JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Landfill Gas Capture Project in Bela-Tserkov City Ver001, 01/03/2008

A.2. Description of the project:

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In the project, it is planned to capture landfill gas (LFG) emitted on the landfill site in Bela-Tserkov City, Ukraine, and to break down methane gas, which is a flammable greenhouse gas (GHG) contained in the LFG, into carbon dioxide through combusting the gas in a flare system or a gas engine generator (GEG). Bela-Tserkov Landfill Site, which is owned by Bela-Tserkov City Municipality, covers an area of approximately 11 ha. It started receiving waste in 1983 and is scheduled to be closed down by the end of 2008.

The project proposes to install landfill gas (LFG) collection pipes on the landfill site, and to collect and treat LFG before sending it to a district heating plant roughly 2 km away, where it will be used in a boiler for supplying hot water to the local area. The district heating plant supplies hot water during the summer and heating and hot water during the winter, and the boiler operates throughout the year. Meanwhile, LFG that cannot be used in the boiler will be combusted and destroyed via flare stacks. Since the utilization of heat from this system will lead to reduction in use of natural gas as fuel for the boiler house, the project can be expected to have an energy saving and a greenhouse gas reduction effect. Moreover, since methane gas in the LFG that cannot be used in the boiler can be converted to carbon dioxide through combustion and destruction in the flare stacks, further reduction in greenhouse gas emissions can be expected even if it doesn't directly link to energy saving.

In the project, it is planned to commission the system from January 2009.

The project crediting period is 15 years, and the aggregate reduction of emissions during this period is estimated as 410,063 ton -CO_2 ("ton-CO_2" means "ton-CO_2 equivalent").

In addition to realizing reduced emissions of GHG, in Bela-Tserkov, it is anticipated the project will contribute to sustainable development in the following ways:

- Environmental improvement through prevention of odor on the landfill site;
- Environmental improvement through prevention of fires on the landfill site;
- Effective utilization of energy;
- Development of human resources through introduction of new technology; and
- Creation of new employment through project realization (construction, operation)

A.3. Project participants:

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Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (host country)	Public entity / Bela-Tserkov City	No
Ukraine (host country)	Private entity / Food processing company	No
Japan	Private entity / Shimizu Corporation	No

A.4. Technical description of the project:

A.4.1. Location of the project:

>>

A.4.1.1. Host Party(ies):

>>
Ukraine

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

>>
N/A

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

>>
Bela-Tserkov City

Figure 1 shows the location of Bela-Tserkov. It is situated approximately 80 km from the capital Kiev in the southern part of Kiev Province.

Figure 1 Location of Bela-Tserkov City

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

>>

Bela-Tserkov landfill site is located approximately 10 km south of central Bela-Tserkov City It is located on the outskirts of the city, and there are no residential districts nearby.

The landfill site covers a total area of around 11 ha, and of this landfilling has already been completed on 9 ha. Landfilling is currently taking place on a new area known as Area 1, however, this is scheduled to become filled up by the end of 2008. Earth covering is carried out on the parts where landfilling has been finished, however, because no progress is being made on the search for new landfill area, there are plans to carry new waste once again onto areas that were landfilled before. Waste is landfilled to depths of between 15~20 m, and it is estimated that between 16~20 million tons of waste have been carried onto the site since the start of landfilling in 1983.

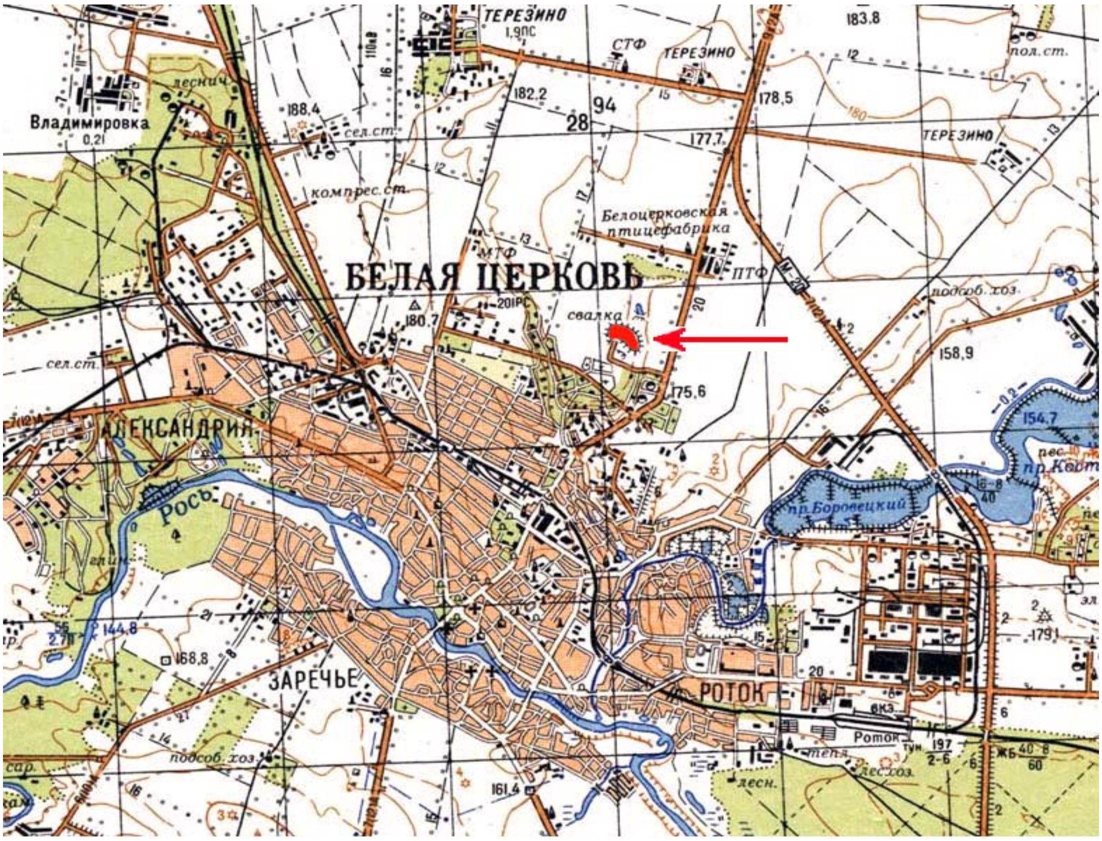

Figure 2 Map of the Bela-Tserkov Landfill Site

A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:

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○ **LFG collection system technology**.
This is composed of vertical extraction wells, horizontal gas drains, earth covering, gasholders, measuring instruments, blowers, gas treatment equipment and gas storage facilities, etc.

○ **Flaring technology**.
The flare facilities combust and thereby destroy any LFG that could not be destroyed in the gas boiler. In order to combust and destroy LFG, open flare facilities are used.

Figure 3 shows the schematic of the overall project system.

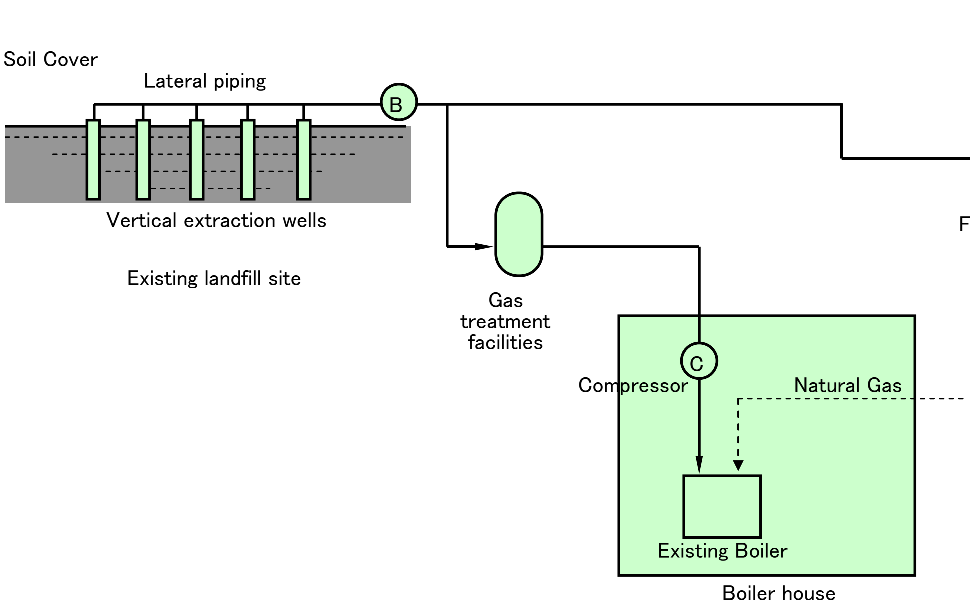

Figure 3 Project system schematic

The main equipments of the flare system are as follows:

- The flare elements consist of the flare itself, a demister with filter element, isolation and control valves, blower and instrumentation. The demister element protects the fan from moisture and particulates that flow with the gas from the waste deposit.
- Flame arrestor device: to avoid flashback of a flame to the fuel feed pipe.
- Burner(s): to provide controlled mixing of the fuel and air and ensure controlled combustion over a range of landfill gas flow rates.
- Ignition system: to provide safe, controlled ignition of the landfill gas.
- Air inlet dampers and thermocouples in the stack: control flame temperature.
- Combustion air system: to provide air for combustion support, depending on burner load. The additional air is drawn into the chamber by natural draught via control louvers or open vents.
- Stack: the stack height of the flares will be specified to provide sufficient residence time for destruction of compounds in the gas at high temperature and in a controlled environment to destroy extracted methane.
- Control panel: houses all of the flare controls, motor starters, alarms and interlocks that ensure safe operation of the flare.

The unit includes sophisticated monitoring equipment that will be comprehensively described in the following sections (please refer to the section D) and is briefly listed below:

- Flow meter to measure the volumetric flow of the gas through the system;
- LFG pressure and temperature transducers for calculation of the gas mass flow rate;
- Gas analyser (methane, carbon dioxide, oxygen, nitrogen) that measures the quality of the gas delivered to the flare;

- Sampling points for taking gas samples with portable instrumentation and for laboratory analysis;
- Thermocouple that monitors the temperature of the flame in the stack and feeds back the signal to the automated air louver in order to maintain the temperature within the stack at desired level; and
- Data logging system.

Origin of technology. There are no landfills applying active LFG collecting and flaring. Much of the flaring system and controls, therefore, will come from abroad. Training to properly maintain and operate the equipment will be arranged for local operators and engineers.
In the table below, the expected origin of the LFG collection and flaring system components is given.

Component	Imported or locally manufactured	Standard
Wells	Locally manufactured	According to local standards
Gas collection system	Locally manufactured	According to local standards
Flaring system	Imported from EU	According to EU Standards
Monitoring and control systems	Imported from EU	According to EU Standards

* Local standards refer to Gost (Russian abbreviation for State Standard: GOsudarstvennyi STandart).
* EU standards refer to "The European Standard EN" and DIN, etc. according to this.

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

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Most Ukrainian landfills were started as unauthorized dumps and are not in compliance with any environmental protection measures as regards LFG control. Before 2005, national standards on landfills operation did not envisage mandatory LFG control. In 2005, National Construction Standard DBN V.2.4-2-2005 Basics of Sites Design was introduced containing requirements on LFG collection and flaring/utilization after the landfill closure. However, municipalities and municipal companies operating landfills are in a poor financial state and cannot invest in such projects.

This landfill site continues to generate methane gas, which has a high warming coefficient, and all of this is discharged into the atmosphere. Moreover, the methane gas will continue to be discharged if the project is not implemented.
On the other hand, in the event where the project is implemented, the following additional GHG emissions reductions will be realized:

1) Reduction of methane gas emissions through the capture of methane gas (GHG) by LFG collection, and destruction of the methane gas through supply to a boiler / flaring, i.e. combustion.

A.4.3.1. Estimated amount of emission reductions over the crediting period:

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The project crediting period is 15 years and the amount of reduction is calculated as follows. Moreover, the estimate was made taking into account the additional installation of gas collection facilities.

	Years
Length of the crediting period	15
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2009	34,844
2010	35,877
2011	34,190
2012	32,586
2013	31,062
2014	29,612
2015	28,234
2016	26,923
2017	25,676
2018	24,489
2019	23,361
2020	22,287
2021	21,265
2022	20,292
2023	19,366
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	410,063
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	27,338

A.5. Project approval by the Parties involved:

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The LoE was issued by the Government of Ukraine on …, …, 200 .

The Government of Ukraine plans to give its approval following submission of the Draft Determination Report.

The Government of Japan plans to give its approval before the application for registration with the UN.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

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1. Referencing of the approved baseline and monitoring methodology applied to the project

ACM0001 "Consolidated baseline and monitoring methodology for landfill gas project activities" (Version 08)

Tool

"Tool for the demonstration and assessment of additionality" (Version 04)

"Tool to determine project emissions from flaring gases containing methane" (Version 01)

"Tool to calculate project emissions from electricity consumption" (Version 01)

"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" (Version 01)

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

In the methodology ACM0001, the following conditions are stated:

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);
c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodology AM0053.

Meanwhile, conditions in the Project are as follows:

1) Currently, LFG collection is not carried out on Bela-Tserkov Landfill Site and all LFG is released into the atmosphere. (Baseline)
2) The project proposes to collect LFG on Bela-Tserkov Site and the captured gas is flared.
3) The captured gas is supplied to an existing boiler house and is used as a source of thermal energy.

Therefore, since the project falls under applicability of (a) and (b) for the approved consolidated baseline methodology ACM0001, this methodology is applicable.

3. Description of how the methodology is applied in the context of the project

The selection of the most plausible baseline scenario

The baseline scenario is set based on ACM0001.

STEP 1: Identification of alternative scenarios.

According to *ACM0001*, *Step 1* of the *"Tool for the demonstration and assessment of additionality"* is used to identify the baseline alternatives.

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

Out of the scenarios indicated in ACM0001, upon considering conditions and legislation, etc. in the host country, the most realistic and reliable baseline scenario is as follows. Moreover, since there will be no additional local demand for electricity in the project, this will not be considered in the alternative scenarios either.

Scenario	Baseline			Description of situation
	LFG	electricity	Heat	
1	LFG2	-	-	Atmospheric discharge of LFG, no collection based on legislation, etc. (Maintenance of the status quo)
2	LFG1	P6	-	Collect LFG and combust it by flaring. Obtain project electric power from the grid.
3	LFG1	P6	H4	Collect LFG for use in faring and heat utilization. LFG is supplied to the existing boiler house for utilization as heat. Natural gas is currently suppid to the boiler house as fuel. Obtain project electric power from the grid. Also, gas supply to the boiler house is free. (In the case where the project is implemented without JI project registration).

Current legislation, regulations and guidelines concerning the above scenarios are as indicated below.
<Legislation, regulations, guidelines, etc. (general contents)>
- Ukrainian law on 'On Municipal Waste' (March 5, 1998)
- Ukrainian law 'On Protection of Ambient Air' (June 21, 2001)
- Law of Ukraine 'On Alternative Liquid and Gas Fuels' (January 14, 2000)
- President's Decree 'On measures concerning development of biofuel' (September 26, 2003)

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

Baseline energy is not used in Scenario 1. In Scenario 2 and Scenario 3, since energy is electricity and this is obtained from the grid, there is no limit on supply. Moreover, the natural gas supplied to the existing system in Scenario 3 is also unlimited because the project system is connected to the gas pipeline.

STEP 3:Assess which of alternatives should be excluded from further consideration.

According to *ACM0001*, *Step 2* and *Step 3* of the *"Tool for the demonstration and assessment of additionality"* are used.

(Step 2: Investment Analysis)

(sub-step 2a: Determine appropriate analysis method)

Since there is no related income in any of the scenarios, adopt *Option I: Apply simple cost analysis.*

(sub-step 2b: Option I: Apply simple cost analysis)

In Scenario 2 and Scenario 3, there is investment involved in installing the blower system, etc., however, because sale of LFG is not included in the project, there is no revenue. Accordingly, these scenarios cannot be the baseline.

(Step 3: Barrier Analysis)

Step 3 can be skipped because Step 2 was implemented.

STEP 4: Determine baseline scenarios

STEP 3 showed that Scenarios 2 and 3 cannot become the baseline. Moreover, since the host country has no legal obligation or funding regarding the collection of methane, it is projected that the status quo will continue. Accordingly, Scenario 1 (maintenance of status quo) is set as the baseline scenario.

Calculation of emission reductions

Baseline emissions, project emissions and emission reductions in the project are calculated as follows based on ACM0001. Moreover, in the project, formulae have been arranged considering the fact that there will be no power generation of supply to the natural gas pipeline in the project.

Baseline emissions

$$BE_y = (MD_{project,y} - MD_{BL,y}) \times GWP_{CH4} + ET_{LFG,y} \times CEF_{ther,BL,y} \qquad (1)$$

BE_y	Baseline emissions in year y (tCO_2e)
$MD_{project,y}$	The amount of methane that would have been destroyed/combusted during the year in project scenario (tCH_4).
$MD_{BL,y}$	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4)
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 (tCO_2e/tCH_4).
$ET_{LFG,y}$	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y (TJ).
$CEF_{ther,BL,y}$	CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation (tCO_2e/TJ).

Here, each item is defined as follows.

$$MD_{BL,y} = MD_{project,y} \times AF \tag{2}$$

AF	Adjustment Factor

$$MD_{project,y} = MD_{flared,y} + MD_{thermal,y} \tag{3}$$

$MD_{flared,y}$	Quantity of methane destroyed by flaring (tCH_4)
$MD_{thermal,y}$	Quantity of methane destroyed by generation of thermal energy (tCH_4)

$$MD_{flared,y} = (LFG_{flare,y} \times w_{CH4,y} \times D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \tag{4}$$

$LFG_{flare,y}$	The quantity of landfill gas fed to the flare(s) during the year (m^3)
$w_{CH4,\,y}$	The average methane fraction of the landfill gas as measured during the year (m^3CH_4/m^3LFG)
D_{CH4}	The methane density (tCH_4/m^3CH_4)
$PE_{flare,y}$	The project emissions from flaring of the residual gas stream in year y (tCO_2e) determined following the procedure described in the *"Tool to determine project emissions from flaring gases containing Methane"*.

Here, the project emissions from flaring ($PE_{flare,y}$) are calculated by the following formula based on the *"Tool to determine project emissions from flaring gases containing methane."*

$$PE_{flare,y} = \sum_{(h=1\sim8760)} LFG_{flare,h} \times w_{CH4,h} \times D_{CH4} \times (1 - FE) \times GWP_{CH4} \tag{5}$$

$LFG_{flare,h}$	The quantity of landfill gas fed to the flare(s) in an hour (m^3)
$w_{CH4,h}$	The average methane fraction of the landfill gas in an hour (m^3CH_4/m^3LFG)
FE	Flare efficiency (-)

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{CH4,y} \times D_{CH4} \tag{6}$$

$LFG_{thermal,y}$	The quantity of landfill gas fed into the boiler (m^3)
$w_{CH4,\,y}$	The average methane fraction of the landfill gas as measured during the year (m^3CH_4/m^3LFG)
D_{CH4}	The methane density (tCH_4/m^3CH_4)

Moroever, $CEF_{ther,BL,y}$ is calculated by the following formula based on *ACM0001*.

$CEF_{ther,BL,y} = EF_{fuel,BL} / (\varepsilon_{boiler} \times NCV_{fuel,BL})$ (7)

ε_{boiler}	The energy efficiency of the boiler used in the absence of the project activity to generate the thermal energy
$NCV_{fuel,BL}$	Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler to generate the thermal energy in the absence of the project activity (TJ/m^3 or t)
$EF_{fuel,BL}$	Emission factor of the fuel as identified through the baseline identification procedure, used in the boiler to generate the thermal energy in the absence of the project activity (tCO_2/m^3 or t)

Project emissions

$PE_y = PE_{EC,y}$ (8)

$PE_{EC,y}$	Emissions from consumption of electricity in the project case calculated following the latest version of *"Tool to calculate project emissions from electricity consumption"*

Here, since the electric power consumed in the project is obtained from the grid, "Case A: Electricity consumption from the grid" of the *"Tool to calculate project emissions from electricity consumption"* is applied. $PE_{EC,y}$ is calculated by the following formula.

$PE_{EC,y} = EC_{PJ,y} \times EF_{grid,y} \times (1 + TDL_y)$ (9)

$EC_{PJ,y}$	The quantity of electricity consumed by the project activity during the year y (MWh)
$EF_{grid,y}$	The emissionsfactor for the grid in year y (tCO_2/MWh)
TDL_y	The average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site

Leakage

According to ACM0001, there is no need to take the effects of leakage into account.

Emission Reductions

Emission reductions are calculated by the following formula.

$ER_y = BE_y - PE_y$ (10)

ER_y	Emission reductions in year y (tCO_2e/yr)
BE_y	Baseline emissions in year y (tCO_2e/yr)
PE_y	Project emissions in year y (tCO_2e/yr)

Data and Parameter

Data / Parameter:	**Regulatory requirements relating to landfill gas projects**
Data unit:	---
Description:	Regulatory requirements relating to landfill gas projects
Source of data used:	The DNA shall be contacted to provide information regarding host country regulation.
Value applied:	AF = 0
Justification of the choice of data or description of measurement methods and procedures actually applied:	Based on information obtained from the host country DNA, it has been confirmed that the host country has no legislation concerning capture of methane from landfill gas.
Any comment:	---

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied:	21 for the first commitment period.
Any comment:	---

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

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

>>

Setting of the baseline scenario and demonstration of additionality shall be carried out according to the *"Tool for the demonstration and assessment of additionality* (Version04)."

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 alternatives to the project activity are as were indicated in selection of the baseline scenario (Section B. 2.3).

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

As indicated in STEP1 in selection of the baseline scenario (Section B. 2.3).

Step2. Investment Analysis

As indicated in STEP3 in selection of the baseline scenario (Section B. 2.3).

Step 3. Barrier Analysis

As indicated in STEP3 in selection of the baseline scenario (Section B. 2.3).

Step 4. Common Practice Analysis

There is no evidence to suggest that a similar project has been, is being, or will be implemented in the same country/region using a broadly similar technology of a similar scale, and taking place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc.

As was indicated in STEP3 in selection of the baseline scenario (Section B. 2.3), Scenario 1 (maintenance of the status quo) was determined as the baseline scenario. Moreover, Scenario 3, which is the project activity, cannot be the baseline scenario and, since it is estimated that the project will realize aggregate emission reductions of 410,063 ton-CO_2 over 15 years, the project can be said to be additional.

B.3. Description of how the definition of the project boundary is applied to the project:

>>

According to ACM0001, the project boundary is the site of the project activity where the gas is captured and destroyed/used. In the project, however, since the electricity for project activity is sourced from the grid, the project boundary shall include all the power generation sources connected to the grid to which the project activity is connected. The project boundary here is as indicated in Figure 4.

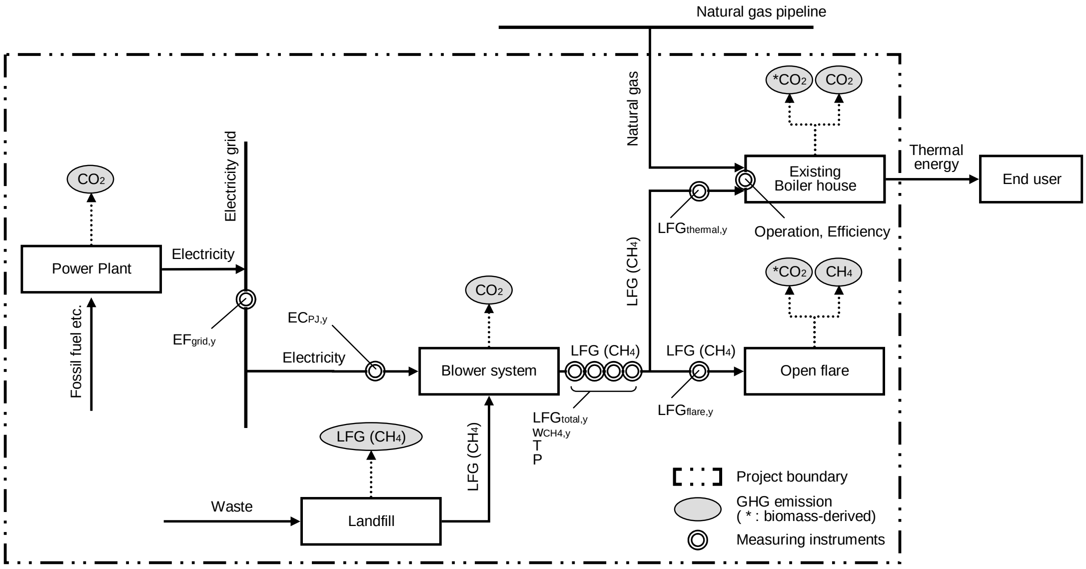

Figure 4 Project boundary

Moreover, generation sources and gases included in the project boundary are as indicated below.

	Source	Gas	Included?	Justification/Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Yes	The major source of emissions in the baseline
		N_2O	NO	--
		CO_2	NO	--
	Emissions from electricity consumption	CO_2	NO	On-site electricity consumption is not included in the baseline, and electricity is not conducted in the project.
		CH_4	NO	--
		N_2O	NO	--
	Emissions from thermal energy generation	CO_2	Yes	Thermal energy is generated in the project.
		CH_4	NO	--
		N_2O	NO	--
Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	NO	There is no consumption of fossil fuels onsite.
		CH_4	NO	--
		N_2O	NO	--
	Emissions from on-site electricity use	CO_2	Yes	Electricity is consumed on-site in the project activity.
		CH_4	NO	--
		N_2O	NO	--

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

>>

Date: 01/03/2008

General Manager: Kurita Hiroyuki, and
Manager: Kazuhide Maruyama
Manager: Yashio Akira
Shimizu Corporation
GHG Project Department
SEAVANS SOUTH, 1-2-3
Shibaura, Minato-ku, Tokyo 105-8007
03-5441-0137 (from within Japan)
+81-3-5441-0137 (from overseas)
(Japanese HP) http://www.shimz.co.jp/
(English HP) http://www.shimz.co.jp/english/index.html

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

>>

01/01/2009

C.2. Expected operational lifetime of the project:

>>

15 years

C.3. Length of the crediting period:

>>

15 years

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

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As was described in B.1, in this project, the approved consolidated monitoring methodology ACM0001/ Version08 "Consolidated monitoring methodology for landfill gas project activities" will be applied. Figure 5 shows the monitoring plan in the project.

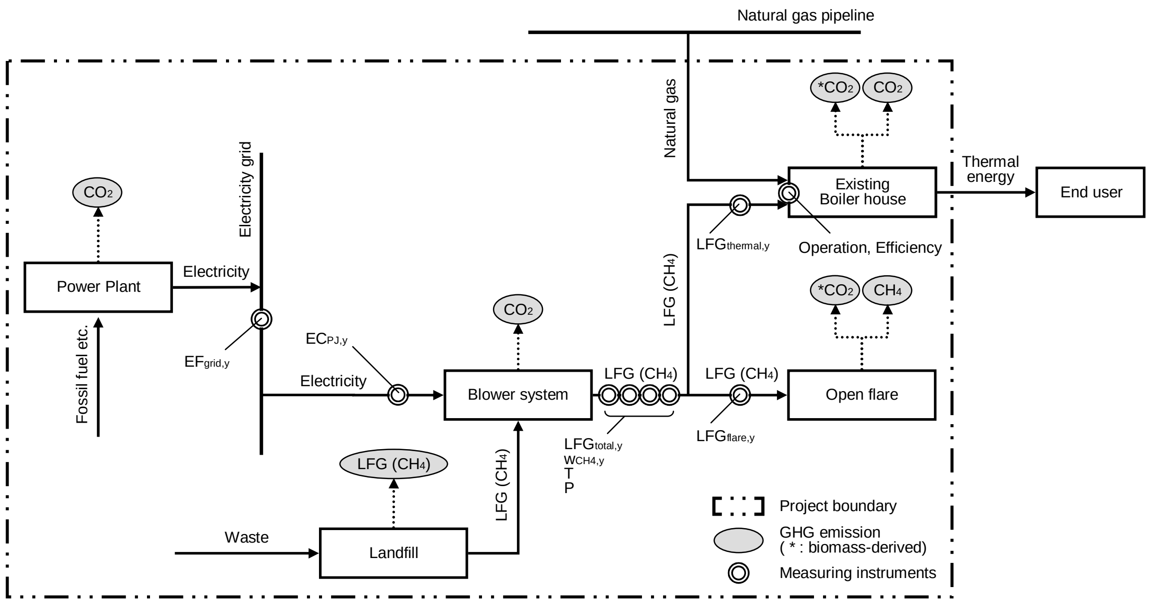

Figure 5 Flow Chart of Monitoring Plan

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

Because Option 2 is selected, this section is not filled in.

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

>>

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

>>

D.1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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
ID 1	$LFG_{flare,y}$ *Amount of landfill gas flared*	*Flow meter*	m^3	*m*	*Measured continuously and aggregated monthly and yearly*	*100%*	*electronic*	
ID 2	$LFG_{electricity,y}$ *Amount of landfill gas combusted in boiler*	*Flow meter*	m^3	*m*	*Measured continuously and aggregated monthly and yearly*	*100%*	*electronic*	
ID 3	*FE Flare efficiency*	*Default value based on the "Tool to determine project emissions from flaring gases containing methane"*	-	-	-	*100%*	*electronic*	*Since an open flare is adopted in the project, the default value of 0.5 is adopted.*

ID 4	$w_{CH4,y}$ *Methane fraction in the landfill gas*	*Methane fraction meter (gas quality analyser)*	$m^3 CH_4/m^3 LFG$	*m*	*Measured continuously and recorded*	*100%*	*electronic*	*Measured on wet basis.*
ID 5	*T* *Temperature of the landfill gas*	*Thermo meter*	*K*	*m*	*Measured continuously and recorded*	*100%*	*electronic*	*Measured to determine the density of methane* D_{CH4}. *No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.*
ID 6	*P* *Pressure of the landfill gas*	*Pressure gauge*	*Pa*	*m*	*Measured continuously and recorded*	*100%*	*electronic*	*Measured to determine the density of methane* D_{CH4}. *No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.*
ID 7	$ET_{LFG,y}$ *Net amount of thermal energy generated using LFG*	*Calculate from* $LFG_{thermal,y}$. $ET_{LFG} = LFG_{thermal,y} \times w_{CH4,y} \times D_{CH4} \times NCV_{methane} \times \varepsilon_{boiler}$	*TJ*	*c*	*Aggregated monthly and yearly*	*100%*	*electronic*	

ID 8	$EF_{fuel,BL}$ *CO_2 emission factor of fossil fuel (natural gas)*	*Data received from DNA of the host country.*	tCO_2/m^3	*-*	*Recorded yearly*	*100%*	*electronic*	*Receive country specific data from the host country. If this isn't available, use the IPCC default value.*
ID 9	$NCV_{fuel,BL}$ *Net calorific value of fossil fuel (natural gas)*	*Data received from DNA of the host country.*	TJ/m^3	*-*	*Recorded yearly*	*100%*	*electronic*	*Receive country specific data from the host country. If this isn't available, use the IPCC default value.*
ID 10	ε_{boiler} *Efficiency of the baseline boiler for producing thermal energy*	*Based on the method stated in ACM0001, adopt Option B. In Option B, as a conservative approach, boiler efficiency is assumed to be 100%.*	*-*	*-*	*-*	*100%*	*electronic*	
ID 11	*Operation of the boiler*	*Operating records by the operation manager*	*hours*	*m*	*Recorded daily*	*100%*	*paper or electronic*	
ID 12	$EC_{PJ,y}$ *Electricity consumption by the project activity*	*Watt hour meter*	*MWh*	*m*	*Measured continuously and recorded at least annually*	*100%*	*electronic*	

ID 13	*$EF_{grid,y}$ Emission factor for the grid*	*Data received from the Government of the host country*	*tCO_2/MWh*	*-*	*Recorded yearly*	*100%*	*electronic*	*Receive data calculated based on the "Tool to calculate project emissions from electricity consumption." If this isn't available, use the default value of 1.3.*
ID 14	*TDL_y Average technical transmission and distribution losses in the grid*	*Data received from DNA of the host country*	*-*	*-*	*Recorded yearly*	*100%*	*electronic*	*If data is not available from the host country, use the default value of 0.2.*

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

>>

From the results of the monitoring, the following method is used to calculate baseline emissions, project emissions and project emission reductions.

Baseline emissions

$$BE_y = (MD_{project,y} - MD_{BL,y}) \times GWP_{CH4} + ET_{LFG,y} \times CEF_{ther,BL,y}$$

$$MD_{BL,y} = MD_{project,y} \times AF$$

$$MD_{project,y} = MD_{flared,y} + MD_{thermal,y}$$

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

$$PE_{flare,y} = \sum_{(h=1\sim8760)} LFG_{flare,h} \times w_{CH4,h} \times D_{CH4} \times (1 - FE) \times GWP_{CH4}$$

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

$$CEF_{ther,BL,y} = EF_{fuel,BL} / (\varepsilon_{boiler} \times NCV_{fuel,BL})$$

Project emissions

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

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

Emission Reductions

$ER_y = BE_y - PE_y$

D.1.3. Treatment of leakage in the monitoring plan:

According to ACM0001, there will be no leakage in this project.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	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.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

>> Not applicable

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

>>
The amount of emission reductions is obtained as the difference between the baseline emissions and the project emissions.

Baseline emissions

$$BE_y = (MD_{project,y} - MD_{BL,y}) \times GWP_{CH4} + ET_{LFG,y} \times CEF_{ther,BL,y}$$

$$MD_{BL,y} = MD_{project,y} \times AF$$

$$MD_{project,y} = BE_{CH4,SWDS,y} / GWP_{CH4}$$

$$ET_{LFG} = MD_{project,y} \times 0.9 \times NCV_{methane} \times \varepsilon_{boiler}$$

$$CEF_{ther,BL,y} = 55.8195$$

Project emissions

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

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

Emission Reductions

$$ER_y = BE_y - PE_y$$

The detailed estimation is shown in E.1.

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

>>

Environmental impact legislation relating to the project is as follows.

- Law on the protection of the environment (June, 1991)
- Ukrainian law 'On Protection of Ambient Air' (June 21, 2001)

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:

Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
ID 1~2	*Low*	*Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.*
ID 4	*Low*	*Methane fraction meter (gas quality analyser) should be subject to a regular maintenance and testing regime to ensure accuracy.*
ID 5	*Low*	*Thermo meter should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.*
ID 6	*Low*	*Pressure gauge should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.*
ID 12	*Low*	*Electricity meter should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.*

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

>>

In the project, quality control and quality assurance shall be carried out by the following methods.

○ The project implementing organization will consist of operating personnel and management.
○ Management will prepare written procedures for operating facilities.
○ Written procedures, containing daily work contents, periodic maintenance methods and judgment criteria, etc., will be compiled according to appropriate formats.

○ Management will check reports from operating personnel and determine there are no problems according to the procedures. If problems are found in such checks, management will implement the appropriate countermeasures with appropriate timing.
○ Management will everyday file and store reports from operating personnel according to the procedures.
○ In the event of accidents (including the unforeseen release of GHG), management will ascertain the causes, implement and instruct countermeasures to the operating personnel.
○ In cases of emergency (including the unforeseen release of GHG), operating personnel will take stopgap measures and implement countermeasures according to instructions from management.
○ Measuring instruments will be periodically and appropriately calibrated according to the procedures. Calibration timing and methods will be in accordance with "the monitoring plan".
○ Measured data will be disclosed and open to public comment. Received comments and the steps taken in response to them will also be disclosed.
○ Measured data will also be subject to audit by government agencies in the host country.

D.4. Name of person(s)/entity(ies) establishing the monitoring plan:

>>

Date: 01/03/2008

General Manager: Kurita Hiroyuki, and
Manager: Kazuhide Maruyama
Manager: Yashio Akira
Shimizu Corporation
GHG Project Department
SEAVANS SOUTH, 1-2-3
Shibaura, Minato-ku, Tokyo 105-8007
03-5441-0137 (from within Japan)
+81-3-5441-0137 (from overseas)
(Japanese HP) http://www.shimz.co.jp/
(English) http://www.shimz.co.jp/english/index.html

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

>>

Project emissions are calculated using Formula (8) as indicated in Section B.2.

$$PE_y = PE_{EC,y} \tag{8}$$

In the project, since consumed power is obtained from the grid, "Case A: Electricity consumption from the grid" of the *"Tool to calculate project emissions from electricity consumption"* is applied. $PE_{EC,y}$ is calculated using the following formula:

$$PE_{EC,y} = EC_{PJ,y} \times EF_{grid,y} \times (1 + TDL_y) \tag{9}$$

For the grid electric power CO_2 emission factor $EF_{grid,y}$, the default value of 1.3 indicated in the *"Tool to calculate project emissions from electricity consumption"* was used.
Concerning the grid transmission and distribution loss factor TDL_y, as a conservative value, the default value of 0.2 indicated in the *"Tool to calculate project emissions from electricity consumption"* was used.

Moreover, in the project, concerning waste that was landfilled before 2007, facilities will be installed in the latter part of 2008 and gas collection will be started from 2009. Concerning the waste landfilled in 2008, since works will be conducted in 2009 and gas collection will be started from 2010, LFG from the waste that was landfilled in 2008 will not be collected but will be discharged into the atmosphere. Accordingly, the LFG that is discharged into the atmosphere without being collected is counted as project emissions.

E.2. Estimated leakage:

>>

According to ACM0001, there will be no leakage in this project.

E.3. The sum of E.1. and E.2.:

>>

The same as in Section E.1.

E.4. Estimated baseline emissions:

>>

As was indicated in Section B.2, baseline emissions are calculated using formula (1).

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

$$MD_{BL,y} = MD_{project,y} \times AF \tag{2}$$

$MD_{project,y}$, according to *ACM0001*, is calculated by the following formula in ex-ante estimation.

$$MD_{project,y} = BE_{CH4,SWDS,y} / GWP_{CH4} \tag{11}$$

$BE_{CH4,SWDS,y}$	The methane generation from the landfill in the absence of the project activity at year y (tCO_2e)

$BE_{CH4,SWDS,y}$ is calculated using the latest version of the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site."* Incidentally, details of the calculation of $BE_{CH4,SWDS,y}$ are as indicated in Annex 2 BASELINE INFORMATION.

$ET_{LFG,y}$ is calculated from the amount of LFG that is supplied to the boiler in the district heating plant. Basically, all the collected LFG is supplied to the boiler. The boiler is operated throughout the year, however, taking maintenance and so on into account, the annual operating rate is assumed to be 90%. Accordingly, the amount of LFG supplied to the boiler shall be 90% of the collected LFG $MD_{project,y}$.
The unit heating value of methane is 0.000035839TJ/m^3 and the boiler efficiency is 100%.

$$ET_{LFG} = MD_{project,y} \times 0.9 \times NCV_{methane} \times \varepsilon_{boiler} \tag{12}$$

Concerning $CEF_{ther,BL,y}$, since the baseline fossil fuel is natural gas, this is calculated as follows using the unit carbon emission of natural gas (15.3tC/TJ) and the carbon oxidization factor of 0.995.

$$CEF_{ther,BL,y} = 15.3 \times 0.995 \times 44 / 12 \tag{13}$$

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

>>

The amount of emissions reductions is calculated using Formula (10) as indicated in Section B.2.

$$ER_y = BE_y - PE_y \tag{10}$$

The results of the above calculation are as indicated below. However, these are only trial estimations and it should be remembered that they do not represent actual emission reductions.

			2009	2010	2011	2012	2013	2014	2015	2016
	$BE_{CH4,SWDS,y}$	tCO_2e	33,898	32,313	30,806	29,374	28,012	26,717	25,486	24,315
	collected LFG	tCO_2e	31,390	32,313	30,806	29,374	28,012	26,717	25,486	24,315
	EqC	-	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	BE_y	tCO_2e	37,652	36,177	34,491	32,887	31,363	29,913	28,534	27,223
	$MD_{project,y}$	tCH_4	1,614	1,539	1,467	1,399	1,334	1,272	1,214	1,158
	$MD_{reg,y}$	tCH_4	0	0	0	0	0	0	0	0
	AF	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ex-ante	$ET_{LFG,y}$	TJ	67	69	66	63	60	57	55	52
	$CEF_{ther,BL,y}$	tCO_2e/TJ	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
	PE_y	tCO_2e	2,809	301	301	301	301	301	301	301
	$PE_{EC,y}$	tCO_2e	301	301	301	301	301	301	301	301
	$EC_{PJ,y}$	MWh	193	193	193	193	193	193	193	193
	$EF_{grid,y}$	tCO_2e/MWh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	TDL_y	-	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
	not collected LFG	tCO_2e	2,508	0	0	0	0	0	0	0
	ER_y	tCO_2e	34,844	35,877	34,190	32,586	31,062	29,612	28,234	26,923

			2017	2018	2019	2020	2021	2022	2023	TOTAL
	$BE_{CH4,SWDS,y}$	tCO_2e	23,201	22,142	21,134	20,174	19,261	18,393	17,565	372,791
	collected LFG	tCO_2e	23,201	22,142	21,134	20,174	19,261	18,393	17,565	370,283
	EqC	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	BE_y	tCO_2e	25,976	24,790	23,661	22,587	21,565	20,593	19,667	417,080
	$MD_{project,y}$	tCH_4	1,105	1,054	1,006	961	917	876	836	17,752
	$MD_{reg,y}$	tCH_4	0	0	0	0	0	0	0	0
	AF	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ex-ante	$ET_{LFG,y}$	TJ	50	47	45	43	41	39	38	793
	$CEF_{ther,BL,y}$	tCO_2e/TJ	55.8	55.8	55.8	55.8	55.8	55.8	55.8	
	PE_y	tCO_2e	301	301	301	301	301	301	301	7,018
	$PE_{EC,y}$	tCO_2e	301	301	301	301	301	301	301	4,510
	$EC_{PJ,y}$	MWh	193	193	193	193	193	193	193	2,891
	$EF_{grid,y}$	tCO_2e/MWh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
	TDL_y	-	0.200	0.200	0.200	0.200	0.200	0.200	0.200	
	not collected LFG	tCO_2e	0	0	0	0	0	0	0	2,508
	ER_y	tCO_2e	25,676	24,489	23,361	22,287	21,265	20,292	19,366	410,063

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

>>

The following table gives a summary of the ex-ante estimation of emission reductions caused by the project. It should be noted, however, that these figures are estimate values and not actual emissions. Actual emission reductions are directly measured in the monitoring.

Year	Estimation of project activity emission (tonnes of CO_2e)	Estimation of baseline emission (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2009	2,809	37,652	0	34,844
2010	301	36,177	0	35,877
2011	301	34,491	0	34,190
2012	301	32,887	0	32,586
2013	301	31,363	0	31,062
2014	301	29,913	0	29,612
2015	301	28,534	0	28,234
2016	301	27,223	0	26,923
2017	301	25,976	0	25,676
2018	301	24,790	0	24,489
2019	301	23,661	0	23,361
2020	301	22,587	0	22,287
2021	301	21,565	0	21,265
2022	301	20,593	0	20,292
2023	301	19,667	0	19,366
Total (tonnes of CO_2e)	7,018	417,080	0	410,063

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

>>

The following paragraphs describe the results of environmental impact analysis.

The project intends to collect, combust and thereby destroy landfill gas generated from a landfill site. As a result, it will impart positive environmental improvement in terms of reducing emissions of pollutants into the atmosphere. Having said that, concern also exists over the following impacts, so the measures described will need to be taken in order to minimize their impact.

○ **Noise and vibration:**
Installation of the blowers for LFG collection will create noise and vibration. However, since these facilities will be located sufficiently apart from houses around the landfill site, there shouldn't be any problems. Rather, the only problem will be that concerning the working environment (impact on hearing, etc.) for operators on the site. This can be resolved by installing appropriate soundproof covers and vibration-proof frames.

○ **Risk of fire from installation of flaring equipment:**
Installation of flaring equipment and the artificial collection of methane gas may increase the risk of fires occurring along pipe routes and around the flaring equipment. This can be resolved by measuring and monitoring oxygen concentration inside LFG collection pipes, stopping the system when the oxygen concentration becomes too high, and stabilizing flame by means of burner combustion control of the flare equipment.

Conclusions
The landfill collection and flaring system has a significant positive impact on the environment. The system reduces emissions of greenhouse gases, odors and gases causing explosions as well as open fires and damage to wildlife. Additionally, the project will produce the following:
- positive effects on climate and local air quality;
- positive effects on flora and fauna in the surroundings; and
- improved conditions for local inhabitants and site workers.

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

Environmental impact assessment in Ukraine is implemented according to the Ukrainian law 'On Protection of Ambient Air' (June 21, 2001). However, since the project intends to improve the environment, the host government has indicated that it should only be necessary to implement abbreviated environmental impact analysis.

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

>>

In JI projects in Ukraine, there are no particular stipulations regarding who can become stakeholders. Accordingly, comments were collected from the following stakeholders considered to be appropriate at the present time.

1. Bela-Tserkov Municipal Auhority – Administrative Services Department and Environmental Protection Department, and other related persons
2. Bela-Tserkov Municipal Assembly
3. Landfill site operator "1028 Urban Transportation Corporation – in charge of the collection, transportation and disposal of municipal solid waste (MSW) on Bela-Tserkov Landfill Site
4. CJSC "A.E.S. Kyivoblenergo"
5. Ukraine National Power Regulation Authority (NERU) – the main objectives of NERU are: 1) tariff regulations in the Ukrainian fuel and energy sector, 2) review of applications for authorization of energy production, 3) regulations and discussions based on conditions approved by licensed electric power/thermal energy producers, and 4) protection of energy consumer rights.
6. District heating operator Bela Tserkovteploenergo district heating network
7. Ukrainian Ministry of Environmental Protection
8. Representatives of academic groups, the education sector and non-government organizations

A summary of the comments received is given below.

When the project developers and investors visited Bela-Tserkov Landfill Site, they held a number of meetings with stakeholders.
The first meeting was held at Bela-Tserkov Municipal Authority and was attended by the mayor of Bela-Tserkov, the Manager of the Public Services Department and the President of 1028 Urban Transportation Corporation.
The technical and institutional details of the project were explained to the participants at these meetings. They showed an interest in the project and understood the environmental, economic and social benefits of it. The city authorities were extremely interested because the project will enable energy saving based on supply of landfill gas to the district heating plant and use of recyclable energy and it will limit consumption of natural gas, which has been going up in price recently.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	Shimizu Corporation
Street/P.O.Box:	1-2-3, Shibaura
Building:	SEAVANS SOUTH
City:	Minato-ku
State/Region:	Tokyo
Postal code:	105-8007
Country:	Japan
Phone:	81-3-5441-1111 03-5441-1111
Fax:	-
E-mail:	-
URL:	http://www.shimz.co.jp/english/index.html http://www.shimz.co.jp/
Represented by:	-
Title:	General Manager
Salutation:	Mr.
Last name:	Kurita
Middle name:	-
First name:	Hiroyuki
Department:	GHG Project Department
Phone (direct):	+81-3-5441-0137 03-5441-0137
Fax (direct):	+81-3-5441-0469 03-5441-0469
Mobile:	-
Personal e-mail:	kurita@shimz.co.jp

Project Participant 2

Organisation:	Bela-Tserlov Municipality
Street/P.O.Box:	
Building:	
City:	
State/Region:	
Postal code:	
Country:	
Phone:	
Fax:	
E-mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last name:	
Middle name:	
First name:	
Department:	
Phone (direct):	
Fax (direct):	
Mobile:	
Personal E-Mail:	

Annex 2

BASELINE INFORMATION

Methane emission potential

According to the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site,"* $BE_{CH4,SWDS,y}$ can be calculated using the following expression.

$$BE_{CH4,SWDS,y} = 0.9 * (1 - f) * GWP_{CH4} * (1 - OX) * 16 / 12 * F * DOC_f * MCF * \sum_{(x=1\sim y)}\sum_j W_{j,x} * DOC_j * e^{-k\,(y-x)} * (1 - e^{-kj})$$

$BE_{CH4,SWDS,y}$	tCO_2e	Methane emissions potential of landfill site (SWDS)
f	-	Fraction of methane captured at the landfill site (SWDS)
OX	-	Oxidation factor
F	-	Fraction of methane in the LFG (SWDS gas)
DOC_f	-	Fraction of DOC that can decompose
MCF	-	Methane correction factor
$W_{j,x}$	t	Mass of waste type j deposited in the year x
DOC_j	-	Fraction of DOC in the waste type j
k_j	-	Decay rate for the waste type j
j	-	Waste type category

f: Fraction of methane captured at SWDS

Apart from the project, since collection of landfill gas on the project site is not currently implemented and will not be implemented in the future, f = 0 is adopted.

OX: Oxidation factor

Since the project site is a managed site, OX = 0.1 is adopted upon referring to the *"IPCC 2006 Guidelines."*

F: Fraction of methane in the SWDS gas

F = 0.5 as recommended in the *"IPCC 2006 Guidelines"* is adopted.

DOC_f: Fraction of DOC that can decompose

DOC_f = 0.5 as recommended in the *"IPCC 2006 Guidelines"* is adopted.

MCF: Methane correction factor

Since the project site is a managed disposal site, *MCF* = 0.1 is adopted.

$W_{j,x}$: Mass of waste type j deposited in the year x

The landfill quantity and composition of solid waste on the project site are as indicated below. The quantity of solid waste type j can be calculated from the product of a) solid waste landfill quantity and b) solid waste composition.

a) Solid waste landfill quantity W_x
The amount of solid waste carried onto the target landfill site between 1983 and 2008 is as indicated below.

year *x*	W_x ton/year	year *x*	W_x ton/year
1983	38,014	1996	44,000
1984	38,613	1997	48,000
1985	40,000	1998	49,000
1986	40,000	1999	50,000
1987	41,000	2000	49,000
1988	42,000	2001	49,000
1989	42,000	2002	50,000
1990	43,000	2003	50,000
1991	44,000	2004	50,000
1992	41,000	2005	51,196
1993	44,000	2006	51,795
1994	42,000	2007	52,394
1995	43,000	2008	53,000

b) Composition of solid waste
Concerning the composition of solid waste, the results of the waste composition survey conducted on the sites were classified according to the *"IPCC 2006 Guidelines."*

Waste type *j*	Mass portion %
Wood and wood products	4.2
Pulp, paper and cardboard	22.1
Food, food waste, beverages and tobacco	51.1
Textiles	5.1
Garden, yard and park waste	0.0
Glass, plastic, metal, other inert waste	17.5
Total	100.0

DOC_j: Fraction of DOC in the waste type j

In accordance with the state of waste on the project sites, the "wet waste" values as given in the *"IPCC 2006 Guidelines"* were adopted .

Waste type *j*	DOC_j (wet waste)
Wood and wood products	0.43
Pulp, paper and cardboard	0.40
Food, food waste, beverages and tobacco	0.15
Textiles	0.24
Garden, yard and park waste	0.20
Glass, plastic, metal, other inert waste	0.00

k_j: Decay rate for the waste type j

In accordance with the climate in Ukraine, the "Boreal and Temperate and Dry" values as given in the *"IPCC 2006 Guidelines"* were adopted.

Waste type *j*	k_j (Boreal and Temperate ,and Dry)
Pulp, paper, cardboard, textiles	0.040
Wood, wood products and straw	0.020
Other (non-food) organic putrescible garden and park waste	0.050
Food, food waste, beverages and tobacco	0.060

Methane emission

The results of calculating the generated amount of methane gas upon taking the above conditions into account are as shown below.

Year	Generated methane (Nm^3CH_4)	Year	Generated methane (Nm^3CH_4)
2009	2,251,917	2017	1,541,328
2010	2,146,614	2018	1,470,937
2011	2,046,524	2019	1,403,965
2012	1,951,377	2020	1,340,239
2013	1,860,919	2021	1,279,593
2014	1,774,907	2022	1,221,871
2015	1,693,114	2023	1,166,926
2016	1,615,322	--	--

Calculation of financial indicators

The cost parameters used in the project are as follows. Incidentally, in the project, gas supply to the boiler plant is free and there is no related revenue.

Item	Unit	Value	Source or Basis
Initial cost	US$	1,355,065	Estimate based on the project design
Running cost	US$/y	24,000	Estimate based on the project design
Verification cost	US$/y	20,000	Estimate based on the project design
Tax, corporate profit tax	%	15	Government of Ukraine
Depreciation rate	%	90	Estimate based on the project design
Exchange rate Yen⇔US$	Yen/US$	116.0	

Annex 3

MONITORING PLAN

Below is indicated the monitoring plan for each item based on the monitoring methodology.

- ID1 $LFG_{flare,,y}$ Flared amount of LFG
- ID2 $LFG_{thermal,y}$ Amount of LFG supplied to boiler

There are various types of flow meters; meanwhile, the target measurements here are the instantaneous flow rate and integrated flow rate for volumetric flow rate of a gas. The instantaneous volumetric flow rate of a gas can be measured by a differential pressure type flow meter (orifice, etc.), an area type flow meter (float, etc.), an ultrasonic type flow meter, a vortex type flow meter or a turbine flowmeter. The performance requirements for the flow meter here are relatively low price (i.e. a widely available type), accuracy, no major loss in precision even if the flow rate varies somewhat, durability and easy maintenance. The vortex type or turbine type flow meter fulfils these requirements. As is explained below, the flow meter must be capable of outputting to a computing unit.

The turbine flow meter is characterized by having a moving part, i.e. a turbine, in the flow meter unit. Accordingly, it is necessary to attach a filter to the upstream part of the flow meter to ensure that no foreign objects get caught in the turbine. The vortex type flow meter has no movable parts, however, it does have a vortex generator. Therefore, as with the turbine flow meter, it is essential to attach a filter to the upstream part of the flow meter to ensure that no foreign objects get caught in the vortex generator. Accordingly, it is very important to manage the filter and keep it clean. If the filter is managed and cleaned adequately, there is no need to perform regular calibration of the flow meter unit.

Measurement of flow is made possible by connecting the above flow meter, pressure gage, thermometer and computing unit by wiring. The computing unit shall be capable of displaying the instantaneous flow rate as well as the integrated flow rate.

The flow rate is continuously measured and automatically integrated by the computing unit. Since the accumulated integrated flow and not the instantaneous flow rate needs to be known, there is no need to make frequent visual checks and record value. As a rule, checking for abnormalities in the display shall be conducted at least once per week and records shall be taken once per month.

- ID4 $w_{CH4,y}$ Methane concentration in LFG

Methods for measuring the volumetric concentration of methane in gas include gas chromatograph analysis, solid sensor gas analyser, optical sensor gas analyser, hydrogen flame ionisation detector, and so on. The performance requirements for the gas analyser here are relatively low price (i.e. a widely available type), accuracy, no major loss in precision even if the concentration level varies somewhat, durability and easy maintenance. Measured concentration here is in the order of 0~70% and are not measured in ppm. Easy measurement and easy calibration are also desired. The optical sensor gas analyser fulfils these requirements, and in particular the infrared type is appropriate.

The infrared methane gas analyser can be easily calibrated. It is possible to calibrate an infrared methane gas analyser by preparing a cylinder of reference methane gas of known concentration and a cylinder of zero methane concentration for zero calibration purposes. In other words, the infrared methane gas analyser can be calibrated in any place that is accessible to gas cylinders.

It is desirable that the infrared methane gas analyser can also measure the oxygen concentration. This is because, although not directly linked to the monitoring, since there is risk of explosion if the oxygen concentration of LFG rises to abnormal levels, it is necessary to stop the system.

The methane concentration shall as a rule be checked once a week for abnormal readings and recorded once every month to coincide with recording of the LFG flow.

- ID5 T Temperature of LFG

Concerning thermometers, there are again various types, for example, thermocouple, resistance type, thermistor type, radiation type, glass pipe type, filled type, bimetal type, crystal oscillating type, fluorescent type, optical fibre distribution type and magnetic type. The performance requirements for the thermometer here are relatively low price (i.e. a widely available type), accuracy, no major loss in precision even if temperature varies somewhat, durability, easy maintenance and ability to output to a computing unit, etc. (i.e. fitting with a terminal). The resistance type thermometer fulfils these requirements if measuring relatively low temperature (0℃~50℃) objects such as LFG.

The resistance type thermometer has a platinum temperature sensor with extremely high durability.

The temperature of LFG is continuously measured. As a rule, the display is checked for no abnormalities once per week, while the temperature is recorded once per month.

- ID6 P Pressure of LFG

Different types of pressure gage are the liquid column type, the plumb bob type and the elasticity type. The performance requirements for the pressure gage here are relatively low price (i.e. a widely available type), accuracy, no major loss in precision even if the pressure varies somewhat, durability, easy maintenance and ability to output to a computing unit (fitted with a transmitter). The elasticity type pressure gage fulfils these requirements.

As for the pressure gage, a pressure transmitter that utilizes a diaphragm is used, however, since this has excellent durability, there is no need especially to carry out calibration on site.

The pressure of LFG is continuously measured. As a rule, the display is checked for no abnormalities once per week, while the pressure is recorded once per month.

- ID12 $EC_{PJ,y}$ Amount of electricity consumed in the project

The watt-hour meter shall be installed in order to monitor the amount of electricity consumed in the facilities newly installed in the Project. Incidentally, the site already has power consumption and watt-hour meter to measure the amount of purchased electricity, however, it will be necessary to install a separate watt-hour meter for measuring just the project power. The new watt-hour meter shall be the same type as the existing one. Accordingly, the meter demanded by the grid owner shall be installed, and the calibrations that are required by the grid owner shall be carried out.

Electric energy is continuously measured and automatically integrated. Since the integrated electricity and not the instantaneous electricity needs to be known, there is no need to make frequent visual checks and record values. As a rule, recording shall be performed to coincide with recording of the LFG flow rate, and checking for abnormalities in the display shall be conducted at least once per week and records shall be taken once per month.

○ In the absence of any international calibration standards for the above calibration items, calibration shall be conducted based on standards of the instrument makers.

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