the Malaysia Government in August 2007 and this law is yet to be enforced. A new Department of National Solid Waste Management and a Solid Waste Management Corporation have been set up to implement this law. This law provides a comprehensive regulatory framework for managing solid waste from generation to treatment and disposal. However, in the main act, no specific requirement for landfill gas management is included.

The Environmental Quality Act 1974 is the main legislation governing the environmental management in Malaysia. Environmental impact assessment is required for establishing a landfill. However, under these regulations, no specific requirement is set for landfill gas management.

The Local Government Act 1976 & Street, Drainage and Building Act 1974 empowers the local authorities (municipalities) to set up and manage solid waste management within their own jurisdiction. Under the law, no specific requirement is set for landfill gas management.

Reviewing the above, there are no mandatory legal requirement to collect, recover and utilise gases generated from landfills in Malaysia. Landfill gas venting is considered to be part of a "Level 4" sanitary landfill in Malaysia under a guideline (not enforceable) published[4]. However, the collection, extraction and utilisation have not been mentioned or required. This has also been further confirmed with the Department of National Solid Waste Management Malaysia[5].

All alternatives (LFG 1-5) listed in ***Sub-step 1a*** are in compliance with the relevant mandatory applicable legal and regulatory requirements of Malaysia and will be further assessed in following steps.

Baseline Fuel for Electricity Supply

Generation of electricity supply in Malaysia is subjected to the following regulations[6]:

Energy Commission Act 2001 - This law was pass to fulfil the need to regulate an increasingly energy industry. In January 2002, the Energy Commission also empowered to regulate, enforce and promote all matters related to the electricity and gas supply industry within the scope of the legislation provided by the Electricity Supply Act 1990, Gas Supply Act 1993, Electricity Supply Regulations 1994, Gas Supply Regulations 1997 and Licensee Supply Regulations 1990.

The Energy Commission regulates all matters relating to the electricity supply industry and to protect any person from dangers arising from the generation, production, transmission, distribution, supply and use of electricity as provided under the electricity supply laws.

In Malaysia, an electricity demand can be met by either connecting to the TNB national grid or by generating own electricity by means of on-site or off-site fossil fuel based power plant. However, a license is required from the Energy Commission for such installation. There are no restrictions of the baseline fuel to be used. Fossil (e.g. diesel) or renewable (e.g. landfill gas) can be utilized to generate power.

The relevant energy policies in Malaysia[7] are:

- National Energy Policy 1979 – Set the overall energy policy with broad guidelines on long-term energy objectives and strategies to ensure efficient, secure and environmentally sustainable supplies of energy.

[4] "Technical Requirements for Safe Closure of Landfill Sites. (4) Gas Ventilation Facility – Gas ventilation facility should be provided and the venting pipes should be installed at 50m intervals. The purpose of the venting pipes is to allow the landfill gas to be released into the atmosphere and thus preventing gas explosion. This facility will also assist the acceleration on the landfill stabilisation by enhancing the waste decomposition process." *Source: Japanese International Corporation Agency & Ministry of Housing and Local Government Malaysia. 2004. "The Study on the safe closure and rehabilitation of landfill sites in Malaysia, Volume 3 - II - 6)"*

[5] Personal communication with Department of National Solid Waste Management, Malaysia on 3 December 2007.

[6] Energy Commission Malaysia Website. http://www.st.gov.my/. (Accessed 2 August 2008).

[7] Energy Information Bereau, Malaysia Energy Centre Website. http://eib.ptm.org.my/. (Accessed 2 August 2008).

- National Depletion Policy 1980 – Introduced to safeguard the exploitation of natural oil reserves because of the rapid increase in the production of crude oil.
- Four Fuel Diversification Policy 1981 – Designed to prevent over-dependence on oil as the main energy resource, its aim was to ensure reliability and security of the energy supply by focusing on four primary energy resources: oil, gas, hydropower and coal.
- Fifth Fuel Policy (Eighth Malaysia Plan 2001-2005) – In the Eighth Malaysian Plan, Renewable Energy was announced as the fifth fuel in the energy supply mix. Renewable Energy is being targeted to be a significant contributor to the country's total electricity supply. With this objective in mind, greater efforts are being undertaken to encourage the utilization of renewable resources, such as biomass, biogas, solar and mini-hydro, for energy generation.
- The Ninth Malaysia Plan (2006-2010) strengthens the initiatives for energy efficiency and renewable energy put forth in the Eighth Malaysia Plan that focused on better utilisation of energy resources. An emphasis to further reduce the dependency on petroleum provides for more efforts to integrate alternative fuels.

The Government of Malaysia also encouraged renewable energy through the introduction of the Small Renewable Energy Programme (SREP) since 2001. The SREP offers some financial incentives to power producers. However, such development is still based on voluntary basis i.e. consumers are not mandated under law to develop renewable energy based power supply.

Considering the regulations and policies above, all alternatives (P1-6) listed in ***Sub-step 1a*** for electricity supply (baseline fuel) are in compliance with the relevant mandatory applicable legal and regulatory requirements of Malaysia and will be further assessed in barrier analysis.

The subsequent steps of the analysis were done based on "Tool for the demonstration and assessment of additionality" *(Version 04).*

Step 2 Investment analysis

This step determines whether the proposed project activity is economically or financially less attractive than at least one other alternative, identified in Step 1, without the revenue from the sale of certified emission reductions (CERs). The following sub-steps are used to conduct the investment analysis:-

Sub-step 2a - Determine appropriate analysis method

According to the ""Tool for the demonstration and assessment of additionality" *(Version 04)*, there are several analysis that can be applied for investment analysis i.e. simple cost analysis, investment comparison analysis or benchmark analysis (sub-step 2b). Simple cost analysis could not be applied in the case of this project since the proposed project has potential to generate financial or economic benefits via the generation of electricity for own consumption (savings in electricity cost) in addition to CDM related income. Benchmark Analysis (Option 3) was thus chosen to be applied in this PDD to assess and demonstrate the additionality of the proposed Project.

Sub-step 2b - Option III Benchmark Analysis

Internal Rate of Return (IRR) is deemed most suitable financial indicator for the Project and is compared to a benchmark value. In this analysis, project IRR is applied.
The entire analysis was made in accordance to guidelines provided by the UNFCCC Executive Board (Annex 45, EB 41).

<u>Determination of "Benchmark"</u>

Several possible benchmarks were considered:

<u>Base Lending Rate</u>

In December 2007 (upon signing of term sheet with CER buyer for this project – date of real action), the Base Lending Rate (BLR) for Commercial Banks in Malaysia was 6.72% and the average lending rate was 6.29%. This is illustrated in the table below.

Interest Rates: Banking institutions (in percent per annum)

Average rates at end-period	Commercial Banks						
	Period (in months)					Base Lending Rate	Average Lending Rate
	1	3	6	9	12		
2007 Dec	3.08	3.15	3.29	3.38	3.70	6.72	6.29

Source: Monthly Statistical Bulletin December 2007, Central Bank of Malaysia

<u>Project IRR Benchmark for Renewable Energy Projects</u>

Although there are no official published figure available for this, several published sources by reputable organizations (Board of Engineers and Study commissioned by the Ministry of Energy, Water and Communication/Malaysian Energy Centre) can be referred to. These are further elaborated below:

An article published by the Board of Engineer in year 2005 can be referred to. The main figures are summarized below:

Research Survey: Comparison of Responses from Various Stakeholders on Investment (Project IRR) in Renewable Energy Generation

	Renewable Energy Developers (Non-millers)	Bankers
Project IRR (%)	12-15	15-18
Loan Tenure (years)	10-15	10

Source: Article Renewable Energy: The Failure of the Malaysian 5th Fuel Policy, Ingeniur Magazine, published by Board of Engineer Malaysia (2005).

To finance a renewable energy project that is viable, the Malaysian Bankers and private business owners viewed that they will be comfortable with a project IRR of not less than 15%. On the other hand, it can be noted that typical Malaysian Renewable Energy Developers will be comfortable with a project IRR of not less than 12% while financier such as bankers demand a higher return mainly attributed to the risk and uncertainties of the projects.

Landfill gas projects that provide energy in the form of electricity is rather new to Malaysia and their deployment is still rater limited. The uncertainties over the application of new technology and the supplies of wastes compared to conventional energy investments (coal power plant) add additional level of risk to the investment and these risks must be considered when applying a benchmark IRR for this project.

Another report, named “Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia”, Renewable Energy & Energy Efficiency Component(Sub-Component III: CDM Action Plan) published by Ministry of Energy, Water and Communications, Malaysia Energy Centre and Danish International Development Assistance (DANIDA) stated that the benchmark for CDM for project is set at financial IRR of 15% in Malaysia. This is comparable to the 12-15% IRR indicated by the Board of Engineer articles.

In view of the few rates mentioned, the benchmark rate of IRR for the project is deemed at least have to be more than the BLR of 6.72% and with the risk of the application of the new technology and likelihood of other risks that might not be foreseen, the **project IRR of 12%** (Source: Article Renewable Energy: The Failure of the Malaysian 5th Fuel Policy, Ingeniur Magazine, published by Board of Engineer Malaysia) is **deemed appropriate to be selected as the benchmark for this project.** 12% Project IRR benchmark presents the lower bound of the range indicated by the Board of Engineer article. This is a conservative approach.

Sub-step 2c - Calculation and comparison of financial indicators

The table below represents the main parameters and assumptions used in the IRR calculation for the Project. As per “Tool for the demonstration and assessment of additionality” (Version 04), the project IRR is computed. (Refer to excel sheet “FA1_BTSL_KBE_Financial_4MW to 5.5MW_ver 7.0_070716_0.4669_latest.xls” for details computation and assumptions of the IRR).

Parameters/Assumptions	**Value**
Revenues (excluding CER revenues)	
- Sale of electricity to grid from 2012 onwards (1MW)	RM 1,497,960/yr
- Sale of electricity to grid from 2013 -2015 (4MW[8])	
- Sale of electricity to grid from 2016 - 2028 (5.5MW)	RM 6,622,560/yr
	RM 12,144,119/yr
Total capital outlay up to year 2028	RM 68,944,754
Interest rate for long term bank loan	8% p.a.
Average electricity tariff	
- For sale to the grid from 2011 onwards (1MW)	0.19/kWh

[8] According to the Feed-in Approval, the declared annual availability for GE no.1 (installed capacity of 1.2MW) is 7,446MWh per year, for GE no.2&3 (total installed capacity of 3.12MW) is 22,338MWh per year and for GE no.4 (installed capacity of 2MW) is 9,855MWh per year. Assuming 90% availability of GEs, the delivery capacity rating for the GEs is 5.69MW. In addition, after taking into account of the energy consumed for project activity of 0.09MW, the total amount of energy generated from the GEs is 5.12MW which is less than the amount of 5.5MW used in the financial analysis calculation. Therefore, the value of 5.5MW used is conservative.

- For sale to the grid from 2013 onwards (4MW)	0.21/kWh
- For sale to the grid from 2016 onwards (2MW)	0.4669/kWh
Average operations and maintenance costs	RM 1,844,680/yr
Project lifespan	21 years
Project payback period (with CERs)	10 years
Project payback period (without CERs)	>21 years
Project NPV at discount rate of 8% for 10 years (without CERs)	(20,847,329)
Project NPV at discount rate of 8% for 21 years (without CERs)	(12,998)
Project NPV at discount rate of 8% for 10 years (with CERs)	(3,588,041)
Project NPV at discount rate of 8% for 21 years (with CERs)	17,246,290
Project IRR for 10 years (without CERs)	**-15.7%**
Project IRR for 21 years (without CERs)	**8.0%**
Benchmark Project IRR	**12.0%**
Project IRR for 10 years (with CERs)	**2.2%**
Project IRR for 21 years (with CERs)	**17.8%**

The table above shows the financial analysis for the project activity. As shown, the project IRR for the project in 21 years without CDM is estimated to be only 8.0%, way below benchmark of 12%. The low project IRR indicates that the project is financially unattractive and not viable without CDM. With the CDM revenue, project IRR is significantly improved and exceeds the lending rates of commercial banks (6.29% to 6.72%) and benchmark IRR. Therefore, the proposed project with the CDM revenue can be considered as financially viable to the investors.

The average electricity tariff for sale to the grid used in the analysis from year 2013 onwards is based on the energy price stated under the Small Renewable Energy Programme. The Renewable Energy Act 2010, prescribing special Feed-in Tariff (FiT) for renewable energy project was enforced only from 01/12/2011. According to the Guideline on application of E- policy for additionality demonstration through investment analysis and proposed revision to “Combined tool and Additionality” tool, EB 74, Annex 8, version 01.0, the FiT rate is applicable after seven years from the effective implementation date of the E-policy. In this case, the RE and SEDA Bills were gazetted in June 2011.

Sub-step 2d - Sensitivity analysis

A sensitivity analysis based on the following scenarios are established and analysed to examine whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. The critical assumptions include:

(1) Changes in electricity tariff (sell to grid), -10% and +10% (without CDM)
(2) Changes in electricity sold to grid[9], -10% and +10% (without CDM)
(3) Changes in the total investment costs (capital outlay), -10% and +10% (without CDM)
(4) Changes in total operating & maintenance (O&M) costs, -10% and +10% (without CDM)

These parameters were selected as being the most likely to fluctuate over time due to external factors.

[9] Amended production hour to electricity sold to grid for better representation.

Financial analyses were performed by altering each of these parameters by 10% (average plausible range) and assessing the impact on the project IRR for each scenario (without CDM), see table below.

<table>
<tr><th colspan="2" rowspan="3">Description</th><th colspan="2">Project IRR 10 and 21 years (without CDM)</th></tr>
<tr><th colspan="2">Scenario</th></tr>
<tr><th>-10%</th><th>+10%</th></tr>
<tr><td rowspan="2">Electricity tariff (sell to grid)</td><td>10 years</td><td>-19.9%</td><td>-11.9%</td></tr>
<tr><td>21 years</td><td>5.3%</td><td>10.4%</td></tr>
<tr><td colspan="4">It is unlikely that the electricity tariff for renewable energy will be further decreased 10% due to government’s policy to increase RE share in electricity supply. Likely to be increased 10% as the interest of government to increase RE may motivate this move.</td></tr>
<tr><td rowspan="2">Electricity sold to grid[10]</td><td>10 years</td><td>-18.7%</td><td>-11.9%</td></tr>
<tr><td>21 years</td><td>6.2%</td><td>10.4%</td></tr>
<tr><td colspan="4">The amount of electricity sold to grid depends on the operating hours of the gas engine. The likelihood of the decrease in electricity sold to grid of another 10% is possible considering the possible breakdown, the needs for regular maintenance and the consistency of gas supply may affect the electricity sold to grid. It is technically impossible that the power plant can operate at 100% capacity (24 hours, 365 days) (10% increase in production hours), considering that there would be at least downtime for mandatory servicing and maintenance.</td></tr>
<tr><td rowspan="2">Total capital outlay</td><td>10 years</td><td>-12.4%</td><td>-18.6%</td></tr>
<tr><td>21 years</td><td>9.8%</td><td>6.4%</td></tr>
<tr><td colspan="4">The capital outlay of the project cannot decrease 10% as the actual prices of the equipment is applied and tabulated in financial analysis. It is likely that the capital outlay of the project might increase 10% in future as prices of some of the equipment for future purchase may increase over time due to inflation as well as increasing demand of equipment.</td></tr>
<tr><td rowspan="2">Total O&M costs</td><td>10 years</td><td>-14.8%</td><td>-16.6%</td></tr>
<tr><td>21 years</td><td>8.6%</td><td>7.4%</td></tr>
<tr><td colspan="4">It is likely that the O&M might decrease to this level as the company might be able to optimize the process, proper maintenance and thus reducing the overall O&M cost. It is very likely that the O&M might increase to this level as cost of material and services is likely to increase over time in line with the inflation. Furthermore, raw materials prices are increasing and thus the spare parts and replacement parts of the plant will surely be increased in parallel.</td></tr>
</table>

Further sensitivity analysis by different parameters until the project IRR meets the identified project IRR benchmark (12.0%) was estimated and tabulated as below:

Parameters	Increase/ decrease of percentage in order to meet the 12% benchmark (without CDM)
Electricity tariff (sell to grid)	+17.5%
Electricity sold to grid	+17.5%
Total capital outlay	-21.1%
Total O&M costs	-75.0%

[10] Amended production hour to electricity sold to grid for better representation. The results remain same for increase in production hours or actual electricity sold to grid as it is directly correlated.

The results obtained above are not realistic, the description is as below:

Electricity tariff (sell to grid) – It is not likely to be increased to this level (+17.5%) as the cost of energy at this price already exceeds the production cost of conventional energy production. The main utility (Tenaga National Berhad) would be resistant to enter into any purchase agreement at this price. There is no obligatory requirement for TNB to purchase electricity from renewable sources.

Electricity sold to grid – The amount of electricity sold to grid depends on the operating hours of the gas engine. There are only 24 hours a day (8,760 hours a year). Hence, it is not logical that production hours could go beyond the 8,760 hours, i.e. +17.5% to 10,293 hours.

Total capital outlay – It is very unlikely to decrease to this level (-21.1%) because the prices of some of the equipment and installation have been determined and agreed upon and quotation prices of other equipment and installation have also been obtained. Furthermore, it is very unlikely for the capital outlay to decrease up to -21.1% without any changes in the scope and equipment.

Total O&M cost – It is impossible for not having O&M cost as the plant will go into deterioration if there is no O&M cost furthermore with a decrease in 75% in the cost.

Conclusion for Step 2d – Sensitivity Analysis

As it is shown in the various scenarios above, the project IRR can only achieve the project benchmark of 12% with “unrealistic” scenarios. With the variation of 10%, which is likely to occur, the project IRR is still remains lower than the benchmark (12.0%). This further confirms that the project is unlikely to be financially attractive and feasible without CDM financing.

Step 3. Barrier analysis

Step 3a. Identify barriers that would prevent the implementation of alternative scenarios:

Outcome of Step 3 a:

Barriers related to the alternative scenarios are closely related to barriers on developing renewable energy in Malaysia (landfill gas recovery and utilisation is a RE project). Malaysia has been promoting renewable energy as the “fifth fuel” since year 2000. However, the take up of renewable energy has not been successful and there are many widely recognised barriers identified. This is demonstrated from the fact that until today, only 2[11] of the 60 SREP (Small Renewable Energy Project) applications have been commissioned since 2000.

[11] Tenaga National Berhad. (2007). TNB’s Role in Supporting Renewable Energy Development in Malaysia. Renewable Energy Roadshow, Kuala Lumpur. 8 August 2007.

For the alternatives identified in Step 1 above, the main categories of barriers identified that may prevent alternative scenarios to occur include the following:

Table 5: Summarised List of Barriers Preventing Alternative Scenarios

Categories of Barriers	Types of Barriers
Investment barriers	• Project viability – due to economic of scale, low electricity tariffs & high capital investments[12] (most RE technology are imported today) • Project financing – in-sufficient equity[13], difficult to obtain loans[14] etc. • Lack of effective financial incentives[15] • Lengthy application process and licensing conditions[16]
Lack of prevailing practices	• Nobody is taking the initiatives since there are no legal requirements. • Business culture – conservative and resistance to change[17]
Others	• Lacking of clear policy, regulation and direction • Subsidies on fossil fuel but not on Renewable Energy • Lack of awareness – for example, not sure that landfill gas can generate power

Sub-step 3b. Eliminate alternative scenarios which are prevented by the identified barriers:

Landfill Gas Management

Assessments of the barriers for the different alternatives are carried out below:

Table 6: Barriers Preventing Alternative Scenarios for Landfill Gas Management

Alternative scenarios for Landfill gas (methane) management	Investment barriers	Lack of prevailing practice	Other Barriers
LFG 1 – Business as usual	None of the identified barriers will prevent this alternative. This is the prevailing practice that is in compliance with all laws in Malaysia.		
LFG 2 – LFG is recovered and flared without CDM	This alternative will require significant investment in landfill gas collection system as well as blowers and flares. Investment for the first cell in bukit tagar landfill will be at minimum RM 4 million ringgit [18]. There is no	As the active collection and flaring of landfill gas is not a common practice in Malaysia, this would present a major barrier by itself to this alternative. It is not a typical business	It is not a regulatory requirement for collection and flaring of landfill gas.

[12] Shigeoka, Hitoshi. (2003). Overview of International Renewable Energy Policies and Comparison with Malaysia's Domestic Policy.

[13] Energy Commission.(2007). RE Development Challenges in Small Renewable Energy Programme. Energy Roadshow 2007.

[14] Energy Commission (Malaysia). (2006). Statistics of Electricity Supply in Malaysia (2005 Edition).

[15] See Shigeoka, Hitoshi. (2003).

[16] Ministry of Energy, Water and Communication/Malaysia Energy Centre/DANIDA. (2004). Study on the Clean Development Mechanism Potential in the Waste Sector.

[17] See Ministry of Energy, Water and Communication/Malaysia Energy Centre/DANIDA. (2004).

[18] Based on quotations provided by potential suppliers to KBE in Dec 2007.

Alternative scenarios for Landfill gas (methane) management	Investment barriers	Lack of prevailing practice	Other Barriers
	income generated from this investment and thus such investment will not be paid back.	culture in Malaysia to take pro-active steps and changes towards protection of global environment, unless driven by regulation or fiscal incentives.	
LFG 3 – LFG is recovered, flared and utilised on-site without CDM	This option will require the implementation of Alternative 2 and further require additional investment in electricity generation power plants using the landfill gas. Although there will be cost savings by substituting with electricity generated from landfill gas, the same barriers identified in Alternative 2 above will prevent this option. The investment of the gas collection, power generating engine or alternative electricity generating system based on landfill gas requires substantial additional investment (minimum RM 3 million for 1MW gas engine) that is way higher than the cost saving. A financial analysis was conducted for the alternative LFG3 without consideration of CDM. The finding from the financial analysis shows that electricity generation from biogas is not a financially viable option if the only revenue is from the energy savings of electricity. Please refer to excel sheet (FA1_BTSL_KBE_Financial_4MW to 5.5MW_ver 7.0_070716_0.4669_latest.xls) attached.	The same lack of prevailing practice barrier for alternative 2 applies to this alternative.	Not a regulatory requirement
LFG 4 – LFG is recovered, flared and utilised on-site	The same barriers identified in Alternative 3 apply to this alternative. Although extra revenue can be generated by	The same lack of prevailing practice barrier for LFG 3 applies to this alternative.	Same barrier as LFG 3. The fossil fuel

Alternative scenarios for Landfill gas (methane) management	Investment barriers	Lack of prevailing practice	Other Barriers
as well as sold to grid without CDM	selling the extra power to the grid, the additional investment for additional gas engines and connection to the grid far outweigh the revenue from the sells to grid. Referring to the financial analysis done (see excel sheet "FA1_BTSL_KBE_Financial_4MW to 5.5MW_ver 7.0_070716_0.4669_latest.xls" attached), it can be concluded that revenues from the electricity sales in addition to the National TNB Grid in addition to the savings from the purchase of electricity from grid would not be significant to overcome the investment barrier. Such projects are considered high risk by banks and it may be difficult to obtain financing without CDM.		based grid power is subsidised by the Government but no special premium are given to power generation from landfill gas.
LFG 5 – LFG is recovered, flared and utilised for thermal energy without CDM	The same financial and technical barriers for LFG 3 apply to this alternative.	The same lack of prevailing practice barrier for alternative 2 applies to this alternative.	Same barrier as alternative 3.

Baseline Fuel Choice for Electricity

Alternative to Electricity	Investment barriers	Lack of prevailing practice	Others
P 1 – Power from LFG without CDM	This option will be prevented since it requires the investment of the gas collection system as well as the Renewable Energy power generation plant. The low tariffs offered to small renewable energy	There is so far only one operating case where power from landfill gas is generated for utilisation.	

Alternative to Electricity	Investment barriers	Lack of prevailing practice	Others
	project like this is well been recognised as a main barrier leading to such investment as a non-viable proposition[19]. This fact is also supported further by the Ministry of Industrial Development Authority[20] and well as other sources referred above.		
P 2 – Use on-site of off-site fossil fuel co-generation plant	The Bukit Tagar Landfill is currently connected to the grid. There are no existing off-site fossil fuel cogeneration plants nearby and it will not be feasible to invest in one for the landfill.	It is common to utilise grid connected electricity since the power is subsidised and it presents the most economical option with the required stability of supply.	
P 3 – Use on-site of off-site renewable based co-generation plant	This would require addition investment. Lack of fiscal incentives for renewable energy. There are no economic of scale for such investment.	Limited success stories on off-site renewable energy plants.	
P 4 – Use on-site or off site fossil fuel fire captive plant	There are existing backup diesel generators for the landfills but it would be cheaper to utilise grid power as compared to running on diesel.	Same barrier as alternative 2.	
P 5 – Use on-site of off-site renewable fired based captive plant	Same barrier as P 3.	Limited success stories on off-site renewable energy plants.	
P 6 – electricity from grid	None of the identified barriers will prevent this alternative since there are already an existing grid connection to the landfill. This is the prevailing practice that is in compliance with all laws in Malaysia.		

[19] Engr Dr. Maulud Hj. Latif. (2006). “Renewable Energy: The Failure of the Malaysian 5th Fuel Policy”. Published in the “Jurutera” magazine by the Board of Engineers Malaysia, Issue July 2006.

[20] Malaysian Industrial Development Authority (MIDA). (2007). http://www.mida.gov.my/beta/view.php?cat=4&scat=19&pg=194 [2007, August 14]

Outcome 3b: The Baseline Scenario

Based on the above assessments, the only ***plausible baseline scenario*** (business-as-usual) identified for this project is the "Continuation of the current scenario whereby landfill gas consisting of methane is passively vented and not recovered (LFG 1)" where the baseline for the electricity consumption will be supplied by the national grid (P6).

Figure 8: Identified Baseline Scenario: Landfill gas released to the atmosphere, baseline electricity from TNB National Grid

B.5. Demonstration of additionality

By referring to the latest version of "*Tool for the demonstration and assessment of additionality (Version 04"),* the additionality of this project will be demonstrated according to the steps illustrated in Figure 8 on page 24.

Step 1 (Identification of alternatives), Step 2 (Investment Analysis) & Step 3 (Barrier Analysis) have already been demonstrated in B.4 above.
The conclusion from B.4 is that this project is not a baseline scenario. Further steps to demonstrate additionality are elaborated below:

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

In Malaysia, municipal solid waste is typically handled by the local government under public cleansing activities. Waste are collected and transported to disposal sites. Open dumps and landfills are the most common disposal method for solid waste. There are approximately 260 operating and closed landfills throughout the country. Most of these landfills are not engineered and do not have gas venting or collection systems[21].

In 2007, a new Solid Waste Management and Public Cleansing Act was gazetted to empower the federal government of Malaysia to take over the solid waste management in Peninsula Malaysia in the coming future. Under the new legislation, there are no obligations for landfill operators to recover and utilize landfill gas.

[21] Ministry of Energy, Water and Communication/Malaysia Energy Centre/DANIDA. (2004). Study on the Clean Development Mechanism Potential in the Waste Sector.

The following table shows the current status of landfill gas management (closed and operating) in some of the major landfills throughout Malaysia:

Table7: Landfills in Malaysia

Name of landfill	State	Landfill Condition	Current Status on Landfill Gas
Jabi	**Kedah**	Operation	Not recovering the landfill gas
Semeling	**Kedah**	Operation	Not recovering the landfill gas
Mukim Padang Cina	**Kedah**	Operation	Not recovering the landfill gas
Jelutong	**Penang**	Closed	Not recovering the landfill gas
Ampang Jajar	**Penang**	Closed	Not recovering the landfill gas
Pulau Burung	**Penang**	Operation	Not recovering the landfill gas Passive venting of landfill gas
Bercham	**Perak**	Operation	Not recovering the landfill gas
Jebong	**Perak**	Operation	Not recovering the landfill gas
Jabor Jerangau	**Pahang**	Operation	Proposed to implement landfill gas recovery (CDM)
Ulu Tualang	**Pahang**	Operation	Not recovering the landfill gas
MPSA	**Selangor**	Closed	Not recovering the landfill gas
Hulu Langat	**Selangor**	Closed	Not recovering the landfill gas
Sg Kembong	**Selangor**	Closed	Not recovering the landfill gas
Teluk Kapas	**Selangor**	Operation	Not recovering the landfill gas
Kelana Jaya	**Selangor**	Closed	Not recovering the landfill gas
Kundang	**Selangor**	Closed	Not recovering the landfill gas
Air Hitam Sanitary Landfill	**Selangor**	Closed	Recovering landfill gas (TNB subsidiary). Applying for CDM in 2008 for full implementation.
Sg Sedu	**Selangor**	Operation	Not recovering the landfill gas
Jeram	**Selangor**	Operation	Passive venting of landfill gas
Bkt Tagar	**Selangor**	Operation	Passive venting of landfill gas. Not recovering the landfill gas
Tmn Beringin	**K. Lumpur**	Closed	Not recovering the landfill gas
Sikamat	**N. Sembilan**	Closed	Not recovering the landfill gas
Kpg Dato' Wong Sin Chow	**N. Sembilan**	Closed	Not recovering the landfill gas
Bkt Palong	**N. Sembilan**	Operation	Not recovering the landfill gas
Pajam	**N. Sembilan**	Operation	Not recovering the landfill gas
Krubong	**Malacca**	Operation	Proposed to implement landfill gas recovery (CDM)
Jln Tahana	**Johor**	Closed	Not recovering the landfill gas
Ulu Tiram	**Johor**	Closed	Not recovering the landfill gas
Tmn Mega Ria	**Johor**	Closed	Not recovering the landfill gas
Kpg Kelichap	**Johor**	Closed	Not recovering the landfill gas
Seelong Sanitary	**Johor**	Operation	Recovering landfill gas (CDM)
Ladang CEP 1	**Johor**	Operation	Not recovering the landfill gas
Teluk Kitang	**Kelantan**	Operation	Not recovering the landfill gas
Kayu Madang	**Sabah**	Operation	Not recovering the landfill gas
Mambong Intergrated Waste Management Park	**Sarawak**	Operation	Passive venting of landfill gas. Proposing to recovery landfill gas (CDM)
Ulu Segan	**Sarawak**	Operation	Not recovering the landfill gas

(Source: DANIDA Solid Waste Management Component, 2008 and Own Survey 2005-2008)

There is only one landfill gas recovery activity (TPS Air Hitam Sanitary Landfill) that is similar to the proposed project activity which was not a CDM project originally. The project was funded and implemented as a demonstration project as a renewable energy demonstration initiative under a "Small Renewable Energy Programme" under the Energy Commission of Malaysia. The project was operated by Jana Landfill Sdn Bhd, a subsidiary of Tenaga Energy Services (a subsidiary of the national utility TNB) under the largest electricity supplier in Malaysia and Worldwide Landfill Sdn Bhd. since November 2003. The project, however, is currently applying for CDM to fully implement the landfill gas recovery system. A Project Design Document (PDD) was prepared in November 2006 and revised in May 2008.

Sub-step 4b. Discuss similar options that are occurring:

To date, apart from Air Hitam, there are 4 other landfills that are/have proposed to implement landfill gas recovery and utilization projects:

In operation

- Seelong sanitary landfill (State of Johor)

Planning

- Krubong landfill (State of Melaka)
- Mambong Intergrated Waste Management Park (State of Sarawak)
- Jabor Jerangau (State of Pahang)

All projects similar to the proposed project activity listed above are developed with CDM. Therefore, these are excluded from the common practice analysis.

Outcome of Sub-step 4a & 4b:

From the common practice analysis, it is concluded that either no gas management or passive venting method are common practices in landfills in Malaysia.

Landfill gas projects that are similar are all implemented with consideration of CDM.

With Sub-steps 4a and 4b satisfied, therefore this **project activity is additional**.

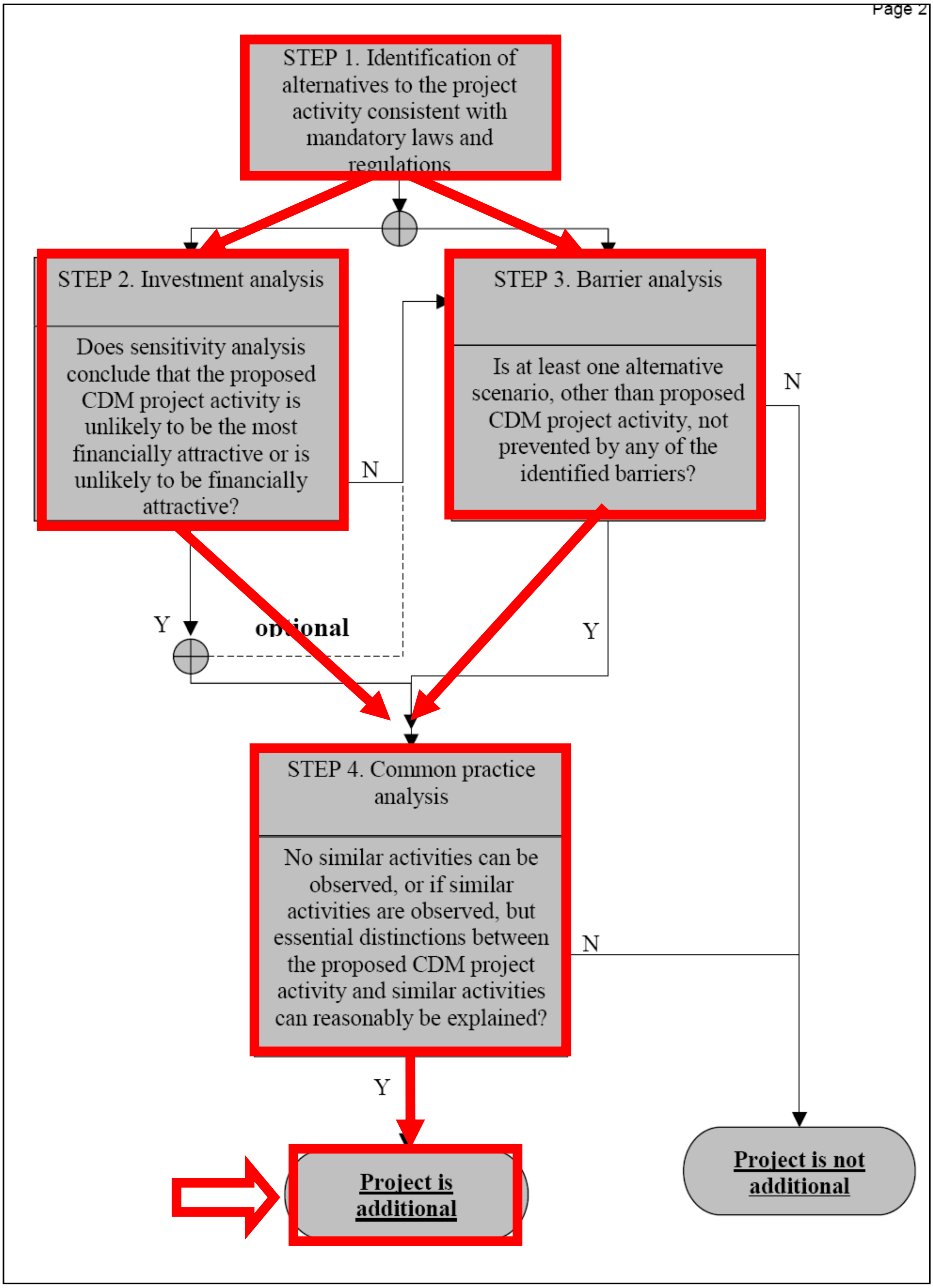


Figure 9: Step by step path in demonstrating that this project is additional

Source of tool: "*Tool for the demonstration and assessment of additionality (Version 04" approved by CDM Executive Board at EB 36.*

B.6. Emission reductions

B.6.1. Explanation of methodological choices

Emission Reduction

$ER_y = BE_{,y} – PE_{,y}$

ER_y	Emission reductions in year y (tCO_2e/y)
$BE_{,y}$	Baseline emissions in year y (tCO_2e/y)
$PE_{,y}$	Project emissions in year y (tCO_2e/y)

Baseline Emissions

The following equation based on ACM0001 (Version 8) was used to calculate the baseline emissions on a particular year (y):

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

Where:

BEy	Baseline emissions in year *y* (tCO_2e)
$MD_{project,y}$	The amount of methane that would have been destroyed/combusted during the year, in tonnes 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 requirements, in tonnes of methane (tCH_4)
GWP_{CH4}	Global Warming Potential value for methane valid for the commitment period, tCO_2e/tCH_4 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* (MWh)
$CEF_{elec,BL,y}$	CO_2 emissions intensity of the baseline source of electricity displaced (tCO_2e/MWh)
$ET_{LFG,y}$	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from on-site/off-site fossil fuel fired boiler, during the year *y* (TJ)
$CEF_{ther,BL,y}$	CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation (tCO_2e/TJ)

$MD_{project,y}$ will be determined *ex post* by metering the actual quantity of methane captured and destroyed once the project activity is operational. The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and used to generate electricity as well as the total quantity of methane captured.

The sum of the quantities fed to the flares, power plant, boilers and the natural gas distribution network must be compared with the total quantity of methane generated on an annual basis. The lowest value of the two must be adopted as $MD_{project,y}$. The following equation is applicable:

$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y}$[22] (2)

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)
$MD_{thermal,y}$	Quantity of methane destroyed for the generation of thermal energy (tCH_4)
$MD_{PL,y}$	Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH_4)

In turn, the amount of methane flared can be calculated as follows:

$$MD_{flared,y} = (LFG_{flare,y} \cdot w_{CH4} \cdot D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (3)$$

Where:

$MD_{flared,y}$	Quantity of methane destroyed by flaring (tCH_4)
$LFG_{flare,y}$	Quantity of landfill gas fed to the flare(s) during the year *y* (m^3)
w_{CH4}	Average methane fraction of the landfill gas as measured during the year *y* (m^3CH_4 / m^3LFG)
D_{CH4}	Methane density (tCH_4 / m^3CH_4)
$PE_{flare,y}$	Project emission from flaring of the residual gas stream in year *y* (tCO_2e). This will be determined following the procedure set in the *"Tool to determine project emissions from flaring gases containing methane"*.

And the amount of methane destroyed by the generation of electricity calculated like this:

$$MD_{electricity,y} = LFG_{electricity,y} \cdot w_{CH4,y} \cdot D_{CH4} \quad (4)$$

Where:

$MD_{electricity,y}$	Quantity of methane destroyed be generation of electricity (tCH_4)
$LFG_{electricity,y}$	Quantity of landfill gas fed into the electricity generator (m^3LFG)
$w_{CH4,y}$	Average methane fraction of the landfill gas as measured during the year *y* (m^3CH_4 / m^3LFG)

For this project, since the baseline is electricity generated by plants connected to the grid, the emission factor $CEF_{elec,BL,y}$ is calculated according to "*Tool to calculate the emission factor for an electricity system*" (*Version 1.0*). Since the power generation by diesel generator set during TNB grid downtime is relatively insignificant, emissions from diesel power generation was not included. This is conservative since diesel fuel has a higher emission factor (0.8 tCO_2/MWh) compared to the grid emission factor in Peninsular Malaysia (0.622 tCO_2/MWh).

For this project, the following applies:

- $MD_{thermal,y}$ and $MD_{PL.y}$ are not applicable (= 0) to this project since there are no heat generation and feeding to natural gas pipeline; and

[22] This project will not include both thermal energy component $MD_{thermal,y}$ and methane sent to pipeline for feeding to the natural gas distribution network $MD_{PL,y}$

- For this project, $MD_{BL,y}$ is zero since there are no destroy or combustion of methane today due to
  regulatory and contractual requirements;
- $ET_{LFG,y}$ and $CEF_{ther,BL,y}$ are not applicable (= 0) to this project since there are not thermal energy production.

The ex-ante calculations are calculated based on ACM0001 (version 8).

<u>Ex-ante Estimation of Methane Emissions</u>

The ex-ante calculations is done based on *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"* according to ACM0001.

The amount of methane generated in absence of the project activity in the year *y* ($BE_{CH4,SWDS,y}$)is calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot 16/12 \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{X=1} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-kj(y-x)} \cdot (1-e^{-kj}) \quad (5)$$

Where (for the case of this project):

$BE_{CH4,SWDS,y}$	Methane emissions during the year *y* from waste disposed at the landfill during the period from the start of the project activity to the end of the year y (tCO2e)
φ	Model correction factor to account for model uncertainties (0.9)
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
GWP_{CH4}	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_f	Fraction of degradable organic carbon (DOC) that can decompose
MCF	Methane correction factor
$W_{j,x}$	Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)
DOC_j	Fraction of degradable organic carbon (by weight) in the waste type *j*
k_j	Decay rate for the waste type *j*
j	Waste type category (index)
x	Year during the crediting period: *x* runs from the first year of the first crediting period (x = 1) to the year y for which avoided emissions are calculated (*x* = *y*)
y	Year for which methane emissions are calculated

There are several relevant organic waste type disposed at the landfill and this is determined by the following equation:

$$Wj,x = Wx \cdot \frac{\sum_{n=1}^{y} p_{n,j,x}}{z} \quad (6)$$

Where:

$W_{j.x}$	Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)
W_x	Total amount of organic waste prevented from disposal in year *x* (tons)
$P_{n,j,x}$	Weight fraction of the waste type j in the sample n collected during year *x*
z	Number of samples collected during the year *x*

The waste composition considered for the calculations is a result of a detailed Waste Characterization tests made in 2005 on the Bukit Tagar Sanitary Landfill by a private company. The references are attached under the "Waste Composition" section in Appendix 4.

Project Emissions

From Energy Consumptions

$$PE_y = PE_{EC,y} + PE_{FC,,j,y} \quad (7)$$

Where:

PE_y	Project emissions in year y (tCO_2e)
$PE_{EC,y}$	Emissions from consumption of electricity in the project case. (tCO_2e)
$PE_{FC,j,y}$	Emissions from consumption of fossil fuel in the project case. (tCO_2e)

For calculating ex-ante $PE_{EC,y}$, the *"Tool to calculate project emissions from electricity consumption" (Version 1)* was used. Project emissions resulted from electricity consumption to operate the landfill collection and flaring system are estimated in two stages:

1 - Before the LFG engine is available on site (year 2009 from March to August for 6 months);
2 - After the LFG engine installation and commissioning (tentatively September 2009).

The $PE_{EC,y}$ is calculated according to *"Tool to calculate project emissions from electricity consumption" (Version 1)* as below:

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \cdot (1+TDL_y) \quad (8)$$

Where:

$PE_{EC,y}$	Project emissions from consumption of electricity by the project activity during the year y (tCO2e/yr)
$EC_{PJ,y}$	Quantity of electricity consumed by the project activity during the year y (MWh)
TDL_y	Average technical transmission and distribution losses in the ECPG in the year y for the voltage level at which electricity is obtained from the grid at the project site
EF_{grid}	Emission factor for the grid in year y (tCO_2eq/MWh)

The quantity of electricity consumed was estimated based on the estimated consumption of power from grid to run the gas extraction and flaring system in 2008. The consumption would be mainly attributed to blower, consumption for pressurized air, air-conditioning and control system. The

average power consumption ($EC_{PJ,y}$) estimated by the technology supplier is 25 kW x 8760 hours x 0.9 capacity load which is equivalent to 197,100 kWh or **197 MWh.** A table showing the estimated average annual power consumption for the flaring and power generation system is as below.

Estimated average annual power consumption for the flaring and power generation system		
Flare 1	50	MWh
Flare 2	37	MWh
1.2MW GE	113	MWh
3.12MW GE (2013 onwards)	239	MWh
Gas Supply System 1 (GSS 1) (2013 onwards)	55	MWh
2MW GE (2016 onwards)	160	MWh
GSS 2 (2016 onwards)	57	MWh

The Transmission and Distribution Loses (TDL_y) value applied in this project is 10%. This value was reported in the latest Tenaga National Berhad[23] Annual Report 2007[24].

Before the LFG engine is installed and commissioned on site, grid power will be used and the ex-ante $PE_{EC,y}$ is therefore calculated as 197 MWh x 0.622 tCO_2eq/MWh[25] x (1+0.1) x 0.5 (for Mar-Aug 09) = 67.4 tCO_2eq.

After the LFG engine installation, assuming a utilization time of 90%, and using grid power as a backup for the LFG engine, the $PE_{EC,y}$ is calculated as 197 MWh x 0.622 tCO_2eq/MWh x (1+0.1) x (1-0.9) = 13 tCO_2eq.

In year 2013 when the 3.12MW gas engines and Gas Supply System (GSS) are expected to be commissioned, the $PE_{EC,y}$ is calculated as (50 + 37 + 113 + 239 + 55) MWh x 0.622 tCO_2eq/MWh x (1+0.1) = 338 tCO_2eq. The emission for year 2014 and 2015 are the same as year 2013.

For year 2016, the $PE_{EC,y}$ is calculated as (50 + 37 + 113 + 239 + 55 + 160 + 57) MWh x 0.742 tCO_2eq/MWh x (1+0.1) * (6/12) (for January – June 2016) = 290 tCO_2eq.

For $PE_{FC,y}$, for this project, is the emission from diesel backup generators. In ex-ante emission calculation, the diesel consumption is considered zero, because the diesel generator installed at the site is used only in emergency case when no electricity import from the national grid.The fuel consumption will be monitored during the actual implementation.

During the actual implementation, to calculate ex-ante $PE_{FC,y}$, the *"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 2)* will be used.

$$PE_{FC,j,y} = \sum FC_{i,j,y} \times COEF_{i,y} \quad (9)$$

Where:

[23] Tenaga National Berhad (TNB) is the largest electricity provider in Malaysia and responsible for the grid transmission and distribution in Peninsula Malaysia.

[24] http://announcements.bursamalaysia.com/EDMS/subweb.nsf/7f04516f8098680348256c6f0017a6bf/303144432ec5170e482573af00388df6/$FILE/TENAGA-Cover%20to%20Page%2050%20(2.3MB).pdf

[25] Emission factor of grid electricity in Peninsular Malaysia (see page 36 for details).

$PE_{FC,j,y}$	CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr)
$FC_{i,j,y}$	Quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)
$COEF_{i,y}$	CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)

Option B is selected to calculate $COEF_{i,y}$, The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type i, as follows:

$$COEF_{i,y} = NCV_{,i,y} \text{ x } EF_{CO2,I,y} \tag{10}$$

Where:

$COEF_{i,y}$	CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
$NCV_{,i,y}$	Weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,I,y}$	Weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)

From Flaring

Project emissions from flaring will be calculated based on the "Tool to determine project emissions from flaring gases containing methane" *(EB 28 Annex 13)*.

$$MD_{flared,y} = (LFG_{flare,y} \cdot w_{CH4,y} \cdot D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \tag{11}$$

Where:

$MD_{flared,y}$	Quantity of methane destroyed by flaring (tCH_4)
$LFG_{flare,y}$	Quantity of LFG fed to the flare during year y measured in cubic meters (m^3)
$w_{CH4,y}$	Average methane fraction of the LFG as measured during year *y* and expressed as a fraction (in m^3CH_4/m^3LFG)
D_{CH4}	Methane density expressed in tonnes of methane per cubic meter of methane (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"*

The $\mathbf{PE_{flare,y}}$ is calculated as below:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \cdot (1-\eta_{flare,h}) \cdot \frac{GWP_{CH4}}{1000} \tag{12}$$

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year y (tCO_2e)
$\eta_{flare,h}$	Flare efficiency in hour h
GWP_{CH4}	Global Warming Potential of methane valid for the commitment period, tCO_2e/tCH_4
$TM_{RG,h}$	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h

The project will install a *fully enclosed high temperature flaring system* with flaring efficiency around 99% (technical specification by flare supplier). The project developer however undertakes a conservative approach with the monitoring of project emissions from flaring by selecting the default value (90%) for enclosed flares efficiency ($\eta_{flare,h}$). For this approach, continuous monitoring of compliance with manufacturer's specification of flare temperature ($T_{flare,y}$), flow rate of residual gas at the inlet of the flare ($LFG_{flare,y}$) will be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, the flare efficiency will be determined as follows (according to "Tool to determine project emissions from flaring gases containing methane" (EB 28 Annex 13):

- 0% if the temperature in the exhaust gas of the flare ($T_{flare,y}$) is below 500 °C for more than 20 minutes during the hour *h*.
- 50%, if the temperature in the exhaust gas of the flare ($T_{flare,y}$) is above 500 °C for more than 40 minutes during the hour *h,* but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.
- 90%, if the temperature in the exhaust gas of the flare ($T_{flare,y}$) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

The flare temperature will be monitored according to the monitoring plan (Page 53).

B.6.2. Data and parameters fixed ex ante

The applicable data and parameters to this project include:

Data / Parameter	**Regulatory requirement relating to landfill gas projects**
Unit	-
Description	Regulatory requirement relating to landfill gas projects
Source of data	There are no regulatory requirement to recovery and utilize landfill gas in Malaysia. Validator can contact the Conservation and Environmental Management Department of the Ministry of Natural Resources and Environment (NRE) Malaysia (also the DNA), Department of Environment (under NRE), Department of National Solid Waste Department of the Ministry of Housing and Local Government and the Kuala Lumpur City Hall regarding regulation aspects of landfill gas.
Value(s) applied	NA
Choice of data or Measurement methods and procedures	NA
Purpose of data	NA
Additional comment	References of the non-existence of regulatory requirement for landfill gas project are given in Step 1 b of B4 above in this PDD.

Data / Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global warming potential of CH4
Source of data	With reference to decision 4/CMP7 and paragraph 66 of the EB 69 Meeting Report, for the second commitment period of the Kyoto Protocol, the global warming potentials used by Parties to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of the greenhouse gases listed in Annex A to the Kyoto Protocol shall be those listed in the column entitled “Global Warming Potential for Given Time Horizon” in Table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, i.e. 25 tCO_2/tCH_4
Value(s) applied	21 for the first commitment period 25 for second commitment period
Choice of data or Measurement methods and procedures	21 for the first commitment period. 25 for second commitment period. Shall be updated according to any future COP/MOP decisions
Purpose of data	Baseline emission calculation
Additional comment	NA

Data / Parameter	D_{CH4}
Unit	t_{CH4}/m^3_{CH4}
Description	Methane density
Source of data	ACM0001/Version 08 – *“Consolidated baseline and monitoring methodology for landfill gas project activities”*
Value(s) applied	0.0007168
Choice of data or Measurement methods and procedures	At standard temperature and pressure: 0 degree Celsius and 1,013 bar, the methane density applied is 0.0007168 t_{CH4}/m^3_{CH4}
Purpose of data	Baseline and project emission calculation
Additional comment	NA

Data / Parameter	**φ**
Unit	-
Description	Model correction factor to account for model uncertainties
Source of data	This uncertainty factor was adopted and the value of 0.9 based on recommendations in the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*".
Value(s) applied	0.9
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	NA

Data / Parameter	**f**
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner.
Source of data	*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*
Value(s) applied	0
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	There are no methane flaring, combustion or other usage of the methane in the baseline scenario.

Data / Parameter	**OX**
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	Site visit reveals that this landfill is well managed and soil cover is applied on a daily basis. Therefore, the value of 0.1 was applied as recommended by the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*".
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	NA

Data / Parameter	**F**
Unit	%
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	This value is applied based on the recommendation of the IPCC in the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".*
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	NA

Data / Parameter	**DOC_f**
Unit	%
Description	Fraction of degradable organic carbon (DOC) that can decompose
Source of data	This value is applied based on IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	NA

Data / Parameter	**MCF**
Unit	-
Description	Methane Correction Factor
Source of data	This value is applied based on the recommendation of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. The Bukit Tagar landfill site is a fully **anaerobic managed solid waste disposal sites**. The waste received at the landfill is deposited at specific tipping face and there is no scavenging of waste in the landfill. Waste are covered daily with compacted soil and compaction as well as leveling are practiced based on international landfill operational practices.
Value(s) applied	1.0
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	NA

Data / Parameter	**DOC_j**
Unit	-
Description	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data	The above values were adopted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 2.4)
Value(s) applied	The following values for the different waste fractions (types) were applied: (see table below)
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	NA

DOC_j		
Waste type j	**DOC_j (% wet basis)**	**DOC_j (% dry basis)**
Wood and wood products	**43**	50
Pulp, paper and cardboard (other than sludge)	**40**	44
Food, food waste, beverages and tobacco (other than sludge)	**15**	38
Textiles	**24**	30
Garden, yard and park waste	**20**	49
Glass, plastic, metal, other inert waste	**0**	0
Nappies	**24**	60

Data / Parameter	k_j
Unit	-
Description	Decay rate for the waste type *j*
Source of data	The above values were adopted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value(s) applied	The following values for the different waste fractions (types) were applied: (see table below)
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission calculation
Additional comment	The project site is located in the State of Selangor, Malaysia. The climate is tropical with an annual mean 24 hr temperature of approximately 27 degree Celsius and annual mean precipitation of around 2700 mm. These values are long term average documented in the EIA Report prepared for the landfill in 2005. Thus, the k values for tropical temperature and wet climate was used.

Waste type j		**Boreal and Temperate (MAT<20°C)**		**Tropical (MAT>20°C)**	
		Dry (MAP/PET <1)	**Wet (MAP/PET >1)**	**Dry (MAP< 1000mm)**	**Wet (MAP> 1000mm)**
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	**0.07**
Slowly degrading	Wood, wood products and straw	0.02	0.03	0.025	**0.035**
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.1	0.065	**0.17**
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	**0.4**

B.6.3. Ex ante calculation of emission reductions

Based on the above formula and values, the baseline methane emissions were estimated from 2005 to 2015. We assumed 50% degradation on the first year of disposal (this is considered conservative).

The total baseline methane emissions were calculated based on a different collection efficiency estimated for the 2 cells (Advanced and Phase 1 cell). Average 50% collection efficiency was used for the Advanced cell (which was closed in November 2007) and 40% collection efficiency was used for the Phase 1 (operating until 2012)[26]. It is believed that the gas extraction will be more effective in the closed cell as compared to the operating landfills. The operation of the landfilling may reduce the collection efficiency of the landfill gas. These estimates used are considered conservative. Most landfill gas projects nowadays with proper design claim to achieve efficiency rate between 60-70%[27].

Crediting Year	BEch4,swds generated (tCO_2eq)	BEch4,swds not captured (tCO_2eq)	BEch4,swds captured (tCO_2eq)
2009 July	149,779	83,610	66,168
2010	347,998	173,999	173,999
2011	392,567	196,284	196,284
2012	434,788	217,394	217,394
2013	475,725	221,770	253,955
2014	516,136	244,287	271,849
2015	546,275	261,125	285,151
2016 June	339,451	163,399	176,052

The amount of methane captured will be used to feed in the gas engine for power generation while the remaining will be sent to the flare. The ex-ante baseline emissions of methane for power generation and flaring are calculated and summarised below:

Crediting Year	Total BEch4,swds captured (tCO_2eq)	Estimated Power generation from LFG (MWh)	Methane for Power Generation (t)	Methane for Power Generation (tCO_2eq)	Methane to Flare (tCO_2eq)
2009 July	66,168	-	-	-	66,168
2010	173,999	-	-	-	173,999
2011	196,284	14,191	2,543	53,404	142,879
2012	217,394	14,191	2,543	53,404	163,990
2013	253,955	31,536	6,787	142,530	111,424
2014	271,849	31,536	6,787	142,530	129,318
2015	285,151	31,536	6,787	142,530	142,620
2016 June	176,052	21,681	4,666	116,654	59,398

Assumptions: LHV 5 kWh / m^3 of landfill gas, 50% methane / m^3 of LFG, (2009 – 2012) and 60.05% methane / m^3 of LFG (2013 onwards) Density of 0.0007168 ton/m^3, GWP CH4 =21, Capacity load = 90%

[26] Personal Communication with GasCon A/S / Q2 Engineering Sdn Bhd, 15 January 2008.

[27] Personal Communication with Landfill Gas and Power Pty Ltd. 7 December 2007.

Baseline emissions from electricity

Since the baseline electricity source avoided is electricity generated by plants connected to the TNB national grid of Peninsula Malaysia, the emission factor should be calculated according to *"Tool to calculate the emission factor for an electricity system" (Version 01)*.
Latest available baseline electricity data was obtained from the Malaysia Energy Centre (PTM) 1st July 2008[28]. These data were used on the Study on Grid Connected Electricity Baselines in Malaysia (Year 2005) published by the Malaysia Energy Centre (PTM) in January 2008[29]. The grid electricity baseline calculations for large scale projects in the published report was based on fuel emission factors using "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" instead of the values published in the latest "2006 IPCC Guidelines for National Greenhouse Gas Inventories". The following calculations were carried out using fuel emission factor published in 2006 IPCC Guidelines mentioned above.

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 (largest national utility company in Malaysia), 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 Bukit Tagar today is imported from the *national grid of Peninsular Malaysia*.

Step 2. 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 3. 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 (tCO_2/MWh) of all generating power plants serving the system in Peninsula Malaysia, not including low-cost / must-run power plants / units.

Data on fuel consumption and net electricity generation of each power plant / unit(Option A) is used.

The $EF_{grid,OMsimple,y}$ is calculated based on the following formula:

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{m} EG_{m,y}} \qquad (13)$$

Where:

[28] A "Non-Disclosure Agreement" was signed for these raw data obtained. These data, under the agreement, must not be released in whole or part to any third party.

[29] http://cdm.eib.org.my/upload/articles1016,article,1204621745,CDMBaseline2005.pdf

$EF_{grid,OM,simple,y}$	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	Amount of fossil fuel type *i* consumed by relevant power sources *j* in year *y*
$NCV_{i,y}$	Net calorific value of the unit of fuel i (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	Net electricity generated and delivered to the grid by source m (MWh)

The Simple OM is calculated using the data of all operational fossil fuel fired power plants generating electricity to the grid for the years 2003, 2004 and 2005[30].

	Simple Operating Margin (OM)
2003	0.565
2004	0.637
2005	0.594
Average	**0.598**

Step 4. Identify the cohort 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 five power units that have been built most recently. The source of data is from the Energy Commission of Malaysia.

The latest available data reveals that these five power units as follows:

Name	Type	Capacity (MW)	Fuel Consumption (TJ)	CO2 Emission (ton) IPCC2006
Tunku Jaafar Power Station	CC	714	20,914	1,173,441
Janamanjung Power Station	Conv	2,100	112,024	10,597,206
TTPC Perlis Power	CC	650	91,678	6,784,883
Panglima Power Station	CC	720	36,162	2,034,668
SKS Prai	OC	350	15,855	890,296
Total		4,534	276,633	21,480,494
Comprises more than 20% of the total production			**Build Margin**	**0.645**

In terms of vintage of data for the first credit period (2009 March – 2015 February), 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.

[30] Derived from raw data obtained from Malaysian Energy Centre, 1 July 2008.

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 5. Calculate the build margin (BM) emission factor.

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (14)$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emissions 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)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh) *see equation (15)*
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available

The calculations of “Build Margin” are based on the weighted average emissions of the 5 most recently installed power plants in Peninsular Malaysia (data obtained from Malaysia Energy Centre 1 July 2008 as listed in Step 4 above). The total power output generated by these 5 plants in 2005 is 33,291 GWh. This is around 35% (i.e. more than 20% as stipulated by the *“Tool to calculate the emission factor for an electricity system” (Version 01))* of the total system generation in Peninsular Malaysia (93,526 GWh).

The total CO_2 emission from the 5 power plants is calculated to be 21,480,494 tons CO_2.Therefore the calculated Build Margin for Peninsular Malaysia is 21,480,494 tons CO_2/33,291,000MWh = ***0.645 t CO_2/MWh.***

Step 6. Calculate the combined margin (CM) emissions factor.

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \cdot W_{OM} + EF_{grid,BM,y} \cdot W_{BM} \quad (15)$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year (tCO_2/MWh)
W_{OM}	Weighting of operating margin emissions factor (%)
W_{BM}	Weighting of built margin emissions factor (%)

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

Thus, the calculations are as below:
$EF_{grid,CM,y}$= 0.598 x 0.5 + 0.645 x 0.5 = ***0.622 tCO_2/MWh.***

The latest grid emission factor for 2013 is 0.742 tCO2/MWh. As a result, the emission reduction calculation will apply 0.742 tCO_2/MWh from 2016 onwards

The ex-ante emissions from power generation derived from landfill gas is calculated as below:

Crediting Year	Estimated Power generation from LFG(MWh)	CoEF of Grid Power (tCO_2eq/MWh)	Ex-ante Emissions (tCO_2eq) from Power Generation ($MD_{electricity,y}$)
2009 July	-	0.622	-
2010	-	0.622	-
2011	14,191	0.622	8,827
2012	14,191	0.622	8,827
2013	31,536	0.622	19,615
2014	31,536	0.622	19,615
2015	31,536	0.622	19,615
2016 June	21,681	0.742	16,087

Assumptions: CEF Grid = 0.622 t CO_2/MWh (July 2009 – 2015), 0.742 t CO_2/MWh from 2016 onwards, overall average gas engine capacity load of 90%.

The overall *ex-ante baseline emissions* $BE_{,y}$ is summarised below:

Crediting Year	BEch4,swds captured (tCO_2e)	Baseline Emissions (tCO_2eq) from Power Generation	Total BE (tCO_2e)
2009 July	66,168	0	**83,610**
2010	173,999	0	**173,999**
2011	196,284	8,827	**205,111**
2012	217,394	8,827	**226,221**
2013	253,955	19,615	**273,570**
2014	271,849	19,615	**291,464**
2015	285,151	19,615	**304,766**
2016 June	176,052	16,087	**192,139**

Leakage

According to ACM0001 (Version 8), no leakage effects need to be accounted for in this project.

The overall ex-ante project emissions (PE_y for electricity consumption and flaring) are summarized in tabular form below:

Crediting Year	$PE_{EC,y}$ (tCO_2eq)	$PE_{FC,j,y}$ (tCO_2eq)	$PE_{flare,y}$ (tCO_2eq)	Total Project Emissions - PE_y (tCO_2eq)
2009 July	7	0	5,955	**5,962**
2010	13	0	15,660	**15,673**
2011	13	0	12,859	**12,873**
2012	13	0	14,759	**14,773**
2013	338	0	10,028	**10,366**
2014	338	0	11,639	**11,977**
2015	338	0	12,836	**13,174**
2016 June	290	0	5,346	**5,636**

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2009 July	83,610	5,962	0	77,648
2010	173,999	15,673	0	158,326
2011	205,111	12,873	0	192,238
2012	226,221	14,773	0	211,448
2013	273,570	10,366	0	263,204
2014	291,464	11,977	0	279,487
2015	304,766	13,174	0	291,592
2016 June	192,139	5,636	0	186,503
Total	**1,750,880**	**90,433**	**0**	**1,660,447**
Total number of crediting years	**7**			
Annual average over the crediting period	**250,126**	**12,919**	**0**	**237,207**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	**$LFG_{total,y}$**
Unit	m^3
Description	Total amount of landfill gas captured during the project at normal temperature and pressure.
Source of data	Continuous measurement by flow meters during operation of project activity. During temporary malfunctioning of flow meters or data logging system resulting in unrepresentative data, the value of LFG_{total} for the affected period will be taken as the sum of LFG_{flare} and $LFG_{eletricity,y}$.
Value(s) applied	**86,873,515**m^3 (2009 July – 2012) as calculated in the ex-ante emissions (50% volume, fraction of methane in landfill gas) **109,191,658**m^3 (2013 – 2016 June) as calculated in the ex-ante emissions 60.05% volume, fraction of methane in landfill gas
Measurement methods and procedures	Measured with flow meters. Data will be aggregated on both a monthly and yearly basis
Monitoring frequency	Continuous measurement
QA/QC procedures	Flow meters will be tested, calibrated and maintained regularly
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	**$LFG_{flare,y}$**
Unit	m^3
Description	Total amount of landfill gas sent to flare at normal temperature and pressure.
Source of data	Continuous measurement by flow meters during operation of project activity. During temporary malfunctioning of flow meters or data logging system resulting in unrepresentative data, the value of LFG_{flare} for the affected period will be derived by subtracting $LFG_{electricity}$ from $LFG_{total,y.}$
Value(s) applied	**72,682,315**m^3 (2009 July – 2012) as calculated in the ex-ante emissions (50% volume, fraction of methane in landfill gas) **47,930,920**m^3 (2013 – 2016 June) as calculated in the ex-ante emissions 60.05% volume, fraction of methane in landfill gas
Measurement methods and procedures	Measured with flow meters. Data will be aggregated on both a monthly and yearly basis
Monitoring frequency	Continuous measurement
QA/QC procedures	Flow meters will be tested, calibrated and maintained regularly.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	$LFG_{electricity,y}$
Unit	m^3
Description	Amount of landfill gas combusted in power plant (gas engines) at normal temperature and pressure.
Source of data	Continuous measurement by flow meters during operation of project activity. During temporary malfunctioning of flow meters or data logging system resulting in unrepresentative data, the value of $LFG_{electricity}$ for the affected period will be derived by subtracting LFG_{flare} from $LFG_{total,y}$
Value(s) applied	**14,191,200** m^3 (2009 July – 2012) as calculated in the ex-ante emissions (50% volume, fraction of methane in landfill gas) **61,260,738** m^3 (2013 – 2016 June) as calculated in the ex-ante emissions 60.05% volume, fraction of methane in landfill gas
Measurement methods and procedures	Measured with flow meters. Data will be aggregated both monthly and yearly
Monitoring frequency	Continuous measurement
QA/QC procedures	Flow meters will be tested, calibrated and maintained regularly.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	$PE_{flare,y}$
Unit	tCO_{2e}
Description	Project emissions from flaring of the residual gas stream in year y
Source of data	Calculated as per the “Tool to determine project emissions from flaring gases containing Methane”.
Value(s) applied	**89,082** tCO_{2e} for first credit period (2009 July – 2016 June) calculated as per the “Tool to determine project emissions from flaring gases containing Methane”.
Measurement methods and procedures	As per the “Tool to determine project emissions from flaring gases containing Methane”.
Monitoring frequency	-
QA/QC procedures	As per the “Tool to determine project emissions from flaring gases containing Methane”.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	w_{CH4}
Unit	m^3 CH4 / m^3 LFG
Description	Fraction of methane in landfill gas
Source of data	Continuous measurement by using certified equipment. In case of temporary situation such as the installed CH_4 gas analyser mal-functioned or giving unrepresentative results due to data logging problem, the w_{CH4} shall be measured manually with portable gas analyser according to ACM 0001 version 8.At least 8 hourly samples shall be taken per operating day. For any affected day, the calculation of the values measured using the portable analyser will be based on the *Guidelines to calculate the fraction of methane in the landfill gas from periodical measurements* (Version 01). As conservative approach, the lower bound of the 95% Confidence Interval will be applied as per guideline.
Value(s) applied	50% volume (June 2009 – 2012) and 60.05%[31] volume (2013 onwards)
Measurement methods and procedures	The methane fraction will be measured continuously with certified equipment or measured manually with portable gas analyser during emergency cases.
Monitoring frequency	Continuous measurement
QA/QC procedures	The methane gas analysers will be checked and calibrated regularly according to the manual given by the manufacturer.
Purpose of data	Baseline emission calculation
Additional comment	Referring to AM_CLA_0092, for LFG temperatures below 60°C, moisture could be neglected due to its very low influence on final results, thus measurement in wet or dry basis are not important (as reflected in the amendments to ACM 0001 version 9.1 onwards). In the case where LFG temperature exceeds 60°C, the same basis for both methane concentration and flow measurement will be considered according to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 2.0).

[31] Average fraction of methane in landfill gas calculated from actual monitored data from August 2009 – June 2012 for flare 1 and flare 2

Data / Parameter	**T**
Unit	°C
Description	Temperature of the landfill gas.
Source of data	Continuous measurement by temperature transmitters. This value is to be used to determine density of methane.
Value(s) applied	The temperature of the LFG is expected to be about 24°C. This is based on reference to actual measurement results done in another landfill gas project (Air Hitam Landfill Gas Recovery and Utilisation) that has been running for 2 years.
Measurement methods and procedures	Measured continuously by temperature transmitters (as part of the flow meters).
Monitoring frequency	Continuous measurement
QA/QC procedures	The temperature transmitters will be tested and calibrated regularly according to the manual given by the manufacturer.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	**P**
Unit	Pa
Description	Pressure of the landfill gas.
Source of data	Continuous measurement by using the integrated flow meters with function to measure pressure. This value is to be used to determine density of methane.
Value(s) applied	The pressure of the landfill gas is expected to be at atmospheric pressure 101,300 Pa (1atm)
Measurement methods and procedures	Measured continuously with integrated flow meters with function to measure pressure.
Monitoring frequency	Continuous measurement
QA/QC procedures	The meters will be checked and calibrated regularly according to the manual given by the manufacturer.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	EL_{LFG}
Unit	MWh
Description	Net amount of electricity generated using landfill gas
Source of data	Data as measured by electricity meters to be installed.
Value(s) applied	The total net amount is estimated at **144,671**MWh within the first crediting period (2009 July – 2016 June) based on the ex-ante calculation.
Measurement methods and procedures	Measured continuously with electricity meters installed. The amount of electricity generated is recorded by installed electricity meter (EL4, EL9, EL10 and EL12). (Figure 10)
Monitoring frequency	Continuous measurement

QA/QC procedures	As a quality control procedure, the amount of electricity actually uploaded to grid will be measured by another electricity meter (EL5, EL11 and EL13) and compared with the amount of electricity recorded by installed electricity meter (EL4, EL9, EL10 and EL12). Lower value of the amount will be taken as the net amount for emission reduction calculations. Electricity meters (except the meter owned by the grid operator, i.e. EL5, EL11 and EL13) will be checked and calibrated regularly according to manufacturer's recommendations.
Purpose of data	Baseline emission calculation
Additional comment	The meters EL5, EL11 and EL13 are owned by the grid operator and thus, it is not within the control of the project. The calibration of the meter s will be based on the grid operator's requirement and standard practice

Data / Parameter	$CEF_{elec,PR,y}$
Unit	tCO_2/MWh
Description	Carbon emission factor of electricity
Source of data	Calculated.
Value(s) applied	0.622 (July 2009 – 2015) calculated based on *"Tool to calculate the emission factor for an electricity system" (Version 1)*. 0.742 (Jan – June 2016) calculated based on "*Tool to calculate the emission factor for an electricity system" (Version 04.0).*
Measurement methods and procedures	To be calculated based on *"Tool for calculation of emission factor for electricity systems" (Version 01 & version 04.0)*.
Monitoring frequency	NA
QA/QC procedures	Not applicable.
Purpose of data	Baseline and project emission calculation
Additional comment	-

Data / Parameter	**Operation of the energy plant (t)**
Unit	Hours
Description	Operation of the energy plant
Source of data	Based on actual documented operating hours.
Value(s) applied	7,884 hours (90% capacity load). This is conservative as disruption and maintenance is expected to be minimal.
Measurement methods and procedures	This is monitored annually using run time meters to ensure methane destruction is claimed for methane used in the electricity plant when it is operational
Monitoring frequency	Annually
QA/QC procedures	The run time meters will be checked and calibrated regularly according to the manual given by the manufacturer.
Purpose of data	-
Additional comment	-

Data / Parameter	$EL_{PJ,y}$
Unit	MWh
Description	Quantity of electricity consumption by project activity.
Source of data	Based on continuous measurement by sealed electricity meters installed.
Value(s) applied	*Before 1.2MW landfill gas engine installed* 197 MWh calculated based on electricity need estimates by technological supplier. This is only applicable since power consumption will be sourced from grid. *After 3.12MW landfill gas engine installed* From June 2011, power will be generated from the landfill gas by using the 1.2MW gas engine and 3.12MW gas engines (expected to be commissioned in year 2013) and thus, replacing the source of power for project activity (flaring and gas engine) consumptions. The quantity of electricity consumed from grid during the down time, breakdown or maintenance of the gas engines was estimated to be around 494MWh. *After 2MW landfill gas engine installed* From 2016, power will be generated from the landfill gas by using the 1.2MW gas engine, 3.12MW gas engines and 2MW gas engine (initial operation date in October 2015) and thus, replacing the source of power for project activity (flaring and gas engine) consumptions. The quantity of electricity consumed from grid during the down time, breakdown or maintenance of the gas engines was estimated to be around 711MWh. The quantity of electricity consumed by project activity will be recorded by installed electricity meter EL6 which measured the total electricity consumed by the project activity (Flare 1, Flare 2, Gas Engine No.1, Gas Engine No.2, Gas Engine No.3, Gas Engine No.4, GSS 1 and GSS 2) (Figure 10). In case of temporary situation such as the installed electricity meter mal-functioned (EL6) leading to no readings captured, $EL_{PJ,y}$ shall be estimated or calculated as described as below: 1. Using the backup meter EL1 which recorded the actual power consumption for Flare 1, Flare 2 and Gas Engine No.1; 2. For Gas Engine No. 2, Gas Engine No.3, Gas Engine No.4, GSS 1 and GSS 2, the power consumption will be estimated using the power rating (technical specifications) of the system involved during the power generation. The power consumed will be calculated based on the operating maximum capacity for the full period, including the 10% addition to account for transmission and distribution losses, according to paragraph 2 (3), Appendix 1 of the CDM Project Standard, version 09.0. In the case of project GHG emissions related to the consumption of electricity, the estimate shall include an addition of 10% to account transmission and distribution losses. In the case temporary situation where EL1 is mal-functioned leading to

	no reading captured, the power consumption for Flare 1, Flare 2 and Gas Engine No.1 will be using the estimated historical data (April 2013 to March 2015) of 72.96 MWh and compared with the calculated future 24 months data prior the malfunction period and, whichever higher will be applied for the project emission calculation. The higher power consumption selected for the project emission calculation shall be derived based on 95% confidence interval principles (source: IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, page 6.6). The upper bound of 95% confidence interval with reference to the above mentioned guideline to be applied. Additional 10% will be added to the upper bound of the interval boundaries calculated to account for transmission and distribution losses, according to paragraph 2 (3), Appendix 1 of the CDM Project Standard, version 09.0. In the case of project GHG emissions related to the consumption of electricity, the estimate shall include an addition of 10% to account for transmission and distribution losses
Measurement methods and procedures	The consumption of electricity ex-post will be measured by ammeters (electricity meters). The value will be used to determine the project emissions from project activity ($PE_{EC,y}$) based on the “Tool to calculate project emissions from electricity consumption” *(Version 1).*
Monitoring frequency	Continuous measurement
QA/QC procedures	The electricity meters should be tested and calibrated as per the specifications prescribed by the manufacturer.
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$\mathbf{T_{flare,y}}$
Unit	°C
Description	Temperature in exhaust gas of the enclosed flare.
Source of data	Continuous measurement by temperature transmitters.
Value(s) applied	The exhaust gas from the enclosed flare is expected to be in the range of 800-1200°C. Temperature above 500°C indicates that the flare is operated in a reliable way where the default value of destruction efficiency of 90% is valid.
Measurement methods and procedures	The enclosed flare is monitored continuously by temperature transmitters.
Monitoring frequency	Continuous measurement
QA/QC procedures	The temperature transmitters will be tested and calibrated as per the specifications prescribed by the manufacturer.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	$FC_{i,j,y}$
Unit	ton/yr
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements
Value(s) applied	-
Measurement methods and procedures	Onsite measurements using fuel meter, the measurement from fuel meter is in liter, for the calculation, the amount of diesel in liter will be convert to tonne/year by multiply the density of diesel (kg/l).
Monitoring frequency	Continuously
QA/QC procedures	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Purpose of data	Project emission
Additional comment	-

Data / Parameter	$EFCO_{2,i,y}$
Unit	tCO_2/GJ
Description	Weighted average CO2 emission factor of fuel type i in year y
Source of data	Option A will be used is the value are available from the fuel supplier in invoices; Option D will be used if there is no data available from the fuel supplier.
Value(s) applied	0.0741
Measurement methods and procedures	If the values are provided by fuel supplier, the measurements should be undertaken in line with national or international fuel standards. If the value is according to IPCC default value, any future revision of the IPCC Guidelines should be taken into account.
Monitoring frequency	For a): The CO_2 emission factor should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For d): Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures	-
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$NCV_{i,y}$
Unit	GJ/ton
Description	Weighted average net calorific value of fuel type i in year y
Source of data	Option A will be used is the value are available from the fuel supplier in invoices; Option D will be used if there is no data available from the fuel supplier.
Value(s) applied	43
Measurement methods and procedures	If the values are provided by fuel supplier, the measurements should be undertaken in line with national or international fuel standards.

	If the value is according to IPCC default value, any future revision of the IPCC Guidelines should be taken into account
Monitoring frequency	For a): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For d): Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures	If option A value is used for the calculation, verify if the values under a) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a) should have ISO17025 accreditation or justify that they can comply with similar quality standards.
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$\rho_{i,y}$
Unit	Kg/l
Description	Weighted average density of fuel type i in year y
Source of data	Option A will be used is the value are available from the fuel supplier in invoices; Option C which is regional or national default values will be used if there is no data available from the fuel supplier.
Value(s) applied	0.84
Measurement methods and procedures	If the values are provided by fuel supplier, the measurements should be undertaken in line with national or international fuel standards. If the value is according to national data (Petronas-http://www.pecj.or.jp/japanese/overseas/asian/asia_symp_5th/pdf_5th/8-FazilMatIsa.pdf), any future revision of the data should be taken into account.
Monitoring frequency	For a): The density should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For c): Any future revision of the data should be taken into account
QA/QC procedures	-
Purpose of data	Project emission calculation
Additional comment	-

B.7.2. Sampling plan

Not applicable.

B.7.3. Other elements of monitoring plan

The monitoring plan for this project includes all monitoring requirements following the procedures set by ACM0001 (version 8). The monitoring will be based on direct and continuous measurement of the amount of landfill gas captured and destroyed at the flare platform or sent for generating electricity.

The main variables that need to be monitored during project activity include:

- Total quantity of landfill gas captured ($LFG_{total,y}$) in m^3;
- Temperature (T in ^oC) and pressure (P in Pa) of landfill gas captured;
- Methane fraction of landfill gas captured ($w_{CH4,y}$ - %);
- Total quantity of landfill gas captured that is sent to the enclosed flares ($LFG_{flare,y}$ in m^3);
- Total quantity of landfill gas sent to gas engines for electricity generation ($LFG_{electricity,y}$ in m^3);
- Total electricity generated from the landfill gas ($EL_{LFG,y}$ in MWh)*;*
- Total electricity consumed by project activity from grid ($EL_{PJ,y}$ in MWh) – before landfill gas engine is installed and including during downtime of landfill gas power generator*;*
- Temperature in exhaust gas of the enclosed flares ($T_{flare,y}$ in ^oC);
- Project emissions from $PE_{flare,y}$ to be determined based on latest “Tool to determine project emissions from flaring gases containing Methane”.

The monitoring measurement method and quality assurance/control description for the different parameters can be found in B7.1 above.

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

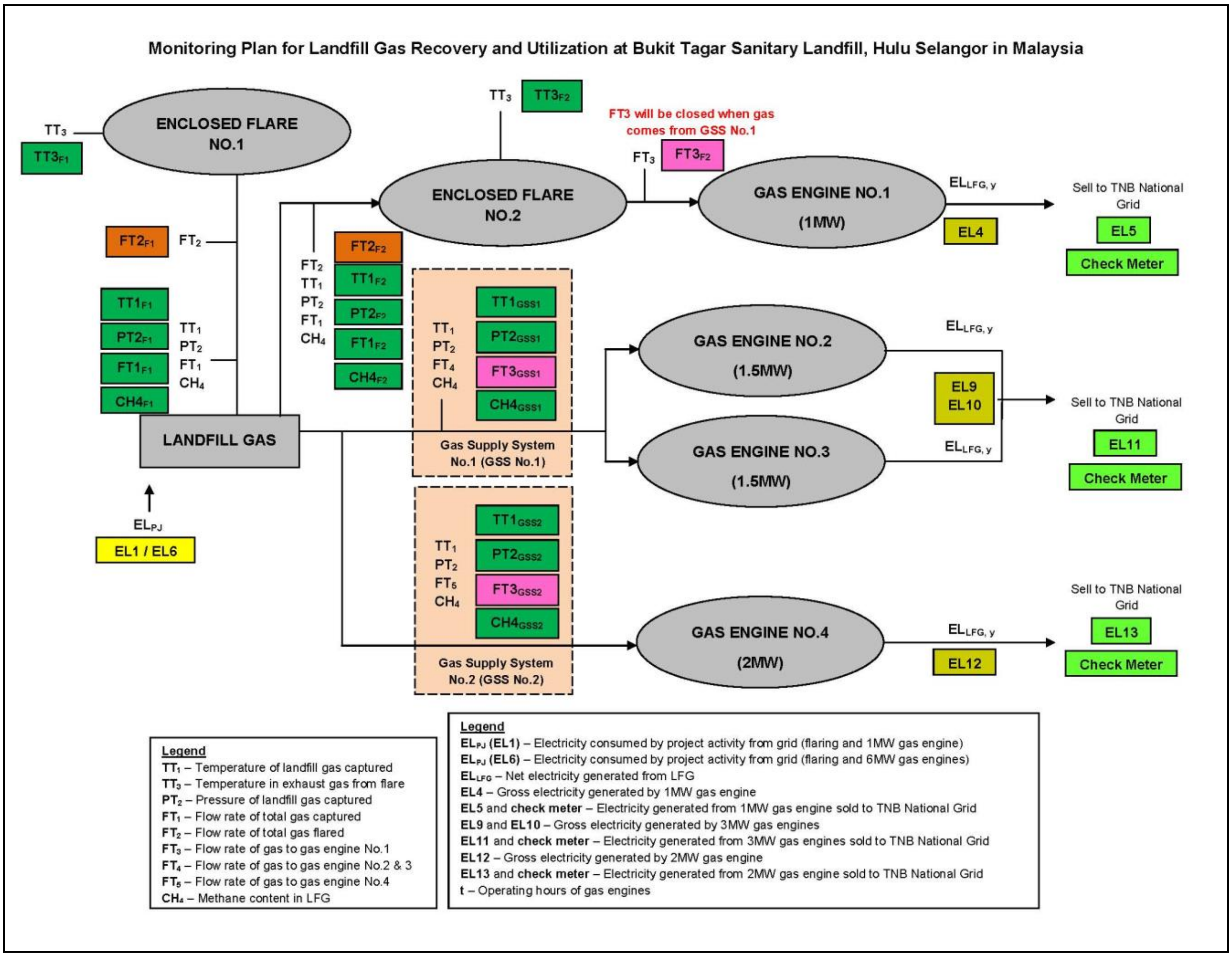


Figure 10: Monitoring Plan for Landfill Gas to Energy and Flare System at Bukit Tagar
Source: Own Illustration

As data will be captured separately in the flaring and power generation system in the different cells (Flare No.1, Flare No.2, Flare No.3 and so forth), a subscript specific to the cell will be assigned to the monitoring parameters of the different equipment installed at different cells.

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 ($MD_{BL,y}$).

Implementation of the Monitoring Plan

The landfill gas system operator will adopt the instructions presented in the monitoring plan and ensure all activities related to the implementation of the procedures given in the guidelines for LFG plant operation and monitoring are implemented. The main responsibilities of monitoring include:

- Data reading and handling: maintaining an adequate system for collecting, recording and storing data in accordance with the protocols determined by the monitoring plan as well as checking data quality, collection and record keeping procedures on a regular basis. This also includes making sure that all relevant electronic data is backed-up electronically for at least 2 years after the end of crediting period in case of an unanticipated loss of data. The data recording frequency and requirement are detailed in B7.1 above;
- In the case of erroneous data recorded for the monitored parameter occurred during short period, data for the affected period shall be derived based on the approach based on 95% confidence interval principles (source: IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, page 6.6). A total of 10 readings before and after the constant period will be used to calculate the lower bound of 95% confidence interval with reference to the above mentioned guideline. The lower bound of the interval boundaries calculated will be applied to the period for the constant data as a conservative approach;
- Reporting: preparing periodic summaries and reports that include emission reductions generated and observations regarding monitoring plan procedures;
- Training: assuring assigned personnel received adequate and regular training on project performances and the monitoring plan. Any new staff taking over the role of monitoring and reporting will be fully trained as well; and
- Quality control and quality assurance: complying with quality control and quality assurance procedures to facilitate periodical audits and verification. Any observation of matters affecting data quality will be reported to the management immediately.

Responsibility of Monitoring Plan

A dedicated CDM monitoring team will be assigned to be responsible for undertaking the monitoring as well as the quality control and assurance tasks. The following are the position and responsibility of the CDM monitoring team:

Personnel	Description of Roles in Monitoring Plan
Management Representative	• Reports to and obtain decisions from management on CDM-related matters • Chairs internal meetings on CDM matters • Signs off official correspondence for external parties

Personnel	Description of Roles in Monitoring Plan
Deputy General Manager - Operation	• Reports to the management representative (MR) • Oversees entire operation of landfills (including LFG management system) • Covers responsibility of CDM Manager when he is not available
CDM Manager	• Reports to the Deputy General Manager - Operation • Oversees and coordinates the entire CDM monitoring plan • Verifies and signs off all relevant monitoring records • Ensures Quality Control / Quality Assurance (QC/QA) is carried out • Ensures all data are recorded and necessary documentations are prepared according to the requirements of CDM monitoring • Responsible in optimising the LFG extraction and utilisation system
Engineer	• Reports to the CDM Manager • Assists the CDM Manager in performing CDM monitoring works • To monitor daily operation for landfill gas operations • To assist in daily monitoring records for all CDM related equipment • To prepare daily summary record for landfill gas operation
Supervisors	• Report to the CDM Manager on CDM monitoring issues • Check and ensure that the flaring system is functional • Ensure all data recording devices are functioning and calibrated as planned (including performing QA/QC) • Check and sign the daily monitoring log sheets for CDM monitoring • Supervise general workers in maintenance work and record monitored parameters for CDM monitoring • Identify maintenance requirement and contact the supplier if maintenance and support are needed • Optimise the flare operation together with the CDM Manager • Responsible with the security of locked Programmable Logic Controller (PLC) control room. The supervisor will hold the door key for the PLC control room
General Workers	• Perform regular operational and maintenance tasks • Record necessary readings in daily monitoring log sheets and request verification from the supervisors on the log sheets • Report any fault to supervisor-in-charge or the electrical chargeman
CDM Consultant	• Provides advice on all CDM-related matters • Prepares monitoring reports for verifications • Liaises with the verifier on verification process • Conducts regular audits on CDM monitoring

Quality Control, Assurance and Maintenance Schedule

Regular maintenance of monitoring equipment is a crucial part of the quality control and assurance of the monitoring plan. A regular maintenance schedule of the different equipment is included in Annex 4.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

Not applicable

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

27/5/2008 (Appointment of EPC Contractor)

C.1.2. Expected operational lifetime of project activity

21 years.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

Renewable crediting period

C.2.2. Start date of crediting period

01/07/2009 (tentative). The crediting period will only start when the project is finally registered.

C.2.3. Length of crediting period

7 years.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The project activities include the installation of landfill gas collection system (gas collection wells and blower) as well as the flaring and landfill gas electricity generation facility. The project, will recover landfill gas that is currently been released directly into the surrounding and atmosphere.

As a result, the following positive environmental impacts can be realised:

- Improvement of local air quality and reduce environmental and health risk;
- Possibility of structural damage to landfill through gas seepage (migration) minimized;
- LFG as renewable energy sources – cleaner fuel that replaces fossil fuel based grid power;
- In line with Malaysia’s National Policy on Environment and its commitment to reducing climate change.

The project activity will not create any major environmental issues. The project activity will not include any land clearance as all the installation and equipment will be mostly on-site (landfill). The system installed will minimise the emission of landfill gas and will not result in any environmental emissions which exceeds the current emissions from the landfill and its facilities.

Programme to address safety (e.g. gas leakage) issues related to the project will be in place. Exhaust fumes of the flare and gas generators will be monitored. High quality equipment and regular maintenance and monitoring of system will be taken by the landfill operator to ensure that the impacts (if any) from these processes are minimized.

D.2. Environmental impact assessment

There are no significant negative impacts resulting from this project.

Positive impacts are the improvement of air quality and the reduction of fossil fuel based electricity usage, leading to reduction in greenhouse gas emission reduction.

No environmental impact assessment (EIA) is required for the implementation of this project. List of prescribed activities requiring EIA is attached in Annex 3.

EIA is required for establishment of sanitary landfill. The EIA for Bukit Tagar Sanitary Landfill was approved in 2005.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

A stakeholders meeting to obtain comments on the proposed project activity was held on 22nd of January 2008; 10:00am - 12:00pm at Boardroom 2, Level 3 Eastin Hotel, Petaling Jaya.

The stakeholder meeting was opened to the public and widely promoted in English and Malaysian language through the local media (see the newspaper announcement below).

METRO AHAD, AHAD, 20 JANUARI, 2008

223. NOTIS AM

JEMPUTAN MENGHADIRI MESYUARAT PIHAK BERKEPENTINGAN ATAU "STAKEHOLDERS" PADA 22 JANUARI 2008:

Tapak pelupusan sanitari Bukit Tagar untuk pengumpulan dan penggunaan gas metana

KUB-Berjaya Enviro Sdn Bhd (KBE) (Co. No: 614497-H) adalah pemaju dan penyelenggara tapak pelupusan sanitari Bukit Tagar di Hulu Selangor, Selangor, Malaysia. Tapak pelupusan sanitari ini menerima kira-kira 1,800 tan matrik sampah perbandaran sehari dari Kuala Lumpur dan Selayang.

Tapak pelupusan sanitari Bukit Tagar telah direkacipta untuk memenuhi piawaian alam sekitar yang ditetapkan Kerajaan Malaysia. Kini, walaupun semua peraturan dalam piawaian alam sekitar dipenuhi, tapak pelupusan sanitari Bukit Tagar masih melepaskan gas rumah kaca seperti metana ke atmosfera. Menyedari pentingnya usaha mengurangkan peningkatan suhu global selain potensi menggunakan gas berkenaan yang dikumpul sebagai sumber tenaga, KBE merancang untuk melabur dalam usaha memanfaatkan gas berkenaan sebagai sumber tenaga alternatif.

Dalam usaha ini, KBE merancang untuk memulakan projek di bawah Mekanisme Pembangunan Bersih atau 'Clean Development Mechanism' (CDM). CDM adalah mekanisma kewangan di bawah Protokol Kyoto di mana negara maju boleh melabur dalam projek mengurangkan pelepasan gas di negara membangun menggantikan projek mengurangkan pelepasan gas rumah kaca di negara mereka sendiri yang membabitkan kos lebih tinggi.

KBE dengan segala hormatnya, ingin menjemput pihak yang berkepentingan atau 'stakeholders' untuk menghadiri mesyuarat dan sesi penerangan mengenai projek tersebut. Tarikh dan tempat mesyuarat adalah seperti di bawah:

TARIKH : 22 Januari 2008
MASA : 10.00 pagi (diikuti dengan makan tengah hari)
TEMPAT : Bilik 2, Tingkat 3, Eastin Hotel, Petaling Jaya

Jika anda berminat untuk menghadiri mesyuarat atau untuk sebarang pertanyaan, sila hubungi **Puan Iza Bakar, (Tel: +6 03-7882 6333)**

theSun | FRIDAY JANUARY 18 2008

classified

For greater reach call Tel: 03-7784 8888 or Fax: 03-7784 44

Messages / Other Announcements

INVITATION TO STAKEHOLDER MEETING 22 January 2008:
Bukit Tagar Landfill for Gas Extraction & Utilization

KUB-Berjaya Enviro Sdn Bhd (KBE)

Date : 22 January 2008
Time : 10:00am-12:00pm
Venue : Boardroom 2, Level 3, Eastin Hotel, Petaling Jaya

Please contact **Puan Iza Bakar (Tel: +603-7882 6333)** should you are joining the meeting or require any clarification.

Figure 11: Press releases of stakeholders meeting invitation on local newspaper

In addition to public announcement, invitation by letter to a number of identified organizations and individuals relevant to the project was issued.

The meeting attendants included private companies, NGOs, government representatives, among others.

The attended institutions are listed below:

- Ministry of Natural Resources and Environment Management (the Designated National Authority for Malaysia in CDM);
- Ministry of Housing and Local Government (Department of National Solid Waste Management) – recently established federal authority to take over all solid waste management matters in Peninsula Malaysia;
- Dewan Bandaraya Kuala Lumpur – Kuala Lumpur City Hall (local authority);
- Majlis Perbandaran Selayang – Selayang City Council (local authority);
- Solid Waste Disposal Sdn. Bhd. (Transfer station operators delivering to Bukit Tagar);
- Nearby residents to the landfill;
- Nearby Palm Oil estate representatives;
- Perunding Utama Sdn. Bhd. (EIA consultant to landfill);
- ENSEARCH – Environmental NGO;
- KUB-Berjaya Enviro Sdn. Bhd. (Project developer); and
- Eco-Ideal Consulting Sdn. Bhd. (CDM consultant).

Figure 12: CDM Stakeholder Holder Meeting, 22 January 2008

Source: Own Illustration

During a project presentation, by the project representatives, different aspects of the project, such as social, environmental, economical and technical issues, were outlined to the 29 attendees. After the presentations, the audience was invited to an open session of questions and comments. The comments are recorded in E.2 below.

E.2. Summary of comments received

Figure 13: Question and Answer at CDM Stakeholder Meeting

Source: Own Illustration

Question asked by a representative of Solid Waste Disposal Sdn. Bhd.
Is Environmental Impact Assessment required for this project?
Answers: • EIA is only required in Malaysia if the proposed activity is listed as "prescribed activities" under the Environmental Quality Act. Landfill gas recovery project does not require EIA as it is not in the list. EIA was conducted for the overall landfill development and operation and was already approved in 2005. There is no regulatory requirement to capture and utilize landfill gas.

Question asked by a representative of Ministry of Natural Resources and Environment Management (NRE)
What kind of technology will be applied? Is this technology new or existing? What are the costs?
Answers: • It was explained that a proven gas recovery and utilization system from overseas will be applied to the proposed project activity. Vertical wells equipped with gas cleaning systems will be drilled to enable gas extraction and an imported gas engine will be installed for power generation purposes. Gas recovery and utilization system has been implemented all over the world but the technology is still relatively new to Malaysia. To date, there is only one project i.e. the Puchong Air Hitam Landfill gas recovery project is implemented. • Therefore, the design of the landfill gas extraction and utilization system is considered relatively new to Malaysia. • The total costs of implementation are expected to amount to around RM 10 million (on-site power utilisation only – not including grid connection).

Question asked by a representative of Kementerian Sumber Asli & Alam Sekitar – Natural Resources and Environment Management
Is there more environmentally friendly solutions other than flaring the landfill gas?
Answers: • It was explained that flaring only partially solves the environmental problems related to the release of landfill gases as this process does not generate renewable energy. • However, if all the landfill gas recovered is to be used for power generation, then the overall investment will be higher and there will be an excess of power on-site (Bukit Tagar only requires 500 kW). Generation of additional power, connection and selling addition power to grid requires economic of scale as it involves extra investment. Furthermore, Soon also highlighted the difficulties of selling power to grid, including the low tariffs, long application process time and complex agreement with the national power company TNB and so forth. • However, as the total waste accumulated increases and when the power generation potential becomes greater, then the connection to grid option will become more feasible.

Question asked by Mr. Gui Hun Chuen – Ministry of Housing and Local Government
How many tons of waste is required for such project to become feasible? When will the project commence?
• Mr. How explained that the project can start immediately since almost 1.4 million tons of wastes were disposed of at the cell where the proposed gas extraction and utilization is to be implemented. This would be sufficient to justify the investment. • Mr. Soon added that the project can only start claiming CERs after receiving letter of approval (for CDM) from the Government of Malaysia as well as the registration of the

project as a CDM project with United Nations.
Question asked by Encik Zamzuri Bin Nordin – Solid Waste Disposal Sdn. Bhd.
Could you please elaborate on how the Certified Emission Reductions (CERs) are calculated?
• It was explained the concept of baseline emissions and project emissions from the landfill. He explained that emission reductions generated from the project is the difference between baseline (current emissions without project) and project emissions (emissions during the project). The calculation is based on internationally approved methodologies. He stressed that the proposed project will not be able to capture 100% of the landfill gas. Typical collection efficiency is around 50%. • It was also mentioned that the degradation of waste resulting in methane emissions will occur over an extensive period of time and that the figures presented earlier in the meeting were solely estimates based on the approval methodology. The actual emission reductions from the project will be determined by actual measurement during the project implementation.

There were no negative comments received.

E.3. Report on consideration of comments received

The following are actions taken in response to the questions and comments received from the stakeholder meeting:

Questions/comments	Response and follow up action by project developer
Is EIA required?	Relevant list of prescribed activity requiring EIA in Malaysia attached to this PDD.
Technology type and cost	Details of the technology to be applied and cost implication will be included in the PDD.
More environmental friendly solutions than flaring?	In consideration of the issue raised, the project developer decided to include generating additional power for selling to the grid by including the recovery of landfill gas from the current cell (phase 1) in the PDD. A 2 MW additional electricity capacity is added to the project plan. Converting the landfill gas captured to electricity generation will contribute to the renewable energy development in Malaysia as well as contribute to the reduction of greenhouse gas emissions from fossil fuel.
Feasibility of landfill gas project	No further action required. There are sufficient wastes in placed to justify this project.
How is CERs calculated?	This was sufficiently explained at the meeting. No further actions required.

SECTION F. Approval and authorization

KEMENTERIAN SUMBER ASLI DAN ALAM SEKITAR
LOT 4G3, PRESINT 4, 62574 PUTRAJAYA
TEL: 03-8886 1111 FAX: 03-8886 1512
Web: http://www.nre.gov.my

Our Reference: NRE(S)62.120.010.001.
002/012 Jld. 7 (23)
Date: 22 January 2009

Chief Executive Director
KUB-Berjaya Enviro Sdn Bhd
No. 15, Jalan 16/11, Off Jalan Damansara
Suite 806, Block A, Pusat Dagangan Phileo Damansara
46350 Petaling Jaya
SELANGOR DARUL EHSAN
(Attention: Mr. How Lim Sek)

Fax: 03-7882 6332

Dear Sir,

Host Country's Letter of Approval for Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor, Malaysia

As the Designated National Authority (DNA) for the implementation of Clean Development Mechanism (CDM) in Malaysia, I am pleased to inform that your project proposal for Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor, Malaysia as defined in the Project Design Document is found to be in compliance with the national criteria for the CDM activities and will assist Malaysia to achieve sustainable development.

2. I hereby confirm that:

(i) Malaysia has ratified the United Nations Framework Convention on Climate Change on 13th July 1994 and Kyoto Protocol on 4th September 2002; and

(ii) Malaysia participates voluntarily in this proposed CDM activity.

3. In this regard, your project can now be submitted to the CDM Executive Board for registration as a CDM project activity.

4. As Malaysia does not support unilateral CDM project, this approval is considered void if this project is found to be a unilateral project by the CDM Executive Board.

5. This approval is valid if it is submitted to the Executive Board for registration within 6 months from the date of this letter and is independent of the time taken by the Executive Board to register the project.

ER

6. You are required to submit a written report to the DNA on the stages and progress of the project implementation at least twice a year.

Thank you.

Yours sincerely,

(DR. LIAN KOK FEI)
Conservation and Environmental Management Division
for Secretary General
Ministry of Natural Resources and Environment
As the DNA

Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	KUB-Berjaya Enviro Sdn. Bhd. (KBE)
Street/P.O. Box	No. 1, Jalan Imbi,
Building	09-03 & 09-05, Level 9 East, Berjaya Times Square
City	Kuala Lumpur
State/Region	
Postcode	55100
Country	Malaysia
Telephone	+603-2688 6333
Fax	+603-2688 6332
E-mail	mail@kbenviro.com.my
Website	http://www.kbenviro.com.my/
Contact person	How Lim Sek
Title	
Salutation	Mr.
Last name	How
Middle name	
First name	Lim Sek
Department	
Mobile	
Direct fax	+603-2688 6332
Direct tel.	+603-2688 6333
Personal e-mail	howls@kbenviro.com.my

Appendix 2. Affirmation regarding public funding

Not applicable. The project will be privately funded and will not involve any public funding or Official Development Assistance (ODA).

Appendix 3. Applicability of methodology and standardized baseline

Refer to section B for detail.

Appendix 4. Further background information on ex ante calculation of emission reductions

BASELINE INFORMATION

Climatic Data Used to Estimate Methane Emissions

Climate Condition	**:**	Tropical
Average Temperature	**:**	26.7 degree Celsius (24 hr mean) 23.0 degree Celsius (24 hr mean Minimum) 32.3 degree Celsius (24 hr mean Maximum)
Average Rainfall	**:**	2,767 mm
Rel. Humidity	**:**	82.9 % (24 hr Mean)

Source: Detailed EIA for Proposed Bukit Tagar Sanitary Landfill, 2004. (figures derived from Malaysian Meteorological Services Department at Subang and KLIA stations.)

Waste Amount Received at Bukit Tagar

Table of the Monthly Waste Received (actual amount recorded by weight bridge) by Bukit Tagar Sanitary Landfill:

Year / Month	**Waste Received** (t)	**Accumulated Waste Received** (t)
2005		
April	34,252	34,525
May	37,656	71,908
June	39,199	111,106
July	45,893	157,000
August	42,779	199,778
September	40,546	240,324
October	40,715	281,039
November	38,320	319,360
December	42,641	362,001
2006		
January	43,927	405,928
February	37,988	443,916
March	42,761	486,676
April	41,779	528,455
May	45,324	573,779
June	35,598	609,377
July	45,372	654,749
August	47,285	702,034
September	43,447	745,482
October	45,711	791,193

Year / Month	**Waste Received** (t)	**Accumulated Waste Received** (t)
November	44,868	836,060
December	46,121	882,182
2007		
January	48,824	931,006
February	44,624	975,630
March	49,133	1,024,763
April	47,390	1,072,153
May	49,692	1,121,845
June	47,889	1,169,734
July	62,639	1,232,373
August	63,097	1,295,470
September	58,669	1,354,139
October	59,579	1,413,718
November	58,491	1,472,209
December 2007	57,949	1,530,158

(Source: Weight bridge record, Bukit Tagar Sanitary Landfill, Mar 2008)

Note: 1. Total waste in placed (advanced cell) – 1,429,279.34 metric tonnes.
2. Estimated waste in placed (phase 1) until Feb 08 – 219,863 metric tonnes.

Summarised amount received and projected amounts of waste at the Bukit Tagar Sanitary Landfill:

Year	**Avg. Waste Received** (tonnes/day)	**Total Waste Received** (tonnes/yr)	**Accumulated Waste** (tonnes/yr)
2005	-	362,001	362,001
2006	1,425	520,181	882,182
2007	1,775	647,976	1,530,158
2008	1,864	680,269	2,210,427
2009	1,957	714,282	2,924,709
2010	2,055	749,996	3,674,705
2011	2,158	787,496	4,462,201
2012	2,265	826,871	5,289,072
2013	2,379	868,214	6,157,287
2014	2,498	911,625	7,068,912
2015	2,622	957,206	8,026,118
2016	2,754	1,005,067	9,031,185

Note: *Assuming 5% increase in amount of waste received per year (after year 2007)*

Waste Projections

The National Strategic Plan for Solid Waste Management (2005) by the Ministry of Housing and Local Government anticipated an overall average annual growth of waste generation at 4% by weight.

For the case of Bukit Tagar, since the waste is mainly received from Kuala Lumpur which is a growing city, a higher increase of waste generation is expected than the national 4% waste growth. Based on the amount of waste received by Bukit Tagar landfill, the waste amount has been growing up to 11% by weight per year since its operation in 2005.

A 5% by weight annual increase of waste amount received at landfill was considered from year 2008. This is considered conservative, considering the following reasons:

- Kuala Lumpur, urban dwellers are expected to continue to increase with high in flux of rural population migrating to this capital town for employment and business opportunities;
- The waste amount generation from the urban population is expected to be growing with the improvement in lifestyle and consumption. Such growth trend has been seen in most developed countries in the past.

Waste Composition

Summaries of Organic Composition Used for the Baseline Methane Calculation in this project:

Waste types	% wt (wet basis)
Food waste & organics	47.51%
Paper/Cardboard	18.54%
Textiles	2.13%
Wood	4.41%
Garden and Park waste	2.72%
Nappies	3.81%
Rubber and Leather	1.01%

Rubber and Leather were excluded for the calculations. This is conservative.

The above composition is based on actual waste characterization samples from Bukit Tagar Landfill in 2005. Samples of results are attached:

1st Sample

SATANG ENVIRONMENTAL SDN. BHD. (Co. Reg. No. 546811V)

(Subsidiary of Satang Jaya Sdn. Bhd. - 223732 V)
29 & 31, Jalan Tiara 5, Bandar Baru Klang, 41150 Klang, Selangor Darul Ehsan, Malaysia.
Tel : 60 (03) 3344 8822 Fax: 60 (03) 3344 8811
E-Mail : sjsbenv@satangjaya.com.my http://www.satangjaya.com
SE

WASTE CHARACTERIZATION - BUKIT TAGAR LANDFILL
RESULTS

Our Ref.	SW/0705/028 (2)
Your Ref.	RDM/CONT/004/07
Sample Received	25.07.2005

Test Parameter	Results
Gross Calorific Value	2236
LCV 1	873
LCV 2	1634
LCV 3	2040
LCV 4	1616
LCV 5	2189
LCV 6	3135
Total Moisture	43.48
Volatile Matter	72.34
Ash Content	23.21
Fixed Carbon	4.45
Carbon	51.12
Hydrogen	6.32
Nitrogen	2.76
Sulfur	0.18
Chlorine	0.23
Oxygen	16.41
Sodium	1238
Potassium	407.3
Calcium	365.8
Cadmium	0.172
Copper	0.951
Aluminium	10.05
Nickel	5.95
Iron	335.3
Lead	27.42
Mercury	0.167
Tin	0.058
Zinc	0.664
Chromium	1.17
Arsenic	0.133
Cobalt	ND(<0.05)
Manganese	2.32
Silica	0.034

Component	%
Food/Organic	22.77
Mix Paper	7.81
News Print	3.50
High Grade Paper	6.10
Corrugated Paper	2.66
Plastic (rigid)	6.06
Plastic (film)	9.11
Plastic (foam)	0.02
Diapers	3.78
Textile	1.64
Rubber/Leather	3.01
Wood	0.35
Yard	1.64
Glass (clear)	4.92
Glass (colored)	0.00
Ferrous	0.05
Non - Ferrous	0.00
Aluminium	0.04
Batteries/Hazards	0.01
Fine	0.01
Other Organic	0.21
Other In-Organic	0.00
Others (fruits)	26.30
Total Sum	99.99

Total Paper , Pa	20.07
Total Plastic, Pl	15.18
Other Combustible, Oc	5.78
Total Organic/ food, Ga	49.29

2nd Sample

SATANG ENVIRONMENTAL SDN. BHD. (Co. Reg. No. 546811V)
(Subsidiary of Satang Jaya Sdn. Bhd. - 223732 V)
29 & 31, Jalan Tiara 5, Bandar Baru Klang, 41150 Klang, Selangor Darul Ehsan, Malaysia.
Tel : 60 (03) 3344 8822 Fax: 60 (03) 3344 8811
E-Mail : sjsbenv@satangjaya.com.my http://www.satangjaya.com
SE

WASTE CHARACTERIZATION - BUKIT TAGAR LANDFILL
RESULTS

Our Ref.	SW/0705/033 (1)
Your Ref.	RDM/CONT/013/07
Sample Received	30.07.2005

Test Parameter	Results
Gross Calorific Value	2397
LCV 1	920
LCV 2	1771
LCV 3	2033
LCV 4	1728
LCV 5	2111
LCV 6	3108
Total Moisture	42.64
Volatile Matter	76.92
Ash Content	16.23
Fixed Carbon	6.85
Carbon	50.87
Hydrogen	6.85
Nitrogen	2.92
Sulfur	0.07
Chlorine	0.84
Oxygen	23.06
Sodium	1459
Potassium	780.3
Calcium	239.8
Cadmium	0.082
Copper	5.01
Aluminium	4.65
Nickel	3.71
Iron	344.9
Lead	16.46
Mercury	0.085
Tin	ND(<0.05)
Zinc	0.443
Chromium	6.02
Arsenic	0.090
Cobalt	ND(<0.05)
Manganese	3.68
Silica	0.162

Component	%
Food/Organic	28.86
Mix Paper	2.68
News Print	5.21
High Grade Paper	5.67
Corrugated Paper	2.68
Plastic (rigid)	6.87
Plastic (film)	2.54
Plastic (foam)	3.20
Diapers	3.69
Textile	1.77
Rubber/Leather	0.01
Wood	12.09
Yard	2.64
Glass (clear)	2.56
Glass (colored)	1.91
Ferrous	1.56
Non - Ferrous	0.00
Aluminium	1.09
Batteries/Hazards	0.13
Fine	0.08
Other Organic	0.71
Other In-Organic	0.00
Others (fruits)	14.06
Total Sum	**100.00**

Total Paper , Pa	16.24
Total Plastic, Pl	12.61
Other Combustible, Oc	18.42
Total Organic/ food, Ga	43.64

3rd Sample

SATANG ENVIRONMENTAL SDN. BHD. (Co. Reg. No. 546811V)
(Subsidiary of Satang Jaya Sdn. Bhd. - 223732 V)
29 & 31, Jalan Tiara 5, Bandar Baru Klang, 41150 Klang, Selangor Darul Ehsan, Malaysia.
Tel : 60 (03) 3344 8822 Fax: 60 (03) 3344 8811
E-Mail : sjsbenv@satangjaya.com.my http://www.satangjaya.com
SE

WASTE CHARACTERIZATION - BUKIT TAGAR LANDFILL
RESULTS

Our Ref.	SW/0705/033 (2)
Your Ref.	RDM/CONT/014/07
Sample Received	30.07.2005

Test Parameter	Results
Gross Calorific Value	2479
LCV 1	944
LCV 2	1813
LCV 3	1902
LCV 4	1424
LCV 5	1917
LCV 6	2916
Total Moisture	46.90
Volatile Matter	71.23
Ash Content	22.85
Fixed Carbon	5.92
Carbon	48.53
Hydrogen	7.12
Nitrogen	3.03
Sulfur	0.19
Chlorine	0.73
Oxygen	18.28
Sodium	1550
Potassium	865.3
Calcium	400.3
Cadmium	0.155
Copper	2.78
Aluminium	10.39
Nickel	6.92
Iron	516.4
Lead	23.05
Mercury	0.126
Tin	0.057
Zinc	1.25
Chromium	5.33
Arsenic	ND(<0.05)
Cobalt	ND(<0.05)
Manganese	5.25
Silica	0.081

Component	%
Food/Organic	34.15
Mix Paper	2.88
News Print	6.44
High Grade Paper	5.62
Corrugated Paper	4.37
Plastic (rigid)	2.26
Plastic (film)	8.64
Plastic (foam)	0.87
Diapers	3.83
Textile	2.99
Rubber/Leather	0.00
Wood	0.80
Yard	3.87
Glass (clear)	3.00
Glass (colored)	3.84
Ferrous	0.86
Non - Ferrous	0.00
Aluminium	0.02
Batteries/Hazards	0.07
Fine	0.01
Other Organic	0.26
Other In-Organic	0.00
Others (fruits)	15.22
Total Sum	**100.00**

Total Paper , Pa	19.30
Total Plastic, P1	11.77
Other Combustible, Oc	8.50
Total Organic/ food, Ga	49.63

Electricity Consumption by Bukit Tagar, supplied from Peninsular Malaysia Grid (TNB)

KUB-Berjaya Enviro Sdn. Bhd. - Bukit Tagar Sanitary Landfill

Site electricity consumption and cost today

MONTH	Unit/Rate			Rate			Other Charge	Amount (RM)
				Peak	Off Peak	MD		
	kwh	kwh	KW	RM0.234	RM0.144	RM0.29		
Jun-06	85,400	82,476.67	300	19,983.60	11,876.64	8,700.00		40,560.24
Jul-06	10,183.00	72,070.00	370	2,382.82	10,378.08	10,730.00		44,936.30
Aug-06	112,400.00	80,810.00	370	26,301.60	11,636.64	10,730.00		48,668.24
Sep-06	104,760.00	74,620.00	370	24,513.84	10,745.28	10,730.00		45,989.12
Oct-06	116,780.00	84,030.00	380	27,326.52	12,100.32	11,020.00		50,446.84
Nov-06	102,020.00	73,000.00	400	23,872.68	10,512.00	11,600.00		45,984.68
Dec-06	163,540.00	82,380.00	380	38,268.36	11,862.72	11,020.00		47,701.08
Jan-07	119,770.00	82,560.00	390	28,026.18	11,888.64	11,310.00		51,224.82
Feb-07	103,460.00	71,750.00	380	24,209.64	10,332.00	11,020.00		45,561.64
Mar-07	116,670.00	84,452.71	370	27,300.78	12,161.19	10,730.00		50,191.97
Apr-07	109,040.00	74,850.00	360	25,515.36	10,778.40	10,440.00	152.00	46,885.76
May-07	112,350.00	78,170.00	400	26,289.90	11,256.48	11,600.00	0.17	49,380.61
Jun-07	112,970.00	74,490.00	370	26,434.98	10,726.56	10,730.00		47,891.71
Jul-07	118,900.00	78,860.00	380	27,822.60	11,355.84	11,020.00		50,198.44
Aug-07	111,150.00	71,580.00	400	26,009.10	10,307.52	11,600.00		47,916.62
Sep-07	113,480.00	75,150.00	390	26,554.32	10,821.60	11,310.00		48,685.92
Oct-07	112,840.00	74,016.67	370	26,404.56	10,658.40	10,730.00		47,792.96
Nov-07	118,640.00	82,280.00	390	27,761.76	11,848.32	11,310.00		50,920.08
Dec-07	129,660.00	90,450.00	460	30,340.44	13,024.80	13,340.00		56,705.24
TOTAL	2,074,013	1,487,996	7,230	485,319	214,271	209,670	152	917,642
Average	**109,159**	**78,316**	**381**	**25,543**	**11,277**	**11,035**		**48,297**

Source: KUB-Berjaya Sdn Bhd. TNB bills 2006-2007.

The average monthly consumption is around 190,000 kWh. The average capacity load is 381 kW with maximum load up to 460 kW. The average cost incurred from electricity on-site is slightly higher than RM 50,000.00.

Project emissions from flaring (based on "Tool to determine project emissions from flaring gases containing methane"):

Year	Methane to Flare (tCO2eq)	Methane to Flare (tCH4)	Average % of Methane in LFG (wCH4,y)	LFG flared (m3)	FV (RG,h) (m3/h)	TM (RG,h) (kg/h)	PE (flare,y) (tCO2e)	MD (flared, y)
2009 July	66,168	3,151	50%	8,791,483	903	324	5,955	2,867
2010	173,999	8,286	50%	23,118,500	2,375	851	15,660	7,540
2011	142,879	6,804	50%	18,983,760	1,950	699	12,859	6,191
2012	163,990	7,809	50%	21,788,571	2,239	802	14,759	7,106
2013	111,424	5,306	60%	12,326,799	1,266	545	10,028	4,828
2014	129,318	6,158	60%	14,306,397	1,470	633	11,639	5,604
2015	142,620	6,791	60%	15,777,975	1,621	698	12,836	6,180
2016 June	49,894	2,376	60%	5,519,750	567	244	4,490	2,162
			Total	120,613,235	12,392	4,796	88,226	42,479

Comparison of Project with the Malaysia National CDM Criteria

National CDM Criteria in Malaysia	Conditions for this Project
Criterion 1: Contribute to Sustainable Development in Malaysia	Improve local environment (air quality, reduce health risk) Supports renewable energy policy
Criterion 2: Must involve Annex 1 (developed countries) parties	Buyer : Japanese Technology : Denmark or Australia
Criterion 3: Must involve technology transfer or improvement of technology	Transfer of technology from overseas & improvement of technology from existing venting
Criterion 4: Must fulfill International CDM conditions	LFG recovery is voluntary and this project fulfills all conditions outlined by the CDM Executive Board
Criterion 5: Ability of Project Developer to undertake project	KBE Sdn Bhd is a local incorporated company, JV by two public listed companies in the KLSE

List of prescribed activities requiring EIA

ENVIRONMENTAL QUALITY (PRESCRIBED ACTIVITIES) (ENVIRONMENTAL IMPACT ASESSMENT) ORDER 1987*

In exercise of the powers conferred by section 34A of the Environmental Quality Act 1974, the Minister, after consultation with the Environmental Quality Council, makes the following order:

1. Citation and commencement.

This order may be cited as the **Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987** and shall come into force on the 1st April 1988.

2. Prescribed activities.

The activities specified in the Schedule are prescribed to be prescribed activities.

3. Order not applicable to Sabah and Sarawak in certain prescribed activities. [*Subs. PU(A) 489/2000*]

This Order shall not apply in respect of—

(*a*) the prescribed activities [except item 7(viii)] listed in the First Schedule of the Conservation of Environment (Prescribed Activities) Order 1999 published under the Second Supplementary of the Sabah Government *Gazette* on the 30 August 1999; and

(*b*) the prescribed activities listed in the First Schedule of the Natural Resources and Environment (Prescribed Activities) Order 1994 published under Part II of the Sarawak Government *Gazette* on the 18 August 1994.

4. Items in the Schedule still applicable to Sabah and Sarawak. [*Am. PU(A) 489/2000*]

Notwithstanding paragraph 3, the prescribed activities listed as Items 2, 5(*a*) and (*b*), 8, 9, 10, 12, 13(*a*), (*c*) and (*d*), 15, 16 and 18 in the Schedule shall continue to apply in respect of the States of Sabah and Sarawak.

SCHEDULE

1. AGRICULTURE:

(*a*) Land development schemes covering an area of 500 hectares or more to bring forest land into agricultural production.

(*b*) Agricultural programmes necessitating the resettlement of 100 families or more.

(*c*) Development of agricultural estates covering an area of 500 hectares or more involving changes in types of agricultural use.

2. AIRPORT:

(*a*) Construction of airports (having an airstrip of 2,500 metres or longer).

(*b*) Airstrip development in state and national parks.

**Published as PU (A) 362/1987. Came into force on 1.4.1988 and amended by PU (A) 117/1995, 44/1996, 489/2000.*

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3. DRAINAGE AND IRRIGATION:

(*a*) Construction of dams and man-made lakes and artificial enlargement of lakes with surface areas of 200 hectares or more.

(*b*) Drainage of wetland, wild-life habitat or of virgin forest covering an area of 100 hectares or more.

(*c*) Irrigation schemes covering an area of 5,000 hectares of more.

4. LAND RECLAMATION:

Coastal reclamation involving an area of 50 hectares or more.

5. FISHERIES:

(a) Construction of fishing harbours.

(b) Harbour expansion involving an increase of 50 percent or more in fish landing capacity per annum.

(c) Land based aquaculture projects accompanied by clearing of mangrove swamp forests covering an area of 50 hectares or more.

6. FORESTRY:

(a) Conversion of hill forest land to other land use covering an area of 50 hectares or more.

(b) Logging or conversion of forest land to other land use within the catchment area of reservoirs used for municipal water supply, irrigation or hydro-power generation or in areas adjacent to state and national parks and national marine parks.

(c) Logging covering an area of 500 hectares or more.

(d) Conversion of mangrove swamps for industrial, housing or agricultural use covering an area of 50 hectares or more.

(e) Clearing of mangrove swamps on islands adjacent to national marine parks.

7. HOUSING:

Housing development covering an area of 50 hectares or more.

8. INDUSTRY:

(a) Chemical – Where production capacity of each product or of combined products is greater than 100 tonnes/day.

(b) Petrochemicals – All sizes.

(c) Non-ferrous – Primary smelting:

- Aluminium – all sizes.
- Copper – all sizes.
- Others – producing 50 tonnes/day and above of product.

(d) Non-metallic

- Cement – for clinker throughput of 30 tonnes/hour and above.
- Lime – 100 tonnes/day and above burnt lime rotary kiln or 50 tonnes/day and above vertical kiln:

(e) Iron and steel

- Require iron ore as raw materials for production greater than 100 tonnes/day; or
- Using scrap iron as raw materials for production greater than 200 tonnes/day

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(f) Shipyards – Dead Weight Tonnage greater than 5,000 tonnes.

(g) Pulp and paper industry – Production capacity greater than 50 tonnes/day.

9. **INFRASTRUCTURE:**

(a) Construction of hospitals with outfall into beachfronts used for recreational purposes.

(b) Industrial estate development for medium and heavy industries covering an area of 50 hectares or more.

(c) Construction of expressways.

(d) Construction of national highways.

(e) Construction of new townships.

10. **PORTS:**

(a) Construction of ports.

(b) Port expansion involving an increase of 50 percent or more in handling capacity per annum.

11. **MINING:**

(a) Mining of minerals in new areas where the mining lease covers a total area in excess of 250 hectares.

(b) Ore processing, including concentrating for aluminium, copper, gold or tantalum.

(c) Sand dredging involving an area of 50 hectares or more.

12. **PETROLEUM:**

(a) Oil and gas fields development.

(b) Construction of off-shore and on-shore pipelines in excess of 50 kilometres in length.

(c) Construction of oil and gas separation, processing, handling, and storage facilities.

(d) Construction of oil refineries.

(e) Construction of product depots for the storage of petrol, gas or diesel (excluding service stations) which are located within 3 kilometres of any commercial, industrial or residential areas and which have a combined storage capacity of 60,000 barrels or more.

13. **POWER GENERATION AND TRANSMISSION:**

(a) Construction of steam generated power stations burning fossil fuels and having a capacity of more than 10 megawatts.

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(b) Dams and hydro-electric power schemes with either or both of the following:

(i) dams over 15 metres high and ancillary structures covering a total area in excess of 40 hectares;

(ii) reservoirs with a surface area in excess of 400 hectares.

(c) Construction of combined cycle power stations.

(d) Construction of nuclear-fueled power stations.

14. **QUARRIES:**

Proposed quarrying of aggregate, limestone, silica, quartzite, sandstone, marble and decorative building stone within 3 kilometres of any existing residential, commercial or industrial areas, or any area for which a licence, permit or approval has been granted for residential, commercial or industrial development.

15. **RAILWAYS:**

(a) Construction of new routes.

(b) Construction of branch lines.

16. **TRANSPORTATION:**

Construction of Mass Rapid Transport projects.

17. **RESORT AND RECREATIONAL DEVELOPMENT:**

(a) Construction of coastal resort facilities or hotels with more than 80 rooms.

(b) Hill station resort or hotel development covering an area of 50 hectares or more.

(c) Development of tourist or recreational facilities in national parks.

(d) Development of tourist or recreational facilities on islands in surrounding waters which are gazetted as national marine parks.

18. **WASTE TREATMENT AND DISPOSAL:**

(a) Toxic and Hazardous Waste—

(i) Construction of incineration plant.
(ii) Construction of recovery plant (off-site).
(iii) Construction of wastewater treatment plant (off-site).
(iv) Construction of secure landfill facility.
(v) Construction of storage facility (off-site).

(b) Municipal Solid Waste—

(i) Construction of incineration plant.
(ii) Construction of composting plant.

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(iii) Construction of recovery/recycling plant.
(iv) Construction of municipal solid waste landfill facility.

(c) Municipal Sewage–
(i) Construction of wastewater treatment plant.
(ii) Construction of marine outfall.

19. **WATER SUPPLY**:

(a) Construction of dams or impounding reservoirs with a surface area of 200 hectares or more.

(b) Groundwater development for industrial, agricultural or urban water supply of greater than 4,500 cubic metres per day.

Made the 30th September 1987.

DATUK AMAR STEPHEN K.T. YONG,
Minister of Science, Technology and Environment

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Appendix 5. Further background information on monitoring plan

The project will monitor the emission reductions by the method, indicators and frequency as required by the Approved Methodology ACM0001.

The main variables that need to be monitored during project activity include:

- Total quantity of landfill gas captured ($LFG_{total,y}$) in m^3;
- Temperature (T in ^oC) and pressure (P in Pa) of landfill gas captured;
- Methane fraction of landfill gas captured ($w_{CH4,y}$ - %);
- Total quantity of landfill gas captured that is sent to the enclosed flares ($LFG_{flare,y}$ in m^3);
- Total quantity of landfill gas sent to gas engines for electricity generation ($LFG_{electricity,y}$ in m^3);
- Total electricity generated from the landfill gas ($EL_{LFG,y}$ in MWh);
- Total electricity consumed by project activity (flaring and gas engine) from grid ($EL_{PJ,y}$ in MWh);
- Temperature in exhaust gas of the enclosed flares ($T_{flare,y}$ in ^oC);
- Project emissions from $PE_{flare,y}$ to be determined based on latest “Tool to determine project emissions from flaring gases containing Methane”.

<u>Quality Control / Assurance</u>

Quality control and quality assurance procedures will be carried out on all parameters monitored. The practices to be undertaken in the context of the proposed project are as follows:

1. Gas field monitoring records:

- Daily readings of all field meters will be filled out in paper worksheets and filed consequently. All data collected will also be entered in electronic worksheets and stored in a computer (immediately) and on discs (periodically).
- Periodic controls of the LFG field monitoring records will be carried out to check any deviation from the estimated emission reductions following the guideline for LFG plant operation and monitoring for correction or future references.
- Periodic evaluation reports concerning overall performance will be released to aid future performance management.

2. Equipment calibration and maintenance:

- Flow meters, gas analyzers and other sensors will be subject to regular maintenance and testing according to the technical specifications by the manufacturers to ensure accuracy and good performance.
- Calibration of equipment will be conducted periodically according to technical specifications.

3. Corrective actions:

- Actions to correct deviations from the monitoring plan and the guidelines for LFG plant operation and monitoring will be implemented as these deviations are observed either by the operator or during internal audits.
- Apart from periodic meetings, additional technical meetings will be held in order to define any necessary corrective actions to be undertaken.

4. Site audits:

- A CDM Project Team will make regular site audits to ensure that monitoring and operational procedures are being observed in accordance with the monitoring plan and the guideline for LFG plant operation and monitoring.

5. Training:

- A training plan will be set out for all Bukit Tagar Sanitary Landfill employees. This will ensure that both operational and monitoring staff involved in the project are properly trained so that they are able to undertake the tasks required by this monitoring plan. Appropriate staff training must be provided before the project starts operating and generating emission reductions.

6. Storage of documents:

- List of monitoring equipment (e.g. flow meters, gas analyzers, thermometers) including their numbers, names, manufacturers, specifications, user requirements, etc.
- Calibration lists and reports, including equipment or parts calibrated, date, method and procedures of calibration, precision following these processes, personnel, devices needed, etc.
- Maintenance lists and reports, including equipment or parts maintained, date, method and procedure of maintenance, performance following these procedures, personnel, devices needed, etc.
- Operation manual of the proposed project.
- Registration of minutes during meetings.
- Non-conformance reports.
- Monthly and annual worksheets.
- Training plan.
- Internal audit reports, including personnel, time, findings, corrective actions, follow-up inspections, etc.
- Annual monitoring review.

Quality Control and Maintenance Schedule of LFG Monitoring Equipment

Main task **Inspection task**	Daily	weekly	2 x monthly	monthly	3 months	6 months	Yearly
General							
Inspection round	X						
Fill in operating data log	X						
Check for vibrations	X						
Empty condensate trap	X						
Gas analyzing equipment							
Calibrating CH4 / CO2		x					
Calibrating O2		X					
Check filter in analyzer		X					
Check gas pump		x					
Blowers							
Check safety system							
Check lubricating oil level			X		X		X
Change of lube oil				X		X	
Gas pipe system							
Check / Clean gas filter		X					
Inspection of gas pipe system						X	
Check gas valve system						X	
Alarm system							
Test of function					X		

Electrical switch boards							
Visual control				X			
Cleaning of switch boards					X		
Check electrical connections							X
Other							
Check the fire fighting equipment						X	

Appendix 6. Summary of post registration changes

1st revision of monitoring plan was submitted to UNFCCC and approved on 9 May 2012.[32]

The revision is related to alternative measurement and handling of data during emergency conditions for methane content, flow meters and electricity meter.

1st notification of change request was submitted to UNFCCC and approved on 9 May 2012.[33]

The change is related to the internal use of power generated for the landfill operation was not successful and was not approved by the relevant authorities and the grid operator. This was due to technical constraints and deleted the onsite utilization from the PDD.

2nd notification of change request (PRC-2467-001) was submitted to UNFCCC on 25 April 2013 and was approved by UNFCCC on 10 September 2013.

The change is related to the following:

- Increase of power generation approximately 3MW and upload to the grid by year 2013
- Installation of an additional pipeline and flare system equipped with skid mounted LFG gas blower to handle any excess LFG captured which is expected to be commissioned at the beginning of year 2014

3rd notification of change request (PRC-2467-003) was submitted to UNFCCC on 09 June 2015 and was approved by UNFCCC on 12 November 2015.

The revision is related to the utilisation of EL6 meter instead of EL1 meter for the measurement of power consumed for the project activity and non-implementation of Flare No.3.

4th notification of change request (PRC-2467-004) was submitted and awaiting for approval. The change is related to the following:

- Operation of an additional 2MW gas engine which was expected to run by year 2016 and hence, making the expected total grid upload capacity to about 5.5MW
- Included the monitoring of fuel consumption from diesel gen-set as backup during the power failure of grid
- Removal of the monitoring parameter for relevant policies and circumstances at the beginning of each crediting period

Updated the ex-ante for Global warming potential (GWP) of CH_4 to 25 for second commitment period

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32 http://cdm.unfccc.int/Projects/DB/DNV-CUK1238680609.1/view

33 http://cdm.unfccc.int/Projects/DB/DNV-CUK1238680609.1/view