DRAFT

Banter Gebang LFG (Landfill Gas) Collection & Energy Recovery CDM (Clean Development Mechanism) Project

PREPARED BY

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CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

The title of the project activity:
BANTAR GEBANG LFG COLLECTION & ENERGY RECOVERY CDM PROJECT
The version number of the document: 2
The date of the document: 10th/March/2006

A.2. Description of the project activity:

The proposed project consists of following activities: collecting landfill gas (LFG) with soil cover and installed equipment, generating electricity by utilising the collected gas, burning excessive LFG by burners. As a result, a great amount of LFG including methane, which shows high coefficient of greenhouse effect, is reduced not only by burning and generating electricity but also by displacing the conventional fuel-based electricity. Moreover the plant, consisted of an LFG recovery system, an LFG flaring system, and an LFG power generation system, is sound for the environment since significant alteration is not required to the status quo.

The Bantar Gebang Landfill, the project site, belongs to the government of DKI Jakarta, but it is located in city of Bekasi, approximately 40km north of downtown Jakarta. The total area is 108ha (effective area: 68.46ha) and is divided into 5 zones. The landfill site has been operated since 1989 and today receives approximately 6,000 tons per day of domestic and non-hazardous industrial waste. While DKI Jakarta operates the landfill including collection and transportation of municipal solid waste, daily management of the landfill site is committed to Patriot Bangknit Bekasi (PBB) until 2006, and then the private company funded both by DKI Jakarta and by Bekasi City is expected to be responsible for operation. Although the Bantar Gebang landfill site is now almost full, the waste management department of DKI Jakarta plans to continue the operation because of the lack of substitutive or new landfill sites. In this document, we evaluate the project feasibility for ten years focusing on Zone IV and V, which have already been closed. The recovery volume of LFG in 2008, the first year of the proposed project, is estimated to be approximately 56,000 Nm^3/day for these two zones. Now safety closure treatment of the landfill site is not planned or implemented other than soil cover for Zone IV and V, and the LFG generated from the landfill site is diffused into the atmosphere.

The project is intended to play an important role in the safety closure of the landfill site by eliminating the emission of LFG. The project is consistent with the national criteria and indicators of sustainable development, which is mentioned in a draft of "the Indonesian DNA's Approval Mechanism", policy paper of the Ministry of Environment.

Contributions of the project to the Greenhouse gas (GHG) reduction are as follows.

- Destruction of methane by collecting LFG formed inside the accumulated waste in the landfill site, and
- Reduction of carbon dioxide by replacing fossil fuel consumption for electricity generation to renewable energy.

A.3. Project participants:

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as appricable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Indonesia (host)		No
Japan	KAJIMA Corporation	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The site is located at latitude 06 ° 15 ′ north and longitude 106 ° 30 ′ east, and about approximately 40km north of downtown Jakarta. The location map is following.

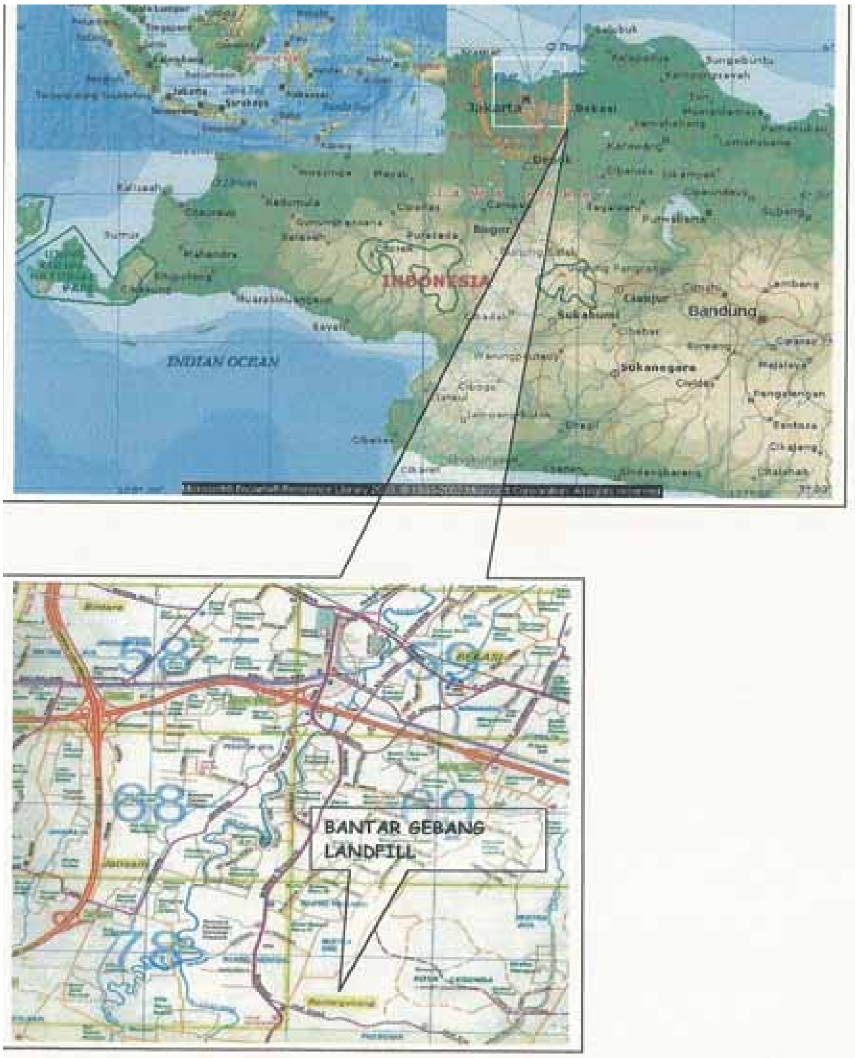

Figure-1 Location of Project Site

A.4.1.1. Host Party(ies):

Indonesia

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

West Java

A.4.1.3. City/Town/Community etc:

City of Bekasi

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

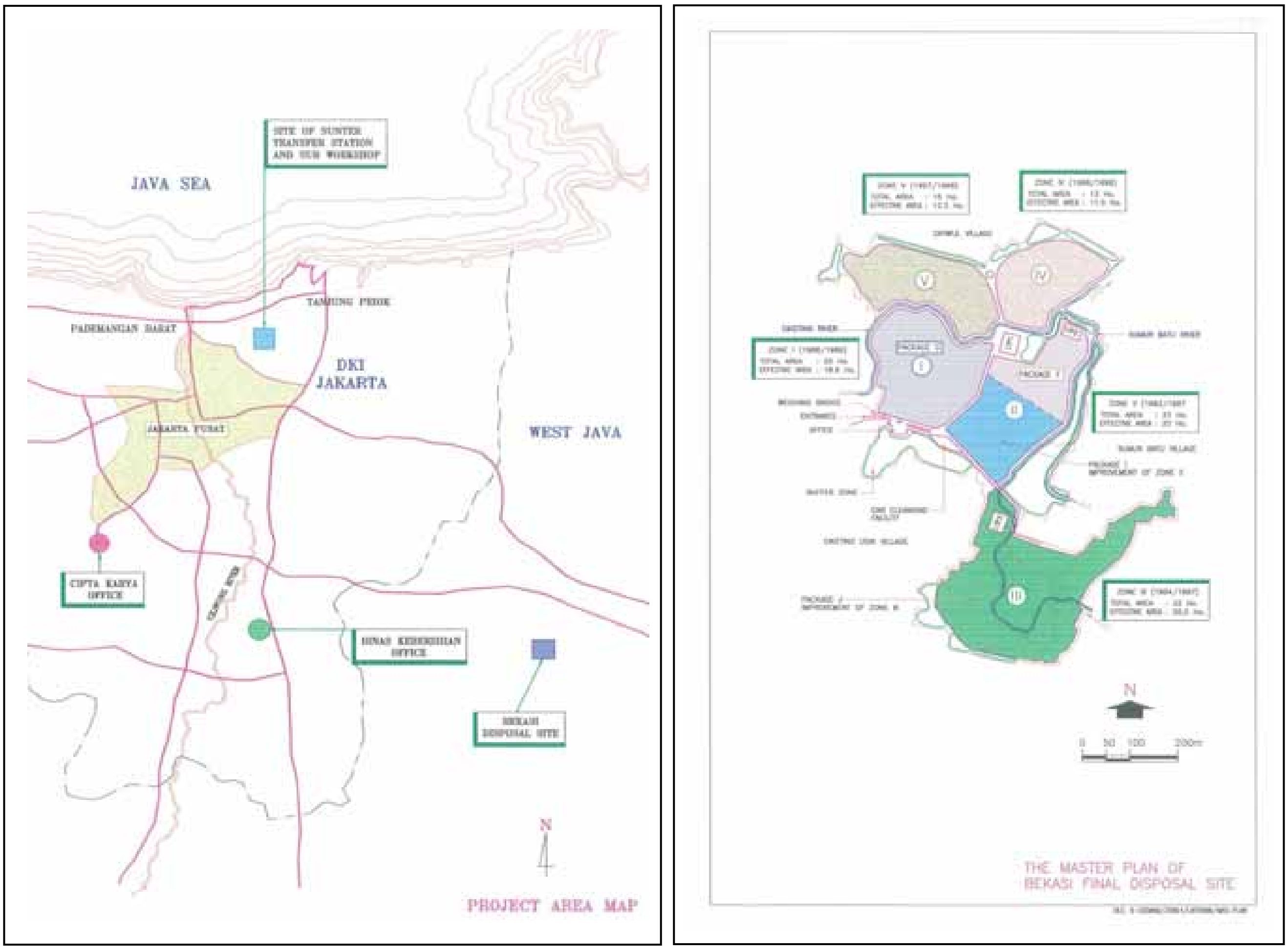

Figure-2 Project Area Map

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

Waste handling and disposal, Sectoral Scope 13

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

The project will involve proven technology and hardware for the recovery, collection, flaring, and power generation of LFG which is environmentally sound and safe.

The facilities proposed for the project consist of an LFG recovery system, an LFG flaring system, and an LFG power generation system as shown in Figure-3. The details of each system are as follows.

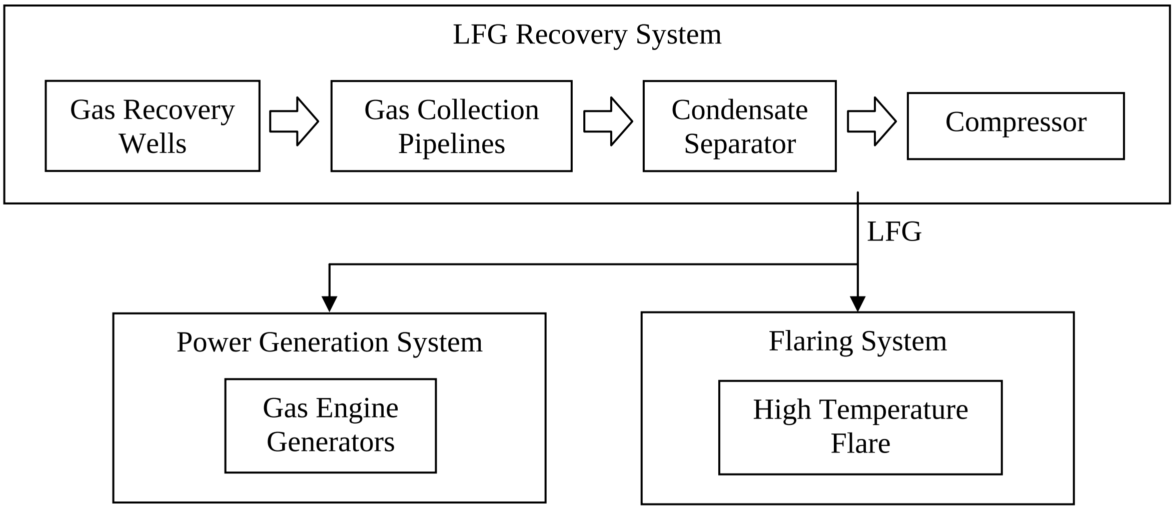

Figure-3: Overview flowchart of the LFG facility

LFG recovery system

In the LFG recovery system, LFG is collected through gas recovery wells located at the landfill area and conveyed to the flaring system and the power generation system by LFG collection pipelines. Condensate is separated before entering the compressor, bringing the LFG to an appropriate state for combustion in the flare and the gas engine.

One of the critical factors that control methane gas content in the LFG is the covering layer of the landfill surface. In order to maximize the methane gas recovery, the landfill area of the project will be covered with compacted soil or geotextiles.

Flaring System

The high temperature flare burns excessive LFG beyond the gas engine capacity and colleted LFG during maintenance (inspection, malfunction, overhaul, etc.) of the gas engine generators.

Power generation system

Gas engine generators combust the gas as fuel and generate electricity. All the electric power generated by the facility excluding its in-house consumption is sold to Perusahaan Listrik Negara (PLN), a regional power generator and distributor.

Facilities in summary

In summary, the following components are installed in the LFG recovery, flaring, and power generation facilities:

- Approximately forty vertical wells with perforated pipe casing
- Horizontal pipeline system conveying the collected LFG
- Condensate separator
- Compressor
- High temperature flare
- Gas engine generators
- Step-up transformers
- Underground transmission line to the grid
- Monitoring equipment

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

Bantar Gebang Landfill is open-dumping landfill assuming anaerobic systems like most of landfill sites operated in Indonesia and it receives waste of DKI Jakarta.

Table-1 shows current operation of the Banter Gebang site.

Table-1 Current Operation of Banter Gebang Site

Zone	Area (ha)	Status	Remarks
Zone Ⅰ	25	Operating	- Compacting existing layers and dumping over them. - Expand the capacity up to Approx. twice
Zone Ⅱ	23	Will be operating	
Zone Ⅲ	31	Will be operating	
Zone Ⅳ	14	Final Closing	Additional dumping over existing layer
Zone Ⅴ	15	Temporary Closing	1 additional monitoring well for measurement

In Indonesia, a great amount of LFG including methane, which shows high coefficient of greenhouse effect, is today diffused to the atmosphere without capturing. That means to increase greenhouse effect even after the closure of the site.

The proposed project installs gas-collecting pipes in the site, collects and consumes the methane gas emitted from the landfill site with gas engine generators to generate electricity. The electricity will be sold to PLN, and this renewable energy will replace the conventional fuel-based-electricity by generators. Therefore, carbon dioxide from the said generation is also reduced adding to direct capturing and combustion of LFG.

It is unlikely that any countermeasures for preventing methane emission from the landfill site will voluntarily be planned and implemented, because Indonesia is now on the way of economical development and the government has many important public projects with higher priority. Actually in this country, no regulations or laws requiring GHG capturing exist or are foreseen at the time of PDD preparation. In addition, this project does not seem to be economically feasible without the carbon credits.

The State Ministry of Environment issued the national policy toward CDM projects, suggesting four sustainability criteria; economical, environmental, social, and technical. The proposed CDM project in Indonesia is to satisfy these criteria, and contributes to safe closure of landfill sites, promotion of renewable energy use, and sustainable development as well as reducing GHG emission.

The following table shows the estimate of anticipated total reductions in tonnes of CO2 equivalent by the proposed project. Detailed information is shown in Section E.

Table-2 Summary of Baseline and Project Emissions (in tCO_2e)

Crediting Period	Baseline Emissions	Project Emissions	Emission Reductions
10 years	3,071,000	1,799,000	1,272,000

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

The following Table-3 shows emission reduction in terms of CO_2 tonnage.

Table-3 Annual Gas Generation and GHG Reduction

Year	Annual Estimation of emission reductions in tonnes of CO2e
2008	164,128
2009	155,922
2010	147,716
2011	139,509
2012	131,303
2013	123,096
2014	114,890
2015	106,683
2016	98,477
2017	90,270
Total estimated reductions (in tonnes of CO2e)	1,271,994
Total number of crediting years	10 years
Annual average over the crediting period of estimated reductions (in tonnes of CO2e)	127,000

A.4.5. Public funding of the project activity:

No Official Development Assistance (ODA) funding will be provided.

SECTION B. Application of a baseline methodology

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

The Baseline Methodology used is ACM0001/Version02 "Consolidated baseline methodology for landfill gas project activities."

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

The Baseline Methodology ACM0001/Version02 is applicable to LFG capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources[1]; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable." If capacity of electricity generated is less than 15MW, and /or thermal energy displaced is less than 54 TJ (15GWh), small-scale methodologies can be used.

This baseline methodology shall be used in conjunction with the approved monitoring methodology ACM0001 ("Consolidated monitoring methodology for landfill gas project activities").

The proposed project is defined as follows:
- To collect LFG from a closed landfill.
- To generate electricity using collected LFG.
- To flare excess LFG.

The proposed project claims emission reduction for the captured LFG and for displacing electricity from other sources.

B.2. Description of how the methodology is applied in the context of the project activity:

LFG capturing has not been commonly implemented in Indonesia, since such a treatment is financially infeasible without CER revenue. Therefore LFG generated in landfills is generally diffused into the atmosphere. The proposed project will be implemented under such conditions.
For the detailed data to determine the baseline scenario such as parameters, refer to Annex 3.

The baseline approach adopted by this methodology is the latest version of the "Tool for the demonstration and assessment of additionality(Version 02)." It provides for a step-wise approach to demonstrate and assess additionality as is shown in the Figure-4.

[1] Although in this case no emission reductions are claimed for displacing or avoiding energy from other sources, all possible financial revenues and/or emission leakages shall be taken into account the analyses performed.

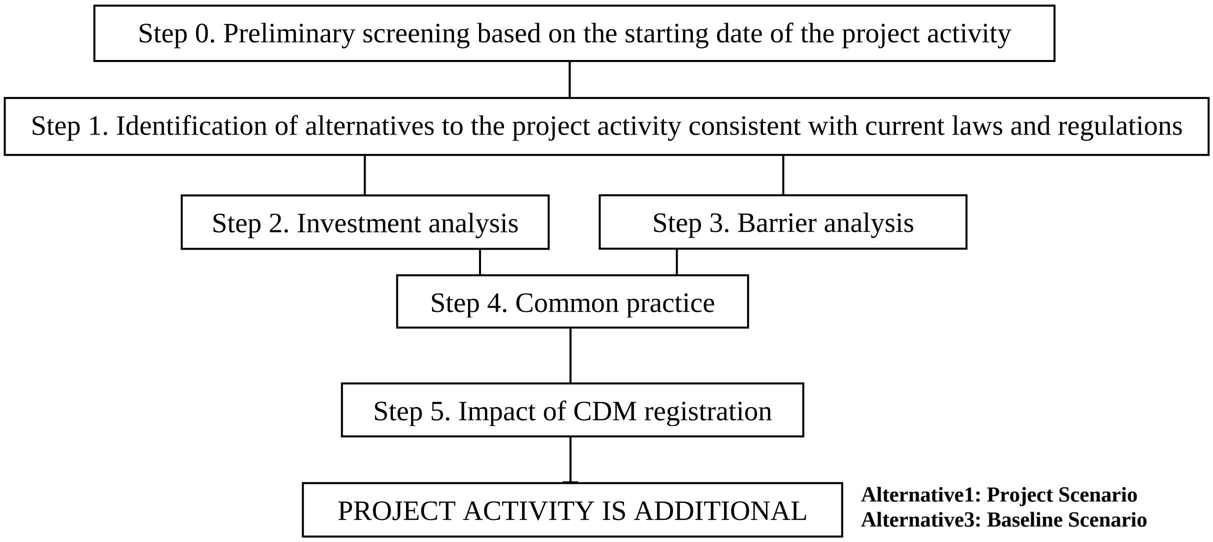

Figure-4 Flowchart of Additionality Scheme

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

The following paragraphs describe how the baseline methodology is applied to single out the baseline scenario for the proposed project, and prove that the proposed project is additional. As mentioned above, we here demonstrate the project additionality according to the latest version of the "Tools for the demonstration and assessment of additionality(version 02)."

Step 0: Preliminary screening based on the starting date of the project activity

The proposed CDM project won't claim the credits before the registration. We therefore skip this step.

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

Landfill (open dumping) is a generally accepted solid waste management system in Indonesia.

Composting system has also now started to be introduced tentatively. It is however still experimental phase. Small-scale composting pilot plants cannot be an alternative waste management system. And it is not financially viable to perform composting, since the market for the product in Indonesia is limited.

As for incineration system, Surabaya city introduced its own incinerator with 200t/day capacity in 1991. They however stopped the operation of the incinerator in 1998 due to rising cost of waste disposal.

Taking local situations and contribution to sustainable development into account, we propose three plausible scenarios for safety closure of landfill sites and valid use of solid wastes as follows.

Sub-step 1a. Define alternatives to the project activity:

Alternative 1: Soil covering and generating electricity by LFG (Proposed project)

- A landfill is closed with soil cover and biogas is captured through vertical pipes deeply installed into a landfill. Electricity is generated by collected LFG (biogas).

Alternative 2: Soil covering and flaring gas

- A landfill is closed with soil cover and biogas is captured through vertical pipes deeply installed into a landfill. Captured gas is flared by burners, instead of generating electricity.

<u>Alternative 3</u>**: Soil covering with/without installing shallow vertical pipes**

- A landfill is closed with soil cover and shallow vertical pipes are installed for stabilizing landfill sites, in other word, enhancing aerobic reaction. Emitted LFG is not captured nor flared.
- This treatment is commonly applied for landfill closure in Indonesia such as Zone IV and Zone V of the Banter Gebang landfill site.

Here, Alternative 2 is rejected as an unrealistic alternative for following reasons:

- This alternative yields investment cost without any revenue other than CERs. This fact makes the activity infeasible in terms of finance.
- Actually, such a method is not commonly implemented in the country.
- Since there is no regulations or laws to limit the LFG emission, voluntary effort for the treatment is not likely to be implemented.

The list of alternatives is limited to only two alternatives: Alternative 1 (the proposed project) and Alternative 3 (the continuation of current practices).

<u>Sub-step 1b. Enforcement of applicable laws and regulations:</u>

There are no official enforcements or guidelines regulating biogas emitted from landfill sites. Moreover, there are no regulations for closure treatment.

<u>Step 2. Investment analysis</u>

<u>Sub-step 2a. Determine appropriate analysis method</u>

For Alternative 1, we here choose benchmark analysis that is applicable for a project generating benefits other than CDM-related-income, i.e. electricity income in this case.

<u>Sub-step 2b – Option III. Apply benchmark analysis</u>

Based on the ex-ante estimation of gas emission volume analysed by site measurement and laboratory sample tests, we evaluated the economic feasibility of Alternative 1 by IRR. According to the data of BANK INDONESIA, the interest rate of Indonesian government bond due to 2017 is 8.3-8.4%. Taking account of a risk premium to reflect private investment without governmental support , it is unlikely that private projects whose IRRs are under 8.4% would be put into practice.

<u>Sub-step 2c. Calculation and comparison of financial indicators (only applicable to options II and III):</u>

The principal data and calculated IRR is shown in following table.

Exchange rate	
Construction cost	6,000,000US$
Amount of generated electricity	17,849,000kwh/year(average)
Electricity sales price	0.04 US$/kWh
Project Period	10years
Project IRR	-12%
O&M costs	240,000US$

The only revenue generated by the Alternative1 is the sale of electricity. The following conditions are set for the IRR calculations.

- Electricity sale price: 0.04 US$/kWh
- Methane intensity: 50%
- Capture rate: 30% (variable in each year)
- Parameters by First Order Decay Model:
  - Decay factor: 0.150/year
  - Total Organic Carbon in Waste (TOC): 80kg/ton
- Amount of deposited waste: evaluated by regression analysis
- Inflation Rate: 5.78%
- Corporate Tax: 30%

Cash flow analysis of Alternative 1 indicated that the project IRR for ten years without CERs turned out to be negative (-12%). Obviously Alternative 1 is financially unattractive course of action. Therefore Alternative 1 is additional and cannot be a baseline scenario. (See Annex 3)

Sub-step 2d. Sensitivity analysis

Among the parameters to calculate IRR, the changes of following parameters are considered to influence on IRR.

A) Construction costs for LFG equipment and plant
For this analysis, we examine the case where the construction cost is curtailed to 5millionUS$.

B) Electricity tariff
It is assumed that the electricity sales price increases according to the rate of inflation.

C) Methane capture rate
It is variable in each year for the proposed project, here we suppose taking into account a new way to improve the capture rate.

The sensitivity analysis results confirm that even if all the three parameters take very conservative values coincidently, the IRR is much lower than Benchmark. Therefore, it is clear that the proposed project cannot be implemented in terms of finance without CDM.

Step 3. Barrier analysis

For this step, project participants may select whether to apply Step 3 Barrier Analysis or not. In this case, since the conclusion in Step 2 shows that the proposed project is unlikely to be financially attractive without CDM, we determine to proceed to Step4.

Step 4. Common practice analysis

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

There have not been commercial projects that aim capturing LFG to generate electricity. Although one project was once proposed by companies of China and Canada, for which the site investigation was actually implemented at the Banter Gebang Landfill, it was discontinued for the lack of funds.

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

Not applicable

Step 5. Impact of CDM registration

There are a large number of open dumping landfill sites in Indonesia such as Banter Gebang landfill site. Appropriate closure treatment and valid use of collected biogas from landfill sites will contribute to not only preventing global warming but also improving local environment. Moreover, spread of this kind of project will contribute to technological sustainability as well as environmental sustainability, that is Indonesian environmental policy.

However, as described above such activities are not available without CDM registration in terms of finance. That means that the proposed project is additional.

Baseline Scenario and GHG Emission Reduction

ACM0001 indicates that the baseline is the atmospheric release of the gas generated in the landfill. In Indonesia, utilization of LFG is not planned nor implemented without CDM as is described above. Therefore Alternative 3, the total LFG diffusion to the atmosphere, is the baseline.

Alternative 1, the proposed project scenario, is based on the collection of the LFG and its combustion for the electricity generation. Combustion of the LFG to produce electricity will convert the highly potent methane content to less potent carbon dioxide, and result in significant greenhouse gas emission reductions.

Consequently, the emissions in the baseline scenario would likely exceed emissions in the project activity scenario.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

A full flow diagram of the proposed project and system boundaries is presented in Figure-5. The flow diagram comprises all possible elements of the LFG collection system and the equipment for electricity generation.

ACM0001 indicates that no leakage effects need to be accounted under this methodology.

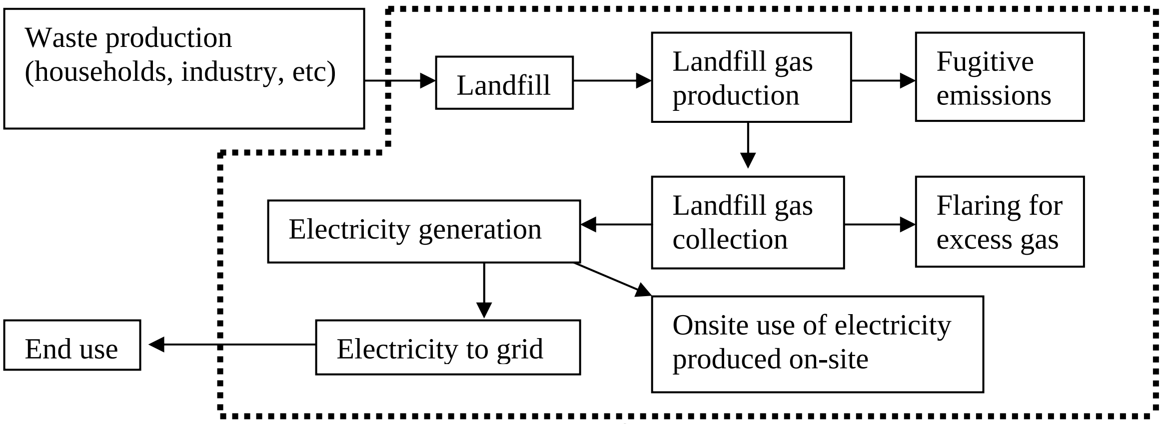

Figure-5 Flow chart of system boundaries

Table-4 shows gas generated in the project boundaries.

Table-4 Gas Generated in the Project Boundaries

Activities		Source	Gas	Remarks
Baseline	Direct onsite	Landfill gas	CH_4	Considered

			CO_2	Carbon neutral
	Direct offsite	Fuel combustion for grid power	CO_2	Considered
			N_2O	Not considered on conservative side
Project	Direct onsite	Landfill gas	CH_4	Considered
			CO_2	Carbon neutral
		LFG combustion for power	CO_2	Carbon neutral
			N_2O	Negligible
		Battery use for start-up	CO_2	Nominal (ignored)
		Project Operation	CO_2	Electricity by LFG used and carbon neutral

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Date of completing the final draft of this baseline section: 31/03/2005
Name of person/entity determining the baseline:

Hiroaki Tanabe
Kajima Corporation
5-30 Akasaka 6-chome,
Minato-ku
Tokyo 107-8502
Japan
Telephone: +81-3-6229-6730
Fax: +81-3-5561-2153
E-mail: tanabeh@kajima.com

The person/entity is a project participant listed also in Annex1.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

Estimated as 01/01/2008

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

10 years

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

The proposed project activity will use a fixed crediting period.

C.2.1. Renewable crediting period

Not applicable

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

C.2.1.2. Length of the first crediting period:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/01/2008

C.2.2.2. Length:

10 years

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

The approved consolidated monitoring methodology ACM0001 "Consolidated monitoring methodology for landfill gas project activities" is applied to the project.

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

The applicability for this methodology is described as follows.

This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity / thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources; or
c) The captured gas is used to produce energy (e.g. electricity / thermal energy), and emission reductions are claimed for displacing or avoiding energy from other sources

The item c) is applicable to this project because this project aims for LFG recovery and electricity generation with the greenhouse gas for the emission reduction as following where the baseline scenario is the total atmospheric release of the gas:
- Conversion to CO_2 of the methane in the LFG
- Displacement of grid electricity with the electricity generated by LFG

According to the approved monitoring methodology ACM0001, the monitoring methodology is based on direct measurement of the amount of LFG captured and destroyed at the flare platform and the electricity generating units to determine the quantities. In the case of the proposed CDM project activity, the direct measurements same as the applied methodology will be done as proposed in the monitoring plan.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

Not applicable

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number	Data variable	Source of Data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
A								
1	Methane fraction in the LFG	M^3 CH_4 / M^3 LFG	%	M	Continuous	100%	Electronic	
2	Gas pressure	Pressure	kPa	M	Continuous	100%	Electronic	
3	Gas temperature	Temperature	ºC	M	Continuous	100%	Electronic	
B								
4	LFG Volume	Volume	M^3	M	Continuous	100%	Electronic	
5	CH_4 Volume	Volume	M^3	C	Continuous	100%	Electronic	Data 1,2,3,4 are used
C								
6	LFG Volume	Volume	M^3	M	Continuous	100%	Electronic	
7	CH_4 Volume	Volume	M^3	C	Continuous	100%	Electronic	Data 1,2,3,7 are used
8	FE (Flare Efficiency)	Percentage	%	M	Quarterly	100%	Electronic	(1) Periodic measurement of methane content of the flare exhaust gas (2) Continuous measurement of operation time of flare (e.g. with temperature)
Electricity used during maintenance and emergency								
9	Electricity used	Electricity	kWh	M	Continuous	100%	Electronic	Recorded by PLN (Perusahaan Listrik Negara)
Gas collection System								
10	Wells and collection pipe integrity			Inspection	Weekly	100%	Electronic	Visual inspection
Regulations/Documents								

11	Parameters to estimate average emissions			Observation	Annually	100%	Electronic	Published documents are referred.
12	Regulations			Observation	Annually	100%	Electronic	

* Archived data is kept during the period of the project crediting period in files after two years.

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

See E.1.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

As shown in the baseline study, leakage is not likely. Data on this will be therefore not collected.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

The formulae used to calculate project emission reduction is:

$$ER_y = (MD_{project,y} - MD_{reg,y}) \times GWP\_CH_4 + EG_y \times CEF_{electricity,y}$$

Where:

y : Duration of the project activity, 10 years
ER_y : Greenhouse gas emission reduction measured in tonnes of CO2 equivalents (tCO_2e)
$MD_{project,y}$: Amount of methane actually combusted measured in tonnes of methane (tCH_4)
$MD_{reg,y}$: Amount of methane that would have been combusted during the absence of the project activity measured in tonnes of methane (tCH_4) and currently $MD_{reg,y}$= zero
GWP_CH_4 : Approved Global Warming Potential value for methane (GWP_{CH4}) for the first commitment period is 21 tCO2e/tCH4
EG_y : Quantity of electricity displaced measured in mega watt hour (MWh)
$CEF_{electricity,y}$: CO2 intensity of the electricity displaced expressed in tonnes of CO2 equivalents per mega watt hour (tCO2e/MWh)

$MD_{project,y}$ is the sum of $MD_{electricity}$ and $MD_{flare,y}$

$$MD_{project,y} = MD_{electricity,y} + MD_{flare,y}$$

and each formulae used to calculate $MD_{electricity,y}$ and $MD_{flare,y}$ follows.

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{CH4,y} \times D_{CH4}$$

Where:

$LFG_{electricity,y}$: Quantity of landfill gas combusted in power plant measured in cubic meters (m^3)
$w_{CH4,y}$: Methane fraction of the landfill gas measured in cubic meters of methane per cubic meters of landfill gas (m^3CH_4/m^3LFG)
D_{CH4} : Methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3\ CH_4$) and determined by temperature and pressure of LFG

$$MD_{flare,y} = LFG_{flare,y} \times w_{CH4,y} \times D_{CH4} \times FE$$

Where:

$LFG_{flare,y}$: Quantity of landfill gas flared measured in cubic meters (m^3)
$w_{CH4,y}$: Methane fraction of the landfill gas measured in cubic meters of methane per cubic meters of landfill gas (m^3CH_4/m^3LFG)
D_{CH4} : Methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3\ CH_4$) and determined by temperature and pressure of LFG

FE : Flare efficiency is expressed in percentage (%) and determined by the operation hours of flare combustion and the methane content in flare exhaust gas

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
A		
1 Methane fraction in the LFG	Low	Periodical calibration of analyzer according to the Indonesian regulation and periodical sampling and analysis in laboratory
2 Gas pressure	Low	Periodical calibration of sensor according to the Indonesian regulation
3 Gas temperature	Low	Periodical calibration of sensor according to the Indonesian regulation
B		
4 LFG Volume	Low	Periodical calibration of flow meter according to the Indonesian regulation
5 CH_4 Volume	Low	QA by calculation using generated electricity and generator heat rate
6 Heat Rate	Low	Regular maintenance will ensure optimal operation of engine and generators. The heat rate will be checked semi-annually, with monthly checks if the heat rate shows significant deviations from previous values.
C		
7 LFG Volume	Low	Periodical calibration of flow meter according to the Indonesian regulation
8 CH_4 Volume	Low	QA by calculation using gas velocity and operation hours
9 Combustion temperature	Low	Gas temperature is monitored together with the gas pressure and combustion is assured in the control room continuously. Periodical calibration of sensor according to the Indonesian regulation
10 Operation hour	Low	Daily check of operation recorded by the chief engineer
D		
11 Electricity generated	Low	Periodical calibration of Watt-hour meter according to the Indonesian regulation
12 Electricity transmitted	Low	Periodical calibration of flow meter according to the PLN regulation and QA/QC program
Electricity used during maintenance and emergency		
13 Electricity used	Low	Periodical calibration of flow meter according to the PLN regulation and QA/QC program
Gas collection System		
14 Wells and collection pipe integrity	Low	Daily check of operation recorded by the chief engineer

Quality control (QC) and quality assurance (QA) procedures

We will manage our maintenance once a month in the initial year and concentrate on necessity importance procedure accordingly from the 2nd year. We consider our employment of higher education, skill, mastery, etc. concerning solid waste management.

The maintenance plan is described below.

- Patrol by operation staff for the inspection of gas leakage on the site and facilities:
  - Twice a day (in the morning and afternoon)
- Emergency measure:
  - Emergency network and dispatching system for engineers and supervisors
- Maintenance and inspection:
  - Gas engine: Carried out according to the maintenance manual provided by the manufacturer
  - Other facilities: Once a year

We will execute the following QA/QC activities.

Monitoring Records:

Site engineer(s) read and record monitored variables and input the data to a computer database system. The site representative inspects monitoring results everyday and makes a monitoring report to the QA/QC Manager regularly.

Audit by the QA/QC manager

The site representative makes routine reminders. The QA/QC manager makes regular site visits and inspects compliance of the site activities to the routine reminders.

Operation manual

The QA/QC manager makes the operation manual.

Maintenance record

Site engineer(s) maintains equipment and facilities according to the operation manual. The site representative records all maintenance work and reports to the QA/QC manager for approval. When any repair or maintenance work is done by a sub-contractor, site engineer(s) must attend the work and have the sub-contractor prepare a maintenance report. The site representative inspects and submits the report to the QA/QC manager and gets approval from the QA/QC manager.

Approval of maintenance order

Approval from the representative of SPC is necessary to request maintenance and/or repair work(s) by a sub-contractor.

Emergency measure

Site engineer(s) must contact the site representative and the representative of the SPC immediately in case of emergency, such as damages of the gas engine, gas pipes, etc.

Emergency manual must be made to define incidents that should be reported to the police station, fire station, city hall and hospital. All staff should act according to the emergency manual.

Training of staff

The training program focuses on LFG fueled operation of the gas engine.

The staff will be trained by the gas engine manufacturer according to the following schedule.

- Basic training before shipping of the gas engine
- Training during the period of test run, and the installation of the gas engine
- Development and improvement of skills when necessary during the operation period

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

For the operation and maintenance of the Project, O/M teams consisted of the engineers and operators are formulated in the SPC.

Monitoring procedures and QA/QC activities are conducted by the O/M teams stationing at the plant for 24 hours according to ISO 9001. Moreover displacement of grid electricity with LFG-generated electricity, EG y monitored as electricity transmitted to the grid, is controlled and assured by PLN as well as the SPC.

QA/QC activities are conducted by the organization shown in Figure-6 and their main activities are as follows.

Safety operation by:
- Designation of a manager in charge.
- Monitoring gas collection, flare combustion, generation and transmission to the grid.
- Periodical maintenance.
- Training operators.

Accuracy of measurement by:
- Continuous measurements with well-defined routine procedures.
- Record keeping, computation and recording ERs.
- Proper maintenance and calibration of measuring devices.
- Training operators.

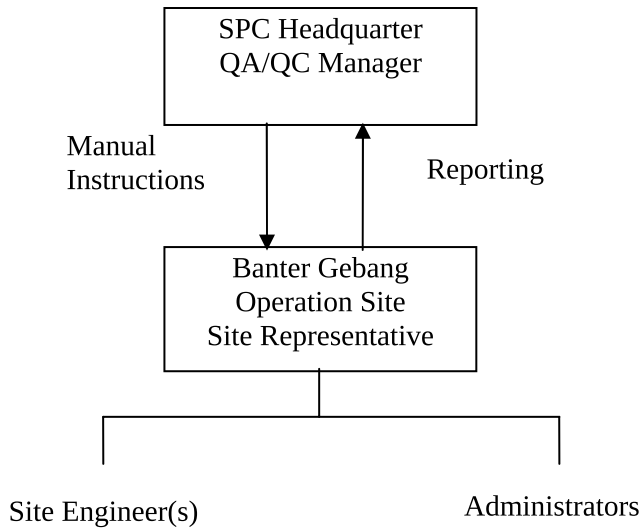

Figure-6. QA/QC and monitoring organization

D.5 Name of person/entity determining the monitoring methodology:

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This persons/entities are project participants listed also in Annex 1.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

Project Emission regarding Landfill Site

1. Gas generation potential

Gas generation potential G_e was calculated by using the equation practiced in Europe. G_e is approximately 146.45 m^3/t The parameters in the equation were determined by site measurements and laboratory tests of samples collected at the Zone V (Bantar Gebang landfill site).As for detailed computation, refer to Annex 3.

2. An annual gas generation

An annual gas generation was calculated by using the following First Order Decay Model (the IPCC Guidelines for National Greenhouse Gas Inventories Volume 3: Reference Manual (1996), p. 6.11)

LFG volume emitted in the year *j* from the solid waste deposited in the year *i* (V_j).

$V_j = M_i \times G_e \times k \times e^{-k(j-i)}$ ---(b)

M_i: amount of solid waste deposited in the year *i* (ton)

k: decay rate (1/year)

G_e: gas generation potential (146.45 m^3/t)

Annual waste volumes deposited into each zones of the Banter Gebang Site has been recorded by DKI Jakarta as attached in Annex 3. Based on the data, the annual LFG generation was calculated by the First Order Decay Model (the IPCC Guidelines for National Greenhouse Gas Inventories Volume 3: Reference Manual (1996),Chapter 6).

$MTVj = \alpha \times TVj$,

where MTVj: amount of methane gas emitted in the year j (m3/year), and

α : percentage of methane gas in landfill gas.

From the measurement at the Banter Gebang Landfill, the percentage of methane gas in the landfill gas, α , is approximately 50%.

The calculation results of annual gas generation are shown in the following table.

Table-5: Annual gas emission

Year	Annual LFG volume (m^3/year)	Annual CH_4 volume (m^3/year)
2008	71,454,000	35,727,000
2009	61,501,000	35,751,000
2010	52,935,000	26,467,000
2011	45,561,000	22,781,000
2012	39,215,000	19,607,000
2013	33,753,000	16,876,000
2014	29,051,000	14,526,000
2015	25,005,000	12,502,000
2016	21,522,000	10,761,000
2017	18,524,000	9,262,000
Total	398,521,000	204,260,000

**Annual CH_4 captured was estimated from annual gas flow velocity.

3. Estimation of captured gas in the project period

To estimate how much landfill gas and methane gas will be able to be captured, capture ratio is used.

CTVj = $\beta \times$TVj , and

CMTVj = $\beta \times$ MTVj ,

where CTVj: amount of landfill gas captured in the year j (m3/year),

CMTVj: amount of methane gas captured in the year j (m3/year), and

β : capture ratio.

The capture ratio is estimated by the ratio of the landfill gas that would be captured now by the proposed project to the landfill gas emitting now. The amount of the landfill gas that would be captured now by the proposed project is evaluated by the number of the boreholes in the proposed project times average flow volume coming out of the five test boreholes at the Banter Gebang Landfill. The flow volume from the test boreholes is getting stabilized and the average over recent stabilized measurements is used for the flow volume for this purpose. Then, the preliminary capture ratio is estimated at 30% and variable in each year.

Computed annual methane gas captured/not-captured in volume (m3) is shown in Table-6. And this fugitive emission accords with the project emission regarding landfill site.

Table-6: Annual Methane Gas

Year	Annual CH_4 captured (m^3/year)	Annual CH_4 not-captured (m^3/year)
2008	10,236,000	25,491,000
2009	9,724,000	26,027,000
2010	9,212,000	17,255,000
2011	8,701,000	14,080,000
2012	8,189,000	11,418,000
2013	7,677,000	9,199,000
2014	7,165,000	7,361,000
2015	6,653,000	5,849,000
2016	6,142,000	4,619,000
2017	5,630,000	3,632,000
Total	79,329,000	124,931,000

Project Emission regarding Electricity Generation

When combusted, methane converts to CO_2 that is much less potent in the global warming. Methane is organic in nature and these emissions are ignored in terms of carbon neutral.

In addition, to operate the facilities, the electricity generated from landfill gas will be used.

Consequently, there is no additional emission other than that from the landfill.

Total Project Emission

The difference of generated CH_4 volume and captured CH_4 volume, that is shown in Table-6 as CH_4 emission not-captured, is total project emission since there is no additional emission by the project.

The results of calculated project emission in CO_2 are shown in the Table-7.

Table-7: Project Emission

Year	Project Emission (tCO_2e/ yr)
2008	382,369
2009	315,398
2010	258,825
2011	211,202
2012	171,281
2013	137,991
2014	110,407
2015	87,734
2016	69,289
2017	54,483
Total	1,798,979

E.2. Estimated leakage:

No leakage effects need to be accounted under ACM0001 methodology.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

The total project activity emission is shown in E.1.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Baseline Emission regarding Landfill Site

Gas emission of baseline scenario is calculated based on Table-5 and shown in Table-8. As for the detailed computation, refer to E.1.

Table-8: Baseline Emission from the Landfill Site

Year	Baseline Emission from the Landfill Site (tCO_2e/ yr)
2008	535,907
2009	461,260
2010	397,010
2011	341,710
2012	294,112
2013	253,145
2014	217,884
2015	187,534
2016	161,412
2017	138,929
Total	2,988,903

Baseline Emission regarding Electricity Generation

The baseline case regarding the electricity displacement will be GHG emitted to generate the electricity, whose amount is corresponding to that of the project-generated electricity.

Considering the operation conditions of the power station, baseline emissions regarding electricity in year *j* , BEG *j*, can be estimated in the following manner.

$$BEG\ j = EG_y \times CEF_{electricity,y}$$
$$EG_y = CMTVj \times CAV \times PWEFF \times PWAVL \times (1\text{-}PWUS)$$

Where:

EG_y : Electricity Generated
$CEF_{electricity,y}$: Emission Factor [$kgCO_2e/kWh$]
CMTV*j* : Amount of Captured Methane Gas in the year *j* [m^3/year]
CAV : Calorific value of methane [GJ/m^3]
PWEFF : Power Efficiency for Electricity Generation [%]
PWAVL : Power Average Availability [%]
PWUS : Power Used for Project Operation [%]

The emission factor of emission reductions due to displacement of electricity in other power plants is estimated by using the following data in Table-9 and Table-10. The weighted average emission factor is 0.484 kg CO_2e/kWh.

Table- 9 Percentage of PLN electricity generated by sources in 2000

Crude oil	Coal	Natural gas	Hydro	Others	Total(GWh)
14.0	34.5	5.8	10.9	34.8	83,5004

Table- 10 Emission factors by sources in Japan (kg CO2e/kWh)
(Data Source: Central Research Institute of Electric Power Industry of Japan)

Crude oil	Coal	Natural gas	Hydro	Others
0.742	0.975	0.608	0.011	0.020(estimated)

Detailed computational steps and some data are summarized in Annex 3.

Emission reduction by displacing the grid electricity by the amount corresponding to the electricity generated by the proposed project is calculated by the baseline methodology explained above, and 0.08 million tones of CO_2e, will be destroyed.

The estimated result is presented in the Table-11.

Table-11: Electricity generated and destroyed CO_2

Year	**Electricity Generated (kwh/year)**	**CO_2 in ton**
2008	23,030,762	10,590
2009	21,879,224	10,060
2010	20,727,686	9,531
2001	19,576,148	9,001
2012	18,424,610	8,472
2013	17,273,072	7,942
2014	16,121,534	7,413
2015	14,969,996	6,883
2016	13,818,457	6,354
2017	12,666,919	5,824
Total	178,488,408	82,070

<u>Baseline Emission</u>

The total CO_2 of gas emission from landfill site and electricity generation accords with baseline emission. The results are shown in Table-10.

Table-10: Baseline Emission

Year	Baseline Emission (tCO_2e/ yr)
2008	546,497
2009	471,320
2010	406,541
2011	350,711
2012	302,584
2013	261,087
2014	225,297
2015	194,417
2016	167,766
2017	144,753
Total	3,070,973

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

Table-11 Summary of Calculated Emissions and Emission Reduction (in tCO_2e)

Crediting Period	Baseline Emissions	Project Emissions	Emission Reductions
10 years	3,071,000	1,799,000	1,272,000

E.6. Table providing values obtained when applying formulae above:

Table-12 Baseline and Project Emissions and Emission Reduction (in tCO_2e)

Year	Estimation of project activity emission (tonnes of CO2e)	Estimation of baseline emission (tonnes of CO2e)	Estimation of leakage (tonnes of CO2e)	Estimation of emission reductions (tonnes of CO2e)
2008	382,369	546,497	Not accounted	164,128
2009	315,398	471,320		155,922
2010	258,825	406,541		147,716
2011	211,202	350,711		139,509
2012	171,281	302,584		131,303
2013	137,991	261,087		123,096
2014	110,407	225,297		114,890
2015	87,734	194,417		106,683
2016	69,289	167,766		98,477
2017	54,483	144,753		90,270
Total	1,798,979	3,070,973	Not accounted	1,271,994

SECTION F. Environmental impacts

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

This project is consisted of LFG collection and small power generation utilizing it and therefore the project will contribute to improve the local environment by collection and combustion of the uncontrolled LFG at the site while there is limited environmental impact by electricity generation.

In Indonesia environmental impact assessment is required in the case of construction of new landfill site having the area more than 10ha or construction of electricity generation facility having the capacity more than 10MW and this is not the case. This project does not aim to establish any new landfill site. In addition, the capacity of electricity generation is approximately 2MW.

In this project, preparation of Environmental Impact Assessment (EIA) is not required but simplified environmental assessment plan(UKL) and monitoring plan(UPL) have to be submitted to the local government.

Major components of LFG are methane and carbon dioxide, which are colorless and odorless. Major global environmental concern over these compounds is the fact that they are greenhouse gases.

If LFG is generated in the confined area with high concentrations, there is a risk of asphyxiation and/or toxic effects on human body. But the risk of toxic effects on the local community and environment will be significantly reduced by collection and combustion of LFG. Although power generation from LFG may produce nitrogen oxides emission, it could be minimized by NO_X-controlling type generators.

Combustion of LFG may also result in the release of organic compounds and toxic substances including mercury and dioxins. Nevertheless these emissions are also regarded as much less harmful than continuous uncontrolled release of LFG.

The following aspects of operation of the LFG to energy project have also been addressed:

Noise: The main prevention against this impact will be the gas engine generator and air compressor. Although the engines and air compressor will be placed to reduce noise emissions, there will be some increase in noise from the landfill site associated with energy recovery. If the resultant noise level at the fencing is greater than 65dB(A), the enclosure should be needed for gas engine and air compressor.

Gas Emission: The potential gas emission during operation phase is sulphur dioxide, nitrogen oxides, particle and others.

-Emission of sulphur dioxide will remain within Emission Standard of 800mg/m3(at 25℃,1atm) as stipulated in Decree of State Minister for Environment No.13 of 1995.

-Emission of nitrogen oxides will remain within Emission Standard of 1,000mg/m3(at 25℃,1atm) as stipulated in Decree of State Minister for Environment No.13 of 1995.

-Particulate production from the combustion of LFG is low as it is mainly in the form of soot. Principally it is known that particulate emission from gas firing is very negligible.

-Other pollutant is mainly carbon monoxides and negligible amount of hydrocarbon.

To enhance the maximum removal of sulphur dioxide and nitrogen oxides from the exhaust gas stream, scrubber and low-NO_x type gas engine will be installed.

Odor: During gas collection process, there will be some odor nuisance. Soil cover for landfill waste will eliminate this odor problem as well as enhance LFG recovery.

Wastewater discharge: The wastewater discharge will be mainly from the cooling water. The scrubber is installed to lower the temperature of LFG. However, quantity of accessorily hydrogen sulphide and carbon dioxides dissolved in the cooling water is negligible.

Visual amenity: Soil covering for gas collection system will also put the landfill waste out of sight thus removing visual nuisance of the site.

The development of LFG utilization schemes, such as this project, is also an opportunity to promote best practices to improve landfill management standards, and contribute towards global sustainable development.

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

No significant negative impacts to the environment will result from the project activity. On the contrary the following environment benefits will result in:

- Significant reduction of methane emission.
- Generation of green energy.
- Reduction of toxic gas emission(like CH_4, H_2S, etc).
- Improvement of landfill cover, reducing leachate generation.
- Reducing risk of groundwater pollution by good quality cover soil.
- Reduction of nuisance odor.

SECTION G. Stakeholders' comments

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

Comments of local stakeholders were compiled through interview survey in three categories summarized below from October 2004 to January 2005.

Table-13 List of Stakeholders

Category		Stakeholders	Status	Survey Period
1.Governmental organizations	Central Government	a. Ministry of Public works	Responsible ministry of SWM policy	24th October 2005
		b. Ministry of Energy and Mineral Resources	Responsible ministry of renewable energy policy	24th October 2005
		c. Ministry of Environment	Responsible ministry of Environment	20th January 2006
	Local Government	d. DKI Jakarta Cleaning Department	Landowner Responsible for landfill operation	16th March 2006
		e. KOTA Bekasi Environmental Agency	Location of landfill Responsible for landfill operation	19th January 2006
2.Private entities		a. PLN (Perusahaan Listrik Negara) Renewable Energy Society	National Electric Company Responsible for renewable energy Planning	5th November 2004
		b. Patriot Bangkit Bekasi	Local enterprises Landfill operating Company	12th August 2005
3.Community		a. Resident Associations	Community Residents	15th March 2006

In the interview survey the proposed project was discussed with the explanation materials in which the environmental and social impacts of the construction and operation of the project were described.

Documentations to support these activities are available in the form of record of interview and minutes of discussion.

In September 29th of 2004, Ministry of Public Works constituted the counterpart team (including above Governmental Organizations) for implementation of this project. They expressed all-out support to this feasibility study.

G.2. Summary of the comments received:

Through the interview survey with the explanation materials of the project, comments were received as follows:

From governmental organizations:

Central government organizations of MOPW as responsible ministry of solid waste management policy, MOEMR as responsible ministry of renewable energy policy and MOE as responsible ministry of environmental conservation have welcomed the project in that the government is encouraging the development of renewable energy projects for diversifying the source of energy and that the project will environmentally contribute to the safety closure of urban solid waste landfill site.

MOPW stated that they do not have the policy to enforce the LFG collection and utilization of the existing or closing municipal solid waste landfill sites.

Local governments of Jakarta who dispose their municipal waste at Banter Gebang Landfill and Bekasi City Council who governs the landfill site as an administrative office of the area also accepted the project. In addition to the reasons mentioned above, they support this project because they expect the post-closure utilization of the landfill site after the acceleration of landfill stabilization by extracting methane gas by the project.

Environment Department of Bekasi City confirmed that the preparation of DEIA, Detailed Environmental Impact Assessment won't be required for the proposed project. Instead, UKL,UPL, a simplified environment assessment and monitoring plan, will be required.

From private entities:

PLN, the national electric company, has agreed to receive the electricity generated by the project as a small renewable energy resource at a designated point in their distribution grid lines.

PBB, the operator of the existing Banter Gebang Landfill site, declared a strong interest for participation to this project.

From Community residents:

Community residents are strongly interested in this project. Because, they hope this project contribute the improvement of the environmental condition in landfill site.

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

There were favourable comments to the project except the unknown response from the residents of Banter Gebang site.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

None

Annex 3

BASELINE INFORMATION

Emission regarding Landfill Site

1. Gas generation potential

Gas generation potential G_e was calculated by using the following equation practiced in Europe. The parameters in the equation were determined by site measurements and laboratory tests of samples collected at the Zone V (Bantar Gebang landfill site).

$G_e=1.868\times C_0\times(0.014\times d+0.28)$---(a)

G_e: gas generation potential,

C_0: amount of total organic carbon in waste, and

d: temperature in landfill.

In estimating the LFG emission for the proposed project, C_0 is determined from the laboratory test on the solid waste sampled at ZoneV, and the temperature inside the observation well in the solid waste was measured for d.

G_e is approximately 146.45 m^3/t

Where: C_0 = 80.0 kg/t,

d = 50 degrees*,

* Temperature (used for calculation) was revised from 43 degree (average measured temperature was 43.5) to 50 degree, because temperature was not measured inside the solid waste but at the top of the well pipe and measured value was influenced of atmospheric temperature(35～40 degree).

2. An annual gas generation

An annual gas generation was calculated by using the following First Order Decay Model (the IPCC Guidelines for National Greenhouse Gas Inventories Volume 3: Reference Manual (1996), p. 6.11)

LFG volume emitted in the year *j* from the solid waste deposited in the year *i* (V_j).

$V_j = M_i \times G_e \times k \times e^{-k(j-i)}$ ---(b)

M_i: amount of solid waste deposited in the year *i* (ton)

k: decay rate (1/year)

G_e: gas generation potential (146.45 m^3/t)

TableA3-1 shows annual waste volumes deposited into each zones of the Banter Gebang Site recorded by DKI Jakarta. Based on the Table, the annual LFG generation was calculated by the First

Order Decay Model (the IPCC Guidelines for National Greenhouse Gas Inventories Volume 3: Reference Manual (1996),Chapter 6).

Table A3-1 Annual Waste Volumes Deposited to Banter Gebang Site (m^3)

	Zone Ⅰ	Zone Ⅱ	Zone Ⅲ	Zone Ⅳ	Zone Ⅴ	Total
1989	5,475,000					5,475,000
1990	5,490,000					5,490,000
1991		5,475,000				5,475,000
1992		6,205,000				6,205,000
1993		6,205,000				6,205,000
1994			6,205,000			6,205,000
1995			6,222,000			6,222,000
1996			6,205,000			6,205,000
1997				6,570,000		6,570,000
1998				6,570,000		6,570,000
1999				6,570,000		6,570,000
2000					6,588,000	6,588,000
2001					6,935,000	6,935,000
2002	6,935,000					6,935,000
2003		2,282,438	3,234,098	1,418,464		6,935,000
2004*	1,138,438		1,650,404		650,158	3,439,000
Total	19,038,438	20,167,438	23,516,502	21,218,464	14,173,158	98,024,000

(Data Source：Cleaning Department, DKI Jakarta)
*Deposited volume for 2004 shows an interim volume

From the measurement at the Banter Gebang Landfill, the percentage of methane gas in the landfill gas, α, is approximately 50%.

MTVj = α × TVj ,

where MTVj: amount of methane gas emitted in the year j (m3/year), and

α: percentage of methane gas in landfill gas.

The calculation results of annual gas generation are shown in the following table.

Table A3-2: Annual gas emission

Year	Annual LFG volume (m^3/year)	Annual CH_4 volume (m^3/year)	Annual CO_2 volume (tCO_2e/ yr)
2008	71,454,000	35,727,000	535,907
2009	61,501,000	35,751,000	461,260
2010	52,935,000	26,467,000	397,010
2011	45,561,000	22,781,000	341,710
2012	39,215,000	19,607,000	294,112
2013	33,753,000	16,876,000	253,145
2014	29,051,000	14,526,000	217,884
2015	25,005,000	12,502,000	187,534
2016	21,522,000	10,761,000	161,412

2017	18,524,000	9,262,000	138,929
Total	398,521,000	204,260,000	2,988,903

**Annual CH_4 captured was estimated from annual gas flow velocity.

Electricity Generation

C. ELECTRICITY SALE BY POWER GENERATION

CO_2 emission vol./kg	=	0.48			
Electicity Price (US$/kwh)	=	0.04			
% of electricity to produce	=	90%			
electricity for operation	=	5%			
Year	mwh/day	Electricity Generated kwh/year	CO_2 in ton	Total	Income from Electricity Sales
2008	70.1	23,030,762	10,590	85,511	875,169
2009	66.6	21,879,224	10,060	81,235	831,411
2010	63.1	20,727,686	9,531	76,960	787,652
2011	59.6	19,576,148	9,001	72,684	743,894
2012	56.1	18,424,610	8,472	68,408	700,135
2013	52.6	17,273,072	7,942	64,133	656,377
2014	49.1	16,121,534	7,413	59,857	612,618
2015	45.6	14,969,996	6,883	55,582	568,860
2016	42.1	13,818,457	6,354	51,306	525,101
2017	38.6	12,666,919	5,824	47,031	481,343

Baseline Emission

The total CO_2 of gas emission from landfill site and electricity generation accords with baseline emission. The results are shown in Table A3-4.

Table A3-4: Baseline Emission

Year	Baseline Emission (tCO_2e/ yr)
2008	546,497
2009	471,320
2010	406,541
2011	350,711
2012	302,584
2013	261,087
2014	225,297
2015	194,417
2016	167,766
2017	144,753
Total	3,070,973

Referenc

A. SUMMARY OF PARAMETERS AND CONDITIONS

Costs

1	Initial Cost	US$	6,000,000.00	
2	Loan Amount	US$	0.00	
	Percentage of Loan		0%	
	Returning Period		10	year
	Total Loan Payment each Year	US$	0.00	
3	Operational & Maintenance Cost	US$	240,000.00	
4	Inflation Rate *1		5.78%	
5	Corporate Tax *2		30%	
6	Salvage Value		0.00	
7	Annual Depreciation Rate		12.5%	
8	Electricity for Operation		5%	
9	CDM Administration Fee		5%	
10	Conversion Rate of $ to $		1.00	

Methane Gas

1	Total Organic Carbon in Waste (TOC)		80.00	kg/t
2	Decay Rate (k value)		0.15	/yr
3	Methane Concentration in Landfill Gas (CH4)		50%	
4	Methane Gas Potential (Ge)		146.45	m3/t
	Borehole Diameter		0.07	m
	Number of Boreholes		120	
	Per unit wait of waste		0.323	t/m3
	Temparature		50	℃

Electricity Computation

1	CO2 Emission Volume		0.48	/kg
2	Electicity Price	US$	0.04	/kwh
3	Annual Power Generation Availability		90%	

Pareameters for Electricity Generation

1	Caloric Value of Methane		8,600.00	kcal/m3
2	Conversion from Calorie to Joule		4.1861	J/cal
3	Power Generation Efficiency		25%	

Notes:

1 Depreciation is exempted from tax
2 Property tax is not considered
3 Income comes only from Sale of Electricity

*1 Data Source: Central Bureau of Statistics, "Statistical Year Book of Indonesia,2 2003
*2 Data Source: JETRO Indonesia

Corporate Tax Rates

-10% for taxable income up to Rp. 50 million.
-15% for taxable income between Rp. 50 and 100 million.
-30% for taxable income in excess of Rp. 100 million.

D. CALCULATION OF INTERNAL RATE OF RETURN

initial value (project value)	=	6,000,000.00	US$
loan amount	=	0.00	
returning period (year)	=	10	
operational period (year)	=	10	
salvage value	=	0.00	
inflation rate	=	**5.78%**	
corporate tax	=	**30.00%**	
discount rate	=	**9.50%**	**2,443,082.46**
subsidy	=	**0.00%**	

operation cost present	capital cost	operation cost future	depreciation present	depreciation future	benefit present	benefit future	taxable amount	tax future	net profit future
	6,000,000.00								**-6,000,000.00**
240,000.00		**253,872.00**	**750,000.00**	**793,350.00**	**0.00**	**875,168.97**	**-172,053.03**	**0.00**	**621,296.97**
240,000.00		**268,545.80**	**750,000.00**	**839,205.63**	**0.00**	**831,410.52**	**-276,340.91**	**0.00**	**562,864.72**
240,000.00		**284,067.75**	**750,000.00**	**887,711.72**	**0.00**	**787,652.08**	**-384,127.39**	**0.00**	**503,584.33**
240,000.00		**300,486.86**	**750,000.00**	**939,021.45**	**0.00**	**743,893.63**	**-495,614.69**	**0.00**	**443,406.76**
240,000.00		**317,855.01**	**750,000.00**	**993,296.89**	**0.00**	**700,135.18**	**-611,016.72**	**0.00**	**382,280.17**
240,000.00		**336,227.02**	**750,000.00**	**1,050,709.45**	**0.00**	**656,376.73**	**-730,559.75**	**0.00**	**320,149.70**
240,000.00		**355,660.95**	**750,000.00**	**1,111,440.46**	**0.00**	**612,618.28**	**-854,483.13**	**0.00**	**256,957.33**
240,000.00		**376,218.15**	**750,000.00**	**1,175,681.72**	**0.00**	**568,859.83**	**-983,040.04**	**0.00**	**192,641.68**
240,000.00		**397,963.56**	**0.00**	**0.00**	**0.00**	**525,101.38**	**127,137.83**	**38,141.35**	**88,996.48**
240,000.00		**420,965.85**	**0.00**	**0.00**	**0.00**	**481,342.94**	**60,377.08**	**18,113.12**	**42,263.96**
2,400,000.00	**6,000,000.00**		**6,000,000.00**	**7,790,417.32**		**6,782,559.54**		**56,254.47**	**3,414,442.12**
								Project IRR=	**-12%**

ANNEX 4
MONITORING PLAN

Attention to the future regulation and/or law applicable to collection and capture of LFG

At the time of PDD preparation, there neither exist nor are foreseen any regulations or laws requiring collection and capture of GHG from landfill site in Indonesia. Future regulations and/or laws applicable to the LFG collection and capture will be monitored throughout the project period and will be followed as required.

Measurement of LFG

The monitoring methodology is based on direct measurement of the amount of LFG captured and destroyed at the flare platform and the electricity generating energy unit(s) except CO_2 emissions intensity ($CEF_{electricity,y}$), which will be obtained from the latest available annual report issued by PLN. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared and the electricity energy generated. The main variables that need to be determined are the quantity of methane actually captured $MD_{project,y}$, quantity of methane flared ($MD_{flare,y}$) and the quantity of methane used to generate electricity ($MD_{electricity,y}$) determined as follows:

Methane collected and flared

The amount of methane actually flared ($MD_{flare,y}$) will be determined by monitoring.

・Amount of landfill gas flared ($LFG_{flare,y}$) [m^3 - using a continuous flow meter].
・Methane fraction in the landfill gas (F_CH_{4y}) [m^3CH_4/m^3LFG - using a continuous gas quality analyzer].
・Flare/combustion efficiency [% - determined by the operation hours and the methane content in the exhaust gas].
  - Flare working hours [hours - using a run time meter].
  - Methane content in the exhaust gas [m^3CH_4/m^3 - using a continuous gas quality analyzer].
・Density of methane [tCH_4/m^3CH_4 - determined by the temperature and pressure of the landfill gas].
  - Temperature of the landfill gas [℃ - using a thermometer].
  - Pressure of the landfill gas [Pa - using a manometer].

Methane collected and used to generate electricity

The amount of methane actually combusted in power plant shall be determined by monitoring.

・Amount of landfill gas combusted in power plant ($LFG_{electricity,y}$) [m^3 - using a continuous flow meter].
・Methane fraction in the landfill gas (F_CH_{4y}) [m^3 - using a continuous gas quality analyzer].
・Density of methane [tCH_4/m^3CH_4 - determined by the temperature and pressure of the landfill gas].
  - Temperature of the landfill gas [℃ - using a thermometer].
  - Pressure of the landfill gas [Pa - using a manometer].

Displacement of grid electricity with the electricity generation by landfill gas

The amount of electricity transferred (= displaced) to the grid and used to operate the landfill project will be directly measured by monitoring.

・Amount of electricity generation ($EG_{total,y}$) [MWh - using a continuous power meter].
・Amount of displaced electricity (EG_y) [MWh - using a continuous power meter].

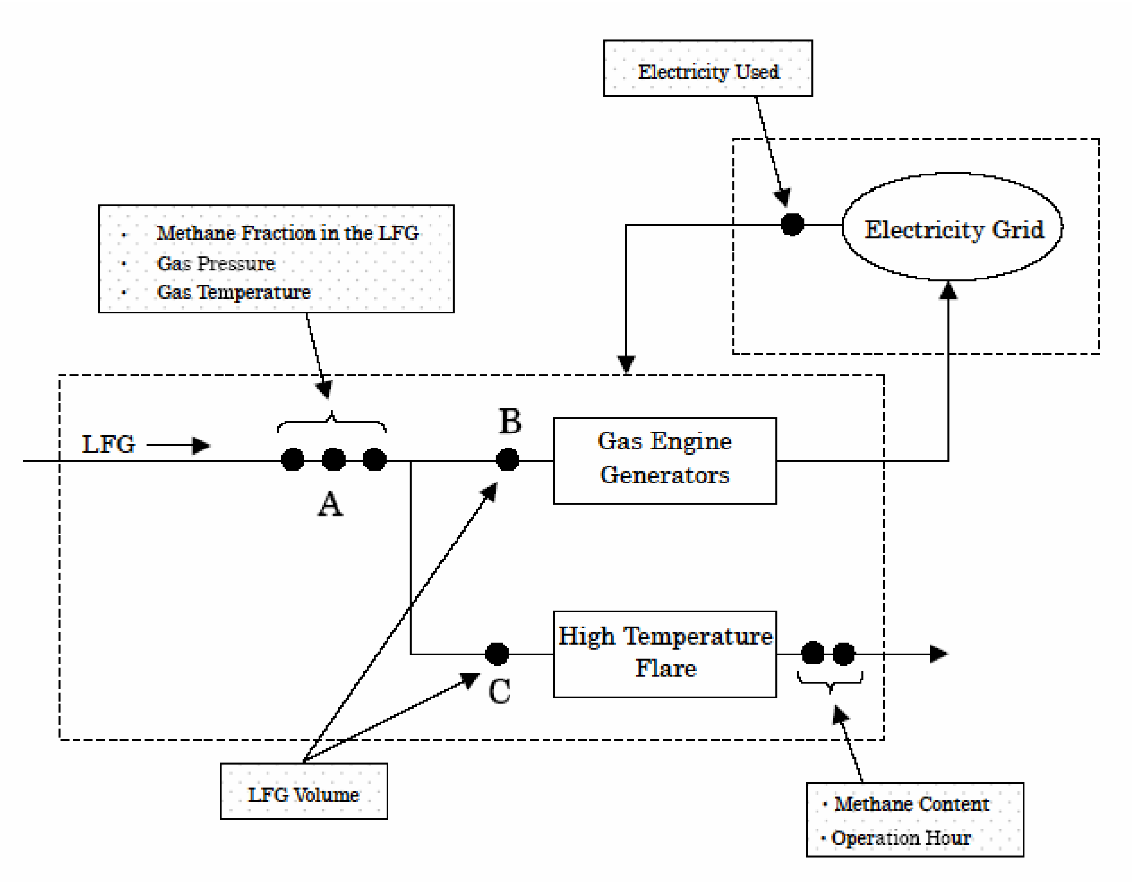

Figure A4-1 Schematic of monitoring

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