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

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Methane Capture and Destruction at the Solid Waste Landfill in the City of Lviv, Ukraine
Sectoral Category 13: Waste Handling and Disposal
Document Version Number: 04
Date: 19/07/2011

A.2. Description of the project:

Purpose of the Project

The "Methane Capture and Destruction at the Lviv Solid Waste Landfill, Ukraine" project (hereinafter referred to as the "Project) will build and operate a Landfill Gas (LFG) collection and flaring system in order to avoid emissions of methane being released into the atmosphere and to produce Emission Reduction Units (ERUs) for sale under the Joint Implementation mechanism of the Kyoto Protocol. LFG is produced from decay of organic waste in the anaerobic conditions that are created in a landfill body. LFG contains approximately 50% methane (CH_4) which is a greenhouse gas (GhG) [1].

Services currently provided by the Landfill

The Lviv Solid Waste Landfill (herein referred to as the "Landfill") is the only landfill servicing the city of Lviv, a regional centre in the western part of Ukraine with population of 800,000. The Landfill was founded in 1957 and is located 5 km north of the city. It is estimated that to date a total of 25.6million m^3 (5.9 million tons) of solid waste has been deposited at the site and in recent years the rate of disposal continues to be in the magnitude of approximately 240,000[2] tons per year.

Management of the Landfill

The Landfill is owned and managed by Lviv City Municipality (herein referred to as "Lviv municipality"). It has a total area of 38.8 hectares of which 26.5 hectares is in use.

Baseline Scenario

With the existing and new waste from the municipality, LFG will continue to be generated through decomposition of the organic waste. In absence of the JI project, the LFG capture and destruction system will not be developed due to lack of funding. Without the system, LFG will continue to be released to the atmosphere.

Project Scenario: LFG collection, flaring and associated activities

The Lviv municipality has signed an agreement[3] granting the rights for degasification and use of the Landfill and utilization of LFG to the Ukrainian private company Gafsa LLC (herein referred to as the

[1] Source: Report on Preliminary Results of the Lviv SW Landfill Pump-Testing (Pg.7)

[2] Source: Report on Preliminary Results of the Lviv SW Landfill Pump-Testing

[3] Gafsa-Lviv Municipality Agreement Translation NY

"project developer") for a 15-year period. Under the terms of the agreement the Project will be owned, managed and operated by Gafsa LLC.

As described more fully in section A.4.2, the Project will involve the following main activities (herein referred to collectively as the "project activity"):

- Landfill remediation
- LFG collection
- Gas flaring
- LFG-to-electricity generating unit and a temporary start-up fossil fuel fired generating unit to supply energy to run the project
- Monitoring the destruction of LFG

Expected Impacts of the Project

Analysis of the Landfill site indicates that approximately 91.7 Mm^3 of LFG will be collected by the Project over the period from 01 April 2009 – till 31 December 2012. The Project is expected to achieve an estimated 434,533 tonnes of CO_2e reductions over the 4-year[4] commitment period.

As described in Section F, the Project will also provide environmental, economic and social benefits to the local area as follows:

- improved safety of the Landfill because of the destruction of LFG which is a potential fire hazard
- improved local environment because capturing and destroying LFG reduces bad odour
- improved local environment because LFG collection and remediation activities will help to reduce seepage of LFG and leachate in the vicinity of the Landfill site
- increased foreign investment and technical innovation in the waste management sector of Ukraine through import of technology for LFG recovery and utilisation
- enhanced knowledge of the best landfill management practices in Ukraine

Project milestones are presented below:

1. **September 12, 2006 -** Letter of Endorsement (LoE) of the JI Project was issued by Ministry for to Gafsa LLC
2. **June, 2008** – Receive of the final Pump Testing reports; Management decision on Project development
3. **July 15, 2008** – Investment Agreement completed and signed.
4. **August 2008** – Stakeholder consultation process completed
5. **August to November 2008 -** Drilling of wells started. Installation of pipes. Purchase of flaring plant and monitoring equipment.
6. **February 2009** – DOE contracted to conduct the JI determination
7. **May 2009** – Completion of LFG collection system establishment; Flaring Plant final commissioning; Project fully operational.

[4] 45 months: 9 months in 2009 (from 01 April till 31 December, 2009) and 3 full years (2010-2012)

A.3. Project participants:

Party involved* (*host - indicates a host Party)	**Legal entity project participant** (as applicable)	**Please indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Ukraine (host)	Gafsa LLC	No
UK	Carbon Capital Markets Ltd	No

A.4. Technical description of the project:

A.4.1. Location of the project:

The Project location is shown on the map below.

A.4.1.1. Host Party(ies):

Ukraine

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

Lviv Region, Zhovkivsky District

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

Grybovychi village

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

The Lviv landfill, known as “Zbyranka”, is located near the Grybovychy village of Zhovkivsky District and 5km north of the city of Lviv. Lviv is located in the western part of Ukraine, 80 km away from the border with Poland. Coordinates for Lviv are 49° 49’ N 23° 57’ E. The Lviv landfill covers an area of 38.8 hectares, of which 26.5 hectares are currently assigned for waste disposal.

Figure 1 Geographical location of Lviv project

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

This section describes the technologies and measures to be employed for the project activities listed in A.2.

LFG collection system

Vertical perforated plastic gas extraction wells will be established in the waste material. The following features of the system will be determined during the design phase of the Project:

- Configuration of the wells in accordance with the depth and slope of different parts of the Landfill
- Number and spacing of the wells in accordance with results of soil boring and gas pumping tests

The wells will be connected to a gas control plant through a network of horizontal underground non-perforated piping consisting of a header, sub-headers and laterals installed within the Landfill and around its perimeter. The LFG collection system will employ the following technologies:

- The flow of gas will be controlled at each of the individual vertical extraction wells by a valve located at the top of the well piping
- Each wellhead will be equipped with a secure monitoring chamber and monitoring ports for gas composition, pressure, and temperature readings
- Dewatering points at strategic low points will allow for effective condensate management

Integrated booster and gas flaring station

This project will adopt Hofstetter technology. The **HOF***GAS* ®- *Ready C* is a complete extraction and flaring station of the enclosed type for safe and economic degassing of landfill sites. The integrated booster and flare station ("integrated station") will consist mainly of a manifold for the incoming pipes, flow control valves, gas blower and pressure boosting pumps, enclosed high-temperature flare stack and continuous gas monitoring and analysis system.

The gas blower system creates a vacuum at slightly less than atmospheric pressure in order to pull LFG through the piping system from the wells. The LFG is transported through a demister and filter to protect the equipment from excessive moisture and particulates in the gas.

A controlled combustion with concealed flame is guaranteed by the **HOF***GAS*®- *Efficiency* high temperature flare. The flare design will incorporate safety features including controlled flame ignition system and flame arrestor device to prevent flashback to the fuel feed pipe. A control panel will incorporate all flare controls, motor starters, alarms and interlocks to ensure safe operation of the integrated station.

The complete degassing unit is built in a ventilated container, which makes the **HOF***GAS*®- *Ready C* plant theft-proof, decreases sound levels outside and also protects it from environmental influences. The electrical PLC control is located in a separate compartment.

LFG generator and back-up power supply for the Project

A portion of the LFG collected will be utilised in a LFG-to-Energy ("LFGTE") unit to produce electricity to power the Project.

Two gas piston generators with power generation capacity of 60 kW each will be installed at the project site to cover its own energy demand from the power consumption of the blower and the monitoring equipment supplied by Hofstetter. The energy demand (30 kW on average) was assessed and determined by the project design developer and approved by the government authority at the project design stage. The selection of two gas piston generators (one duty and one standby) instead of installation of one gas piston generator allows system operation in case 1 generator is under repair or not functioning for other reasons. In practice, the power consumption of the Duty Blower is about 40 kW.

The Project may also utilise a start up gasoline generator to provide a temporary back-up power to the project activity. The gasoline generator will be used on an as needed basis.

Monitoring the destruction of LFG

The design of the integrated station will include monitoring equipment in order to fully implement the monitoring plan that is described in Section D and Annex 3. In summary, the monitoring system will comprise of the following technologies:

- flow meters to **continuously** measure the total volumetric flow of the LFG to the system, as well as LFG to the flare and to the LFG generator[5];
- LFG pressure and temperature transmitters for calculation of the gas mass flow rate[6];
- LFG gas analyser to **continuously** measure the composition of the LFG delivered to the flaring plant;
- sampling points and portable instrumentation for laboratory analysis of the LFG;
- thermocouple to **continuously** measure the temperature of the flame in the stack and to monitor and control the self adjusting system, which maintains the temperature within the optimum range by changing angle of automated air louvers. Note: the LFG supply to the combustion chamber of the flare and the flare's ignition system assure uniform distribution and flaring of the LFG in the combustion chamber as well as high safety standards to avoid gas leak or explosion.
- FlueGas analyser to **continuously** measure the composition of the exhaust gas out of the flare[7].
- **continuous**, automated data logging system

Origin of the technology
The expected origin and standard of the technology described in this section is summarised below:

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
Gasoline power plant	Locally manufactured	According to local standards
Gas engine and generator sets	Main parts imported from EU/ Locally manufactured	According to EU and local Standards
Monitoring and control systems	Imported from EU	According to EU Standards

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:

Decomposition of solid waste under anaerobic conditions produces LFG, which is released into the atmosphere as an anthropogenic emission. Tests of LFG from the Lviv landfill confirm that the gas contains between 50% and 55% methane which is a powerful greenhouse gas.

As summarised in Section A.4.2 the Project will reduce greenhouse gas emissions by capturing the LFG and combusting it in order to destroy the methane producing CO_2 and a small quantity of other by-product gases. The CO_2 released during the combustion process was originally fixed via biomass so when released, it is carbon neutral in the carbon cycle.

[5] The total LFG flow meter to be installed before the LFG is diverted to the flare and the generator to measure the total LFG flow entering the system. Two (2) additional flow meters to be installed: one to measure LFG entering the flare and another one – to measure LFG entering the generator.

[6] The total LFG flow meter is a device integrated with pressure and temperature transmitters in order to automatically measure and record the flow rate in Nm3/hr (flow rate on the dry basis at normal temperature and pressure conditions).

[7] Records from the exhaust gas analyzer to be used only for continuous monitoring approach.

Section B.1 demonstrates that the most likely alternative to the Project is for the Lviv municipality to continue the current practice of releasing all LFG produced at the Landfill into the atmosphere over the crediting period. New requirements for improved management of LFG were introduced at a national level in June 2005; however there is widespread non-compliance because many local authorities are not able to afford the additional cost burden of installing and operating systems for LFG collection.

The Lviv municipality has decided to partner with a private sector partner to collect the LFG and destroy the methane component for the purpose of generating emission reductions. At this time, the only incentive to attract private sector investment is the opportunity to produce and sell ERUs under the Joint Implementation mechanism of the Kyoto Protocol.

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

Estimated ERUs for the proposed project activity is approximately 434,533 tonnes CO_2eqv over the 4-year (45 months) crediting period starting on 01 April 2009 and ending on 31 December 2012. Between the abovementioned period the Project is expected to mitigate on average 115,875 tonnes per year of CO2e.

Table 1: Expected Emission Reductions for the period 2009-2012

	Years
Length of the crediting period	2009-2012*
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2009 (from April)	79,400
2010	112,434
2011	118,340
2012	124,359
Total estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	434,533
Annual average of estimated emission reductions over the crediting period** (tonnes of CO2 equivalent)	115,875

* 45 months – from 01 April 2009 till 31 December 2012. Please also refer to Section C.3.
** Annual average of the estimated ERUs over the crediting period 2009-2012

Table 2: Expected Emission Reductions for the period 2013-2018***

Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2013	128,418
2014	128,696
2015	115,343
2016	103,770
2017	93,704
2018	84,918
Total estimated emission reductions over the 2013 – 2018 period* (tonnes of CO2 equivalent)	654,848

*** Within the second commitment period to be established under Kyoto Protocol, and further to recent Ukrainian government recognition, the project will request ERUs for the duration of, but not exceeding the project operational lifetime.

A.5. Project approval by the Parties involved:

The Host Country Approval (HCA) in the form of the Letter of Approval (LoA) of the Project was issued on April 20, 2011 (No. 986/23/7) by the National Environmental Investment Agency of Ukraine[8].

The Project also received the Letter of Approval (LoA), which was issued on June 07, 2011, from the other Party involved (United Kingdom).

All Project approvals by the Parties involved are available on request.

[8] The Host Country Approval (HCA) / Letter of Approval (LoA) serves as the final approval of the project by the Host country. It supersedes the previously issued Letter of Endorsement (LoE) of the Project that was issued on September 12, 2006.

SECTION B. Baseline

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

Baseline methodology for landfill gas project activities

This Project makes use of the CDM Executive Board Approved Consolidated baseline and monitoring methodology for landfill gas project activities ACM0001 Version 11 in order to determine the baseline.

This methodology is applicable to the JI project, since baseline scenario is the total atmospheric release of the gas and the project scenario is the destruction of captured LFG. ACM0001 also makes reference to the Methodological Tool 'Tool for the demonstration and assessment of additionality' Version 05.2 ("the Additionality Tool")
According to the tool, it is mandatory to apply it to the project to demonstrate and assess the additionality. The second tool is applicable to the project because the LFG stream to be flared is obtained from decomposition of organic material.

Step 1: Identification of all alternatives to the project activity consistent with current laws and regulations
(This sub- section corresponds to Step 1 of the Additionality Tool. The purpose of this sub- section is to define all the alternatives to the project activity.)

The following alternatives, including the proposed project activity undertaken without ERUs that may be considered to be possible alternative baseline scenarios:

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

	Alternatives to Project Activity	**Probability of Scenario**
1	Disposal of the waste at the landfill with electricity generation using landfill gas captured from the landfill site.	*Not probable*: This alternative is in compliance with the mandatory regulatory requirements; however, the main barrier is of financial nature since the revenues from power sales do not outweigh the high investment (i.e., the project's financial return is significantly below market expectations), thus not capable to attract investors. Also, on top of the capital expenditures necessary to the project activity, some additional capital would be required to establish a connection to the national electricity grid because none exists at the Lviv Landfill. The financial barrier, demonstrated in Step 2, combined with the specific circumstances of the Lviv Landfill and the policy and regulatory environment in Ukraine renders this alternative not probable.
2	Disposal of the waste at the landfill with flaring of gas captured from the landfill as a non-JI project.	*Not probable*: This alternative is in compliance with the mandatory regulatory requirements; however, the project activity requires funds for construction of the required facilities and to maintain operations. There are no funding sources available to support this project and the existing regulatory requirements regarding emissions control is not expected to be implemented for the reasons mentioned

	Alternatives to Project Activity	Probability of Scenario
		above. Furthermore, this alternative does not itself provide any potential revenue to the landfills. It is therefore clearly not a plausible scenario and we do not consider it as a baseline scenario and it is therefore not considered a possible alternative.
3	Disposal of the waste at the landfill without capture of landfill gas (current situation)	*Most probable*: Current practice shows that the requirements on LFG management in Ukraine are not enforced around the country (refer to "Analysis of other activities" of B.2 below), it is plausible that there would continue to be complete atmospheric release of LFG from the Lviv landfill during the crediting period.
4	Disposal of the waste at the landfill with heat generation using landfill gas captured from the landfill site.	*Not probable*: This alternative is in compliance with the mandatory regulatory requirements; however, the main barrier is that there is no existing heat system or infrastructure for delivering the heat in the neighbourhood.

Sub-step 1b: Enforcement of applicable 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 venting after the landfill closure. Below is the description of the relevant sections of DBN B.2.4-2-2005.

DBN B.2.4-2-2005 "Grounds of solid domestic waste. Designing provisions":

Section 3: Designing of grounds of solid domestic waste.
I.3.74. While designing grounds of solid domestic waste it is expedient to take into account recovery of biogas formed as the result of anaerobic decomposition of the organic component of solid domestic waste.
The provision refers to the stage of designing a new ground of solid domestic waste and is of a recommendatory nature.

Subsection. Reclamation of lands after grounds of solid domestic waste are closed.
I. 3.125,3.126,3.127. In order to prevent harmful impact of biogas of grounds of solid domestic waste on the environment, gas discharge from the surface of the ground and its getting to the territory adjacent to the ground must be blocked or reduced to a minimum.
Provisions of these items are related only to closed grounds of solid domestic waste, and it is suggested that collection of biogas must be done on the basis of the system of passive degassing through gas drainage equipment.

However, historically, 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. Presently, common practice shows that existing landfills in Ukraine do not capture and flare or utilise their landfill gas (please refer also to "Analysis of other activities" of B.2 below). It should be noted that

Lviv is still in operation (since 1970s) and not a closed landfill. In absence of the JI project (i.e., without the JI revenue from sale of ERUs), the LFG capture and flaring system will not be developed due to lack of funding.

Based on the analysis in Step 1a and 1b, Alternative 3 is the most probable scenario and Alternative 1, Alternative 2, and Alternative 4 are plausible, but not probable. The only reasonable alternative to the project activity is the continued uncontrolled release of LFG to the atmosphere (i.e., Alternative 3) as part of the "business-as-usual" scenario at the site. To confirm that alternative 1 and 2 are financially unfeasible, an investment analysis was conducted for both alternatives.

Investment Analysis

(This sub-section corresponds to Step 2 of the Additionality Tool. As described in the tool, the purpose of this sub-section is to demonstrate that the proposed project activity is economically or financially less attractive than at least one other alternative, identified in step 1, without the revenue from the sale of ERUs.)

Alternative 1:
Alternative 1 would generate income. Therefore, the benchmark analysis, with the financial indicator of Internal Rate of Return ("IRR") is used to assess this alternative.

Power generation systems require significant investment as a project option. Based on the theoretical landfill gas forecasts, there is a potential for power generation with 3 MW of capacity at this site[9]. With a capital expenditure for civil works on the landfill, gas collection system and the engines (not including the required transmission lines and transformer stations), this alternative will yield a 1.39% IRR, rendering this alternative financially unfeasible[10].

According to the CDM Guidance on the Assessment of Investment Analysis (EB41 - Annex 45), the local commercial lending rates should be used as a benchmark when project IRRs are used in the investment analysis. The statistics on lending rates for the banks in Ukraine shows that the minimum rate is 16.4%[11], which is used as the conservative benchmark for the investment analysis[12].

[9] The potential capacity (~3MW) was derived based on the landfill gas flow data from the pump test (Source: Report on Preliminary Results of the Lviv SW Landfill Pump-Testing). The gas flow is used in the "Lviv Gas Financial Analysis" worksheet to calculate the potential capacity (~3MW) using the heat content of LFG and efficiency of gas engines. Both the pump test report and the worksheet were provided to the DOE for review.

[10] It should be noted that several renewable energy policies or orders were recently established. However, those are only orders or recommendations to other state institutions to undertake a study, develop a program, or draft a report on the alternative energy use. More importantly, those renewable energy policies or recommendations did not exist at the time of the investment decision by the project developers.

[11] Interest rates on credits to the real sector of economy and deposits pursuant to reporting statistical data of Ukrainian banks for June 2008. The Management decision was made in June 2008 with the final investment Agreement signed in July 2008. Hence, it is reasonable to use June 2008 as the reference point. Since the loan will be made in national currency, the interest rate for national currency is used. For conservativeness, the lowest interest rate (16.4%) was used as the benchmark.

[12] According to enquiries to the local banks, the commercial lending rate for this proposed project activity would be at least 18% (anecdotal).

Table 3: Costs for Alternative 1

Item	Cost or Value	Data Source
Total Capital Expenditure (incl. engines)	$7,283,237	Full Proposal from a local project developer[13] plus conservative assumptions[14] from a third party report (A&C Report[15])
Engines (for 3MW)	$4,050,000	Based on values from a third party report (A&C Report)
Opex	$28/MWh	Based on values from a third party report (A&C Report) and the lowest value was used for conservativeness
Taxes	25%	PwC Ukraine[16]
Power tariff	$51.3/MWh	Estimate based on data from Wholesale Electricity Market (WEM) Statistics, Ukraine
IRR	1.39%	

<u>Scenario Analysis</u>
A scenario analysis has been conducted to assess the potential project IRRs for various scenarios considering the possibility of a 10% increase or decrease in capital cost, operational cost, and electricity tariff. As shown the tables below, an increase in power tariff by 10% yields the highest project IRR (4.12%) and a decrease in power tariff by 10% yields the lowest project IRR. It can be demonstrated that, even with a project IRR of 4.12%, Alternative 1 is clearly not financially feasible as it is far below the benchmark of 16.4%.

Table 4: Key Variables in the Reference Case

Reference Case	Unit	Value
Engine Cost	US$/MW	1,350,000
Operational Cost	US$/MWh	28
Power Tariff	US$/MWh	51.3

Table 5: Project IRR For Various Scenarios

Scenarios	Project IRR
Reference Case	1.39%
+10% in Capital Cost	0.68%
+10% in Operational Cost	0.64%
+10% in Power Tariff	4.12%
-10% in Capital Cost	2.15%
-10% in Operational Cost	3.43%
-10% in Power Tariff	Investment not recovered

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[13] A full proposal was received from a local project developer, Gafsa Ltd. on Aug 26 of 2008.

[14] Conservative assumptions are included in a detailed investment analysis, which has been provided to the DOE for review.

[15] Andrade and Canellas Report (2009) see my quesiton in the email

[16] PwC Ukraine. 2009. Online Business Guide. Taxation of Corporation. http://www.pwc.com/extweb/insights.nsf/docid/2C64CA11D624A80F80256F1000551884

Alternative 2:

Without the revenue from the sale of ERUs, Alternative 2 generates no financial or economic benefits. Therefore, it is appropriate to apply a simple cost analysis to demonstrate that this alternative requires a substantial investment and would not be financially feasible the revenue from the sale of ERUs. The table below shows that the engineering, procurement and construction costs for the gas collection system are substantial.

Table 6: Costs associated with project activities

Item	Cost, US$	Source
EPC costs	3,233,237	EPC Contract

Based on the investment analysis, it is clear that the proposed JI project activity, without the revenue from the sale of ERUs (i.e., Alternative 2), is not the most economically or financially attractive option. The most economically attractive option is the continued uncontrolled release of LFG to the atmosphere (i.e., Alternative 3), hence the baseline scenario.

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:

The purpose of this section is to demonstrate the 'additionality' of the emission reductions that are described in Section A.4.3.1. 'Additionality' refers to the requirement that greenhouse gas emissions after implementation of the Project are lower than those that would have occurred in the most plausible alternative scenario to implementation of the Project.

Section B.1 utilises ACM0001 to demonstrate that the most plausible alternative scenario to implementation of the Project, the baseline scenario, is complete atmospheric release of LFG from the Lviv landfill. Steps 1 and 2 and 3 of the Additionality Tool have already been completed in order to demonstrate this result. Consequently it is only necessary to complete the final step of the Additionality Tool in this section.

Common practice analysis

(This sub-section corresponds to Step 4 of the Additionality Tool. The purpose of this sub-section is a credibility check to complement the investment analysis and barrier analysis completed in the previous section.)

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. 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 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. The sample represents 40% of the major landfills servicing large cities with number of inhabitants of more than 200 thousand persons.

Table 7: Common Practice[17]

	Number of inhabitants serviced by landfill (‘000)	Rate of waste disposal in 2004 (uncompacted, ‘000 m^3/ year)	Total amount of waste (uncompacted, million m^3)	Starting year	Total landfill area (ha)	LFG control in operation in 2005
Alushta	60	120	3.6	1960	6.9	None
Yalta	150	240	6.5	1973	5.7	None
Cherkassy	310	360	4.8	1992	9	Passive venting
Ivano-Frankivsk	230	260	3.0	1992	22.4	None
Khmelnitsky	250	490	14.8	1956	8.8	None
Kirovograd	280	260	10.9	1949	23	None
Kremenchug	245	290	12.3	1965	28	None
Lutsk	215	340	3.6	1991	9.9	None
Rivne	245	400	12.2	1959	24.5	None
Vinnitsa	385	340	5.1	1985	5	None
Zhytomyr	300	300	8.0	1957	18.7	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.

Other than this demonstration project, LFG collection and flaring or utilisation systems have not been implemented in Ukraine, and the vast majority of landfills do not have a 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. However, implementation of the above projects has not been started due to reduction of the project activities of DEPA in Ukraine and absence of a potential project investment company.

[17] 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

There were also LFG capture projects that were initiated to be developed as JI projects at several other landfills (e.g. Yalta/Alushta, Poltava, Belaya Tserkov, Kremenchuk, Dnipropetrovsk), that, at the time of the management decision, were at different stages of development.

Conclusions of the Additionality Tool
Step 1 has identified realistic and credible alternative scenarios to the project activity registered as a JI project. These are in compliance with legislation in Ukraine taking into account the degree of enforcement at the national level.

Step 2 demonstrates that the proposed project activity is more costly than the probable alternative and, therefore it is not the most financially/ economically attractive of the available options. It was also demonstrated that Alternative 3 is the probable baseline.

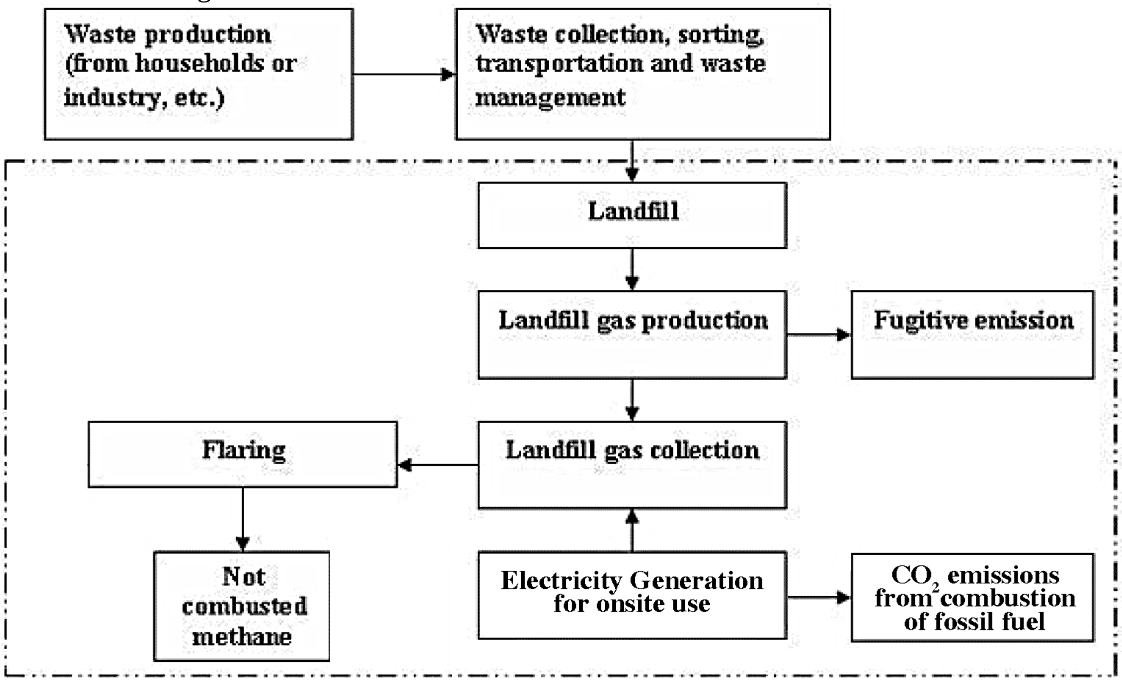
Step 3 was not required

Step 4 has identified one similar activity that has been observed but has identified donor grant funding and technical support as the essential distinction with the project activity.

Since all steps have been satisfied, the conclusion of the Additionality Tool is that the project activity is additional.

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

The project boundary is the site of the project activity where the gas is captured and destroyed as demonstrated in the figure below:



The electricity used for the project activity is from the LFG generator and the start-up fossil fuel generator, both of which are included within the project boundary. Electricity for the project is not sourced from the grid or electricity that would have been generated by power generation sources connected to the grid.

Table 8: Summary of 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 from atmospheric release of LFG in the baseline.
		N_2O	No	N2O emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	No	Electricity is not consumed from the grid or generated onsite/offsite in the baseline scenario.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emission from thermal energy generation	CO_2	No	Thermal energy generation is not 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	Yes	May be an 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.
	Emissions from on-site electricity use	CO_2	Yes	May be an important emission source due to occasional use of gasoline generating unit for start-up and back-up purposes.
		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.

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: 20/12/2008

Mr. Reuben Maltby
Carbon Capital Markets Ltd.
7th Floor, 22, Billiter Street
London EC3M 2RY
United Kingdom
Email: Reuben.Maltby@carboncapitalmarkets.com

Carbon Capital Markets Ltd. is also a project participant listed in Annex 1.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

15/07/2008

The starting date was determined according to its definition in the JI guidelines; that is, the starting date of a JI project is the date on which the implementation or construction or real action of the project begins.

As described in Section A.2, an investment agreement was signed between the project participants on July 15 of 2008. This date is conservatively considered to be the date when the real action of project begins.

C.2. Expected operational lifetime of the project:

15 years

C.3. Length of the crediting period:

During the first commitment period:
4 years (2009-2012)[18]

Beyond the first commitment period:
Within the second commitment period to be established under Kyoto Protocol, and further to recent Ukrainian government recognition, the project will request ERUs for the duration of, but not exceeding the project operational lifetime.

[18] 45 months: 9 months in 2009 (from 01 April till 31 December, 2009) and 3 full years (2010-2012)

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The approved monitoring methodology applied to this project activity is ACM0001 Version 11. The methodology also refers to the following CDM Executive Board approved Methodological Tools that are relevant to this monitoring plan:

- **"**Tool to determine project emissions from flaring gases containing methane" (Version 01) EB 28, Annex 13 (herein referred to as "EB 28 Annex 13")
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01) EB 39, Annex 7 (herein referred to as "EB 39 Annex 7")
- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (Version 05.1.0) EB 61, Annex 10 (herein referred to as "EB 61 Annex 10")

The monitoring methodology is based on direct measurement of the amount of methane captured and destroyed in the flare and the LFG electricity generating unit. The main variables that need to be determined are the quantity of methane actually captured, quantity of methane flared and quantity of methane destroyed to generate electricity. The actual quantity of methane emissions reduced by the project is calculated based on flow volume of the landfill gas, its methane concentration, and the destruction/conversion efficiency of the combustion equipment. Temperature and pressure of the landfill gas will also be measured.

The monitoring plan provides for the continuous measurement of both quantity and quality of LFG captured and fed to the combustion equipment using continuous flow meters and an on-line gas analyzers. All continuously measured parameters will be monitored and recorded with the same frequency (at least hourly) and for the same time period.

Project emissions from incomplete combustion in the flare are taken into account in the monitoring plan. The combustion efficiency of the enclosed flare is determined according to Methodological Tool to determine project emissions from flaring gases containing methane. This tool provides for continuous monitoring of the composition of the residual and exhaust gas in order to determine flare efficiency. Alternatively, flare efficiency can be determined using a 90%, 50%, or 0% default value which is applicable provided the continuity and compliance of operation of the flare system as per manufacturer's specifications.

The temporary fossil fuel start- up generating unit will be a source of project emissions. These will be monitored in accordance with the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01, EB 39 Annex 7) by measuring the quantity of fossil fuel fired and the quantity of electricity generated in order to calculate the appropriate emission factor.

Calibration and maintenance of all the monitoring equipment will be conducted in accordance with manufacturer's requirements.

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	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 at Normal Temperature and Pressure	Flow meter	m^3	m	Continuous	100%	Electronic	
2. $LFG_{flare, y}$	Amount of landfill gas flared at Normal Temperature and Pressure	Flow meter	m^3	m	Continuous	100%	Electronic	
3. $LFG_{electricity, y}$	Amount of landfill gas combusted to produce electricity in the LFG generating unit at Normal Temperature and Pressure	Flow meter	m^3	m	Continuous	100%	Electronic	

4. $PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year '*y*'	Calculated as per Tool "EB 28 Annex 13"	tCO_2e	c	Continuous	100%	Electronic	The values to be calculated as per Tool "EB 28 Annex 13" and aggregated weekly, monthly, and yearly.
5. T	Temperature of the landfill gas	Temperature transmitter	^oC	m	Continuous	100%	Electronic	
6. P	Pressure of the landfill gas	Pressure transmitter	mbar	m	Continuous	100%	Electronic	The values to be continuously measured in 'mbar'; then, if necessary, to be converted in 'Pa'
7. h	Operation of the LFGTE generating unit	LFGTE generating unit counter (control panel)	hours	m	Continuous	100%	Electronic	The records to be aggregated and documented on a weekly basis
8. $PE_{EC, y}$	Project emissions from electricity consumption produced by start-up fossil fuel generator	Calculated as per Tool "EB 39 Annex 7"	tCO_2e	c	Annually	100%	Electronic	

9. w_{CH4}	Volumetric fraction of methane in the residual gas	Continuous LFG analyzer	% Vol. ($m^3CH_4/m^3LFG*100\%$)	m	Continuous	100%	Electronic	
10. w_i	Volumetric fraction of the gas '*i*' in the residual gas, where *i* = O_2, CO_2	Continuous LFG analyzer	% Vol.	m	Continuous	100%	Electronic	LFG Analyzer only continuously measures the CH_4, CO_2, and O_2 content of the LFG. The remaining part of LFG is assumed to be considered as N_2
11. FV_{RG}	Volumetric flow rate of the residual gas at normal condition	Continuous flow meter	m^3/h	m	Continuous	100%	Electronic	
12. w_{O2ex}	Volumetric fraction of O_2 in the exhaust gas of the flare.	Continuous FlueGas analyzer	% Vol.	m	Continuous	100%	Electronic	This parameter to be recorded and applied in ERU calculation only if "Continuous Approach" is used to determine flaring efficiency.

13. w_{CH4ex}	Volumetric fraction of methane in the exhaust gas of the flare at normal conditions.	Continuous FlueGas analyzer	% Vol.	m	Continuous	100%	Electronic	This parameter to be recorded and applied in ERU calculation only if “Continuous Approach” is used to determine flaring efficiency.
14. T_{flare}	Temperature in the exhaust gas of the flare	Thermo-couple	^{o}C	m	Continuous	100%	Electronic	
15.	Other flare operating parameters, if applicable			m				This should include all data and parameters that are required to monitor whether the flare operates with the range of operating conditions according to manufacturer’s specifications.

16. FC_y	Quantity of fossil fuel used by the start-up generator in year *y*	Meter	Mass or normalised volume unit per year	m	Annually	100%	Electronic	Consistency of metered consumption will be cross-checked with annual energy balance that is based on purchased quantities and stock changes of fossil fuel.
17. NCV_y	Average net calorific value of the fossil fuel used by the start-up generator in year *y*	Values provided by the fuel supplier in invoices	GJ / mass or volume unit	e	Per invoice	100%	Electronic	

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):

In accordance with ACM0001, the following equation is used to calculate emission reductions achieved by the project activity:

$$ER_y = (BE_y - PE_y) \qquad (1)$$

Where:

ER_y = Emission reductions in year y (tCO_2e/ year)

BE_y = Baseline emissions in year (tCO_2e/ year)

PE_y = Project emissions in year y (tCO_2e/ year)

The equations used to calculate baseline emissions and project emissions are presented here in the order in which they appear in ACM0001, with clear indication of where the method has been adapted to suit the specific requirements of this project activity such as where:

- Some parameters are set to equal zero because they are not applicable to the project activity
- Default values have been used
- An option/ alternative method of calculation has been selected and followed in accordance with the guidelines provided in the relevant section of ACM0001 or the accompanying methodological tools

Baseline emissions

$$BE_y = (MD_{project,\,y} - MD_{BL,\,y})*GWP_{CH4} + EL_{LFG,\,y}*CEF_{electricity,\,BL,\,y} - ET_{LFG,\,y}*CEF_{thermal,\,BL,\,y} \qquad (2)$$

Where:

BE_y = Baseline emissions in year y (tCO_2e/ year)

$MD_{project,\,y}$ = The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH4) in project scenario

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

GWP_{CH4} = Global Warming Potential value for methane for the first commitment period

$EL_{LFG,\,y}$ = Net quantity of electricity produced using LFG which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours

		(MWh)
$\mathbf{CEF}_{\mathbf{electricity, BL, y}}$	=	CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh
$\mathbf{ET}_{\mathbf{LFG, y}}$	=	The quantity of thermal energy produced utilizing the landfill gas which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y in TJ
$\mathbf{CEF}_{\mathbf{thermal, BL}, y}$	=	CO2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$MD_{BL, y}$	0	See explanation below
GWP_{CH4}	21 tCO_2e/tCH_4	IPCC default value
$EL_{LFG, y}$	0	No electricity is displaced (See Section B.1)
$CEF_{elec, BL, y}$	0	Not applicable because no electricity is displaced
$ET_{LFG, y}$	0	No thermal energy is displaced
$CEF_{ther, BL, y}$	0	Not applicable because no thermal energy is displaced

<u>Methane destruction in the baseline</u>

According to description of the baseline for this Project in Section B.1, there are no regulatory or contractual requirements specifying $MD_{BL,y}$. Therefore, according to ACM0001 the following equation should be used to calculate destruction of methane in the baseline scenario:

$$MD_{BL, y} = MD_{project, y} * AF \qquad (3)$$

The Adjustment Factor should be calculated taking into account the project context. As explained in Section B.1, in the case of the project activity, AF =0.

<u>Methane destruction in the project activity</u>

The formula used to determine $MD_{project, y}$ is as follows:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal, y} + MD_{PL,y} \qquad (4)$$

Where:

$MD_{flared, y}$ = Quantity of methane destroyed by flaring (tCH4)
$MD_{electricity, y}$ = Quantity of methane destroyed by generation of electricity (tCH4)
$MD_{thermal, y}$ = Quantity of methane destroyed by generation of thermal energy (tCH4)

$MD_{PL, y}$ = Quantity of methane sent to pipeline for feeding into natural gas distribution network (tCH4)

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$MD_{thermal, y}$	0	There is no methane destroyed by generation of thermal energy in the project activity
$MD_{PL, y}$	0	There is no methane sent to pipeline in the project activity

<u>Methane destruction in the flare</u>

The formula used to determine $MD_{flared, y}$ is calculated as follows:

$$MD_{flared,y} = (LFG_{flared,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \qquad (5)$$

Where:

$LFG_{flared,y}$ = Quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3)

$w_{CH4,y}$ = Average methane fraction of the landfill gas as measured during the year and expressed as a volumetric fraction (in m^3 CH_4 / m^3 LFG)

D_{CH4} = 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)

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
w_{CH4}	Measurement on same basis as $LFG_{flare,y}$	The measurements are comparable so long as both are taken on the same basis, either wet or dry or alternatively a conversion is made in accordance with guidance provided by ACM0001
D_{CH4}	0.0007168 tCH_4/m^3CH_4	This is the density of methane at standard temperature and pressure

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

$$D_{CH4} = \frac{P_{CH4}}{\frac{R_U}{MM_{CH4}} \times T_{CH4}} \qquad (6)$$

Where:

D_{CH4}	=	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)

<u>This approach will be taken unless the installed flow meters automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.</u>

<u>Methane destruction by generation of electricity</u>

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

$$MD_{electricity,\ y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4} \qquad (7)$$

Where:

$LFG_{electricity\ y}$	=	Quantity of landfill gas used to generate electricity during a year measured in cubic meters (m^3)
$w_{CH4,y}$	=	Average methane fraction of the LFG as measured during the year and expressed as a volumetric fraction ($m^3\ CH_4/m^3$ LFG)
D_{CH4}	=	Density of methane expressed in tonnes of methane (tCH_4/m^3 LFG)

Using EB 28 Annex 13, "Tool to determine project emissions from flaring gases containing methane", to calculate Project Emissions from flaring

Project Emissions from flaring will be determined following the procedure described in EB 28 Annex 13 which 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.

For Step 1 in particular, the mass flow rate of the residual gas ($FM_{RG,h}$) will be the product of the density of the residual gas and the volumetric flow rate of the residual gas ($FV_{RG,h}$). The density of residual gas is calculated based on the Ideal Gas Law using constants at Normal Temperature and Pressure (NTP) and the molecular mass of the residual gas. The molecular mass is calculated based on the volumetric fraction of CH_4, CO_2, O_2 and assuming the other components to be N_2[19]. The volumetric flow rate of the residual gas ($FV_{RG,h}$) is measured by the LFG flow meter (refer to Table A3.1 in Annex 3 for details on the equipment).

For Step 4 in particular, the mass flow rate of CH_4 in the exhaust gas ($TM_{FG,h}$) is the product of the volumetric flow rate of the exhaust gas and the concentration of CH_4 in the exhaust gas ($fv_{CH4,FG,h}$, which is to be calculated by converting the w_{CH4ex} values). The volumetric flow rate of the exhaust gas is calculated in Step 3 whereas the volumetric fraction of CH_4 in the exhaust gas (w_{CH4ex}) is measured using the FlueGas analyzer (refer to Table A3.1 in Annex 3 for details on the equipment)..

Project emissions are determined by the formula 15 of EB28 Annex 13.

The flare efficiency is calculated for each hour (or more frequently) in the year and EB 28 Annex 13 provides two options for calculating this parameter:

[19] The assumption of the other components as N_2 is an accepted approach in accordance with the EB28 Annex 13 Tool (Step 1).

- This Project will use Option 2 which involves continuous monitoring of the methane destruction efficiency of the flare with reference to the result of gas analysis before and after flaring of the gas.

- As a backup approach when there is a problem with the continuous monitoring (e.g., a problem with the CH_4 and/or O_2 exhaust data), the Project may also refer to Option 1 to determine flare efficiency. This involves assuming 90% or 50% default efficiency factor based on flare parameters meeting the manufacturer's operating specifications (such as temperature and flow rate of residual gas at the inlet of the flare).

<u>Project Emissions from combustion of fossil fuels</u>
Project Emissions are calculated using the formula:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \qquad (8)$$

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity in the project case. The project emissions from electricity consumption will be calculated following the Project Emissions Tool

$PE_{FC,j,y}$ = Emissions from consumption of heat in the project case

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$PE_{FC,j,y}$	0	There is no consumption of heat in the project case

According to the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", calculation of emission from consumption of electricity is based on the quantity of electricity consumed and an emission factor for electricity generation:

$$PE_{EC,y} = \sum EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y}) \qquad (9)$$

Where:

$EC_{PJ, j, y}$ = 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 technical transmission and distribution losses for providing

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	Value	Explanation
$TDL_{j, y}$	0	According to the Tool this simplification should be made in the case of Scenario B - electricity consumption from an off-gird captive power plant- which applies to the project activity

According to Approved methodological "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"(version 01) (EB 39 Annex 7), Scenario B "Electricity consumption from an off-grid fossil fuel fired captive power plant" the emission factor of the captive power plant is calculated as follows:

$$EF_{EL,j/k/l,y} = \frac{\sum_{n}\sum_{i} FC_{n,i,t} \times NCV_{i,t} \times EF_{CO_2,i,t}}{\sum_{n} EG_{n,t}} \qquad (10)$$

Where:

$FC_{n,i,t}$ = Quantity of fossil fuel type *i* fired in the captive power plant *n* in the time period *t* (mass or volume unit)

$NCV_{i, t}$ = Average net calorific value of fossil fuel type *i* used in the time period *t* (GJ/ mass or volume unit)

$EF_{CO2, i, t}$	=	Average CO_2 emission factor of fossil fuel type *i* used in period *t* (tCO_2/ GJ)
$EG_{n, t}$	=	Quantity of electricity generated in captive power plant *n* in time period *t* (MWh)
i	=	Fossil fuel types fired in the captive power plant *n* in the time period *t*
j	=	Sources of electricity consumption in the project
n	=	Fossil fuel fired captive power plants installed at the site of the electricity consumption source *j*
t	=	The monitored period (e.g. the year)

The following assumptions have been made for the purposes of adapting this equation to the project activity:

Parameter	**Value**	**Explanation**
$EF_{CO2, i, t}$	73,000kg/TJ	This is the IPCC default value used at the upper limit, which is most conservative.
i	Gasoline[20]	This is the only fossil fuel used to generate electricity for the project
j		There is only one source of electricity consumption for this project
n	1	Only one captive power plant has been installed- this is the fossil fuel fired start up generating unit

The consumption of fossil fuel used for the temporary start-up engine will be monitored and recorded in a weekly report. The consumption is estimated based on purchased quantities and stock changes. The emissions associated with the consumption of fossil fuel ($PE_{EC, y}$) will be calculated by multiplying the consumed quantity and the corresponding emission factor for gasoline/diesel. It should be noted that a very small quantity of fuel is needed for each start-up, which usually last for a few minutes at most. Therefore, the emissions from this source would be much less than 1% relative to the net emission reductions.

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

[20] Fossil fuel can be 'diesel' depending on parameters of the start-up generator; accordingly, the CO2 emission factor relevant to the fossil fuel type will be applied.

No leakage effects need to be accounted under ACM0001. There is no treatment of leakage in the monitoring plan.

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 need to be accounted under ACM0001. There is no treatment of leakage in the monitoring plan.

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:

There are no procedures for collecting and archiving information on environmental procedures required by the host party.

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.
1. $LFG_{total, y}$	Low	Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
2. $LFG_{flare, y}$	Low	Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
3. $LFG_{electricity, y}$	Low	Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
4. PE_{flare}	Low	Data treatment and calculations will incorporate a comprehensive QA/ QC procedure that will be documented for the purposes of verification.
5. T	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
6. P	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
7. h	Medium	Operation hours will be checked against the temperature of flaring and the results of gas analysis.
8. $PE_{EC, y}$	Low	Data treatment and calculations will incorporate a comprehensive QA/ QC procedure that will be documented for the purposes of verification.

9. w_{CH4}	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas. Adjustments will be made to wet/ dry basis as appropriate, if required.
10. w_i	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas.
11. $FV_{RG, h}$	Low	Flow meters will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy.
12. w_{O2ex}	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas.
13. w_{CH4ex}	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. A zero check and typical value check will be undertaken on gas analysers by comparison with standard certified gas Adjustments will be made to wet/ dry basis as appropriate, if required.
14. T_{flare}	Low	Thermocouples will be maintained, calibrated and replaced every year, or in accordance with manufacturer's specifications.
15. Other flare operating parameters	Not yet specified	Not yet specified
16. FC_y	Low	Equipment will be subject to a regular maintenance and testing regime in accordance with manufacturer's specifications to ensure accuracy. The metered consumption of fossil fuel by the project will be cross- checked with annual energy balance based on purchased quantities and stock changes.
17. EG_y	Low	Not Applicable

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

The project developer, equipment provider and local staff will work together to setup and maintain the operational and management structure for implementation of the monitoring plan outlined in Annex 3 of this PDD.

Local site engineers will be responsible to maintain monitoring equipment and supervise the electronic logging of all continuously monitored data parameters relating to methane destruction and project emissions. The local site engineers will receive training on equipment maintenance and calibration, data logging and transfer of electronic data for archiving at off-site locations.

A JI Monitoring Manager will be responsible for Quality Control and Quality Assurance on the raw data as well as processing the data and making Emission Reduction calculations in accordance with the Monitoring Plan.

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

20/12/2008
Mr. Reuben Maltby
Carbon Capital Markets Ltd.
7th Floor, 22, Billiter Street
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SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

The Project emissions are potentially represented by three sources:

1. Fugitive methane emissions due to not captured LFG.
One source of project emissions identified within the system boundary is fugitive methane emissions from the landfill, i.e. methane not captured by the collection system. It is assumed that the gas collection system installed will capture approximately 70% of the total amount of gas released by the landfill in the baseline scenario. The LFG collection efficiency of 70% is an average value commonly used in the industry. A range of 60-85% with a typical value of 75% is referenced in the US EPA AP-42 guidelines. For conservativeness, we used a value that is slightly lower than the typical value[21]. Therefore, the remaining 30% of fugitive emissions will be considered as Project emissions.

Note: these emissions are not caused by the Project, but would take place also in the baseline scenario.

The fugitive methane emissions from not captured LFG can be estimated from the following equation:

$$PEy_1 = W_{CH4,y} * D_{CH4} * (1-CE) * GWP_{CH4} \qquad (11)$$

where:

- PE_{y1} estimated project emissions from non captured methane, tons CO_{2eq}
- $W_{CH_4,y}$ methane generated at the landfill, m^3 of CH_4
- D_{CH4} methane density, kg/m³ of CH_4[22]
- CE LFG collection efficiency
- GWP_{CH4} global warming factor of methane, GWP = 21

2. Fugitive methane emissions in the flare due to the flare efficiency *(applicable for LFG flaring option only)***.**
Another relevant source of project emissions is methane not combusted in the flare. This source is covered through the parameter “flare efficiency” ($\eta_{flare,h}$ [%]), which enters the calculation of the emission reductions. Depending on availability of the monitoring equipment, either a default value of flare efficiency of 90% will be used or continuous monitoring of flare efficiency will be used to claim more than 90% efficiency methane destruction. The 90% value is applicable in the default scenario assuming that the temperature in the exhaust gas of the flare (T_{flare}) will be above 500 °C for more than 40 minutes during the hour *h* and the manufacturer’s specifications on proper operation of the flare are met continuously during the hour *h*.

If the LFG electricity is produced, efficiency of LFG combustion in power engines is 100%.

The methane emissions in the flare due to the flare efficiency can be estimated from the following equation:

$$PE_{y2} = W_{CH_4,y} * D_{CH4} * (1-CE) * (1-FE) * GWP_{CH4} \qquad (12)$$

where:

---

[21] The LFG forecast generated in the LFG model using the LFG collection efficiency (70%) is conservative, since the LFG flow estimated by the LFG model is about 30% lower than the data from the actual pump test.

[22] At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m_3CH_4.

PE_{y2} estimated project emissions from non combusted methane, tonnes CO_{2eq}
FE flare efficiency

Landfill gas collection efficiency is estimated at the level of ***CE= 70%***.

Default value for flare efficiency is fixed at the level of ***FE=90%***.

3. CO_2 emissions resulting from electricity used by LFG pumping equipment

Emissions from fossil fuel (gasoline) / LFG used during the Project for energy requirement on site under project activity during the year y, in TJ are determined according to the following equation:

$$PEy_3 = ET_y * CEF_{thermal, y} \qquad (13)$$

where:

PEy_3 estimated project emissions from fossil fuel (gasoline) / LFG used for electricity generation during the year y, tonnes CO_{2eq}

ETy quantity of gasoline / LFG used for own needs of the LFG flaring plant during the year y, TJ (please refer to the Annex 2 for details)

$CEF_{thermal, y}$ CO2 emissions intensity of gasoline / LFG, $CEF_{thermal, y}$ = 73,000kg/TJ for gasoline (This is conservative)[23]

The sum of the Project emission is equal to:

$$PE_y = PE_{y1} + PE_{y2} + PE_{y3} \qquad (14)$$

4. Emissions from construction works on installation of LFG collection system.

Since share of the construction emissions is less than 1% of the total baseline emissions, it can be neglected.

Results of calculation of the Project emission are given below. The table below shows that no LFG in the proposed project will be used for electricity generation. Only gasoline will be used for power supply.

Table 2 Results of calculation of the Project emission

Year	Methane not captured tonnes CO2e PE_{y1}	Methane not destroyed in Flare tonnes CO2e PE_{y2}	Emissions from Fossil Fuel use tonnes CO2e PE_{y3}	Project emission (flaring) tonnes CO2e PE_y
2009	50,457	11,773	93.5	62,324
2010	53,584	12,503	93.5	66,181
2011	56,397	13,159	93.5	69,650
2012	59,263	13,828	93.5	73,185
2013	61,196	14,279	93.5	75,568
2014	61,328	14,310	93.5	75,732
2015	54,970	12,826	93.5	67,889
2016	49,459	11,540	93.5	61,093
2017	44,666	10,422	93.5	55,181
2018	40,481	9,446	93.5	50,021

[23] Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 (Energy), P.1.23, Table 1.4

E.2. Estimated leakage:

No leakage needs to be accounted for by ACM0001, version 11.

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

The sum of E.1 and E.2 is equal to:

$$PE_y = PE_{y1} + PE_{y2} + PE_{y3} \qquad (15)$$

For the results of the calculation of the project emission please refer to the Section E6.

E.4. Estimated baseline emissions:

For calculation of baseline emissions two options are considered:
Since the LFG is flared in the project scenario, the GHG emissions in the scenario-without-project will come from decay of the whole amount of waste at Lviv landfill.

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 of waste at a solid waste disposal site (Version 04), Annex 10, EB 41”.

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 years *x* with x = 1 to x = y, starting with the first year landfill started receiving wastes until the end of the year *y* (the year 2012), for which baseline emissions are calculated *for* 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:

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

Where:

$BE_{CH4,SWDS,y}$ = Methane emissions avoided during the year *y* from preventing 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 in our case)

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 oxidised 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)
DOC_f = Fraction of degradable organic carbon (DOC) that can decompose (0.5)
MCF = Methane correction factor (1.0 in our case)
$W_{j,x}$ = Amount of organic waste type *j* prevented 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 Lviv landfill, 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) levelling 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 metres.

For the Lviv landfill, the MCF value of 1.0 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*: (see table below) 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.

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

Data used for the calculations are based on the recommended data on waste content for Ukraine and Russia[24].

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.

<table>
<tr><td>Data / parameter:</td><td>k_j</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value to be applied</td><td>
Apply the following default values for the different waste types j:
<table>
<tr><td colspan="2" rowspan="2">Waste type j</td><td colspan="2">Boreal and Temperate (MAT≤20°C)[25]</td><td colspan="2">Tropical (MAT>20°C)</td></tr>
<tr><td>Dry (MAP/PET <1)</td><td>Wet (MAP/PET >1)</td><td>Dry (MAP< 1000mm)</td><td>Wet (MAP> 1000mm)</td></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td><td>0.065</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>0.06</td><td>0.185</td><td>0.085</td><td>0.40</td></tr>
</table>
NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.

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.
</td></tr>
</table>

[24] Report: “On Preliminary Results of the Lviv SW Landfill Pump-Testing”

[25] Since Ukraine is in the boreal and temperate region with MAP/PET >1, the values in the corresponding column are used. The values are drawn from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)

For the calculations for Lviv landfill following values for **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 annual amounts of waste disposed at Lviv landfill during the recent years are shown 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"
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)	1.0	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Site situation

For the Lviv project, the baseline emissions are calculated as follows.

Year	LFG - generated	Methane - generated		baseline emission
	1000 m3	tonnes CH4	tonnes CO2e	tonnes CO2e
2009	16,760	6,006	126,142	126,142
2010	23,732	8,505	178,614	178,614
2011	24,977	8,951	187,990	187,990

2012	26,247	9,406	197,544	197,544
2013	27,103	9,714	203,986	203,986
2014	27,161	9,735	204,428	204,428
2015	24,345	8,725	183,232	183,232
2016	21,905	7,851	164,862	164,862
2017	19,782	7,090	148,885	148,885
2018	17,929	6,426	134,938	134,938

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 tables. The actual emission reductions generated by this project will be measured directly after the project is operational.

Year	Estimated project emissions (tonnes of CO2 equivalent)	Estimated leakage (tonnes of CO2 equivalent)	Estimated baseline emissions (tonnes of CO2 equivalent)	Estimated emission reductions (tonnes of CO2 equivalent)
2009[26]	46,743	N/A	126,142	79,400
2010	66,181	N/A	178,614	112,434
2011	69,650	N/A	187,990	118,340
2012	73,185	N/A	197,544	124,359
Total over 2009-2012 crediting period (tonnes of CO2 equivalent)	255,758*	N/A	690,291*	434,533*

*- Numbers may not add due to rounding

Year	Estimated project emissions (tonnes of CO2 equivalent)	Estimated leakage (tonnes of CO2 equivalent)	Estimated baseline emissions (tonnes of CO2 equivalent)	Estimated emission reductions (tonnes of CO2 equivalent)
2013	75,568	N/A	203,986	128,418
2014	75,732	N/A	204,428	128,696
2015	67,889	N/A	183,232	115,343
2016	61,093	N/A	164,862	103,770
2017	55,181	N/A	148,885	93,704
2018	50,021	N/A	134,938	84,918
Total over 2013-2018 period (tonnes of CO2 equivalent)	385,484*	N/A	1,040,332*	654,848*

*- Numbers may not add due to rounding

[26] Year 2009 values are prorated to 9-month period (from 01 April till 31 December 2009)

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 compliance with the Order No. 342 of the Ministry of Environmental Protection of Ukraine ("On approval of requirements to preparation of the Joint Implementation projects"), the environmental impacts for the LFG project at Lviv were assessed according to the regulation (DBN A.2.2-1-2003) approved by the order of the State Building Committee.

A comprehensive technical report "Technical restoration and active degassing of Lviv city ground of solid domestic waste" was prepared as a technical design document for the project and for evaluation by the five government agencies. The report includes a detailed section on the "assessment of impact on the environment" by the project that covers various impacts including the water quality, air quality, noise, and visual impacts of the project site and the surrounding area.

Implementation of the project will make the landfill site a safe object for LFG exploitation, stabilize environmental conditions at the landfill and surrounding area, and also make an essential contribution to Ukraine's compliance with the requirements of UNFCCC on climate change.

Biogas collection and utilization system at the Lviv landfill will reduce substantially the negative impact on the air quality, both at local and global levels, as well as landfill gas emission into the atmosphere. Capture of the LFG will eliminate the former fire and explosion risks on site.

Implementation of the Lviv Landfill JI Project will eliminate anthropogenic impact on the environment, improve ecological situation, and bring environmental indexes to standard condition, which on the whole will have a positive effect on the living standards of people, living in the vicinity of the landfill site.

During phases of the project design and construction, the following key aspects will be addressed:

- Water Quality

1) LFG Condensate: The system of LFG pump and transportation and compression needs condensate to cool, and the condensate can be reused by the circular collection system. It will not impact environment.
2) Sewage: The sewage will be collected in a sewage tank, and will be transported to the sewage pool by excreta van. It will not impact environment.
3) Landfill Leachate: The leachate of landfill farm will be collected by spray drain, and the spray drain will transport the leachate to the leachate pool. Then the leachate will be pumped to the sewage farm. It will not be released into the environment.

There are no surface water-ways in the area around the Landfill site. There are some quaternary soil water flows and currently, in the surrounding areas to the landfill site traces of contamination of soil waters (particularly in the lake-marsh areas) with toxic components of dump filtrates can be found.

Within the framework of this project, the system of biogas flaring will decrease the level of filtrate from the landfill as the pumping activities will form drainage wells. A larger part of the filtrate will be transported to the sewage system for physical and chemical purification. The re-stabilising works to cover the landfill area with an isolating layer of clay together with the pumping system will considerably reduce the load of landfill filtrates in the soil waters in and around the landfill area.

- Air Quality

This project flares LFG which is collected from the landfill farm. Thus, it reduces greenhouse gas and effluvium currently being emitted into the atmosphere, as well as reducing likelihood of fire or LFG explosion on site. Besides the major components of LFG, CH4 and CO2, there are many volatile organic compounds in LFG, including hydrogen (H), ammonium (NH3), sulphur hydrogen (H2S) and less often carbon oxide (CO). Capture and flaring of this LFG will result in these substances being converted into water and CO2. This will mitigate some of the harmful effects associated with LFG, including; intensive odours, in places; accumulation of toxic effects; and, on a global level, it constitutes a powerful contribution to the Greenhouse effect. Where the waste is fragile and poorly compacted, fires can break out. This leads to pollution of atmosphere with ash, harmful aromatic compounds including nitric oxide, serum oxide and dioxins (known carcinogens). The LFG also includes organic substances, microorganisms, including malignant ones, also having a negative impact on the environment, living organisms and human health. By implementing a system of landfill maintenance, collection and utilization of biogas onsite, these negative impacts on the air quality will be considerably reduced.

- Noise

The equipment selected is state of the art and on a low noise grade. The expected sound level is 65 dB. It is not considered significant and has been approved by State Committee for Industrial Safety Labour Protection.

- Visual Impacts

Most of the LFG collection system is buried under the landfill site, so it will bring negligible negative impact to visual landscape. The construction of the flaring equipment is well coordinated with the surrounding environment. It will not impact environment.

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:

In compliance with the Order No. 342 of the Ministry of Environmental Protection of Ukraine (“On approval of requirements to preparation of the Joint Implementation projects”), the environmental impacts for the LFG project at Lviv were assessed according to the regulation (DBN A.2.2-1-2203) approved by the order of the State Building Committee. The conclusion was that no impacts (as described in Section F.1) were considered negative. This process required individual approvals from four government agencies, as required by DBN A.2.2-1-2203, to be obtained and submitted to the Lviv State Building Committee who then issued the final approval on August 6 of 2008. The construction of the project commenced after all the required approvals were received.

- Final Approval No. 8.749K as of 06/08/2008 by **Lviv State Building Committee**. Ministry of Regional Development And Construction of Ukraine.

SECTION G. Stakeholders’ comments

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

As part of the EIA process, a public stakeholder consultation process was developed to inform the stakeholders of the proposed project and to invite them to provide comments.

The following public events were hosted by the Project Participants in the framework of a stakeholder consultation for the Lviv landfill Project:

1. Stakeholders meeting in The Velyki Grybovychy Local Council, April 2008.
   The participants of the meeting included:
   - Velyki Grybovychy Local Council deputies;
   - Representatives of The Zhovkiv District Administration;
   - Representatives of The Lviv City Council.

2. Stakeholders meeting in The Lviv Regional Administration, May 2008.
   The participants of the meeting included:
   - Lviv City governor;
   - Mayor of the Lviv Municipality.

3. Stakeholders meeting in The Lviv Regional Administration, June 16, 2008.

4. Stakeholders meeting in The Lviv City Council, June 19, 2008

5. Public session in Velyki Grybovychy on June 22, 2008
   The participants of the meeting included:
   - Representatives of The Lviv City Administration;
   - Representatives of The Zhovkiv District Administration;
   - Representatives of The Lviv Regional Administration.

6. Stakeholders meeting in The Lviv Region Administration, June 25, 2008.
   The participants of the meeting included:
   - First Deputy Mayor of The Lviv Municipality;
   - Deputy Mayor of The Lviv Municipality.

In addition to these stakeholder meetings, an article describing the project activities was published in the Lviv local newspaper “Express” and Zhovkiv local newspaper “Vidrodzhennya”, May 31, 2008.

During these public sessions, the community, environmental experts, the City Council and Regional Administration’s commented in positive terms about the project the Project Proponent “Gafsa”. They showed their interest on cooperation on solving the problem with waste treatment at this particular site. These comments were noted and approved in meeting minutes as well as a more formal approval letter and a memorandum of Understanding.

This approval, containing signatures of members of the local community (84 members) was signed. The approval states that the local community would support the project providing it obtained all necessary state approvals and then overall approval by the State Building Commission/UKRDERJBUDEXPERTISA (this condition was subsequently met). This approval was also signed and sealed by the head of the Gribovichy Village, I.Pitel' on 22/06/2008.

The Memorandum of Understanding was signed in 2008 between the representatives from the Lviv Regional Administration, Lviv City Council, Lviv Regional Council and the project investors showing the support from the municipality of the project.

In summary, no negative comments were received from the stakeholder meetings and, in fact, only positive comments that were supportive of the project were received from the stakeholders.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Represented by:	
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Annex 2

BASELINE INFORMATION

Table A2.1 Annual waste input*

Year	Annual waste delivery (1000 tonnes)
1970	0
1971	3
1972	7
1973	10
1974	14
1975	17
1976	21
1977	24
1978	28
1979	31
1980	35
1981	38
1982	42
1983	45
1984	49
1985	52
1986	56
1987	59
1988	63
1989	66
1990	70
1991	73
1992	77
1993	80
1994	84
1995	87
1996	91
1997	94
1998	98
1999	101
2000	105
2001	108
2002	112
2003	115
2004	240
2005	230
2006	240
2007	250
2008	250
2009	250
2010	260
2011	260
2012	270
2013	250

2014	200

*
Source: “On Preliminary Results of the Lviv SW Landfill Pump-Testing” 2008

Note that waste volumes from 2004 to 2014 were provided in the report and historical amounts were extrapolated from total accumulated waste volumes in the report.

The first year of disposal is 1971. The waste composition and waste composition data was taken from “On Preliminary Results of the Lviv SW Landfill Pump-Testing” report and provided by Gafsa. It is the best data source as Gafsa is the operator of the landfill and has access to the historic and current data.

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 flare and LFG generator [Nm3]
- LFG temperature [°C] and pressure [mbar]
- Methane content in the landfill gas [%]
- Flare operation time [h]
- Temperature of the flare exhaust gas [°C]
- O_2, CH_4 in the flare exhaust gas (for determining flare efficiency) [%]

Landfill gas flows and methane content will be determined on a continuous basis. The same applies for the flare operation time and the LFG generator operation time. 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.

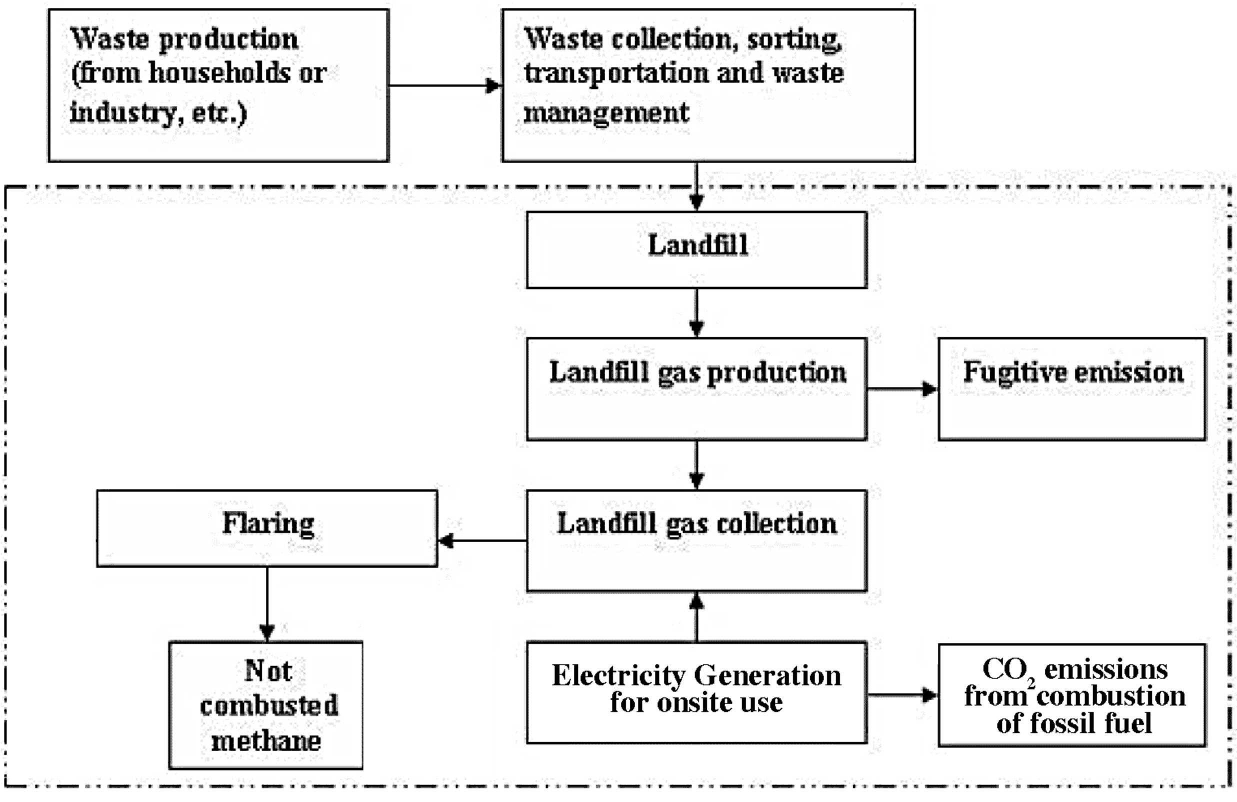

Table A3.1 Additional Information about the Monitoring Equipment

Equipment	Variables Monitored	Operational Range	Calibration Procedure	Comment
LFG flow meter (turbine type)	$LFG_{total,y}$	+/- 1 %	Equipment will be calibrated every three years, as described in the manufacturer's manual.	There is one flow meter of turbine (mechanical) type that measures the volume of residual gas in the main outlet pipe before the gas is diverted into two delivery pipes. The volume of residual gas (m^3/hr) is automatically adjusted to the normal conditions (NTP). Failing that, the measured temperature and pressure will be used to calculate the volume at NTP. The measurement is done in the dry basis. Data will be archived electronically for the crediting period plus two years. At least hourly data will be archived.
LFG flow meter (thermal mass type)	$LFG_{flare,y}$ $LFG_{electricity,y}$	+/- 1 %	Equipment will be calibrated as described in the manufacturer's manual.	After the residual gas is diverted into two streams, there is one flow meter of the thermal mass type measuring the volume of the residual gas entering the flare and another one of the same type measuring the volume of gas entering the gas engine. Data will be archived electronically for the crediting period plus two years. At least hourly data will be archived.
Fixed LFG Analyser	w_{CH4} w_{CO2} w_{O2}	+/- 1%	Equipment will be calibrated on a weekly basis, as described in the manufacturer's manual.	There is a gas analyzer unit, installed before the turbine flow unit, for analyzing the residual gas. Type: Infrared for measuring CH_4 and CO_2 Type: Electrochemical for measuring O_2 The analysis is done on the dry basis.

Equipment	Variables Monitored	Operational Range	Calibration Procedure	Comment
				Data will be archived electronically for the crediting period plus two years. At least hourly data will be archived.
FlueGas Analyzer	w_{CH4ex} w_{O2ex}	+/- 1%	Equipment will be calibrated on a weekly basis, as described in the manufacturer's manual.	There is a gas analyzer unit for analyzing the flue gas. Type: Infrared for measuring CH_4 Type: Electrochemical for measuring O_2 The measurement point (sampling point) is in the upper section of the flare. The analysis is done in the dry basis. Data will be archived electronically for the crediting period plus two years. At least hourly data will be archived.
Temperature transmitter	T	+/- 1^{o}C	The transmitter is calibrated when the flow meter unit is calibrated (i.e., transmitter is integrated into the flow meter unit).	There is one temperature transmitter in the turbine flow meter unit (i.e., in the gas main), and one in each of the thermal mass gas-counter unit (i.e., one in the flare delivery line and one in the engine delivery line). Data will be archived electronically for the crediting period plus two years. At least hourly data will be archived.
Thermocouple	T_{flare}	+/- 1.5^{o}C	Equipment is calibrated or replaced every year.	The thermocouple is installed in the flare system to measure the temperature of the exhaust gas. Data will be archived electronically for the crediting period plus two years. At least hourly data will be archived.

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;
- QA/QC procedures;
- 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:

- **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.
    - In the case that the gas engine generator fails to work for any reason, the blowers and flare will be shut down, that is, not run off the diesel engine. Therefore, in these cases, no ERUs will be claimed and no LFG will be vented.

- **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.

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 JI 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 JI Project Team will be formed for monitoring purposes for the project activity. The project team comprises at least one representative of project investor and project developer.

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
- 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.

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