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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

PT Navigat Organic Energy Indonesia Integrated Solid Waste Management (GALFAD) Project in Bali, Indonesia (the "Project" or "Project Activity")

Version 1, completed 05/07/2005

A.2. Description of the project activity:

The Project, to be carried out by PT Navigat Organic Energy Indonesia (PT NOEI), involves the construction and operation of a "GALFAD® (GAsification, LandFill gas and Anaerobic Digestion)" plant at the TPA Suwung landfill site in Bali, which will treat and recovery energy from municipal solid waste. The existing landfill site receives approximately 800 tonnes per day of waste.

The Project will derive energy from municipal solid waste by recovering biogas from the landfill, extracting biogas through anaerobic digestion of wet organic waste and syngas from the gasification of dry organic waste. The recovered energy will be used to supply electricity to the local grid. In doing so, the project will contribute to greenhouse gas (GHG) reductions in two ways. The first is through the destruction of methane that would have been emitted from the landfill site in the absence of the Project. The second is through the displacement of fossil fuel-based grid electricity generation with the Project's carbon-neutral electricity.

The Project will be split into two phases. In the first phase, the facility will be rated at 4.8MW – 2.8MW from gasification and 2.0MW from anaerobic digestion. The second phase will introduce an additional 4.8MW capacity – 2.8MW from gasification, 1.0MW from anaerobic digestion and 1.0MW from landfill gas recovery.

The Project will contribute to the sustainable development of Indonesia in several ways:

- Promoting indigenous fuel for energy: The use of biomass, an indigenous and renewable source of fuel is consistent with Indonesia's stated energy policy to increase by 2020 the share of such resources to 5% of the total energy supply.

- Management of municipal solid waste: The Project will lead to a drastic improvement in municipal solid waste management and set a welcome precedent. By treating the waste, the Project will lead to an improved environment around the landfill site, with reduced health hazards, odours and increased sanitation, among other benefits. Of particular note is the reduction of health hazards. Not only will the Project reduce the methane concentration, thereby decreasing the risk of spontaneous fires and potentially lethal explosions, but by improving the management of the landfill and reducing the volume of waste, it will also make an important contribution to lessening the risk of waste landslides such as that which recently claimed more than 100 lives[1].

[1] "120 missing in dump are likely dead from heat", South China Morning Post article, February 24, 2005

- Use of new technology: The Project will be the first of a kind in Indonesia, adopting advanced technology for solid waste management, a technology which has been proven in industrialised countries. The Project will thus promote important transfer of technical know how.

A.3. Project participants:

Name of Party involved	Private and/or public entity(ies) project participants	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Indonesia (host)	PT Navigat Organic Energy Indonesia (PT NOEI)	No
Japan	Mitsubishi Securities Co., Ltd. (MS)	No

PT Navigat Organic Energy Indonesia (PT NOEI)

PT NOEI is the project developer, which will construct and operate the GALFAD system at the TPA Suwung landfill site. It is a joint venture between PT Navigat, the official GE Jenbacher agent in Indonesia, a company with a wide and mature experience of the Indonesian energy market, and Organics Group plc, a UK based company specialising in waste-related environmental protection and energy recovery by means of a variety of technologies.. They have successfully implemented similar projects in Annex I countries including the United Kingdom, the United States of America, Australia, Greece, Ireland, New Zealand and Spain.

Mitsubishi Securities Co., Ltd. (MS)

Through its Clean Energy Finance Committee, MS acts as the CDM consultant to the Project, and is the contact for the Project Activity.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Republic of Indonesia

A.4.1.1. Host Party(ies):

Republic of Indonesia

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

Bali

A.4.1.3. City/Town/Community etc:

Denpasar

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

The Project will be located at the TPA Suwung Landfill Site, approximately 10km from Denpasar. The landfill site occupies approximately 24 ha.

The TPA Suwung solid waste disposal site is located on reclaimed tidal land on the northeastern edge of Benoa Bay. The site belongs to a Protected Forest Area called "Tahura" but 10 ha has been assigned to the Governor of Bali by the Indonesian Ministry of Forestry to be used as a disposal site for municipal solid waste.

The TPA Suwung Landfill site has been in operation for the last twenty years. Commencing in 1984, the Suwung site has received all the municipal solid waste from the region of Denpasar and that of South Badung. In 2000 North Badung commenced delivery of solid waste to the site as well.

The site is not a sanitary landfill and no covering of waste with any form of cover material is carried out. The local environment is not protected from the leachate infiltration downwards into ground water, nor are there any barriers to prevent deposited waste material escaping with tidal seawater with every outgoing tide

The site is also used as a disposal point for raw untreated sewage which is dumped from septic tank systems located throughout the urban area. Untreated sewage is emptied out of tanker trucks into neighbouring tidal creeks that flow alongside the waste piles.

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

There are currently no categories of project activity given on the UNFCCC website. The project activity can be associated with the following sectoral scopes:

Sectoral scope 1: Energy industries (renewable - / non-renewable sources)
Sectoral scope 13: Waste handling and disposal

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

The Project will use the GALFAD® system assembled by PT NOEI. GALFAD® consists of gasification, landfill gas recovery and anaerobic digestion. The technologies are briefly described below.

<u>Gasification</u>

Gasification is the process of converting biomass into combustible gases (carbon monoxide, methane and hydrogen) that converts somewhere between 60% to 90% of the original energy contained in the waste to energy. The gasification process to be employed combines the thermo-chemical processes of pyrolysis, gasification and high temperature oxidation.

Gasification occurs in an oxygen-deficient atmosphere, which is a key difference to incineration. Gasification is not associated with dioxins and furans – by products of incineration. There product gas may, however, include such substances as heavy metals and NOx. The Poject will employ a baghouse filter, the dry SOLVAY process and cyclone separators to treat these substances. Moreover, the design of the chamber ensures that the gases and any small particles remain at a temperature of 1250℃ for at least two seconds, minimising the emission of pollutants.

The heat from the combusted gas will be used in a waste heat recovery boiler for steam production, which will in turn be used in a steam turbine to produce electricity.

Landfill gas recovery

The landfill gas collection system will consist of vertical wells drilled into the landfilled and capped waste, connected together with medium density polyethylene piping.

Landfill gas will be drawn by a gas delivery unit, which is a package of equipment including a gas blower, filtration equipment, dewatering and gas drying equipment, chillers and other associated instruments and controls. The unit collects and delivers the gas to the engines in a manner which will ensure long-term and stable operation.

Anaerobic digestion

In anaerobic digestion, the waste is fed into a digester in which anaerobic bacteria decomposes the waste into methane, carbon dioxide as well as minor quantities of other gases. The environment in the digester is such that the decomposition is accelerated as compared to what would happen in the natural environment, allowing a rapid reduction in waste volume.

The Project plans to use a high-rate IYO Baffled Anaerobic Reactor, suited for varied or difficult waste streams and which provides a high-rate, low-retention time digestion.

Electricity generation

The Project has plans to use suitable Jenbacher engines, manufactured in Austria. However, given the upward trend of the Euro in recent years, the selection of the engine manufacturer may change. In any event, suitable and internationally-proven engines will be adopted.

The Project will play an important role in technology transfer to Indonesia where the majority of municipal solid waste is disposed of in a landfill, or more often, a dumpsite. If successful, the Project will become the first in the country to offer a more advanced solution to municipal solid waste management. It will offer an example of not only landfill gas recovery and utilization, but will also introduce the more advanced solutions, anaerobic digestion and gasification.

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:

The Project will reduce GHG emissions in two ways. The first is through the destruction of methane that would have been emitted from the landfill site in the absence of the Project. The second is through the displacement of fossil fuel-based grid electricity generation with the Project's carbon-neutral electricity.

Currently, there are no regulations in place in Indonesia that would mandate the recovery and destruction of methane emitted from landfills. Technologies that involve landfill gas recovery and utilization are too expensive and perceived as being risky to attract commercial interest. The Project therefore will not occur without CDM designation and the additional income from the sale of CERs that such designation will entitle it to.

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

The following table shows the estimated amount of emission reductions over 7 years.

Years	Annual estimation of emission reductions in tonnes of CO_2e
Year 1	51,412
Year 2	99,224
Year 3	118,372
Year 4	134,853
Year 5	149,038
Year 6	161,247
Year 7	171,756
Total estimated reductions (tonnes of CO_2e)	885,902
Total number of crediting years	7 years (renewable)
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	126,557

A.4.5. Public funding of the project activity:

The Project does not involve public funding form Annex I countries.

SECTION B. Application of a baseline methodology

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

The proposed new methodology "Integrated solid waste management with methane destruction and energy generation" (the "methodology" or "new methodology")

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

The methodology is appropriate as the Project meets the following applicability conditions.

- The project, through solid waste management technologies destructs the methane that would have been emitted from a landfill or dumpsite.
- The current practice is to discard untreated waste at a landfill or dumpsite.

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

The proposed new methodology follows three main steps:
1. Baseline scenario determination
2. Assessment of additionality
3. Emission reduction calculation

The first two steps, baseline scenario determination and assessment of additionality is carried out by applying the *Tool for demonstration and assessment of additionality*, the steps which are detailed in the ensuing section.

The third step, emission reduction calculation, is given in Section E.

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 new methodology stipulates the adoption of the *Tool for demonstration and assessment of additionality*. The tool, consisting of five steps, is applied below.

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

PT NOEI had seriously considered the incentive from the CDM for the Project, in particular given the inadequate project returns in the absence of the additional CER revenue. The importance of the CDM became more pronounced as the Euro gained strength and contributed to a significant increase in cost projections. By the middle of 2004, PT NOEI had come to realise that their Project will only be feasible with CDM assistance.

Subsequently, PT NOEI decided to pursue CDM status for the Project. To this end, the company began talks with Mitsubishi Securities for the purpose of entering into a CDM consulting agreement. Negotiations between PT NOEI and Mitsubishi Securities began in August, 2004.

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

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

The following scenarios are considered as possible alternatives to the Project Activity.

Scenario A: Untreated disposal in a landfill/dumpsite with no gas (methane) recovery (continuation of current practice)
Waste will continue to be dumped untreated at the existing TPA Suwung Landfill Site. Landfill gas will be formed and released into the atmosphere uncontrolled.

Scenario B: The Project Activity without the CDM
An integrated solid waste management system will be implemented, which includes gasification, anaerobic digestion and landfill gas recovery. The methane that would have otherwise been emitted would be destructed through energy generation and / or flaring.

Scenario C: Landfill gas (methane) recovery and destruction
The landfill gas is recovered. The methane that would have otherwise been emitted would be destructed through energy generation and / or flaring.

Scenario C is rejected as a plausible scenario. Again, the income from electricity sales is insufficient to justify an investment in landfill gas extraction and energy generation technologies. It is pertinent to note that energy generation from extracted landfill gas represents a new technology in Indonesia and does not represent a stable fuel supply for either the project developer or equity / debt investors. This technological uncertainty and risk also applies to Scenarios B and D.

Scenario C may however be plausible if there exists an enforced law that mandates the collection and destruction of landfill gas (flaring). Otherwise, the flaring scenario is implausible since no revenue can be derived. In Indonesia's case, there is no such enforced law mandating the action in Scenario C.

Therefore, the only plausible baseline scenarios are Scenarios A an B; that is the continuation of the current practice of untreated disposal in a dumpsite of landfill, or the project activity carried out without the CDM.

For the grid electricity generation component of the Project Activity, the 9.6MW capacity of the Project plant makes it eligible to apply a small-scale methodology. The appropriate methodology is I.D.: *Renewable electricity generation for a grid*. According to this methodology, the baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO_2equ/kWh) calculated in a transparent and conservative manner as either a) the average of the approximate operating margin and the build margin or b) the weighted average emissions of the current generation mix. The latter approach is chosen due to there being no data currently available to carry out the former calculation.

Sub-step 1b. Enforcement of applicable laws and regulations

All the alternatives listed in Sub-step 1a above are in compliance with the laws and regulations of Indonesia.

The *Tool for the demonstration and assessment of additionality* stipulates that either Step 2 or Step 3 is chosen to demonstrate additionality. Here, Step 2 is selected.

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

The proposed Project faces financial barriers that prevent its implementation in the absence of the CDM. As the Project generates income apart from CDM-related income, Option I (simple cost analysis) is not appropriate. Option II (investment comparison analysis) is also not appropriate, as there is no credible alternative to the Project to compare to. Option III (benchmark analysis) is therefore deemed as the appropriate analysis.

Sub-step 2b. – Option III. Apply benchmark analysis

The IRR was chosen as the relevant financial indicator for the Project. As stipulated in the *Tool for demonstration and assessment of additionality*, the project IRR is calculated.

The benchmark is based on Indonesia's 10 year government bond yield of 7.375%[2]. Being a US Dollar denominated bond, this value does not reflect the country's currency risk, which is relevant particularly to foreign investors. Once this risk is added to the bond yield, the benchmark will be significantly higher. To this, three additional risk premiums are added to derive a suitable benchmark value for the Project. The first kind of risk is that for commercial projects in general as opposed to government financed projects. The second type of risk is that for projects that are one of, if not the first of its kind in the country. The third type of risk is the use in the project of a technology that is new to the country. Once all of these risks are taken into account, the benchmark IRR will be at least 25%[3]. This is a conservative figure, given that it is not uncommon for investors in first-of-the-kind projects in developing countries to demand an IRR of well over 25%.

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

The table below shows the data and assumptions used in calculating the Project's IRR. For simplicity, all figures are based on phase 2 of the Project. Where requested, the basis of the calculation will be disclosed to the DOE during validation.

[2] "Indonesia sells global bonds worth USD1bn at 7.375% yield", April 14, 2005, http://uk.biz.yahoo.com/050414/323/fgasf.html, last accessed April 2005

[3] Verification by an independent expert is pending.

Item	Assumptions / Sources	Value[4]
Equipment cost	Supplied by project developer based on quotes and current prices	EUR15,000,000
Electricity tariff	Average price	EUR0.043/kWh
Electricity supplied to grid	Assuming a load factor of 80%. Capacity is 4.8MW for first year and 9.6MW thereafter.	67,000MWh
Project life	Minimum projected life	20 years
Revenues		
Electricity sales	67,000,000kWh x EUR0 .043/kWh	2,881,000/yr
Expenses		
O & M costs	Approximately 5 % of EPC cost, per year	EUR750,000/yr
Project IRR		**13.47%**

As can be seen from the above, the resultant IRR for the Project is 13.47%, which is lower than the benchmark figure of 17.375%. As the Project's IRR is lower than the benchmark figure, the Project Activity cannot be considered as financially attractive, consistent with the *Tools for demonstration and assessment of additionality*.

Sub-step 2d. Sensitivity analysis

In order to demonstrate that the above conclusion regarding the financial attractiveness is robust to reasonable variations in the assumptions, the IRR is recalculated for the following scenarios.
1. The equipment cost is lowered by 10% (resultant IRR = 15.22%)
2. The electricity tariff is increased by 2% yearly (resultant IRR = 13.41%)
3. The electricity supplied to the grid increases by 5% (resultant IRR = 17.97%)
4. O & M cost is lowered by 10% (resultant IRR = 13.47%)

The sensitivity analysis confirms the conclusion drawn in Sub-step 2c that the Project is not financially attractive without the assistance of the CDM.

Step 4. Common practice analysis

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

The Project will be the first project of its kind in Indonesia. Indeed, there are no regulations that require landfill gas to be collected and destroyed, so that even the more simple and less expensive technology of landfill gas recovery and utilization is yet to be carried out commercially.

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

As there are no similar activities to the Project Activity, this step is not relevant.

[4] Exchange rate is approximately IDR9,565 / USD1

Step 5. Impact of CDM registration

The investment analysis in Step 2 demonstrated that the Project is not financially viable without the CDM. Based on a conservative price of USD5/tCO_2e, CDM designation of the Project will enable it to generate additional revenue from the sale of CERs, increasing the IRR of the Project to a level attractive to investors. Thus, the CDM registration directly impacts on both management and investors' decisions to proceed with the Project.

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

As per the methodology, the project boundary is deemed as the physical extent of the Project facility, which is the TPA Suwung Landfill Site. The system boundary in relation to the grid electricity is extended to include all power plants connected to the same electricity system that the Project is connected to. The gases and sources relevant to the Project are listed below.

	Source	Gases
Baseline	Waste disposal in landfill	CH_4
	Grid electricity generation	CO_2
Project	Onsite fossil fuel use	CO_2, CH_4, N_2O
	Stack gas	CH_4, N_2O

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:

Clean Energy Finance Committee
Mitsubishi Securities Co., Ltd.
Tokyo, Japan
Tel: +81 3 6213 6331
Email: hatano-junji@mitsubishi-sec.co.jp

The baseline information was compiled in April 2005.

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:

04/11/2004

The starting date of the Project is defined as the point at which PT NOEI committed with MS, its CDM consultant, to proceed with the CDM application.

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

At least 20 years.

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

C.2.1. Renewable crediting period

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

10/01/2007

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

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C.2.2.2. Length:

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SECTION D. Application of a monitoring methodology and plan

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

Integrated solid waste management with methane destruction and energy generation

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

The methodology is appropriate as the Project meets the following applicability conditions.

- The project involves solid waste management through one or a combination of technologies including gasification, anaerobic digestion and landfill gas recovery.
- The current practice is to discard untreated waste at a landfill or dumpsite.

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

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
1	Activity level (onsite fossil fuel use)	PT NOEI	Energy equivalent	m	Annual aggregate or continuous	100%	Electronic	
2	Emission factor (onsite fossil fuel use)	IPCC	tCO2e/TJ	-	Annually	100%	Electronic	
3	Activity level (stack gas emission)	PT NOEI	volume stack gas	m	Continuous or periodic (at least quarterly)	100%	Electronic	The Project plant is likely to have one multiple stacks of the same type. At least one of each type will be monitored and the results will be used to deduce the overall flow. The flare stack flow cannot be measured due to the temperature of the exiting gas. The flow will therefore be derived from the feed methane content, flow rate and combustion chamber temperature.
4	Emission factor (stack gas emission)	PT NOEI	tCO2e/ volume stack gas	m	At least quarterly	-	Electronic	

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

1. Onsite fossil fuel use

The CO_2 emission factor is calculated using IPCC default values for the type of fuel used.

$$\underset{(Tco_2/TJ)}{CO_2 \text{ emission factor}} = \underset{(tC/TJ)}{\text{C emission factor}} \times \text{Fraction of C oxidised} \times \underset{(tCO_2/tC)}{\text{Mass conversion factor}}$$

The CO_2 emission factor from above is summed with the CO_2 equivalent values for CH_4 and N_2O emission factors to obtain the total emission factor for fuel use.

$$\underset{(tCO_2e/TJ)}{\text{Emission factor}} = \underset{(tCO_2/TJ)}{CO_2 \text{ emission factor}} + \underset{(tCH_4/TJ)}{CH_4 \text{ emission factor}} \times \underset{(tCO_2e/tCH_4)}{\text{GWP of } CH_4} + \underset{(tN_2O/TJ)}{N_2O \text{ emission factor}} \times \underset{(tCO_2e/tN_2O)}{\text{GWP of } N_2O}$$

The above value is multiplied with the project fuel consumption expressed in energy equivalent.

$$\underset{(tCO_2e/yr)}{\text{Emission from fossil fuel use}} = \underset{(tCO_2e/TJ)}{\text{Emission factor}} \times \underset{(TJ/yr)}{\text{Fuel consumption in energy equivalent}}$$

2. Stack gas

Stack gas emission is calculated as:

$$\underset{(tCO_2e/yr)}{\text{Stack gas emission}} = \underset{(volume/yr)}{\text{Stack gas flow}} \times \underset{(tCH_4/volume)}{\text{Monitored methane content in stack gas}} \times \underset{(tCO_2e/tCH_4)}{\text{Approved GWP of methane}} + \underset{(volume/yr)}{\text{Stack gas flow}} \times \underset{(tN_2O/volume)}{\text{Monitored nitrous oxide content in stack gas}} \times \underset{(tCO_2e/tN_2O)}{\text{Approved GWP of nitrous oxide}}$$

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
6	Activity level (amount of waste fed into digester and gasifier)	PT NOEI	Physical unit	m	Annual aggregate or continuous	100%	Electronic	For use in FOD model. (Anaerobic digestion and gasification)
7	Emission factor (waste composition)	PT NOEI	Fraction	m	Daily	-	Electronic	For use in FOD model. To derive DOC. The measured values are averaged.
8	Emission factor (organic content of each waste stream)	PT NOEI	Fraction	m	At least quarterly	-	Electronic	For use in FOD model. To derive DOC. The measured values are averaged.
9	Activity level (electricity supplied to the grid)	PT NOEI	MWh	m	Continuou s	100%	Electronic	For calculation of emissions from fossil fuel-based grid electricity generation.
10	Emission factor (energy generation	IPCC, PLN	tCO_2e/ MWh	c	Annually	100%	Electronic	For calculation of emissions from fossil fuel-based grid electricity generation.

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

1. IPCC First Order Decay model (anaerobic digestion and gasification)

The amount of methane emitted from the landfill / dumpsite in the baseline case is computed using the IPCC First Order Decay (FOD) model:

$$\text{Methane emissions} = \left(\sum_x \left[\left(A \times W(x) \times MCF(x) \times DOC(x) \times DOC_F \times F \times \frac{16}{12}\right) \times e^{-k(t-x)}\right]\right) \times (1 - OX)$$

in year t

where

W(x)	= amount of solid waste generated in year x (Gg/yr)
MCF(x)	= methane correction factor in year x
DOC(x)	= degradable organic carbon (DOC) in year x (Gg C/Gg Waste)
DOC_F	= fraction of DOC dissimilated
k	= methane generation rate constant (1/yr)
A	= $(1 – e^{-k})$, normalisation factor which corrects the summation
F	= fraction by volume of CH_4 in landfill gas
16/12	= conversion of C to CH_4
OX	= oxidation factor
x	= year of waste input
t	= year of methane generation

2. Energy generation

The small-scale methodology I.D will be used to compute the grid emission coefficient. The emission coefficient is calculated as the weighted average emissions (in kg CO_2e/kWh) of the current generation mix, one of the two approved approaches. This approach was chosen over the average of the approximate operating margin and the build margin due to the unavailability of data necessary to compute the build margin.

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 *(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
11	Activity level (volume of landfill gas captured and fed to flare or boiler / generator)	PT NOEI	Physical unit	m	Continuous	100%	Electronic	For determining methane destructed by project
12	Emission factor (methane content of captured landfill gas)	PT NOEI	Fraction	m	At least quarterly	-	Electronic	For determining methane destructed by project.
13	Emission factor (pressure of captured landfill gas)	PT NOEI	Pressure unit	m	Continuous	100%	Electronic	For determining methane destructed by project
14	Emission factor (flare temperature)	PT NOEI	degC	m	Continuous	100%	Electronic	For determining methane destructed by project.

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

The Project does not involve increased waste collection. Therefore there is no associated leakage.

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

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

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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.)

For the Project, the emission reduction is calculated as:

Emission reduction = Baseline emission $_{indirect}$ + Emission reduction$_{direct}$ – Project emission– Leakage

where

$$\text{Baseline emission}_{indirect} = \text{Emission from landfill/dumpsite related to anaerobic digestion and gasification} + \text{Emission from energy generation related to anaerobic digestion and gasification}$$

$$\text{Emission reduction}_{indirect} = \text{Monitored amount of landfill gas (methane) captured and destructed}$$

$$\text{Project emission} = \text{Emission from onsite fossil fuel use} + \text{Emission from physical leakage} + \text{Stack gas emission}$$

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.
1, 3, 4, 5, , 7, 8, 11, 12, 13, 14	Low	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
2, 10	Low	Values based on IPCC or approved methodologies are used.
6, 9	Low	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Moreover, third parties are able to verify the monitored information.

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

PT NOEI will collect and store relevant data in a systematic and reliable way, evaluate them regularly, generate reports, and ensure the availability of pertinent information for verification. An electronic spreadsheet file will be kept to accumulate all monitored variables, which will be presented to the DOE for verification.

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

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SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

The proposed new methodology identifies four potential sources of project activity emissions.

- Onsite fossil fuel use
- Grid electricity consumption
- Physical leakage
- Stack gas

Onsite fossil fuel use is not foreseen and is not calculated here. However, this will be monitored regardless.

The Project will source all of its energy requirements in-house. Electricity will therefore not be drawn from the grid.

The anaerobic digester is designed such that physical leakage does not occur. As per the methodology, the technology details will be given to the DOE to ascertain that there is not leakage.

Stack gas emissions will be monitored. Emissions from this source is expected to be minor and does not warrant *ex ante* estimation, consistent with the methodology.

E.2. Estimated leakage:

The methodology identifies a possible source of leakage as the emissions from increased transportation activity. Increase in transportation above the baseline would occur if waste collection is increased on the account of increasing the feed for the Project.

Waste collection will not be increased to cater for the Project. To ensure stable feed, the Project has been designed to process somewhat less than is available. Therefore, no leakage will arise from the Project.

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

The *ex ante* estimation results in zero project activity emissions.

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

There are two gases and sources associated with the baseline – landfill gas (methane) from waste disposed of in landfills or dumpsites and carbon dioxide from fossil fuel-based grid electricity generation.

Waste disposal

(a) Methane avoided through anaerobic digestion and gasification

The baseline scenario for waste disposal is the continuation of current practice, which is disposal in a landfill 6 ~ 8 metres in depth, without cover. In the Project case, the Project facility, through anaerobic digestion and gasification, will treat approximately 250 tonnes per day of waste in the first year (Phase 1) and 500 tonnes per day thereafter (Phase 2).

Therefore, the baseline emission calculation is based on the 500tpd of new waste being dumped in a landfill 6~8 metres in depth, without cover. In addition, the Project will recover and destruct landfill gas that is being emitted from the existing waste.

As per the methodology, the calculation method used to estimate methane emissions is the IPCC First Order Decay model, described below.

$$\text{Methane emissions} = \left(\sum_x \left[\left(A \times W(x) \times MCF(x) \times DOC(x) \times DOC_F \times F \times \frac{16}{12} \right) \times e^{-k(t-x)} \right] - R(t) \right) \times (1 - OX)$$

in year t

where:

k	= methane generation rate constant (1/yr)
A	= $(1 – e^{-k})$, normalisation factor which corrects the summation
W(x)	= amount of municipal solid waste generated in year x (Gg/yr)
MCF(x)	= methane correction factor in year x
DOC(x)	= degradable organic carbon (DOC) in year x (Gg C/Gg Waste)
DOC_F	= fraction of DOC dissimilated
F	= fraction by volume of CH_4 in landfill gas
16/12	= conversion of C to CH_4
R(t)	= recovered CH_4 in inventory year t (Gg/yr)
OX	= oxidation factor

The key variables used for the calculation of baseline methane emissions are given below. Much of the data below will be superceded by data monitored after the implementation of the Project. For details, please refer to Section D.

Table 1: Input values for the calculation of methane emissions in the dumpsite

Variable	Input
Amount of organic waste	58,400 tonnes/year (250tpd, 365dpy, 64% organic content) 116,800 tonnes/year (500tpd, 365dpy, 64% organic content)
DOC (degradable organic content of waste)	20.5% (Based on a breakdown of 22% paper and 78% food waste for the organic component of the waste stream)
DOC_F (fraction of DOC dissimilated)	0.77 (IPCC default)
k (decay rate)	0.15 (IPCC default for food waste is 0.2. Scaled down for conservatism pending further analysis)
F (fraction of methane in landfill gas)	50% (IPCC default)

OX (oxidation factor)	10% (IPCC default for managed landfills)
MCF (methane correction factor)	0.8 (IPCC default for landfills over 5 meters deep)

The estimated baseline emissions associated with anaerobic digestion and gasification is given in the table below.

Year	tCH_4 emission	tCO_2 equivalent
1	1,231	25,847
2	2,290	48,094
3	3,202	67,242
4	3,987	83,723
5	4,662	97,908
6	5,244	110,117
7	5,744	120,626

(b) Methane avoided through landfill gas capture and destruction

The Project will also involve the capture of landfill gas, both from existing and fresh waste. The captured landfill gas (methane) will be utilized as fuel for power generation. Consistent with the methodology, the emission reduction for this component will be directly determined through monitoring.

Here, for illustrative purposes, an approximation of the baseline emissions is given. The amount of methane that will be collected and destructed is estimated by back-calculating the energy requirement for a 1MW generator.

Assuming a 30% efficiency and 8000 hours of operation in a year, the energy requirement for power generation is:

$$\underset{(GJ)}{\text{Energy requirement}} = \underset{MW}{1} \times \underset{h}{8000} \times \underset{GJ/MWh}{3.6} \div 30\%$$

$$= 96{,}000 \text{ GJ}$$

$$\underset{(tCH_4)}{\text{Required methane}} = \underset{GJ}{96{,}000} \div \underset{GJ/tCH_4^{5}}{52}$$

$$= 1{,}846 \; tCH_4$$

The estimated baseline emissions associated with landfill gas capture and destruction is given in the table below. As landfill gas capture is part of phase 2, there are no associated baseline emissions in year 1.

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[5] Approximate. Based on $37MJ/m^3CH_4$, $0.0007168tCH_4/m^3CH_4$.

Year	tCH_4 emission	tCO_2 equivalent
1	0	0
2	1,846	38,766
3	1,846	38,766
4	1,846	38,766
5	1,846	38,766
6	1,846	38,766
7	1,846	38,766

Grid electricity

As the Project's electricity generating capacity of 9.6MW is less than the 15MW threshold for small-scale project activities, the small-scale methodology I.D. *Renewable electricity generation for a grid* will be used. The baseline emission is calculated by multiplying the kWh produced by the renewable generating unit multiplied by an emission coefficient. The emission coefficient is calculated as the weighted average emissions (in kg CO_2e/kWh) of the current generation mix, one of the two approved approaches. This approach was chosen over the average of the approximate operating margin and the build margin due to the unavailability of data necessary to compute the build margin.

The calculations were based on the most recently available grid data, that of the Java-Bali grid in 2002.

Fuel type	Consumption
Coal	11,894,648 T
Oil	4,017,399 Kl
Natural gas	159,646 MMSCF

Electricity generated in Java-Bali grid	86,458,590 MWh

Based on the above data and using IPCC formulae and emission factor values, the emission coefficient is 0.760 tCO_2/MWh. The emissions associated with baseline grid electricity generation is provided below.

Year	Electricity supplied to grid (MWh)	tCO_2 equivalent
1	33,638	25,565
2	67,277	51,130
3	67,277	51,130
4	67,277	51,130
5	67,277	51,130
6	67,277	51,130
7	67,277	51,130

The total baseline emission is as follows.

Year	Waste disposal (tCO_2e)	Grid electricity (tCO_2e)	Annual total (tCO_2e)
1	25,847	25,565	51,412
2	86,860	51,130	137,990
3	106,008	51,130	157,138
4	122,489	51,130	173,619
5	136,674	51,130	187,804
6	148,883	51,130	200,013
7	159,392	51,130	210,522
Total	786,153	332,345	1,118,498

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

The emission reduction of the project activity is calculated as:
Emission reduction = baseline emission – project emission – leakage
= (baseline landfill gas emission + grid electricity emission)
– (onsite fossil fuel combustion emission + stack gas emission)

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

The ensuing table shows the *ex ante* estimates of the Project's emission reduction effect (tCO_2e).

Year	Estimation of project activity emissions (tonnes of CO_2e)		Estimation of baseline emissions (tonnes of CO_2e)		Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
	Onsite fossil fuel combustion	Stack gas emission	Waste disposal	Grid electricity		
Year 1	0	0	25,847	25,565	0	51,412
Year 2	0	0	86,860	51,130	0	137,990
Year 3	0	0	106,008	51,130	0	157,138
Year 4	0	0	122,489	51,130	0	173,619
Year 5	0	0	136,674	51,130	0	187,804
Year 6	0	0	148,883	51,130	0	200,013
Year 7	0	0	159,392	51,130	0	210,522
Total (tonnes of CO_2e)	0	0	786,153	332,345	0	1,118,498

SECTION F. Environmental impacts

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

To be completed.

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:

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SECTION G. Stakeholders' comments

To be completed.

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

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G.2. Summary of the comments received:

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

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Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Please refer to Section B.

Annex 4

MONITORING PLAN

Please refer to Section D.

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