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

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

"Landfill methane capture and utilisation at Mariupol landfills, Ukraine"
Document version number: 1.2
Sectoral scope number 13: Waste handling and disposal
January 18, 2010

A.2. Description of the project:

The project "Landfill methane capture and utilisation at Mariupol landfills {hereinafter referred to as Sites}, Ukraine" {hereinafter referred to as Project} has been developed by Scientific-Engineering Centre Biomass, Ukraine.

The Project consists of developing a Landfill Gas ("LFG") collection and flaring system with an opportunity of its further energy utilization in order to avoid emissions of methane being released into the atmosphere. LFG production results from waste decay in the anaerobic conditions created in the landfill body. LFG contains approximately 50% methane ("CH_4"), which is a powerful greenhouse gas ("GhG") contributing to global warming. Additionally, LFG is a fire hazard and causes bad odours in the vicinity of the site. By capturing the LFG, GhG emissions are reduced, local environmental impacts are mitigated and the operational safety of the site is increased.

The proposed Project includes capturing LFG and combusting it in the flare and further utilization for combined electricity and heat production. The estimated capacity of LFG power engines which can be commissioned is 0.7 MW for the Primorsky landfill and 1.5 MW for the Ordzhonikidze landfill. The decision to invest in LFG to Energy ("LFGTE") modules and choice of the actual capacity will be made on the basis of an economic review, possibility to connect to the public grid, heat consumers availability and whether a Power Purchase Agreement ("PPA") can be obtained.

Mariupol is one the largest cities in Donetsk Region and the most developed industrial cities of Eastern Region of Ukraine with population of about 500 thousand inhabitants.

For MSW storage there are two landfills located on the territory of the city, which are among the 900 largest registered landfills of Ukraine. The landfills are owned by municipality and are operated by municipal company "Poligon TPV". The company received official state acts on use of land for operation of MSW landfill sites in 2005.

"TisEco" company has concluded contracts with Mariupol city council on the right of JI LFG collection project realization on two city's landfills in 2009.

Landfills' addresses are:
- 167 Krasnoflotska str., Prymorsky District (further referred to as "Prymorsky" landfill)
- 1 of May avenue, Ordzhonikidze District (further referred to as "Ordzhonikidzevsky" landfill)

Prymorsky landfill is located within the city boundary, 3 km from Azov sea and has a total area of 14.3 ha and the active area of 12.43 ha. The operation of the landfill was started in 1967. It is situated in the previous opencast mine of brick factory with the depth of about 10 meters. Currently the landfill represents a dump with a height of 7 to 23 meters. From the middle of 2008 the landfill doesn't receive waste except inert waste for surface covering.

According to operator's data annual amount of municipal solid waste disposed at the landfill during last years was about 250-300 thousand m^3/year (60-70 thousand tons/year), waste is registered by trucks number and volume. According to operator's the total amount of disposed waste is about 4930 thousand tons. This figure is probably overestimated due to lack of weighting. Total amount of waste accumulated at the landfill is estimated by landfill volume to be about 2.56 million tons (end of 2008).

Ordzhonikidzevsky landfill was put into operation in 1976; it is situated between two residential districts of the city – Illichivskyi and Ordzhonikidzensky, 100 meters from Kalmius river. According to the landfill passport the total area of waste disposal is about 17,6 ha, an active area is 12,16 ha. According to operator's data annual amount of municipal solid waste disposed at the landfill during last years was about 350-400 thousand m^3 per annum (90-100 thousand tons a year). According to operator's data during last years the amount of disposed waste was about 3654 1thousand tons (to the end of 2008). Total amount of waste accumulated at the landfill to the end of 2008 is estimated by landfill volume to be about 2.54 million tons (end of 2008)

The landfills were opened as unofficial dumps not complying with waste disposal standards and ecological and sanitary norms: there are no leachate collection system and leachate protection screen for surface water and soil protection, surface water drainage system, working zone isolation, gas drainage and other environmental arrangements are also absent. Uncontrolled LFG output raises the risks of fires and explosions.

Technology of LFG capture and flaring/utilization is widely used throughout the world increasing safety of landfill operations and providing additional advantage through energy production. LFG collection and flaring system implementation enables methane emission into the atmosphere. In case of energy production additional emission reduction will be obtained by replacement of part of electrical and thermal energy from fossil fuels with the electricity and heat produced from CO_2 neutral fuel – landfill gas.

However, such projects are not financially viable under Ukrainian conditions and therefore cannot be implemented under "business-as-usual" scenario. Historically, non-compliance with requirements on proper operation of landfills is widespread in the host country mainly due to financial barriers, as well as lack of technical knowledge this is expected to continue. These obstacles create very high risk of the LFG project implementation. Currently LFG collection and flaring systems are installed on only 3 landfill sites in Ukraine within the JI Kyoto Protocol frames. Nevertheless, on a national level a potential for LFG recovery is large and LFG recovery and energy utilization can be replicated on other landfills.

Mariupol Municipality has signed the concession long-term agreement granting the rights for degasification of landfills and utilization of LFG to the Ukrainian private company TisEco. TisEco will be the owner and operator of the described projects at both sites.

The Project will contain the main activities at the Sites including:

- installation of wells and a piping network for LFG collection,
- installation of a flaring system including gas booster, flare and monitoring system, and
- commissioning of an CHP-unit set for power and heat production with connection to the power grid and heat supply to consumer.

Additional remediation activities at the landfill will address its environmental liabilities. These include:

- Reshaping the land and accumulated residues; and
- Partial sealing the site with clay or an industrial liner to facilitate the high efficiency of the LFG collection and contribute to the stability of the landfill as well as prevent methane from leaking into the atmosphere.

Planned Project Implementation is presented below.

1. **August – September 2009 –** Project Design Document (PDD) prepared and project business plan finalized.
2. **December 2009 –** Complete drilling on all wells in Prymorsky landfill. Installation of pipes. Purchase of flaring plant and monitoring equipment.
3. **January 2010** – Obtaining Letter of Approval from Ukrainian Government.
4. **January 2010 -** Flaring project testing, trials and fully operational in Prymorsky landfill.
5. **March 2010 –** Feasibility study on power generation.
6. **April 2010** - Decision making on CHP purchase and capacity selection.
7. **September 2010** – engine installation and start-up in Prymorsky landfill.
8. **September – December 2010** – Wells drilling in Ordzhonikidze landfill. Installation of pipes. Purchase of flaring plant and monitoring equipment.
9. **January 2011** – Flaring project testing, trials and fully operational in Ordzhonikidze landfill.
10. **March 2011 –** Feasibility study on power generation.
11. **April 2011** - Decision making on CHP purchase and capacity selection
12. **September 2011** – engine installation and start-up in Ordzhonikidze landfill

Investment schedule is provided in Table below:

Item	2009			2010				2011				2012
	II	III	IV	I	II	III	IV	I	II	III	IV	I
Prymorsky ladfill												
Equipment & construction		X	X	X	X	X						
Degasation system & construction		X	X	X	X	X						
Projection	X	X	X									
Ordzhonikidze landfill												
Equipment & construction								X		X	X	
Degasation system & construction								X	X	X		X
Projection						X	X	X	X			

Please note: final timing of the project implementation phase will depend on the transaction process and investment agreement. The project will be implemented in two stages, first at the Primorsky landfill, than at the Ordzhonikidze landfill with at least one year delay.

Project costs will be partially covered by "TisEco" company and rest will be covered by loan capital; currently negotiations with few banks are in the process, in particular with European Bank of Reconstruction and Development. Also the option of partial project financing by ERUs buyer is under consideration.

The ex-ante analysis shows that the average amount of methane collected annually during the period of 2010-2012 will be 2,5-3,0 million m^3 of LFG per year (with methane share of 50%) at the Primorsky landfill and 4,5-6,0 million m^3 of LFG per year (with methane share of 50%) at the Ordzhonikidze landfill. Flaring alone will achieve an estimate of **126,000 tonnes** of CO_2e reductions over the 3-year commitment period and flaring with combined electricity and heat production will achieve an estimate **of 176,000 tonnes** of CO_2e reductions over the same period.

Besides GHG emission reductions, LFG capture will contribute to the improvement of local environmental, economic and social situations; providing benefits; the most important of which are listed below:

- increasing safety of landfill operational procedures (for the Ordzhonikidze landfill);
- demonstrating the state-of-the-art technology of LFG recovery in Ukraine and knowledge of the best landfill site management after the closing time, thus creating a better environment for replicating of similar investments projects; and
- increasing clean technology investments and promoting of renewable energy sources.

A.3. Project participants:

Party Involved	**Legal entity project participant**	**Does the Party involved wish to be considered as project participant**
Ukraine (Host Country)	• TisEco	No
Ukraine (Host Country)	• Municipality of Mariupol city	No
Ukraine (Host Country)	• SEC Biomass	No

A.4. Technical description of the project:

A.4.1. Location of the project:

The project location is shown on the maps below.

A.4.1.1. Host Party(ies):

Ukraine

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

Donetsk Region

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

Mariupol, Primorsky and Ordzhonikidze districts

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

The Project is located in Mariupol city, Donetsk Region, Ukraine. Mariupol city has a population of about 500 000 inhabitants. Mariupol city is shown by the red arrow on the map below (Figure 1).

Figure 1: Mariupol city (Donetsk Region, Ukraine)

The two landfills are located approximately 12 km apart within the city board. The Sites are highlighted in the Fig. 2a. The Primorsky landfill site is located at the following coordinates: 47º05'12''N and 37º28'20''E. The Ordzhonikidze landfill site is located at the following coordinates: 47º08'05''N and 37º37'46''E. The landfill details can be seen in Figure 2b.

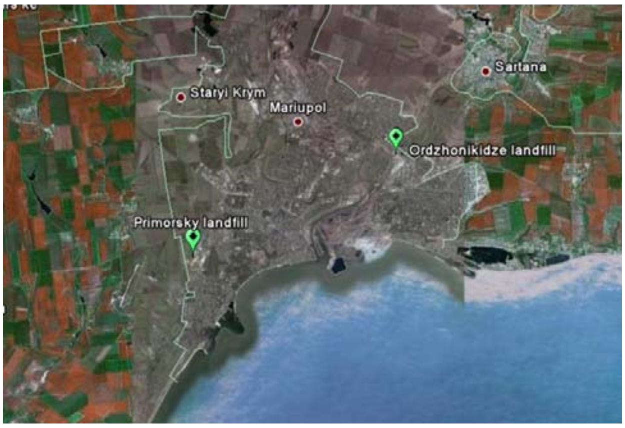


Figure 2a: Mariupol landfills

Figure 2b: Mariupol landfills

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

The Project activity involves installation of active LFG collection systems and efficient gas flaring plants on the Sites with an option to install CHP units if the connection to the public power grid is realized and the PPA is approved.

Additional remediation activities could include reshaping of the landfill body in order to prepare it for LFG collection system installation and landfill capping.

The Project activities are summarized below:

(a) Remediation (landfill reshaping and partial or complete covering system)
(b) Landfill gas collection system
(c) Gas flaring
(d) Combined electricity generation and thermal energy production at CHP unit

(a) Remediation

The landfill will be prepared to support the collection and flaring of the landfill gas, as well as to mitigate current, adverse environmental impacts. This could include capping the landfill surface and slopes to prevent ingress of water and natural ventilation of the landfill gas. Capping will either be a layer of compacted clay or a low permeability geomembrane.

(b) Landfill gas collection system

Technology description. The main elements of LFG collection system are listed below:

- vertical gas extraction wells with regulation valves and connection units for monitoring of gas composition at the gas regulation stations;
- gas transport pipes, transporting gas from the wells to gas regulation stations and then to the integrated gas boosting and flaring plant; and
- condensate shafts.

At each landfill, perforated plastic vertical gas extraction wells will be established in the waste material and will be connected to the blower system through a network of horizontal underground piping installed underground. The LFG collection piping consists of a header, sub-headers, and laterals. LFG flows from the wells through the lateral and sub-header piping to the header piping to the gas control plant. The flow of gas can be controlled at each of the individual vertical extraction wells through the use of a valve located at the hear gas regulation station. Each well will be individually controlled to ensure that the collection systems can be effectively set up and balanced. The systems will be manually monitored and controlled and each well will be equipped with monitoring ports for gas composition, pressure, and temperature readings. Non-perforated LFG collection piping will be utilized to convey the LFG from the extraction wells to the gas control plant at the landfills. The gas collection pipe work allows for effective condensate management by employing dewatering points at strategic low points and returning the condensate back to landfill.

Projection for LFG collection at the Sites. Tentative analysis shows that approximately 4,5-5,5 million m^3 of LFG with 50% methane content is likely to be generated annually during the period of 2010-2012 at the Primorsky landfill. It is assumed that 44 LFG extraction wells will be installed at Primorsky landfill providing coverage of 90% of waste accumulated. The system of pipes is a triangular network with the flaring plant placed outside of landfill. Each well will be connected to the one of the three gas regulation station through laterals. After which, the gas will pass to subheaders and headers and finally proceed to the flaring plant.

The overall LFG collection efficiency is a function of percentage of the area covered by extraction wells, well efficiency and well availability. Considering the overall recovery rate of 60% approximately 2,5-3,0 million m^3 of LFG (0,9-1,1 thousand tonnes of methane) will be annually collected.

A similar design of the methane collection system will be applied at Ordzhonikidze landfill. Tentative analysis for Ordzhonikidze landfill shows that approximately 10,0-12,0 million m^3 of LFG with 50% methane content can be generated annually during the period of 2010-2012. It is assumed that about 40 LFG extraction wells will be installed at Ordzhonikidze landfill providing coverage of 50% (60% after landfill closure in 2012) of waste accumulated. Considering the overall recovery rate of 50% approximately 4,5-6,0 million m^3 of LFG (1,5-2,3 thousand tonnes of methane) will be annually collected.

The configuration of the gas collection wells is sensitive to landfill characteristics, such as varying depths and slopes, determined in the design phase. The exact number and spacing of the vertical extraction wells will be determined by the preliminary soil boring and pumping tests.

(c) Gas flaring integrated booster and flare station

Collected LFG can be either flared or utilised in an LFGTE unit for production of electricity (and possibly heat). The decision to install power generation units will be made at a later project stage upon obtaining field data on methane generation, and depending on the availability of power purchase agreements.

Flaring will use a high-temperature flare in an integrated booster and flare station. The system operates at slightly lower than atmospheric pressure. The blower system will exert vacuum through the piping system to the system of vertical wells. Extracted LFG will be delivered to high-efficiency, state-of-the-art, enclosed flares for destruction of the methane component of the extracted landfill gas.

The flaring plant consists mainly of the following components: manifold for the incoming pipes, flow control valves, gas pressure boosting pumps, enclosed high-temperature flare stack, gas monitoring and analysis system.

The main components of the gas flare system are presented below:

- Pipe work: connects all the elements of the flare from the mains header pipe to the burners via 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) 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.

(d) Electricity generation and production of heat

Collected LFG may be utilised in an CHP unit for production of electricity (and possibly heat) at a future date. A decision to install such a unit will depend on the following and be taken after a trial period of methane capture system operation and a feasibility analysis:

- Establishing grid connection. Currently, the closest power transmission lines are located at the distances of 100 meters for the Primorsky landfill and 100 meters for the Ordzhonikidze landfill.
- Establishing a Power Purchase Agreement. Power would be sold to the power grid or under direct agreements with power consumers.
- Availability of interested off-takers for heat energy
- Flow of LFG. This will be proved after installation of the LFG collection system

The LFG utilisation system in terms of electricity and heat production consists of the following main components in addition to extraction and flaring system:

- CHP unit
- Connection to the electrical grid
- Piping connection to the heat consumers

The technology to be applied in the project is a CHP unit suitable for combined heat and power production. The packaged generation system consists of an outdoor, acoustic, containerized generating set with an engine/alternator set and heat exchangers. The engine units will be fully containerised, turbocharged gas engines with a separate control room and housing for its own transformer and switch. CHP unit allows use thermal energy that usually is lost by conventional boiler-house. As the gas production increases or decreases then containerised engine units can be easily added or taken away to match the gas production.

Origin of technology. Much of the flaring system and controls 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/CHP 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
CHP unit	Imported from EU	According to EU Standards (noise, emissions, operational safety)
Monitoring and control systems	Imported from EU/ Locally manufactured	According to EU Standards/ According to local standards

The schedule of implementation of the project can be summarized in the following two phases:

Phase 1: A gas collection system with collecting pipes, manifolds, blowers and monitoring & control systems will be installed at the Primorsky landfill. Then similar system will be installed at the Ordzhonikidze landfill.

Phase 2: Based on the experience and monitoring data of the first months of operation and negotiations with the potential power and heat consumers, a gas engine/generator set may be installed. The capacities of the generation units will only be determined on the basis of first months operation results. Estimated power capacities are 0.7 MW of installed generating capacity for the Primorsky landfill and 1.5 MW of installed generating capacity for the Ordzhonikidze landfill. The objective is to supply the electricity produced into the high voltage grid of the local utility and to provide thermal energy in to heat consumer in form of hot water. Entire electricity demand of the landfill installations will be covered by electricity obtained from the grid.

The project applies conventional technological decision, that is used on many landfill sites. This is state of the art technology, which can not be substituted by other or more efficient technologies within the project period.

The facility will be operated in the frame of maintenance service. The training is planned to be held by equipment manufacturer before start-up. Personnel will be provided be all necessary instructions for proper technique operation. Project doesn't require extensive initial training and maintenance efforts to work as presumed during the project period.

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:

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/utilisation after the landfill closure. However, municipalities and municipal companies operating landfills are in a poor financial state and cannot invest in such projects. Other hurdles for introduction of LFG collection technologies are presented by a number of investment and technological barriers. LFG recovery projects have yet to be implemented in Ukraine and are unlikely to be implemented on a wider scale for the coming decade.

At present, LFG at the Project Sites is vented into the atmosphere. Application of LFG capture and flaring/utilization technology will allow abatement of methane release into the atmosphere that would otherwise occur under the continuation of the current landfill operation practice.

In the baseline scenario-without-project the GhG emissions will be as follows:

1. full release of landfill methane into the atmosphere;
2. CO_2 emissions from generation of grid electricity to be replaced with the power produced from CO_2 neutral fuel – landfill gas
3. CO_2 emissions from heat production by fossil fuels (natural gas) combustion to be replaced with the thermal energy produced from CO_2 neutral fuel – landfill gas.

The emission reduction from the Project implementation will be as follows:

1. **Abatement of methane release into the atmosphere.** Methane in the form of landfill gas will be captured and destroyed through flaring.
2. **Substitution of the power grid emissions**. CO2 from generation of the grid electricity will be replaced through use of LFG.

3. **Substitution of emissions from thermal energy generation.** CO2 from fossil fuel combustion will be replaced through LFG utilization in CHP unit.

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

The emission reduction estimates for Primorsky and Ordzhonikidze landfills for crediting period are given in the table below.

	Years
Length of crediting period	3 years
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2010	28 382
2011	68 162
2012	79 659
Total estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	176 203
Annual average of estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	58 734

	Years
Length of crediting period	12 years
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2013	81 120
2014	72 607
2015	65 167
2016	58 682
2017	53 010
2018	48 033
2019	43 651
2020	39 778
2021	36 345
2022	33 291
2023	30 563
2024	28 121
Total estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	590 368
Annual average of estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	49 197

A.5. Project approval by the Parties involved:

Letter of Endorsement for Primorsky and Ordzhonikidze LFG project # 907/23/7 from 12/08/2009 from the Ministry of Environmental Protection of Ukraine can be provided on request.

Documents for Letter of Approval obtainment will be applied after determination process completing. LoA from Host Party is expected to be obtained in January 2010. LoA from Sponsor Party will be gained after Sponsor Party definition.

SECTION B. Baseline

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

The baseline and monitoring methodology to be applied for the proposed project activity is the approved consolidated baseline methodology ACM0001, version 11, May 2009: ***"Consolidated baseline and monitoring methodology for landfill gas project activities"*** [1].

ACM0001 is applicable to this Project since the Project baseline is the continuation of the current situation (no landfill gas extraction and its total atmospheric release) and the Project Activities are landfill gas capture and flaring and possible energy generation.

This methodology is applicable to the Project, as outlined below:
- The Project represents a landfill gas capture project activity, where the baseline scenario is total atmospheric release of LFG; and
- Captured gas in project scenario is flared; and/or is used to produce energy (e.gelectricity/thermal energy). Emission reductions are claimed for thermal energy generation, as LFG displaces use of fossil fuel (natural gas) in a boiler.

The key information and data used to establish the baseline (variables, parameters, data sources etc.) in tabular form are provided in Annex 2, Baseline information.

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:

Identification of baseline scenario is made using the ***"Tool for the demonstration and assessment of Additionality"*** *(Version 05.2)*[2].and ***"Combined tool to identify the baseline scenario and to demonstrate Additionality"****(Version 02.2)*[3] agreed by the CDM Executive Board. The baseline is the continued atmospheric release of the landfill gas with no capture and destruction ("business-as-usual" scenario at the site). Landfills in Ukraine operate in a state of non-compliance with existing environmental legislation due to poor finances of landfill owners and operators as well as lack of technical knowledge.

The determination of project scenario Additionality is made using the ***"Tool for the demonstration and assessment of Additionality"*** agreed by the CDM Executive Board:

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

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

	Alternatives to Project Activity	Probability of Scenario
1	The continuation of the current situation: no landfill gas extraction	*Most probable*: Current practice shows that the regulations on landfills across the Ukraine are not enforced. In addition, the technical expertise and financial investment to engage in the LFG collection project is not available in

[1] Reference on methodology and tools: http://cdm.unfccc.int/goto/MPappmeth

[2] Reference: http://cdm.unfccc.int/goto/MPappmeth

[3] Reference: http://cdm.unfccc.int/goto/MPappmeth

	Alternatives to Project Activity	Probability of Scenario
		Ukraine. Therefore, it is not expected that the regulation requiring the capture and destruction of landfill gas at the Sites will be followed.
2	Extraction of landfill gas and combustion of the gas in a flaring stack for methane emission reduction only (as non-JI project);	*Not probable*: The project activity requires funds for both construction of the required facilities and to maintain operations. There are no known or funding sources available to support this project and the existing regulatory requirements regarding emissions control is not expected to be followed. Furthermore, this alternative does not provide itself any potential revenue to the landfills, it is therefore not considered a plausible alternative.
3	Landfill owner invests in the landfill gas extraction system and LFG power and heat generation facility for electricity supply to the public network and heat providing to consumer (as non-JI project);	*Not probable*: The main barrier is of financial nature, since the revenues from power and heat sales do not outweigh the high investment (in absence of the JI component), i.e., the project's IRR is below market expectations, and thus not capable to attract investors (see steps below). Moreover, the technical expertise and financial resources in Ukraine are not available to initiate energy generation from LFG. Combined power and heat generation systems require significantly more investment than landfill gas capture and flaring systems.
4	A different use of biogas offsite is proposed	*Not probable:* *Heat off-take:* No significant interested off-takers for heat energy are thus energy deliveries are economically unattractive. *Fuel production:* "Standard "LFG-to-fuel" technology is not yet commercially available and economically viable, in particular the LFG enrichment/cleaning technology bears significant technical risks.

Outcome of step 1a: The above analysis shows that alternative 4 is not plausible. Alternatives 2 and 3 are plausible, but not probable. The only reasonable alternative to the project activity is the continued uncontrolled release of landfill gas to the atmosphere as part of the "business-as-usual" scenario at the site. Alternative 2 and alternative 3 will be analysed further below.

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

Before 2005, national standards on the operation of landfills 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/utilisation after the landfill closure. However, the legal requirements on proper operation of landfills have not been enforced mainly due to financial barriers. Hence non-compliance with those requirements is widespread in the Host country. Due to financial state and lack of technical knowledge, this is expected to continue. Historically the environmental protection in Ukraine has been of secondary importance regarding both legislation and financing aspects, especially during the recent years of economic depression. Moreover, the implementation of environmental protection legislation in Ukraine has a relatively long lead-time, and the Ministry of Environment has no immediate plans to enforce legislation requiring the collection and flaring of landfill gas from landfill sites. Realistically, full compliance with the existing regulatory framework is not expected to feasible in the short to medium term. Presently, common practice shows that existing landfills in Ukraine do not capture and flare or utilise their landfill gas (please refer also to *Step 4. Common Practice Analysis* below).

Outcome of step 1b: Even if Alternative 1 does not comply with the existing regulation it is considered a plausible baseline scenario. All other alternatives are consistent with aforementioned legislation.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the *"*Tool for the demonstration and assessment of additionality*"*(Ver. 05.2), one of three options must be applied for this step: (1) simple cost analysis (where no benefits other than JI income exist for the project), (2) investment comparison analysis (where comparable alternatives to the project exist), or (3) benchmark analysis.

The benchmark analysis will be applied for the Alternatives 2 and 3.

Sub-step 2b: Benchmark analysis for the Alternative 2 Extraction of landfill gas and combustion of the gas in a flaring stack for methane emission reduction (as non-JI project); ***and Alternative 3:*** Installation of landfill gas extraction system and CHP unit for electricity generation and supply to the public network and heat production and providing to consumer (non-JI project).

The likelihood of development of either Alternative, as opposed to the continuation of current activities (i.e., no collection and combustion of landfill gas), will be determined by comparing the respective IRR values with the benchmark of interest rates available to a local investor. In 2009, commercial interest rates at local banks in Ukraine were 11.4% for EUR deposits (Source: *http://bank.gov.ua/Statist/Statist_data/Inter_r_term_dep.xls*). The benchmark rate of return on projects with similar risks involved is commonly set at least at 17%.

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

In Alternative 2, no returns corresponding to the initial investment or on-going expenses are expected and, therefore, this scenario is has an IRR of zero (0). The analysis shows that without ERUs, the project activity is not economically attractive and not a realistic baseline scenario in Ukraine.

In Alternative 2, total investment of the LFG collection and flaring systems for the Sites is estimated to be about 3 million Euro. The LFG system will also incur additional expenses once it becomes operational (e.g., maintenance, management, administrative) of approximately 6,2% of the total capital cost.

The total investments (phases 1 and 2) for both Sites amounts to 5,900 000 Euro. This includes feasibility study, pumping tests, implementation of two complete gas collection systems and installation of CHP units on both Sites with a total capacity of 2.2 MW. Operating and maintenance costs for all systems are expected to be in the range of 318,000 Euro per year. Assuming a net sales price of 134.5 Euro/MWh for the electricity exported to the grid ("Green tariff") in the period starting from 2010 till 2030 (amounting annually to about 10,000-15,000 MWh), and thermal energy tariff of 10.54 Euro/Gcal for providing heat to consumer, the project IRR is 15.7, showing the project is not financially attractive

The Table below summarizes the financial results of the project with and without carbon finance.

The NPV assumes a 17% discount rate. ERU price is 10 Euros

Main assumptions	**LFGE**		**Flaring**	
Investments, Euros	€ 5,896,360		€ 3,096,460	
Annual operating costs, Euro/yr	€ 317,920		€ 192,530	
Power tariff (Green Tariff)	134.5 Euro/MWh		n/a	
Financial parameters	Without ERU	With ERU	Without ERU	With ERU
IRR, %	15.7	26.6	-	-
NPV (Euro)	€ - 230,650	€ 1,746,730	-	€ -1,107,770
Simple payback period	5.3	3.8	-	>10

The IRR without ERU sale above is significantly lower in comparison to:

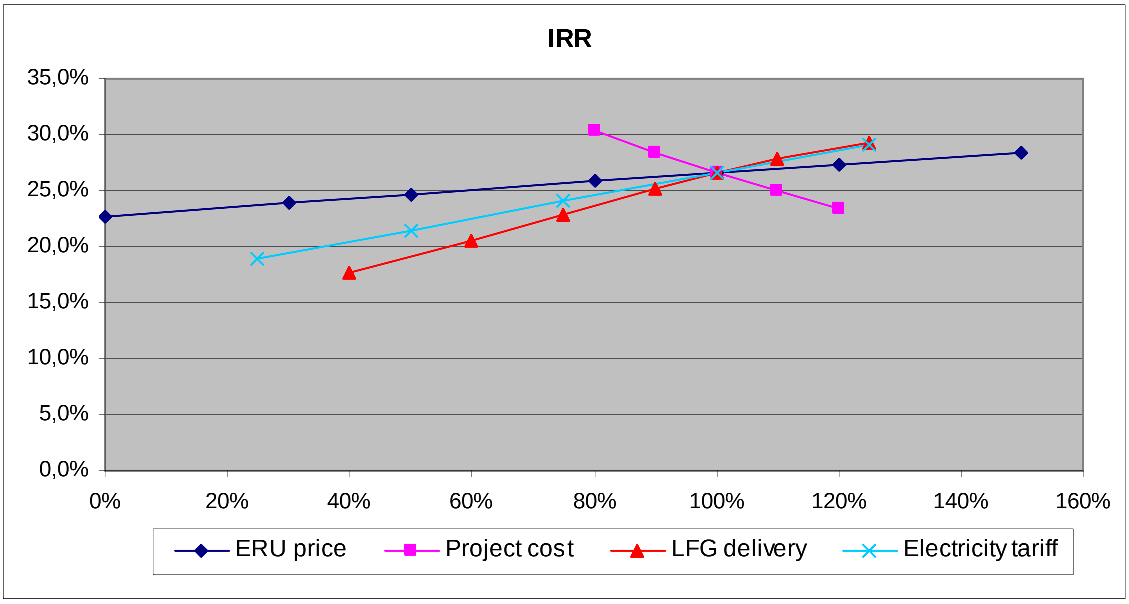
- Average commercial deposit rates of 11.4% interest rate; and
- IRR expectations of > 17% of commercial investors in renewable energy projects or industrial investors using similar technologies (e.g., gas engines) and having similar technical and commercial risks (excluding the Kyoto risks).

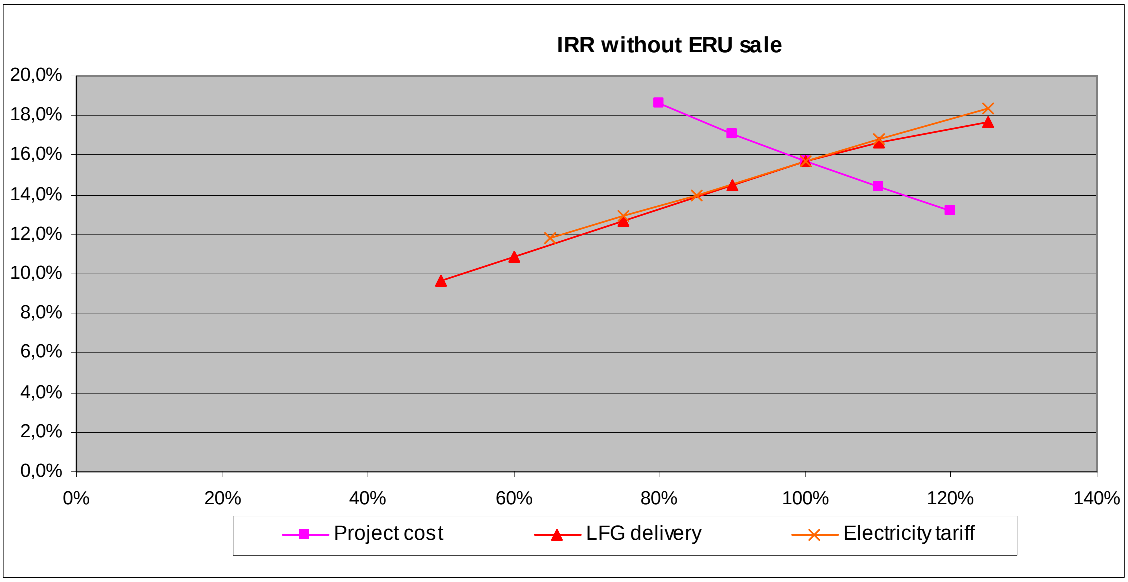
Sub-step 2d: Sensitivity analysis

A sensitivity analysis was conducted by altering the following parameters:

- LFG delivery
- ERU price (10 Euro = 100%)
- Project cost
- "Green tariff" for electricity sale (134.5 Euro/MWh = 100%)

Those parameters were selected as being the most likely to fluctuate over time.
All calculations are provided in Excel files in supported documentation (Appendix A).





Outcome of step 2: The project IRR without ERU sale remains low even in the case where these parameters change in favour of the Project. Even though these numbers are closer to the risk free returns of government bonds, these are still too low for a risky enterprise such as the construction and operation of a landfill gas-to-energy project, and fairly lower than private equity investments such as 17%. Consequently, the Project cannot be considered as financially attractive without ERU sale.

Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity:

Technical and investment barriers impeding implementation of LFG collection and flaring/utilisation project are discussed below:

1) Investment barrier:

One of the main obstacles for establishment of proper landfill operation procedure is lack of funds of the municipalities owning the landfills. The present MSW collection and disposal tariff level is about 0.1% of the average family income compared to the international benchmark of 1%. The revenues of landfill operators from MSW disposal are insufficient to ensure appropriate MSW disposal in accordance with technological standards, e.g. soil covering, leachate treatment, etc. The present tariffs of waste companies do not provide revenues capable of covering the operation and maintenance costs of a proper municipal waste collection and disposal service system, let alone the required investments. Required investments are mainly financed from the local budget and natural environmental protection fund rather than through tariff increases, and amount of financing from these sources as well as funds available from the government budget is very limited[4].

2) Technological barriers:

Since no project activity of this type is currently operational in the Host Country, the barrier of "first mover" is applicable to the proposed project. Related to this situation, there is an absence of technological know-how on LFG systems design and installation as well as no availability of skilled and properly trained labour to operate and maintain the technology. Lastly, standard technical solutions for equipping LFG collection, combustion and utilization systems are not available on the Ukrainian market.

Technical barriers:

- Main technical risk could be associated not with equipment itself but with the deficiency of the related technical knowledge and motivation of the local landfill operational staff.
- Due to the current lack of reliable data on some technical parameters of the landfill that are important for successful project realization (e.g. level of leachate in the landfill body and waste composition) test drilling is recommended to ascertain the potential efficiency of gas collection;
- Risks related to technical design and operation can be minimised by the employment of highly specialized specialists who have an extensive knowledge of landfill gas recovery systems and through the use "off the shelf" and well established technology.

Outcome of step 3a: The above analysis shows that there exist significant investment and technological barriers that may prevent the proposed project activity implementation.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

The investment analysis and barriers described above clearly highlight that continuation of the current situation is the least cost, most plausible option. With regards the legislation requirements in place, the common practice shows that non-compliance with requirements regarding landfill management is widespread in the Host country landfill practices.

Step 4. Common Practice Analysis

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

In spite of the 2005 regulation, waste disposal in Ukraine is, in many cases, carried out at landfills and dumpsites that are improperly located, mainly in terms of hydro geological conditions and distance to water bodies, wells and aquifers.

A major portion of the MSW generated in Ukraine (approx. 96%) is disposed at landfills and dumpsites, 4% is incinerated. There are approx. 900 registered landfills in Ukraine and more than 2000 uncontrolled dump sites with the total area of 5312 ha. Most officially registered landfills have started operations as unmanaged dumps and are operated without any environmental protection measures.

Furthermore, the vast majority of the landfills and dumpsites, of a similar age to the Project Sites (20 – 40 years old), are not properly designed with regard to surface water diversion, leachate collection and

[4] "Ukraine National Municipal Solid Waste Management Strategy" - Danish Cooperation for Environment in Eastern Europe (DANCEE) Ministry of Environment, Denmark Ukrainian State Committee for Housing and Municipal Services Existing Situation and Strategic Issues Report, April 2004.

treatment and also landfill gas management. The operation of many landfills and dumpsites is not carried out with a view to minimise the adverse impacts on environment and human health.

Waste is often disposed over large areas rather than in small well-defined cells and without proper soil cover, resulting in wind dispersal of waste and odour nuisances and enhanced leachate generation. Proper operation of leachate collection and treatment systems as well as gas management systems is uncommon.

The table below presents information regarding a representative sample of landfills throughout the Host Country.[5] The sample represents 40% of the major landfills servicing large cities with number of inhabitants of more than 200 thousand persons.

Landfill site / Aspects investigated	Number of inhabitants serviced by landfill, in thousand	Annual waste amount (uncompacted) 1000 m^3 i	Total amount of waste collected to 2009 (uncompacted), million. m3	Starting year of landfill site operation	Total landfill area, ha	LFG control
Primorsky	500	300	2.56	1967	14.3	None
Ordzhonikidze		400	2.54	1976	17.6	None
Zhytomir	300	300	8.0	1957	18.7	None
Vinnitsa	385	340	5.1	1985	5	None
Khmelnitsky	250	490	14.8	1956	8.8	None
Chernivtsi	260	340	2.7	1995	25	Passive venting
Ivano-Frankivsk	230	260	3.0	1992	22.4	None
Lutsk	215	340	3.6	1991	9.9	None
Rivne	245	400	12.2	1959	24.5	None
Kirovohrad	280	260	10.9	1949	23	None
Cherkassy	310	360	4.8	1992	9	Passive venting
Kremenchuk	245	290	12.3	1965	28	None

As the table indicates, landfills in Host Country either have: a) no system for collecting, venting or flaring LFG, or b) passive system for venting LFG only.

One demonstration project on LFG collection and flaring was implemented at the Lugansk landfill in 2002 supported by EcoLinks grant and USAID. The project was aimed at demonstration of LFG control practice, thus promoting development of clean technologies and renewable energy sources. Three LFG extraction wells, collecting pipe and a flare were installed at the landfill and monitored for a year, however this work has not had any follow-up activities upon project completion.

The vast majority of landfills do not have an LFG control system at all. Development of LFG projects was started in the JI framework only, specifically: project design documents for Kyiv, Donetsk and Kharkiv landfills were developed by Danish Environment Protection Agency (DEPA, Copenhagen, Denmark) in the beginning of 2004 and letter of approval was obtained for Kharkiv landfill. Two LFG JI capture and flaring were recently started at Yalta/Alushta and Lviv landfills by Ukrainian companies “Gafsa-Skhid” and “Gafsa”.

[5] Identification and preparation of ProjectPreCheck (PPC) documents for LFG collection and utilization projects in Ukraine. Final report. For KfW Entwicklungsbank; by DECON Gmbh, SEC “Biomass”, June 2005.

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

Discussions on installation of gas collection and flaring systems in Ukraine have only started in the context of the JI scheme application. Several projects are being prepared as JI projects and are at the different stages of development from Project Idea Note and development of PDD to trial operation.

Implementation of the LFG recovery Project under JI scheme will allow sale of emission reduction units generated by the project activity, thus providing substantial share of revenues for the project and making it feasible.

Alternative 2**:**

Assuming that ERUs have a market value of 10 Euros per tonne, the project may have a negative IRR .

Alternative 3**:**

Assuming that ERUs have a market value of 10 Euros per tonne and generate additional revenues from the sale of electricity to the grid (assuming a market value of 134.5 Euro/MWh) and heat supply to consumers, the IRR is projected to be approximately 26.6% (pending detailed final investment analysis).

The possibility of development of the proposed project under JI scheme of Kyoto Protocol has attracted potential ERU buyers (foreign private or public carbon funds, industrial companies, project development companies) that are often in the position to contribute significantly to the project development with technological know-how, advance payments, equity financing, leasing of equipment etc. Thus, the JI scheme supports heavily solving of practical questions related to realization of the LFG projects.

Summary: The above analysis shows that Alternative 2 and Alternative 3 do not represent the baseline scenario. Since a PPA has yet to be secured, Alternative 2/3 has been chosen as the Project activity. An opportunity of CHP unit installation (Alternative 3) will depend on the experience and monitoring data of the first months of operation and negotiations with the potential power and heat consumers; so the decision will be taken after a trial period of methane capture system operation and a feasibility analysis.

The major source of greenhouse gas emissions in the baseline scenario are methane emissions from decomposition of waste at the landfill site which would evidently exceed the project emissions from electricity consumption; this is proved by calculation of emission reduction.

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

The flow diagrams of the Project activity and system boundaries are presented on the figures below. Two options of the Project implementation are considered:

1. LFG flaring option
2. LFG-to-energy option

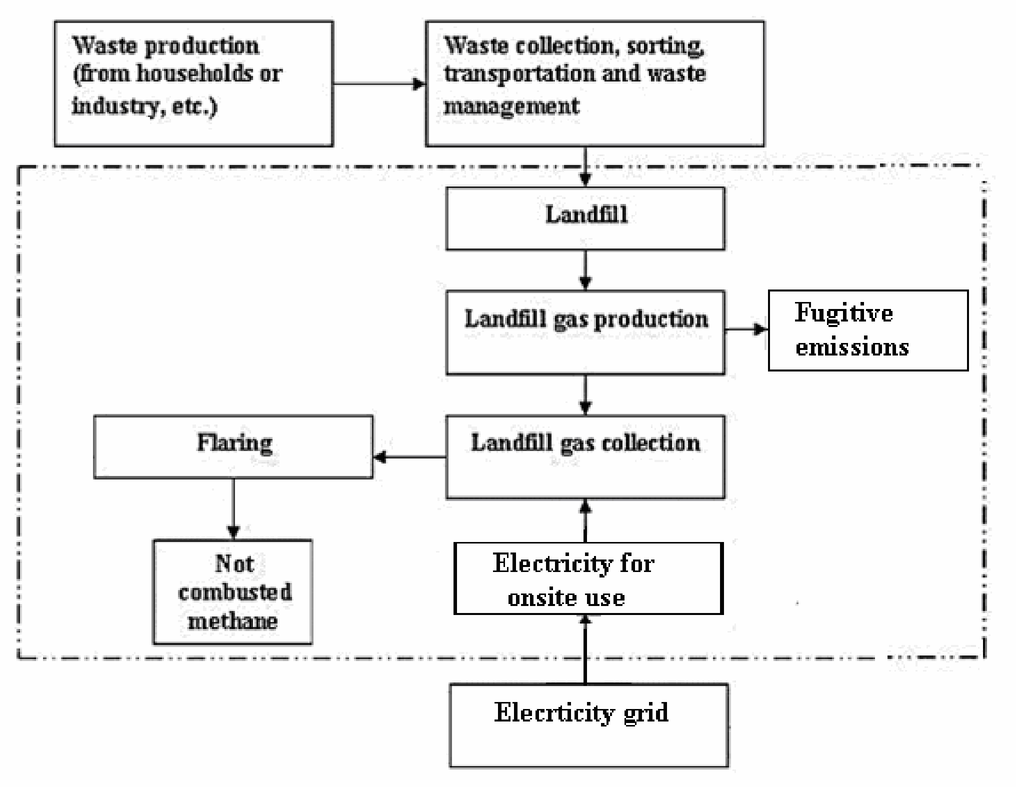


Figure 2. Project boundary for the LFG flaring option

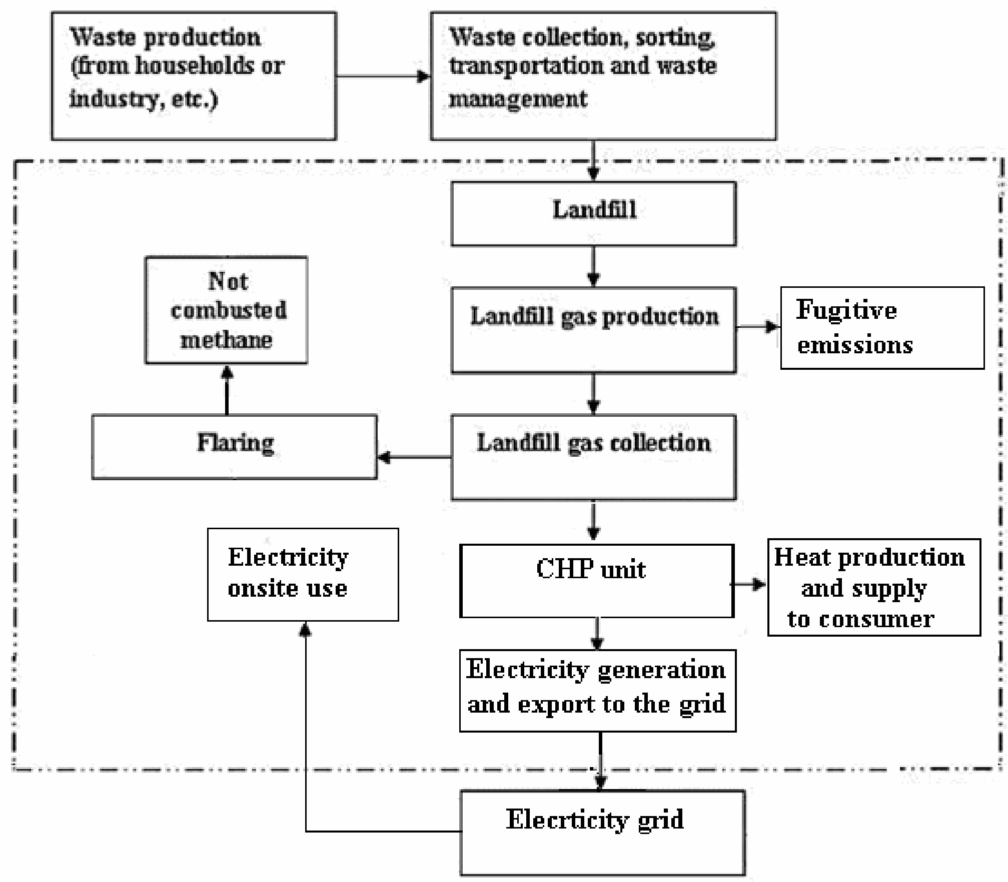


Figure 3. Project boundary for the LFG-to-energy option

Summary of system and project boundaries

	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	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of the organic waste are not accounted.
	Emissions from electricity consumption	CO_2	Yes	Electricity is consumed from the grid in the baseline scenario
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from thermal energy generation	CO_2	Yes	Thermal energy is included in the project activity.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	No	No onsite fossil fuels combustion
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Yes	May be important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small*.

* Assumptions are specified by approved consolidated baseline methodology ACM0001, version 11, May 2009: "*Consolidated baseline and monitoring methodology for landfill gas project activities*"

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 of baseline setting: 28/08/2009
Person/entity determining the monitoring methodology:

Scientific Engineering Centre "Biomass"
Contact person: Yuri Matveev
P.O. Box 66, Kiev-67, 03067, UKRAINE
Tel: (+380 44) 453 2856; 456 9462
Fax: (+380 44) 453 2856; 456 9462
E-mail: mtv@biomass.kiev.ua
http://www.biomass.kiev.ua

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

01/01/2010

C.2. Expected operational lifetime of the project:

15 years/180 months (start operation in January 2010, finish in December 2024 with possible prolongation until 2039, as CHP service life period is meant for 30 years)

C.3. Length of the crediting period:

During the first commitment period:
3 years/36 months (January 2010-December 2012)

Beyond the first commitment period:
Within the second commitment period to be established under Kyoto Protocol, and further but not exceeding the project operational lifetime.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The approved monitoring methodology applied to this project activity is the **ACM0001 "Consolidated baseline and monitoring methodology for landfill gas project activities"** (Ver 11)**.** The methodology also refers to **"Tool to determine project emissions from flaring gases containing methane"** (Ver 01) [6].

The monitoring methodology is based on direct measurement of the amount of methane captured and destroyed in the flare and, optionally, the CHP units. The main variables that need to be determined are the quantity of methane actually captured, quantity of methane flared, quantity of methane used for energy generation, electricity produced and delivered to the grid, heat produced and provided to consumers.

The actual tonnage of methane emissions reduced by the project is calculated based on flow rate of the landfill gas, methane concentration, and destruction/conversion efficiency of the combustion equipment.

The monitoring plan provides for the continuous measurement of both quantity and quality of LFG captured and fed to the combustion equipment using a continuous flow meter and on-line LFG analyzer. Temperature and pressure of the landfill gas will also be measured.

The enclosed flare will be used for the LFG combustion and its efficiency is determined according to the ***"Tool to determine project emissions from flaring gases containing methane*"** (Version 01). This tool provides for a continuous monitoring of the residual and exhaust gas to determine flare efficiency. Should this not be possible, the tool's 90% default value will be used provided that compliance with manufacturer's specification of flare (temperature of the flare exhaust gas and others if applicable) proven through continuous monitoring of the specifications.

Electricity for operation of the methane collection system will be exported from the grid. Continuous metering of the imported electricity quantity will be provided.

For the purpose of monitoring of emission reductions from displacement of grid electricity, the quantity of electricity generated from landfill gas and exported out of the project boundary will be continuously measured. Baseline emission factors for Ukrainian electricity grid will be fixed for crediting period (please refer to the baseline study ***"Standardized emission factors for the Ukrainian electricity grid"*** [7]). The quantity of thermal energy produced will be continuously measured by heat meter with the object of emission reductions estimation avoided from fossil fuel combustion for analogous quantity of heat production.

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[6] Reference: http://cdm.unfccc.int/goto/MPappmeth.
[7] Reference http://ji.unfccc.int/JIITLProject/DB/YHHOHQSI5XVHYM0337REG7SH8JE1B9/details

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

The section was left blank on purpose. Option 2 was selected.

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

The section was left blank on purpose. Option 2 was selected.

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

The section was left blank on purpose. Option 2 was selected.

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

The section was left blank on purpose. Option 2 was selected.

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

The section was left blank on purpose. Option 2 was selected.

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	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
1.	$LFG_{total,y}$	Total amount of landfill gas captured	On-line LFG flow meter	m^3	m	Continuously	100%	electronic	Measured by a flow meter. Values to be averaged hourly. Data to be aggregated monthly and yearly.
2.	$LFG_{flared,y}$	Amount of landfill gas flared	On-line LFG flow meter	m^3	m	Continuously	100%	electronic	Measured by a flow meter. Values to be averaged hourly. Data to be aggregated monthly and yearly.
3.	$LFG_{electricity,y}$ (optional)	Amount of landfill gas combusted in CHP plant	On-line LFG flow meter	m^3	m	Continuously	100%	electronic	Measured by a flow meter. Values to be averaged hourly. Data to be aggregated monthly and yearly.
4.	$LFG_{thermal,y}$ (optional)								
5.	$LFG_{pl,y}$	Amount of landfill gas sent to Pipe Line at Normal Temperature and Pressure	N/A	N/A	N/A	N/A	N/A	N/A	LFG is not sent to Pipe Line in this project

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**	**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.	$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year y	Various	tCO_2e	m/c	see comments	n/a	electronic	The parameters to determine project emissions from flaring will be monitored as per "Tool to determine project emissions from flaring gases containing Methane" Alternatively, a default of 90% will be used and the manufacturer's flare specifications (specific to the final flare design) will be continuously monitored.
7.	$W_{CH4,y}$	Methane fraction in LFG	On-line gas analyser	m^3 CH_4 /m^3 LFG	m	Continuously	100%	electronic	Measured by continuous gas quality analyser.
8.	T	Temperature of the landfill gas	Temperature probe	^oC	m	Continuously	100%	electronic	Temperature of the landfill gas will be measured to determine the density of methane in the landfill gas
9.	P	Pressure of the landfill gas	Pressure gauge	Pa	m	Continuously	100%	electronic	Pressure of the landfill gas will be measured to determine the density of methane in the landfill gas

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**	**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**
10.	$EL_{,LFG}$	Net amount of electricity generated using LFG	Electricity meter	MWh	m	Continuously	100%	electronic	*Applicable for LFG-to-energy option only.* Required to estimate the emission reductions from electricity generation from LFG. Double checked with receipts of sales.
11.	ET_{LFG}	Total amount of thermal energy generated using LFG	Heat meter	TJ	m	Continuously	100%	electronic	*Applicable for LFG-to-energy option only.* Required to estimate the emission reductions from heat generation from LFG.
12.	$CEF_{el.}$ (optional)	Carbon emission intensity of electricity	Baseline study[8]	t_{CO2}/ MWh	c	Once	100%	electronic	*Applicable for LFG-to-electricity option only.* The default data for CEF is fixed before the Project start.
13.	$EF_{fuel,BL}$	CO_2 emission factor for fossil fuel	IPCC Guidelines[9]	tCO_2/ mass or volume	c	Once	N/A	electronic	Monitored for CO_2 emission intensity of the displaced fossil fuel calculation
14.	$NCV_{fuel,BL}$	Net calorific value of fossil fuel	IPCC Guidelines	GJ/mass or volume	c	Once	N/A	electronic	Monitored for CO_2 emission intensity of the displaced fossil fuel calculation

[8] *"Standardized emission factors for the Ukrainian electricity grid"*, version 5, 02 February 2007

[9] *Reference: http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html*

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**	**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**
15.	$\varepsilon_{gen,BL}$	Efficiency of the baseline captive power plant	N/A	N/A	N/A	N/A	N/A	N/A	No captive power plant in this project
16.	$\varepsilon_{boiler/airheater}$	Efficiency of the baseline boiler/air heater for producing thermal energy	"Consoli-dated baseline and monitoring methodology for landfill gas project activities"	%	e	Once	N/A	electronic	Is considered to be 100%/. Monitored for CO_2 emission intensity of the displaced fossil fuel calculation
17.		Operation of the energy plant	Timer	hours	m	yearly	100%	electronic	
18.		Operation of the boiler/air heater/heat generating equipment	N/A	N/A	N/A	N/A	N/A	N/A	No thermal boiler in this project
19.	PE_{ECy}	Project emissions from electricity consumption by the project activity during the year y	Various	tCO_2e	m/c	see comments	N/A	electronic	The parameters to determine project emissions from electricity consumption will be monitored as per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Ver.01) [10]

[10] Reference: http://cdm.unfccc.int/goto/MPappmeth.

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**	**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**
20.	$PE_{FC,j,y}$	Project emissions from fossil fuel combustion in process *j* during the year *y*	N/A	N/A	N/A	N/A	N/A	N/A	No fossil fuel is used in this project
21.	MG_{Pry}	Amount of methane generated during year y of the project activity	Various	tCH_4	m/c	annually	N/A	N/A	Estimated using the actual amount of waste disposed in the landfill as per latest version (ver.04) of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"[11]

[11] Reference:http://cdm.unfccc.int/goto/MPappmeth.

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):

The methodology ACM0001 “Consolidated baseline and monitoring methodology for landfill gas project activities” uses following formula for estimation of the GhG emissions reduction from the Project activity:

$$ER_y = BE_y - PE_y = [(MD_{project, y} - MD_{BL,y})*GWP_{CH4} + EL_{LFG,y}*CEF_{elec,BL, y} + ET_{LFG,y} * CEF_{ther,BL, y}] - [PE_{EC,y} + PE_{FC,j,y}] \quad (1)$$

Step 1

ER_y	GHG emissions reduction (in year y), in tonnes of CO_2 equivalents (tCO_2) as a result of project implementation
BE_y	Baseline emissions in year *y* (tCO_2e)
PE_y	Project emissions in year *y* (tCO_2e)
$MD_{project, y}$	The amount of methane that will be destroyed/combusted during the year, in, tonnes of methane (tCH_4) in project scenario
$MD_{BL, y}$	The amount of methane that would have been destroyed/combusted during the year in 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/CH_4
$EL_{LFG,y}$	Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants during year y, in megawatt hours (MWh)
$CEF_{electricity, y}$	The CO_2 emissions intensity of the electricity displaced, tCO_2e/MWh. Baseline emission factor for Ukrainian electricity grid will be taken from the baseline study *“Standardized emission factors for the Ukrainian electricity grid”*, version 5, 02 February 2007[12])
$ET_{LFG,y}$	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/air heater, during the year y, in TJ

[12] Reference http://ji.unfccc.int/JIITLProject/DB/YHHOHQSI5XVHYM0337REG7SH8JE1B9/details

$CEF_{thermal, y}$	CO_2 emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation , in tCO_{2e}/TJ (*IPCC Guideline*[13]))
$PE_{EC,y}$	Emissions from consumption electricity in the project case. Will be calculated following the latest version of "Tool to calculate baseline, project, and/or leakage emissions from electricity consumption" (Ver. 01)
$PE_{FC,j,y}$	Emissions from consumption of heat in the project case. Calculated following the latest version of "Tool to calculate project or leakage CO_2 emissions from Fossil fuel consumption" (Ver. 02) [14]

Step 2

The amount of methane that would have been destroyed/consumed in the absence of the Project Activity is as:

$$MD_{BL,y} = MD_{project,y} * AF \quad (2)$$

The Adjustment factor ("AF") is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirements to that of the collection and destruction system in the Project Activity. For this project, regulatory and contractual requirements are not considered and the baseline scenario chosen above is that all landfill gas would be released into the atmosphere. Therefore, the AF applied to the Project Activity is 0% and MD_{reg} is = 0.

Step 3

In general case the formula used to determine $MD_{project, y}$ is as follows:

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

In Project activity following formulas can be applied:

Flaring option: In Project activity methane is destroyed through flaring only

$$MD_{project,y} = MD_{flared,y} \quad (3a)$$

LFG-to-energy option: The amount of methane that would have been destroyed / combusted during the year will be the addition of the following terms:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} \quad (3b)$$

[13] Reference http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2

[14] Reference: http://cdm.unfccc.int/goto/MPappmeth.

Components of the equations above are expressed separately in Step 4 and Step 7

Step 4

$MD_{flared,y}$ is the quantity of methane destroyed by flaring by the Project Activity. It is calculated as follows:

$$MD_{flared,y} = (LFG_{flared,y} * W_{CH4y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (4)$$

$LFG_{flare,y}$	The quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3)
W_{CH4}	The average methane fraction of the landfill gas as measured* during the year and expressed as a fraction (in m^3 CH_4 / m^3 LFG)
D_{CH4}	The methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)**
$PE_{flare,y}$	The project emissions from flaring of the residual gas stream in the year y (tCO_2)

(*) Methane fraction of the landfill gas to be measured on wet basis
(**) At standard temperature and pressure (101.325 kPa and 273.15 K) the density of methane is 0.0007168 tCH_4/m^3CH_4)

Formula for calculation of methane density D_{CH4} in every specific hour is:

$$D_{CH4} = \frac{P_{CH4}}{\frac{R_U}{MM_{CH4}} \times T_{CH4}}$$, where

D_{CH4}	The methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)
P_{CH4}	Measured pressure of methane in the hour *h* (Pa)
R_U	Universal ideal gas constant (8 314 Pa.m3/kmol.K)
MM_{CH4}	Molecular mass of methane (kg/kmol)
T_{CH4}	Measured temperature of methane in the hour *h* (K)

Step 5

The Project Emissions (PE) will be determined following the procedure described in the "*Tool to determine project emissions from flaring gases containing Methane" (Ver. 1)* and "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(Ver. 01)*. The tool offers two options for enclosed flares. Where possible, option 2 will be used: continuous monitoring of the methane destruction efficiency of the flare as per the tool methodology. When this is not possible, option 1 will be used: 90% default efficiency factor with continuous monitoring of manufacturer's specifications (temperature and flow rate of residual gas at the inlet of the flare). If in any specific hour, any parameter is out of the limit of manufacturer's specifications, an efficiency of 50% will be used.

This tool involves the following seven steps:
STEP 1: Determination of the mass flow rate of the residual gas that is flared
STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis
STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis
STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis
STEP 6: Determination of the hourly flare efficiency
STEP 7: Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

These steps will be applied to calculate project emissions from flaring ($PE_{flare,y}$) based on the measured hourly flare efficiency or based on the default values for the flare efficiency ($PE_{flare,h}$). Steps 3 and 4 will be applied only in case of enclosed flares and continuous monitoring of the flare efficiency.

The calculation procedure in this tool determines the flow rate of methane before and after the destruction in the flare, taking into account the amount of air supplied to the combustion reaction and the exhaust gas composition (oxygen and methane). The flare efficiency is calculated for each hour of a year based either on measurements or default values plus operational parameters. Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year.

Step 6

LFG-to-energy option: $MD_{electricity}$ represents the quantity of methane destroyed for the generation of electricity in the Project Activity and is expressed by the following equation:

$$MD_{electricity,\ y} = LFG_{electricity,\ y} * W_{CH4y} * D_{CH4} \quad (7)$$

$LFG_{electricity\ y}$	Quantity of landfill gas used to generate electricity during a year measured in cubic meters (m^3)

W_{CH4y}	Average methane fraction of the LFG as measured during the year and expressed as a fraction (m^3 CH_4/m^3 LFG)
D_{CH4}	Density of methane expressed in tonnes of methane (tCH_4/m^3 LFG)

$MD_{thermal}$ represents the quantity of methane destroyed for the generation of thermal energy in the Project Activity and is expressed by the following equation:

$$MD_{thermal,\ y} = LFG_{thermal,\ y} * W_{CH4y} * D_{CH4} \quad (8)$$

$LFG_{thermal\ y}$	Quantity of landfill gas fed into the boiler/air heater/heat generation equipment during a year measured in cubic meters (m^3)
W_{CH4y}	Average methane fraction of the LFG as measured during the year and expressed as a fraction (m^3 CH_4/m^3 LFG)
D_{CH4}	Density of methane expressed in tonnes of methane (tCH_4/m^3 LFG)

Step 7

Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants ($EL_{LFG,y}$) will be measured by electricity meter.

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/air heater ($ET_{LFG,y}$) will be measured by thermal energy meter.

Step 8

For calculation of the electricity consumption for own needs of LFG plant the electricity meter will be applied.
Consumption of heat is out of the project case.

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

No leakage effects have to be accounted for under this methodology

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

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

No leakage effects have to be accounted for under the applied methodology.

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

No leakage effects have to be accounted for under this methodology.

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):

Please see Section D 1.2.2 for details.

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:

According to legal requirements, for the sources of pollution there need to be established limits of emissions.
Referring to EIA concentration of these contaminants does not exceed maximum permissible concentration on the sanitary zone boundary.,
In the frame of the project activity NOx and CO release will be monitored, archived and provided to competent ecological authority on demand.
More detailed information about requirements, forms and accounting will be obtained after completing of EIA ecological expertise.

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.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Table D.1.2.1 #1. $LFG_{total,y}$	Low	Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #2. $LFG_{flared,y}$	Low	Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #3,4. $LFG_{electricity,y}$	Low	Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #6. $PE_{flare,y}$	Low	All equipment used to collect data will be subject to regular maintenance and calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #6(a) T_{flare}	Low	Thermocouples should be replaced or calibrated every year.
Table D.1.2.1 #6 W_{CH4ex}., W_{O2ex}, W_{CO2r}, W_{O2r}	Low	The gas analysers will be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #7. $W_{CH4,y}$	Low	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #8. T	Low	The temperature probe should be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #9. P	Low	The pressure gauge should be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #, 10, 11,19a EL_{lfg}, ET_{lfg}, EC_{pj}	Low	Electricity and heat meters will be periodically calibrated according to the manufacturer's recommendation.
Table D.1.2.1 #12, 13,14 CEF_{el}, $EF_{fuel,BL}$, $NCV_{fuel,BL}$	Low	Default data for emission factors will be used from UNFCCC Guidelines.

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

All continuously measured parameters (LFG flow, CH_4, CO_2, O_2 concentrations, flare temperature, and flare operating hours), will be recorded electronically via a data logger, which will have the capability to aggregate and print the collected data at the frequencies as specified above.

Before commencement of the O&M phase, a training and quality control program will be enacted to ensure that good management practices are ensured and implemented by all project operating personnel. Minimum 3 people (1 site engineer, 1 from project developer staff and 1 from project owner staff) will be trained: in terms of general knowledge about the equipment used in the landfill, record-keeping, equipment calibration, overall maintenance, procedures for corrective action, emergency situation (for instance too high oxygen level or electricity breakdown). An operations manual will be developed for the operating personnel.

Operational procedures and responsibilities for monitoring and quality assurance of emission reductions from the Project activity are presented in the table below (E –executing data collection, R – responsible for overseeing and assuring quality, I- to be informed).

Task	Site Engineer	Equipment Supplier	Project Developer	Manager from ERUs purchaser side
Collect Data	E			
Enter data into Spreadsheet	E		R	
Make monthly and annual reports	E		R	I
Archive data & reports	E		R	I
Calibration/Maintenance, rectify faults	R	E	I	I

For details please also refer to the Annex 3.

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

Date of conclusion: September 2009
Person/entity determining the monitoring methodology:

Scientific Engineering Centre "Biomass"
Contact person: Yuri Matveev
P.O. Box 66, Kiev-67, 03067, UKRAINE
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SECTION E. Estimation of greenhouse gas emission reductions

The estimate of ex-ante emissions reduction is given in this section for reference purpose only, since direct monitoring of methane destroyed in the Project scenario will be applied according to the ACM0001 methodology version 11.

E.1.Estimated project emissions:

Project emissions are calculated from the following equation:

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

Where :

$PE_{EC,y}$ - Emissions from consumption of electricity in the project case. The project emissions from electricity consumption will be calculated following the latest version of "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Ver. 01)

$PE_{FC,y}$ - Emissions from consumption of heat in the project case. Equal to 0, as heat consumption is not supposed in project scenario

$PE_{EC,y} = \Sigma EC_{PJ,j,y} \times EF_{EL,j,y} \times (1+ TDL_{j,y})$

Where :

$PE_{EC,y}$ - Project emissions from electricity consumption in year *y* (tCO_2/yr)

$EC_{PJ,j,y}$ – Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/year)

$EF_{EL,j,y}$ – Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh)

$TDL_{j,y}$ – Average technological transmission and distribution losses for providing electricity to source *j* in year *y*

j - Sources of electricity consumption in the project

Project GHG emissions are the emissions from grid electricity import and have been calculated using conservative assumptions as accounts highest possible electricity consumption .

Results of calculation of the Project emission are given in the table of Section E.6.

E.2.Estimated leakage:

No leakage needs to be accounted for by this methodology.

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

The sum of E.1 and E.2 is equal to: $PE_{EC,y}$

For the results of the calculation of the project emission please refer to the table in Section E.6.

E.4.Estimated baseline emissions:

For calculation of baseline emissions two options are considered:

1. **LFG flaring option**

If the LFG is flared in the project scenario, then the GHG emissions in the scenario-without-project will come from open-air decay of the waste at Primorsky and Ordzhonikidze landfills.

2. **LFG utilisation option.**

If the LFG is used in LFGTE unit for production of electricity and heat in the project scenario, GHG emissions in the scenario-without-project will be sum of the following emissions:

1. Methane release into the atmosphere from the open-air waste decay;
2. CO2 emissions from generation of grid electricity and thermal energy in form of hot water to be replaced with the energy produced from CO2 neutral fuel – landfill gas.

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

Where:

BE_y - Baseline emissions in year *y* (tCO_2e)

$MD_{project,\ y}$ - The amount of methane that will be destroyed/combusted during the year, in, tonnes of methane (tCH_4) in project scenario

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

GWP_{CH4} - Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/CH_4

$EL_{LFG,y}$ - Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants during year y, in megawatt hours (MWh)

$CEF_{electr,\ y}$ - CO_2 emissions intensity of the electricity displaced, tCO_2e/MWh.

$ET_{LFG,y}$ - The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/ofsite fossil fuel fired boiler/air heater, during the year y, in TJ

$CEF_{thermal,\ y}$ - CO_2 emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_{2e}/TJ

The amount of methane that will be destroyed/combusted during the year, in, tonnes of methane (tCH_4) in project scenario is determined as following:

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

Where:

$\mathbf{BE_{CH4,SWDS,y}}$ - Methane generation from the landfill in the absence of the project activity at the year *y* (tCO_2e)

CE - LFG collection efficiency*, is estimated at the level of 60% for Prymorsky and 50% for

Ordzhonikidze landfill

Note*: It is assumed that the gas collection system installed in Prymorsky and Ordzhonikidze landfills in the project activity will capture approximately 60% and 50% respectively of the total amount of gas released by the landfills in the baseline scenario.

1. Estimation of baseline methane emissions into the atmosphere

The amount of methane release in the baseline scenario is estimated using Methodological tool “Tool to determine methane emissions avoided from disposal waste at a solid waste disposal site” (Ver.04).

Under this methodology the amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model. The model differentiates between the different types of waste *j* with respectively different decay rates k_j and different fractions of degradable organic carbon (DOC_j).

The model calculates the methane generation based on the actual (or estimated) waste streams $W_{j,x}$ disposed in each year *x*, starting with the first year after the start of the project activity (the year 2010) until the end of the year *y* (the year 2012), for which baseline emissions are calculated years *x* with x = 1 to x = y).

Since in our case, no SWDS methane is captured and flared, combusted or used in another manner in the baseline scenario, the baseline emissions are not adjusted for the fraction of methane captured at the SWDS.

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

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

Where:

$BE_{CH4,SWDS,y}$ = Methane emissions avoided during the year *y* from waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year (tCO_2e)
φ = Model correction factor to account for model uncertainties (0.9)
f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner (0 for both Prymorsky and for Ordzhonikidze landfill)
GWP_{CH4} = Global Warming Potential (GWP) of methane, valid for the relevant commitment Period (21)
OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) (0 in our case)
F = Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOCf = Fraction of degradable organic carbon (DOC) that can decompose (0.5)
MCF = Methane correction factor (0.8 in our case)
$W_{j,x}$ = Amount of organic waste type *j* from disposal in the SWDS in the year *x* (tonnes)
DOC_j = Fraction of degradable organic carbon (by weight) in the waste type *j*
k_j = Decay rate for the waste type *j*
j = Waste type category (index)
x = Year during the period: x runs from the first year of the period (x = 1) to the year y for which avoided emissions are calculated (x = y)
y = Year for which methane emissions are calculated

Model correction factor to account for model uncertainties *(φ)*
Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results, therefore φ=0.9.

Fraction of methane captured at the SWDS and flared, combusted or used in another manner *(f)*
No methane capture is currently applied at the site, therefore f=0.

Oxidation factor *(OX)*
Oxidation factor reflects the amount of methane from SWDS that is oxidized in the soil or other material covering the waste. IPCC [2006 Guidelines for National Greenhouse Gas Inventories] recommends the following values MCF(x) for the different types of dumps:

Data / parameter:	**OX**
Data unit:	-
Source of data:	Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Value to be applied:	Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal sites.

Since no oxidizing material is applied at Primorsky and Ordzhonikidze landfills, value 0 was used in our case.

Fraction of methane in the SWDS gas *(F)*
This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Fraction of degradable organic carbon (DOC) that can decompose *(DOCf)*
IPCC 2006 Guidelines for National Greenhouse Gas Inventories recommends 0.5 value to be applied.

Methane correction factor *(MCF)*
The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

Data / parameter:	**MCF**
Data unit:	-
Description:	Methane correction factor
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	Use the following values for MCF: • 1.0 for **anaerobic managed solid waste disposal sites**. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a

	degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste. • 0.5 for **semi-aerobic managed solid waste disposal sites**. These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system. • 0.8 for **unmanaged solid waste disposal sites – deep and/or with high water table**. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste. • 0.4 for **unmanaged-shallow solid waste disposal sites.** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters.

For Primorsky and Ordzhonikidze landfills the MCF value of 0.8 was used.

Fraction of degradable organic carbon (by weight) in the waste type *j* (DOC_j)

The values for fraction of degradable organic carbon (by weight) for different types of waste *j* recommended by IPCC are given in the table below.

Data / parameter:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value to be applied	Apply the following values for the different waste types *j*:

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

Glass, plastic, metal, other inert waste	0	0

If a waste type, prevented from disposal by the proposed CDM project activity, can not clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology.

Data used for the calculations are based on the recommended data on waste content for Ukraine and Russia[15].

Recommended date on waste composition for Ukraine and Russia

Waste category	Weight portion, %	Waste type (j)
Food waste	36,1	III
Paper, cardboard	14,3	II
Garden waste (green waste)	9,8	V
Wood waste	1,9	I
Rubber, leather, bones	2,2	IV
Textiles	3,4	IV
Other organics	0,4	IV
Metals	2,3	VI
Construction and demolition	3,6	VI
Glass and ceramics	6,2	VI
Plastics	5,8	VI
Other inorganic waste	14,0	VI
Total	100,0	

Decay rate for the waste type j (*k_j*)

The values for decay rate for different types of waste *j* recommended by IPCC are given in the table below.

Data / parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type *j*
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value to be applied	Apply the following default values for the different waste types *j*:

Waste type *j*		**Boreal and Temperate (MAT≤20°C)**		**Tropical (MAT>20°C)**	
		Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry (MAP< 1000mm)	Wet (MAP> 1000mm)
	Pulp, paper,				

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[15] Sister V.G., Mirniy A.N., Skvortsov L.S. etc. (2001). Solid Municipal Waste Hand-book. Academy of municipal service named after K.D. Panfilov, Moscow (in Russian).

	Slowly degrading	cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
		Wood, wood products and straw	0.02	0.03	0.025	0.035
	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
	Rapidly degrading	Food, food waste, beverages and tobacco (other than sludge)	0.06	0.185	0.085	0.40

NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapo-transpiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapo-transpiration.

If a waste type, prevented from disposal by the proposed CDM project activity, cannot clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of *DOCj* and *kj* result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology.

For the calculations for Primorsky and Ordzhonikidze landfills following values for $\mathbf{k_j}$ were used:

Waste type *j*			**Temperate (MAT≤20°C)**
			Wet (MAP/PET >1)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	II, IV	0.06
	Wood, wood products and straw	III	0.03
Moderately degrading	Other (non-food) organic putrescible garden and park waste	V	0.10
Rapidly degrading	Food, food waste, beverages and tobacco (other than sludge)	I	0.185

Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tonnes) (*Wj,x)*

The statistical data on the waste delivery to Primorsky and Ordzhonikidze landfills through the whole period of landfills operation (back to 1967 and 1976 respectively) is not available at municipalities. The only reported data for the period of 2003-2008 are based on the amount of waste trucks and have big spread and therefore low reliability.

Recently established scale measurements show that during three months (June-August 2009) at Ordzhonikidze landfill were delivered 44.04 tones of waste. That time Primorsky landfill was already closed.

Therefore the approximation approach for the calculation of the annual amount of waste delivered to landfill throughout the period of landfill operation based on the average recent data on waste delivery and the value for total waste accumulated at the sites was applied. It is based on several assumptions:

- The total amount of waste is 2.56 million tonnes for Primorsky landfill and 2.54 million tonnes for Ordzhonikidze landfill by the end of 2008;
- Amount of waste grows constantly during all landfill life period (the calculated yearly growth factor is 2%).
- About 180 thousand tones of waste were delivered to Ordzhonikidze landfill in 2009.

The tables providing the calculated values of yearly waste delivery to the landfills are given in Annex 2.

Summary of correction factors applied

Values of correction factors and other parameters used for calculation are summarized in the table below:

Factor	Value	Source of data
φ	0.9	"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" (Ver. 04)
f	0	Site situation
$GWPCH_4$	21	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
OX	0	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Site situation
F	0.5	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
DOCf	0.5	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
MCF(x)	0.8	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Site situation

2. Estimation of CO2 emissions from generation of grid electricity to be replaced with the landfill gas power

Baseline emission from production of the electricity in the centralized power grid to be replaced by the LFG electricity is calculated based on the following equation:

$$BE_{y,el} = EL_{LFG,y} * CEF_{electricity,y}$$

Where:

EL_y Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants during year y, in megawatt hours (MWh)

$CEF_{electricity,y}$ The CO2 emissions intensity of the electricity displaced, tCO2e/MWh.

Baseline carbon emission factors for JI projects generating electricity in Ukraine are taken from the baseline study ***"Standardized emission factors for the Ukrainian electricity grid"*** (Version 5, 02 February 2007) developed by Global Carbon B.V[16]).

[16] Reference http://ji.unfccc.int/JIITLProject/DB/YHHOHQSI5XVHYM0337REG7SH8JE1B9/details

For the years 2008-2012: $CEF_{electricity,y}$= ***0.807 tCO2e/MWh***

3. **Estimation of CO2 emissions from thermal energy production to be replaced with the landfill gas utilization**

$$BE_{y,\,therm} = ET_{LFG,y} * CEF_{therm,BL\,y}$$

Where:

ET_y Net 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/air heater during year y, in TJ

$CEF_{therm,BL\,y}$ CO2 emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ.

$$CEF_{therm,BL\,y} = \frac{EF_{fuel,BL}}{NCV_{fuel,BL} \times \varepsilon_{boiler/airheater}}$$

For natural gas $CEF_{therm,BL\,y}$ = ***56.1*** tCO_2e/TJ (IPCC Guidelines[17])

Estimation of LFG generation and the related GhG emissions in the baseline scenario, as well as baseline grid electricity emissions and baseline heat emissions is given in the table of Section E.6.

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

The baseline emissions, project emissions and emission reductions are summarized in the section E.6.

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

The estimated results are expressed in the following table. The actual emission reductions generated by this project will be measured directly after the project is operational. The calculations are bundled for Primorsky and Ordzhonikidze landfills.

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2010	118	0	28 500	28 382
2011	236	0	68 398	68 162
2012	236	0	79 894	79 659
Total over the 1-st crediting period (tonnes of CO2 equivalent)	590	0	176 792	176 203

[17] Reference http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2

2013	236	0	81 355	81 120
2014	236	0	72 842	72 608
2015	236	0	65 403	65 167
2016	236	0	58 918	58 682
2017	236	0	53 246	53 010
2018	236	0	48 269	48 033
2019	236	0	43 886	43 651
2020	236	0	40 014	39 778
2021	236	0	36 581	36 345
2022	236	0	33 526	33 290
2023	236	0	30 799	30 563
2024	236	0	28 357	28 121
Total (tonnes of CO2 equivalent)	3422	0	769 988	766 573

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:

In the baseline situation, landfill gas is generated as a result of decomposition of municipal waste under anaerobic conditions. Landfill gas is mainly composed of carbon dioxide and methane. Carbon dioxide and methane are greenhouse gases, which contribute to global warming. LFG in general causes harmful effects to the local environment and effect the economic value of the area where the landfill is implemented. In the baseline situation, landfill gas is associated with the following negative impacts:

- Undesirable odour, nuisance especially for human settlements surrounding the landfill area;
- Methane migration destroying vegetation next to the landfill or on the rehabilitated landfill compartments;
- Safety and health risks to landfills staff due to generation of methane concentration above safe limits as well as explosions and fires at the landfill site;
- Potential for landfill fires and the associated release of incomplete combustion products; and
- Slowing down of the mineralisation process of the waste body leading to more leachate generation and leachate seeping.

A very small percentage of volatile organic compounds (VOCs) are also found in the landfill gas, contributing to the undesirable odour. VOCs emissions are photochemically reactive, and result in the formation of tropospheric ozone. The latter might cause adverse effects to the respiratory system such as breathing difficulties and aggravated asthma, and damages to crops and plants. VOCs are also known for their toxicity and carcinogenic effect from chronic exposure.

In the project activity, the main activity is combusting the landfill gas to convert methane to carbon dioxide. Flaring of the collected biogas will destroy methane and thus lead to a decrease in the amount of greenhouse gases released to the atmosphere. By capture and combustion of LFG, release of VOCs into the atmosphere is significantly reduced. Overall, the project activity leads to positive environmental impacts which contribute to the sustainable development of the area with no significant negative impacts expected.

Transboundary impact is not considered within the project because the project activity is located in the territory of Ukraine, wastes are received from Ukrainian consumers, adverse effects on any territory especially of other states are not expected and produced electricity will be supplied to Ukrainian grid.

The potential environmental effects from implementation of the Project according to the EIA requirements are presented herein:

Human

High concentration of gases in the landfills brings about a risk of explosion. Controlled capture and combustion of LFG will reduce the risks of explosions or poisoning with high-toxic combustion products of inhabitants of surroundings and on site workers.

While the LFG collection and utilization system will minimize explosion risks from methane emissions on the whole landfill site, there are obviously some risks associated with the operation of the flare, similar to any other industrial risks involving a source of fire. Safety devices on the flaring unit will mitigate this risk.

Flora and fauna

Remediation of the landfill site (reshaping and capping) will reduce presence of birds searching for prey and food, abating the pests and disease vectors. The Project will also abate methane migration destroying vegetation next to the landfill.

Air

The LFG collection and flaring system might lead to some minor CO, NOx and VOCs emissions. However, due to the high-efficiency combustion and high-temperature an almost total destruction of the gases is ensured. In that way, emissions of CO, NOx and VOCs and other compounds present in the biogas such as ammonia will be minimal, and much lower to that which would have occurred in the absence of the project activity.

The installed equipment does not produce any significant noise, since it will be placed in noise insulated container or small buildings that will form a sound-absorbing casing.

The landscape

The reshaped body and capped top of the landfill will contribute to better fitting of the landfill into the surrounding landscape. Visual impact from the flare, and noise and vibration will be limited to the localized site.

Conclusions

The landfill collection and flaring system has a significant positive impact on the environment. The system reduces emissions of greenhouse gases, odours 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.

Environmental impact assessment had been completed by Professional Design Company and is under consideration of the ecological inspection authority. Environmental impact assessment can be available at request.

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:

Local EIA procedure

In the Ukraine, both an Environmental Impact Assessment (EIA) and a State Environmental Expertise (EE) are used for estimation of environmental impact of the project activity.

An EIA estimates impact the levels a project may have on the environment, development of actions on prevention or reduction of these influences, and acceptability of design decisions from the environmental point of view. An EIA is a compulsory part of the design documentation of any economic activity and is carried out under strictly established requirements.

An EE is determined based on the analysis and estimation of pre-design, design documentation and other documents concerning the Project which have potential impacts on the state of the environment. Also, an EE is used to determine conformity of the planned project activity with norms and requirements of the legislation on environmental protection and for maintenance of ecological safety.

EIA legislative requirements are defined by Clause 36 of the Law of Ukraine "On Environmental Expertise". Requirements for the EIA structure is contained in the state construction norms of Ukraine DBN A.2.2-1-2003. Requirements for the documentation of the state EE are set in the "Instruction on realization of the state environmental expertise". Requirements for the conclusions of the EE are defined by the Clause 43 of the Law of Ukraine "On Environmental Expertise ".

Design documentation including the EIA is submitted for execution of environmental expertise to the Ministry of Environment and Natural Resources Protection of Ukraine (MENRPU) or its regional bodies. The State EE is undertaken by the MENRPU who then issues an official response.

According to the aforementioned documents, the EIA must contain data about local public opinion on the project activity and problems that should be solved. However, methods and procedures for collection and consideration of public opinions are not specified.

For the proposed Project, the project design documentation (including an EIA) will be submitted to the Mariupol Regional Environmental Inspection for the environmental expertise. In the EIA section of the design documentation the conclusion was made by the project developer that no significant negative environmental impacts are related to the project activity.

SECTION G. Stakeholders' comments

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

Ukrainian EIA legislation stipulates that for every EIA, a public stakeholder consultation process, during which the affected public is informed and invited for commenting must be carried out. This can either be done by publication of the project activity in a local newspaper or by holding an information session to which representatives of the public affected by the project activity are invited to comment on the Project activities.

The following activities were conducted by the Project Participants in the framework of a stakeholder consultation for the Primorsky and Ordzhonikidze Projects:

1. Several Stakeholders meeting in 2008-2009. The participants of the meeting included:

- Representatives of Mariupol City Administration
- Representatives of the Project owner
- Representatives of the Project developer
- Representatives of Mariupol City Administration

2. Publication of the information article on the Project activities in the web mass media is considered

Stakeholders were informed, according to their group, about:

- Problems caused by solid wastes;
- Joint Implementation Mechanisms, GHG and Kyoto protocol;
- Reason to capture the biogas;
- Detailed descriptions about the landfill site;
- Benefits generated by a degassing plant;
- Adopted hypothesis and biogas production model; and
- Information about Project Participants.

During the period for public commenting no negative questions were raised.

ANNEX 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	«TIS ECO» Ltd
Street/P.O.Box:	
Building:	
City:	Chabany settlement
State/Region:	Kyiv Region
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Fax:	+38(044)251-05-81, 82, 83
E-mail:	ecolog@tiseco.com.ua
URL:	www.tiseco.com.ua
Represented by:	Mrs. Nina Isaeva
Title:	Project coordinator
Salutation:	
Last name:	Isaeva
Middle name:	
First name:	Nina
Department:	
Phone (direct):	+38(044)251-05-81, 82, 83
Fax (direct):	
Mobile:	
Personal e-mail:	

Organisation:	Municipality of Mariupol
Street/P.O.Box:	70 Lenina str
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City:	Mariupol city
State/Region:	Donetsk region
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URL:	
Represented by:	German Ivanchenko
Title:	head of municipal service department
Salutation:	Mr
Last name:	Ivanchenko
Middle name:	
First name:	German
Department:	

Phone (direct):	
Fax (direct):	
Mobile:	
Personal e-mail:	

Organisation:	Scientific Engineering Centre “Biomass”
Street/P.O.Box:	P.O. Box 66,
Building:	
City:	Kyiv city
State/Region:	
Postal code:	03057
Country:	Ukraine
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Middle name:	
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Phone (direct):	
Fax (direct):	
Mobile:	
Personal e-mail:	

ANNEX 2

BASELINE INFORMATION

LANDFILL CALCULATION PARAMETERS			
Parameter	Units	**Data**	
Landfill data			
		Primorsky landfill	Ordzhonikidze landfill
Year landfill started operation		1967	1976
Waste in place at the beginning of project	Tonnes	2.56 million	2.54 million
Density of waste (non-compacted)	tonne/m^3	0.80	0.80
Area of site	Hectare	12.43	12.16
Average yearly waste rate	thousand tonnes/year	64	110
Date gas collection project starts		2010	2011
Project operational data			
Gas collection efficiency	%	60%	50%
Flare efficiency	%	90%	90%
Flare capacity (estimated)	m^3/h	800	800
LFG pump&flaring station capacity	kW	15	15
General data			
Methane content of landfill gas	50%	50%	
CH_4 GWP	t CO2/t CH4	21	
Density of Methane	t CH4/m^3	0.0007168	
Baseline data			
Proportion of CH4 flared in Baseline (AF)		0%	

DATA ON WASTE DELIVERY FOR PRIMORSKY AND ORDZHONIKIDZE LANDFILLS

The statistical data on the waste delivery to Primorsky and Ordzhonikidze landfills through the whole period of landfills operation (back to 1967 and 1976 respectively) is not available at municipalities. The only reported data for the period of 2003-2008 are based on the amount of waste trucks and have big spread and therefore low reliability.

Recently established scale measurements show that during three months (June-August 2009) at Ordzhonikidze landfill were delivered 44.04 tones of waste. That time Primorsky landfill was already closed.

Therefore the approximation approach for the calculation of the annual amount of waste delivered to landfill throughout the period of landfill operation based on the average recent data on waste delivery and the value for total waste accumulated at the sites was applied. It is based on several assumptions:

- The total amount of waste is 2.56 million tonnes for Primorsky landfill and 2.54 million tonnes for Ordzhonikidze landfill by the end of 2008;
- Amount of waste grows constantly during all landfill life period (the calculated yearly growth factor is 2%).
- About 180 thousand tones of waste were delivered to Ordzhonikidze landfill in 2009.

Year	MSW delivery, 1000 t/an			MSW in place, 1000 t		
	Primorsky landfill	Ordzho-nikidze landfill	Primorsky and Ordzho-nikidze landfills	Primorsky landfill	Ordzho-nikidze landfill	Primorsky and Ordzho-nikidze landfills
1967	78,63	0,00	78,63	79	0	79
1968	80,20	0,00	80,20	159	0	159
1969	81,81	0,00	81,81	241	0	241
1970	83,44	0,00	83,44	324	0	324
1971	85,11	0,00	85,11	409	0	409
1972	86,81	0,00	86,81	496	0	496
1973	88,55	0,00	88,55	585	0	585
1974	90,32	0,00	90,32	675	0	675
1975	92,13	0,00	92,13	767	0	767
1976	40,55	53,42	93,97	808	53	861
1977	41,36	54,49	95,85	849	108	957
1978	42,19	55,58	97,77	891	163	1 055
1979	43,03	56,69	99,72	934	220	1 154
1980	43,89	57,83	101,72	978	278	1 256
1981	44,77	58,98	103,75	1 023	337	1 360
1982	45,66	60,16	105,83	1 068	397	1 466
1983	46,58	61,37	107,94	1 115	459	1 574
1984	47,51	62,59	110,10	1 163	521	1 684
1985	48,46	63,84	112,30	1 211	585	1 796
1986	49,43	65,12	114,55	1 260	650	1 911
1987	50,42	66,42	116,84	1 311	717	2 027
1988	51,42	67,75	119,18	1 362	784	2 147
1989	52,45	69,11	121,56	1 415	853	2 268
1990	53,50	70,49	123,99	1 468	924	2 392
1991	54,57	71,90	126,47	1 523	996	2 519
1992	55,66	73,34	129,00	1 578	1 069	2 648
1993	56,78	74,80	131,58	1 635	1 144	2 779
1994	57,91	76,30	134,21	1 693	1 220	2 913
1995	59,07	77,83	136,90	1 752	1 298	3 050
1996	60,25	79,38	139,63	1 812	1 377	3 190
1997	61,46	80,97	142,43	1 874	1 458	3 332
1998	62,69	82,59	145,28	1 937	1 541	3 478
1999	63,94	84,24	148,18	2 001	1 625	3 626
2000	65,22	85,93	151,15	2 066	1 711	3 777
2001	66,52	87,64	154,17	2 132	1 799	3 931
2002	67,85	89,40	157,25	2 200	1 888	4 088
2003	69,21	91,19	160,40	2 269	1 979	4 249
2004	70,60	93,01	163,60	2 340	2 072	4 412
2005	72,01	94,87	166,88	2 412	2 167	4 579
2006	73,45	96,77	170,21	2 485	2 264	4 749
2007	74,92	98,70	173,62	2 560	2 363	4 923
2008	0,00	177,09	177,09	2 560	2 540	5 100
2009	0,00	180,63	180,63	2 560	2 720	5 281

Year	MSW delivery, 1000 t/an			MSW in place, 1000 t		
	Primorsky landfill	Ordzho-nikidze landfill	Primorsky and Ordzho-nikidze landfills	Primorsky landfill	Ordzho-nikidze landfill	Primorsky and Ordzho-nikidze landfills
2010	0,00	184,24	184,24	2 560	2 905	5 465
2011	0,00	187,93	187,93	2 560	3 093	5 653
2012	0,00	191,69	191,69	2 560	3 284	5 845
2013	0,00	0,00	0,00	2 560	3 284	5 845
2014	0,00	0,00	0,00	2 560	3 284	5 845
2015	0,00	0,00	0,00	2 560	3 284	5 845
2016	0,00	0,00	0,00	2 560	3 284	5 845
2017	0,00	0,00	0,00	2 560	3 284	5 845
2018	0,00	0,00	0,00	2 560	3 284	5 845
2019	0,00	0,00	0,00	2 560	3 284	5 845
2020	0,00	0,00	0,00	2 560	3 284	5 845
2021	0,00	0,00	0,00	2 560	3 284	5 845
2022	0,00	0,00	0,00	2 560	3 284	5 845
2023	0,00	0,00	0,00	2 560	3 284	5 845
2024	0,00	0,00	0,00	2 560	3 284	5 845

INPUT DATA FOR THE ELECTRICITY GENERATION COMPONENT OF THE PROJECT ACTIVITY	
PROJECT DATA	
Date project starts operating (year)	2010
Installed capacity (MW)	Primorsky landfill: 0.7 Ordzhonikidze landfill: 1.5
Estimated on-line availability of equipment (%)	0.913
Operating period (h/yr)	8000
BASELINE DATA	
Country	Ukraine
CEF country (t CO2e/MWh)	807
Crediting period (years) In the 1st commitment period (2008-2012): and further beyond the 1st commitment period but no longer than project operational lifetime	3 20
FINANCIAL PARAMETERS	
Electricity tariff (EUR/MWh)	58,5
“Green” tariff (EUR/MWh)	134.5
Income tax	25%
Discount rate	17%
Depreciation (quarterly)	6.00%
Price of carbon (Euro/tCO2)	10

ANNEX 3

MONITORING PLAN

Summary of Monitoring Approach The monitoring will be carried out as described in Section D of this PDD, and in line with ACM0001. The basic approach is to monitor on a continuous basis the amount of methane destroyed through flaring and combustion. The main parameters to be monitored include:

- Total flow of captured landfill gas [Nm3]
- Landfill gas flow to flares [Nm3]
- LFG temperature [°C] and pressure [Pa]
- Methane content in the landfill gas [%]
- Flare operation time [h]
- Temperature of the flare exhaust gases [°C]
- O_2, CH_4 in the flare exhaust gas (for determining flare efficiency) [%]
- Landfill gas flow to power plant [Nm^3]
- Gross electricity production [MWh]
- Gross electricity consumption [MWh]
- Power plant operation hours [h]
- *(optional)* Thermal energy production and consumption

Landfill gas flows and methane content will be determined on a continuous basis. The same applies for the flare operation time and the electricity production and consumption. The amount of flared methane will be calculated from the flow of landfill gas to the flare, the methane content of the gas, and the flare efficiency.

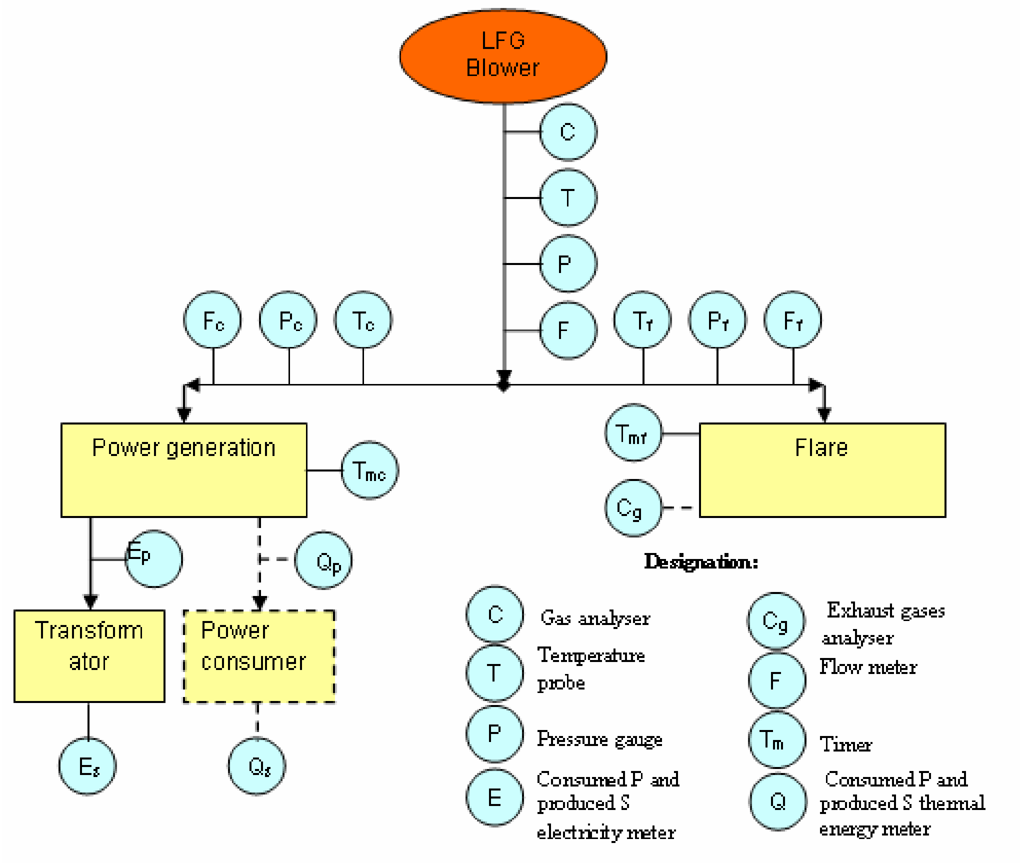

Table. Data and parameters monitored

Data / Parameter:	*LFG total*
Data unit:	m^3
Description:	Total amount of landfill gas captured at Normal Temperature and pressure
Source of data:	Project participants
Measurement procedure (if any):	Measured by flow meter. Data to be aggregated monthly and yearly
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculation of emission reductions)
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	

Data / Parameter:	*LFG flare,y*
Data unit:	m^3
Description:	Amount of landfill gas flared at Normal Temperature and pressure
Source of data:	Project participants
Measurement procedure (if any):	Measured by flow meter. Data to be aggregated monthly and yearly for each flare
Monitoring	Continuous (average value in a time interval not greater than an hour shall be

frequency:	used in the calculation of emission reductions)
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	

Data / Parameter:	$LFG_{electr,y}$
Data unit:	m^3
Description:	Amount of landfill gas combusted in power plant at Normal Temperature and pressure
Source of data:	Project participants
Measurement procedure (if any):	Measured by flow meter. Data to be aggregated monthly and yearly for each flare
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculation of emission reductions)
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO2
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data:	Calculated as per the "Tool to determine project emissions from flaring gases containing methane"
Measurement procedure (if any):	As per the "Tool to determine project emissions from flaring gases containing methane"
Monitoring frequency:	As per the "Tool to determine project emissions from flaring gases containing methane"
QA/QC procedures to be applied:	As per the "Tool to determine project emissions from flaring gases containing methane"
Any comment:	

Data / Parameter:	w_{CH4}
Data unit:	m^3CH_4/ m^3LFG
Description:	Methane fraction in the landfill gas
Source of data:	To be measured continuously by project participants using certified equipment
Measurement procedure (if any):	Shall be measured using equipment that can directly measure methane content in the landfill gas, estimation of methane content of landfill gas based on measurement of other constituents of the landfill gas such as CO_2 is not permitted. Measured by continuous gas quality analyser
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculation of emission reductions)
QA/QC procedures to be applied:	The gas analyser should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	

Data / Parameter:	*T*
Data unit:	˚C
Description:	Temperature of the landfill gas
Source of data:	Project participants

Measurement procedure (if any):	Measured to determine 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
Monitoring frequency:	Continuous
QA/QC procedures to be applied:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards
Any comment:	

Data / Parameter:	P
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data:	Project participants
Measurement procedure (if any):	Measured to determine 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
Monitoring frequency:	Continuous
QA/QC procedures to be applied:	Measuring instruments should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards
Any comment:	

Data / Parameter:	EL_{LFG}
Data unit:	MWh
Description:	Net amount of electricity generated using LFG
Source of data:	Project participants
Measurement procedure (if any):	Electricity meter
Monitoring frequency:	Continuous
QA/QC procedures to be applied:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing regime to ensure accuracy
Any comment:	

Data / Parameter:	ET_{LFG}
Data unit:	TJ
Description:	Total amount of thermal energy generated using LFG
Source of data:	Project participants
Measurement procedure (if any):	Thermal energy meter (temperature, pressure, flow rate will be measured)
Monitoring frequency:	Continuous
QA/QC procedures to be applied:	Thermal energy meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing regime to ensure accuracy
Any comment:	Required to estimate emission reduction from thermal energy from LFG if credits are claimed

Data / Parameter:	*$CEF_{j,k}$*
Data unit:	tCO2/MWh
Description:	Carbon emission factor for electricity
Source of data:	
Measurement procedure (if any):	Eaken from the baseline study ***"Standardized emission factors for the Ukrainian electricity grid"*** (Version 5, 02 February 2007) developed by Global Carbon B.V
Monitoring frequency:	Annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	*$ET_{fuel, BL}$*
Data unit:	$tCO_{2/}$mass or volume
Description:	CO_2 emission factor for fossil fuel
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default value. As per guidance from the Board, IPCC default value should be used only when country or project specific data are not available or difficult to obtain
Measurement procedure (if any):	
Monitoring frequency:	Annually
QA/QC procedures to be applied:	
Any comment:	Fossil fuel that would have been used in the baseline thermal energy generation

Data / Parameter:	*$NCV_{fuel, BL}$*
Data unit:	$GJ_{/}$mass or volume
Description:	Net calorific value of fossil fuel
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default value. As per guidance from the Board, IPCC default value should be used only when country or project specific data are not available or difficult to obtain
Measurement procedure (if any):	
Monitoring frequency:	Annually
QA/QC procedures to be applied:	
Any comment:	For fossil fuel that would have been used in the baseline for thermal energy generation

Data / Parameter:	$\varepsilon_{boiler/arheater}$
Data unit:	
Description:	Efficiency of baseline boiler/air heater for production thermal energy
Source of data:	
Measurement	Assume a boiler efficiency of 100% based on net calorific value as a conservative

procedure (if any):	approach.
Monitoring frequency:	Annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Operation of the energy plant
Data unit:	Hours
Description:	Operation of the energy plant
Source of data:	Project participants
Measurement procedure (if any):	
Monitoring frequency:	Annual
QA/QC procedures to be applied:	
Any comment:	This is monitored to insure methane destruction is claimed for methane used in electricity plant when it is operational

Data / Parameter:	$PE_{EC,y}$
Data unit:	tCO2
Description:	Project emissions from electricity consumption by the project activity during the year *y*
Source of data:	Calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Measurement procedure (if any):	As per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Monitoring frequency:	As per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
QA/QC procedures to be applied:	As per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Any comment:	

Data / Parameter:	$MG_{PR,y}$
Data unit:	tCH_4
Description:	Amount of methane generated during year y of the project activity
Source of data:	Project proponents
Measurement procedure (if any):	Estimated using the actual amount of waste disposed in the landfill as per the latest version of the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”
Monitoring frequency:	Annually
QA/QC procedures to be applied:	As per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Any comment:	

Table. Equipment used to monitor emissions reductions from the project activity

Equipment	Variables Monitored	Operatio-nal range	Calibration procedures	Parties responsible for operating equipment	Procedure in case of failure	Default value to use in case of failure	Comments
LFG flow meter	$LFG_{total,y}$ $LFG_{flare,y}$ $LFG_{electricity,y}$ $LFG_{therm,y}$		Equipment will be calibrated annually after initial installation by the local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.	Daily average of the volume in the previous month minus 5%, per day of flow meter failure	
Portable gas analyser	$PE_{flare,y}$ (O2, CH4 in the flare exhaust gas)		Equipment will be calibrated annually local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. Repeat procedure within one month and if not possible contact other external company.	90% based on manufacturer's specifications	
Fixed Gas Analyser	$W_{CH4,\ y}$		Equipment will be calibrated annually by the local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.	Average of the measured methane content in the previous month minus 5%, per day of gas analyser failure	

Electricity meters	EL_{LFG} EC_{PJ}		Equipment will be calibrated annually by the local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.	Daily average of the electricity generated in the previous month minus 5%, per day of electricity meter failure	
Heat meter	ET_{LFG}		Equipment will be calibrated annually by the local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.	Daily average of the thermalenergy generated in the previous month minus 5%, per day of heat meter failure	
Pressure	P		Equipment will be calibrated annually by the local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.		
Temperature	T		Equipment will be calibrated annually by the local accredited standardization and certification entity on site	Site Engineer and Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.		

The monitoring plan will be described in detail in an Operational Manual. It will be the responsibility of the site manager and undertaken by site staff responsible for the maintenance and care of the landfill gas collection system and flaring unit. The monitoring plan covers:

- responsibility of members of the monitoring team;
- routine reminders for site staff;
- QA/QC procedures;
- service forms for data reporting;
- corrective action plans;
- maintenance plans; and
- monitoring schedules.

The site manager will ensure the measurements are recorded and calibration/maintenance actions are performed per schedule, review the results of the measurements, ensure proper records are kept and transmit data for archiving.

Project developer and project investor will perform quality assurance on the data and ensure archiving of the data for the specified period (crediting period plus two years). At the time of verification, training materials and information about the timing of completed trainings would be provided to the DOE.

The monitoring plan covers procedures for the systematic surveillance of the CDM Project Activity's performance by measuring and recording performance-related indicators relevant to the project or activity. The Plan includes:

- **Routine Reminders for site staff:** All site staff will be issued with a reminder list to guide them through their daily, weekly and monthly routine. In addition, archived data will be checked to ensure it is being appropriately maintained.

- **Corrective Actions:** There will be quality assurance measures to handle and correct nonconformities in the implementation of the Project or this Monitoring Plan. In case such nonconformities are observed:
  - An analysis of the nonconformity and its causes will be carried out,
  - Appropriate corrective actions to eliminate the non-conformity and its causes will be identified, and
  - The implementation of corrective actions will be reported.

- **Service Forms:** Service sheets will be used to ensure all aspects of the monitoring are completed and recorded. These sheets will serve as a procedural reminder and record of the monitoring that is required for the CDM project activity.

- **Calibration of measurement equipment:** Calibration of measurement equipment will be defined and scheduled by the technology provider.

- **Operational Manual**: All the information about monitoring procedures and quality assurance measures will be included in an Operational Manual. The Operational Manual will include procedures for training, capacity building, proper handling and maintenance of equipment, emergency plans.

There will be a team that will cover all aspects of the monitoring. The team members will be responsible for collecting, reviewing, recording and archiving the data. There will be a Monitoring Manager who will quality check the team's work ensuring that the monitoring is performed correctly and on time. The manager will report monthly to project investor and developer about project performance and data. He/She will inform investor and project developer immediately in the event of non-conformance and technical problems. The manager will be the one of the main contacts for the verifier, DNA of Ukraine, and local authorities, during the crediting period.

A Project Team will be formed for monitoring purposes for the project activity. The project team comprises at least one representative of project investor, project developer, the chief engineer of the landfill, and the Carbon Monitoring Manager. It will gather at least monthly, face-to-face or by conference call, to discuss the performance of the project activity. In case of non-conformance, each member of the team could call for a meeting. The meeting minutes will be recorded.

The monitoring tools that will be available to the team and the manager include:

- Operational Manual (see above) including procedures on what is to be monitored, frequency of the monitoring, equipment to be used, maintenance required on instrumentation, corrective actions, etc.
- This Project Design Document UNFCCC baseline and monitoring methodology (ACM0001and "Tool to determine project emissions from flaring gases containing methane")
- Service sheets (see above)
- Spreadsheets

The spreadsheets will serve as a registry of the all data collected by the different measuring equipments distributed all over the facilities. They will also be used to quantify ERs achieved by the projects activity during specific time periods through the use of auxiliary equations.

For the purposes of QA/QC and archiving data will be transmitted electronically to project investor and developer on a weekly basis as well as a reporting of any anomalies, equipment failures or any other causes of data loss. A final data quality check of the information will be made before an archived copy is created.