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

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Annexes

SECTION A. General description of the project

A.1. Title of the project:

"Landfill methane capture and flaring at Yalta and Alushta landfills, Ukraine"
Document version number: 03
April 17 2007

A.2. Description of the project:

The project "Landfill methane capture and flaring at Yalta and Alushta landfills {hereinafter referred to as Sites}, Ukraine" {hereinafter referred to as Project} has been developed by Scientific-Engineering Centre Biomass, Ukraine and Carbon Capital Markets Ltd., UK.

The Project consists of developing a Landfill Gas ("LFG") collection and flaring system (with possible extension to the electricity production in the 2nd Project phase) in order to avoid emissions of methane being released into the atmosphere. LFG production results from waste decay in the anaerobic conditions created in the landfill body and contains approximately 50% methane ("CH_4"), which is a powerful greenhouse gas ("GhG") contributing to global warming. Additionally, LFG is a fire hazard and causes bad odours in the vicinity of the site. By capturing the LFG, GhG emissions are reduced, local environmental impacts are mitigated and the operational safety of the site is increased.

The proposed Project includes capturing LFG and combusting it in the flare. As an optional later phase, LFG may be utilized for electricity (and possibly heat) production. The estimated capacity of LFG power engines which can be commissioned is 1.2 MW for the Yalta landfill and 0.6 MW for the Alushta landfill. The decision to invest in a LFG to Energy ("LFGTE") modules will be made on the basis of an economic review, possibility to connect to the public grid, and whether a Power Purchase Agreement ("PPA") can be obtained.

The Ukrainian towns of Yalta and Alushta have a population of 150,000 and 60,000 inhabitants, respectively and are located 30 km apart. They are served by two separate landfills located at a distances of up to 10 km from the towns. The **Yalta landfill** has a total extension of 5.7 hectares and commenced operation in 1973. Approximately 60,000 tons of waste per year has gone into the landfill and the total amount of waste in the landfill is approximately 1.3 million tons. The Yalta landfill consists of two major sections, one of which is currently receiving waste. The other section with a total area of 3.4 ha has already reached its capacity and is closed. The LFG collection system will be installed at this old part of the landfill.

Operation of the **Alushta landfill** commenced in 1960. The Alushta landfill area is 6.9 hectares with approximately 720,000 tons of waste in place. The landfill owner is Alushta City State Administration and the landfill operator is the municipal waste transportation company. Today, the landfill has not reached capacity and, therefore, has no plans to close.

On both Sites, connection to the power grid is presently unavailable which presents a barrier for the realization of power generation.

Municipalities of the both towns have signed the concession agreement, granting the rights for degasification of landfills and utilization of LFG to the Ukrainian private company Gafsa-Skhid for a 10-year period.

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

- installation of wells and a piping network for LFG collection,
- installation of a flaring system including gas booster, flare and monitoring system, and
- optional connection to the power grid and commissioning of an engine-generator set for power production.

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

- reshaping the land and accumulated residues; and
- sealing the site with an industrial liner to facilitate the correct drainage of the biogas and contribute to the stability of the landfill as well as prevent methane from leaking into the atmosphere.

The ex-ante analysis shows that the average amount of methane collected annually during the period of 2008-2012 will be 2.0-2.5 thousand tons of methane tones per year at the Yalta landfill and 1.0-1.2 thousand tons of methane per year at the Alushta landfill. Flaring alone will achieve an estimate of **312,230 tonnes** of CO_2e over the 5-year commitment period and flaring with electricity production will achieve an estimate of **406,309 tonnes** of CO_2e over the same period.

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

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

A.3. Project participants:

Party Involved	Legal entity project participant	Does the Party involved wish to be considered as project participant
Ukraine (Host Country)	• Gafsa-Skhid	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 maps below.

A.4.1.1. Host Party(ies):

Ukraine

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

Autonomous Republic of Crimea.

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

Yalta and Alushta towns.

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

The Project is located in the Autonomous Republic of Crimea in the Ukraine on the Black Sea at the municipal landfills of Yalta and Alushta. The two towns are located approximately 30 km apart. Yalta has a population of 150,000 inhabitants and Alushta has 60,000 inhabitants. Yalta and Alushta towns are marked with red dots on the map below (*Figure 1*).

Figure 1: Towns of Yalta and Alushta (Autonomous Republic of Crimea, the Ukraine)

The Yalta landfill is located next to the village of Gaspra at a distance of 8-10 kilometres from Yalta and 40 kilometres from Alushta. The Alushta landfill is located next to Alushta at a distance of 6 kilometres from Alushta and 35 kilometres from Yalta. The Sites are highlighted below (*Figure 2*).

Figure 2:Yalta and Alushta landfills (left to right)

The Yalta landfill site is located at the following coordinates: 44º26’57’’N and 34º06’31’’E. The Alushta landfill site is located at the following coordinates: 44º43’18’’N and 34º26’05’’E.

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

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

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

The Project activities are summarized below:

(a) Remediation (landfill covering system)
(b) Landfill gas collection system
(c) Gas flaring
(d) *Optional:* Electricity generation

Prior to the development and installation of a methane capture and recovery system, a feasibility study will be carried out including soil boring tests and pumping tests to determine landfill characteristics and quantity as well as quality and flow rate of the landfill gas. The final equipment design will be decided after the feasibility study.

(a) Remediation

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

(b) Landfill gas collection system

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

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

At each landfill, perforated plastic vertical gas extraction wells will be established in the waste material and will be connected to the blower system through a network of horizontal underground piping installed on/around the perimeter of the landfill. The LFG collection piping consists of a header, sub-headers, and laterals. LFG flows from the wells through the lateral and sub-header piping to the header piping to the gas control plant. The flow of gas can be controlled at each of the individual vertical extraction wells through the use of a valve located at the top of the well piping. The gas collection pipe work allows for effective condensate management by employing dewatering points at strategic low points and returning the condensate back to landfill.

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

(c) Gas flaring integrated booster and flare station

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

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

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

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

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

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

- flow meter to measure the volumetric flow of the gas through the system;
- LFG pressure and temperature transducers for calculation of the gas mass flow rate;
- gas analyser (methane, carbon dioxide, oxygen, nitrogen) that measures the quality of the gas delivered to the flare;
- sampling points for taking gas samples with portable instrumentation and for laboratory analysis;
- thermocouple that monitors the temperature of the flame in the stack and feeds back the signal to the automated air louver in order to maintain the temperature within the stack at desired level; and
- data logging system.

(d) Electricity Generation

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

- Establishing grid connection. Currently, the closest power transmission lines are located at the distances of 1.5 km for the Yalta landfill and 5 km for the Alushta landfill.
- Establishing a Power Purchase Agreement. Power would be sold to the power grid or under direct agreements with power consumers.
- Flow of LFG. This will be proved after installation of the LFG collection system

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

- Gas engine-generator
- Connection to the electrical grid

The packaged generation system consists of an outdoor, acoustic, containerized generating set with an engine/alternator set. The engine units may be fully containerised, turbocharged gas engines with a separate control room and housing for its own transformer and switch. As the gas production increases or decreases then containerised engine units can be easily added or taken away to match the gas production.

In the meantime, a small diesel generator will be used on-site for power requirements for various components of the system such as blowers. Specifics of the size will be finalised as part of the design of the landfill collection system.

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

In the table below, the expected origin of the LFG collection and flaring/LFGTE system components is given.

Component	Imported or locally manufactured	Standard
Wells	Locally manufactured	According to local standards
Gas collection system	Locally manufactured	According to local standards
Flaring system	Imported from EU	According to EU Standards
Diesel power plant	Locally manufactured	According to local standards
(optional) Gas engine and generator sets	Imported from EU	According to EU Standards (noise, emissions, operational safety)
Monitoring and control systems	Imported from EU	According to EU Standards

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

Phase 1: a gas collection system with collecting pipes, manifolds, blowers and monitoring & control systems will be installed on both Sites. Final design will take place after feasibility tests.

Phase 2 (optional): Based on the experience and monitoring data of the first months of operation and negotiations with the potential power consumers, a gas engine/generator set may be installed. The capacities of the generation units will only be determined on the basis of the pump testing results. Estimated power capacities are 1.2 MW of installed generating capacity for the Yalta landfill and 600 kW of installed generating capacity for the Alushta landfill. The objective is to cover the entire electricity demand of the landfill installations and to supply the surplus of electricity produced into the high voltage grid of the local utility.

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

Most Ukrainian landfills were started as unauthorized dumps and are not in compliance with any environmental protection measures as regards LFG control. Before 2005, national standards on landfills operation did not envisage mandatory LFG control. In 2005, National Construction Standard DBN V.2.4-2-2005 Basics of Sites Design was introduced containing requirements on LFG collection and flaring/utilisation after the landfill closure. However, municipalities and municipal companies operating landfills are in a poor financial state and cannot invest in such projects. Moreover, implementation of LFGTE technologies in Ukraine as commercial projects is not possible due to low electricity tariffs. Other hurdles for introduction of LFG collection technologies are presented by a number of investment and technological barriers. LFG recovery projects have yet to be implemented in Ukraine and are unlikely to be implemented on a wider scale for the coming decade.

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

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

1. full release of landfill methane into the atmosphere;
2. CO_2 emissions from generation of grid electricity to be replaced with the power produced from CO_2 neutral fuel – landfill gas.

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

1. **Abatement of methane release into the atmosphere.** Methane in the form of landfill gas will be captured and destroyed through flaring.
2. *(optionally, in case the LFGTE unit is installed)* **Substitution of the power grid emissions**. Methane in the form of landfill gas will be captured and destroyed through flaring and CO2 from generation of the grid electricity will be replaced through use of LFG.

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

The emission reduction estimates for Yalta and Alushta landfills are given in the table below.

	Years					
Length of the crediting period	5 [1]					
Year	Estimate of annual emission reductions in tonnes of CO_2equivalent					
	Yalta landfill		**Alushta landfill**		**Total for Yalta and Alushta landfills**	
	Flaring option	**LFG-to-electricity option**	**Flaring option**	**LFG-to-electricity option**	**Flaring option**	**LFG-to-electricity option**
2008	40 078	52 432	18 521	24 556	58 600	76 988
2009	41 406	53 907	19 075	25 171	60 481	79 078
2010	42 760	55 412	19 643	25 802	62 403	81 214
2011	44 143	56 949	20 225	26 449	64 368	83 398
2012	45 556	58 519	20 822	27 112	66 378	85 631
Total estimated emission reductions over the crediting period **2008-2012** (tonnes of CO_2equivalent)	**213 944**	**277 220**	**98 286**	**129 089**	**312 230**	**406 309**

A.5. Project approval by the Parties involved:

Letter of Endorsement for Yalta and Alushta LFG project from the Ministry of Environmental Protection of Ukraine is available on request.

[1] After the end of the 1st commitment period the crediting period will be extended according to the UNFCC regulatory framework.

SECTION B. Baseline

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

The baseline and monitoring methodology to be applied for the proposed project activity is the approved consolidated baseline methodology ACM0001, version 5, December 2006: ***"Consolidated baseline methodology for landfill gas project activities"*** and ***"Consolidated monitoring methodology for landfill gas project activities"***. For emissions reductions associated with electricity generation using LFG, this PDD also incorporates the small-scale CDM methodology AMS I.D Version 10, December 2006 ***"Grid connected renewable electricity generation"***.

ACM0001 is applicable to this Project since the Project baseline is total atmospheric release of LFG and the Project Activities are gas capture and flaring and possible energy generation. Since the Project will claim emission reduction from avoided energy generation from other sources, the small-scale AMS I.D is also employed.

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 baseline is the atmospheric release of the gas with no capture and destruction. Landfills in Ukraine operate in a state of non-compliance with existing environmental legislation due to poor finances of landfill owners and operators as well as lack of technical knowledge.

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

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

This step is not applicable to the Project Activity.

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

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

	Alternatives to Project Activity	Probability of Scenario
1	The continuation of the current situation: no landfill gas extraction	*Most probable*: Current practice shows that the regulations on landfills across the Ukraine are not enforced. In addition, the technical expertise and financial investment to engage in the LFG collection project is not available in Ukraine. Therefore, it is not expected that the regulation requiring the capture and destruction of landfill gas at the Sites will be followed.
2	Extraction of landfill gas and combustion of the gas in a flaring stack for methane emission reduction only (as non-JI project);	*Not probable*: The project activity requires funds for both construction of the required facilities and to maintain operations.

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

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

Sub-step 1b. 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 flaring/utilisation after the landfill closure. 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 *Step 4. Common Practice Analysis* below).

Thus, even if Alternative 1 does not comply with the existing regulation it is considered a plausible baseline scenario. All other alternatives are consistent with aforementioned legislation.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

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

Alternative 2, which represents the Project activity without ERUs, does not contain any income, therefore, a simple cost analysis may be used.

In case of Alternative 3, which represents possible second development stage of the Project activity, there would be economic benefits other than related to JI income, but not on a scale comparable to other alternatives. Therefore, for the Alternative 3, benchmark analysis will be applied.

Sub-step 2b: Simple cost analysis for the Alternative 2: Extraction of landfill gas and combustion of the gas in a flaring stack for methane emission reduction (as non-JI project).

Total investment of the LFG collection and flaring systems for the Sites is estimated to be about **1.1 million USD**. The LFG system will also incur additional expenses once it becomes operational (e.g., maintenance, management, administrative) of approximately 5% of the total capital cost.

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

Sub-step 2b: Benchmark analysis for the Alternative 3: Installation of landfill gas extraction system and LFG power generation equipment for electricity production and supply to the public network (non-JI project).

The likelihood of development of this project, as opposed to the continuation of current activities (i.e., no collection and combustion of landfill gas), will be determined by comparing its IRR with the benchmark of interest rates available to a local investor. In February 2007, commercial interest rates at local banks in Ukraine were 10.0% for USD deposits. The benchmark rate of return on projects with similar risks involved is commonly set at least at 20%.

Sub-step 2c: Calculation and comparison of financial indicators (Alternative 3**).**

The total investments (phases 1 and 2) for both Sites amounts to 3,200,000 USD. This includes feasibility study, pumping tests, the implementation of 2 complete gas collection systems and installation of gas engines/power generator sets on both Sites with a total capacity of 1.8 MW. Operating and maintenance costs for all systems are expected to be in the range of 200,000 USD per year, representing 6 % of the total investment. Assuming a net sales price of 40 USD/MWh (exchange rate 1 USD = 5.05 UAH) for the electricity exported to the grid in the period starting from 2008 till 2017 (amounting annually to about 14,400 MWh), a project IRR of 5.6 % results.

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

NPV uses 10% discount rate.

LFG-to-electricity utilization (main assumptions)	
Investments, USD	3,200,000

Annual operating costs, (aver. 2008-2020) USD /yr	200,000,000	
Power tariff	40 USD/MWh	
Discount rate	10 %	
ERU price (USD)	11	
Financial parameters	Without ERU sale	With ERU sale
IRR, %	5.6	21.8
NPV (USD)	-614,500	1,330,000

The IRR as explained above is significantly lower in comparison to:
• Average commercial deposit rates of 10% interest rate
• IRR expectations of > 20% of commercial investors in renewable energy projects or industrial investors using similar technologies (e.g. gas engines) and having similar technical and commercial risks (Excluding the Kyoto risks).

Sub-step 2d: Sensitivity analysis
A sensitivity analysis was conducted by altering the following parameters:
• Increase in project revenue (price of electricity sold to the grid);
• Reduction in project capital and running costs.

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 10%, and assessing what the impact on the project IRR would be (see Table below). As it can be seen, the project IRR remains lower than its alternative even in the case where these parameters change in favour of the project.

Table: Sensitivity analysis

Scenario	**% change**	**IRR (%)**	**NPV, Euro**
Original		5.6	-614,500
Increase in project revenue	10%	7.9	-296,000
Reduction in project costs	-10%	7.3	-341,700

Note: NPV applies a 10% discount rate.

In conclusion, the project IRR remains low even in the case where these parameters change in favour of the Project. Even though these numbers are closer to the risk free returns of government bonds, these are still too low for a risky enterprise such as the construction and operation of a landfill gas-to-energy project, and fairly lower than private equity investments such as 20%. Consequently, the Project cannot be considered as financially attractive.

Step 3. Barrier analysis
Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity:
Technical and investment barriers impeding implementation of LFG collection and flaring/utilisation project are discussed below:

1) Investment barrier.
One of the main obstacles for establishment of proper landfill operation procedure is lack of funds of the municipalities owning the landfills. The present MSW collection and disposal tariff level is about 0.1% of the average family income compared to the international benchmark of 1%. The revenues of landfill operators from MSW disposal are insufficient to ensure appropriate MSW disposal in accordance with technological standards, e.g. soil covering, leachate treatment, etc. The present tariffs do not provide a revenue stream capable of covering the operation and maintenance costs of a proper municipal waste collection service system, let alone the required investments. Required investments are mainly financed from the local budget and natural environmental protection fund rather than through tariff increases, and amount of financing from these sources as well as funds available from the government budget is very limited[2].

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

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):
The investment analysis and barriers described above clearly highlight that continuation of the current situation is the least cost, most plausible option. With regards the legislation requirements in place, the common practice shows that non-compliance with requirements regarding landfill management is widespread in the Host country landfill practices.

Step 4. Common Practice Analysis

Sub-step 4a: Analyse other activities similar to the proposed project activity
In spite of the 2005 regulation, waste disposal in Ukraine is, in many cases, carried out at landfills and dumpsites that are improperly located, mainly in terms of hydro geological conditions and distance to water bodies, wells and aquifers.

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

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

[3] 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.

Landfill site / Aspects investigated	Number of inhabitants serviced by landfill, in thousand	Annual waste amount (uncompacted) in 1000 m^3 in 2004	Total amount of waste collected (uncompacted), mln. m^3	Starting year of landfill site operation	Total landfill area, ha	LFG control
Yalta	150	240	6.5	1973	5.7	None
Alushta	60	120	3.6	1960	6.9	None
Zhytomir	300	300	8.0	1957	18.7	None
Vinnitsa	385	340	5.1	1985	5	None
Khmelnitsky	250	490	14.8	1956	8.8	None
Chernivtsi	260	340	2.7	1995	25	Passive venting
Ivano-Frankivsk	230	260	3.0	1992	22.4	None
Lutsk	215	340	3.6	1991	9.9	None
Rivne	245	400	12.2	1959	24.5	None
Kirovohrad	280	260	10.9	1949	23	None
Cherkassy	310	360	4.8	1992	9	Passive venting
Kremenchuk	245	290	12.3	1965	28	None

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

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

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 an LFG control system at all.

Sub-step 4b: Discuss any similar options that are occurring
Discussions on installation of gas collection and flaring systems in Ukraine have only started in the context of the JI scheme application. Several projects are being prepared as JI projects and are at the different stages of development from Project Idea Note to development of PDD.

Step 5. Impact of JI registration

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

Alternative 2:
Assuming that ERUs have a market value of 11 USD per tonne, the project may have an IRR of approximately 60%.

Alternative 3:
Assuming that ERUs have a market value of 11 USD per tonne and generate additional revenues from the sale of electricity to the grid (assuming a market value of 40 USD/MWh), the IRR is projected to be approximately 20% (pending detailed final investment analysis).

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

Summary: The above analysis shows that Alternative 2 and Alternative 3 do not represent the baseline scenario. Since a PPA has yet to be secured, Alternative 2 has been chosen as the Project activity.

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

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

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

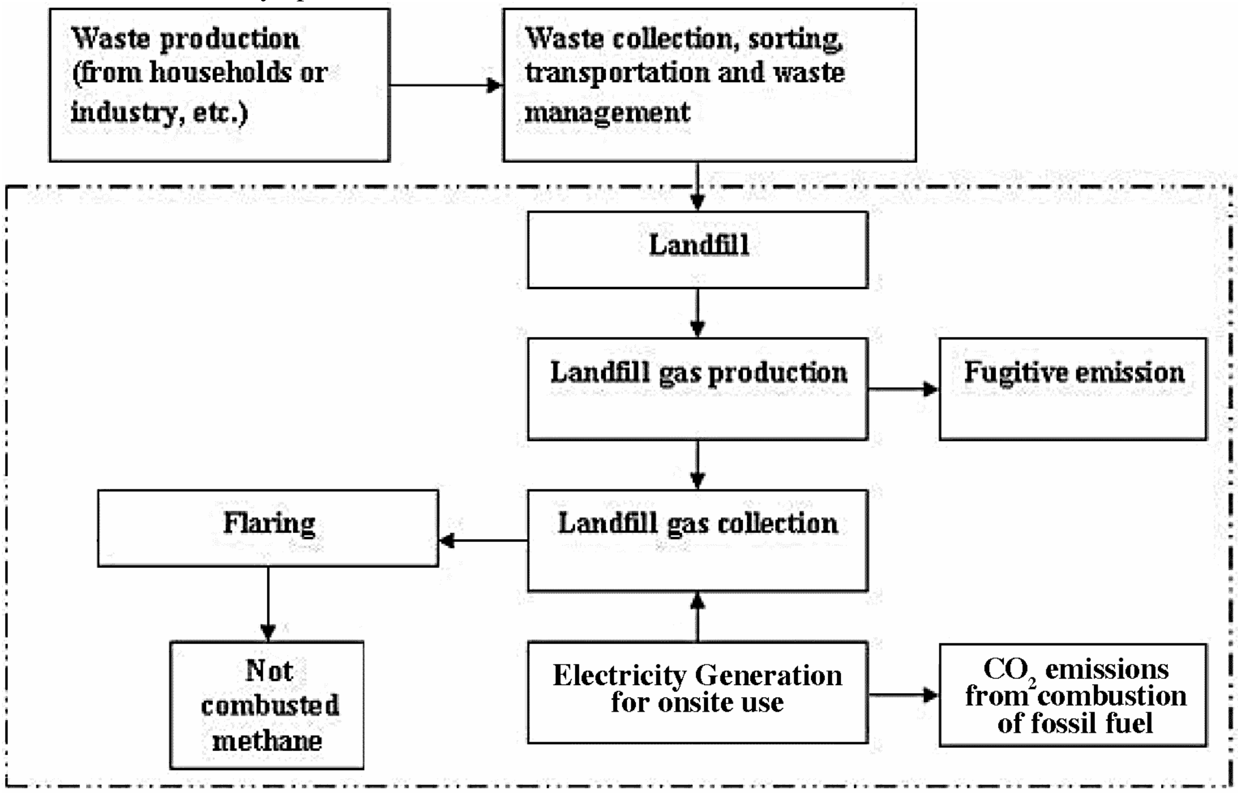

Figure 3 Project boundary for the LFG flaring option

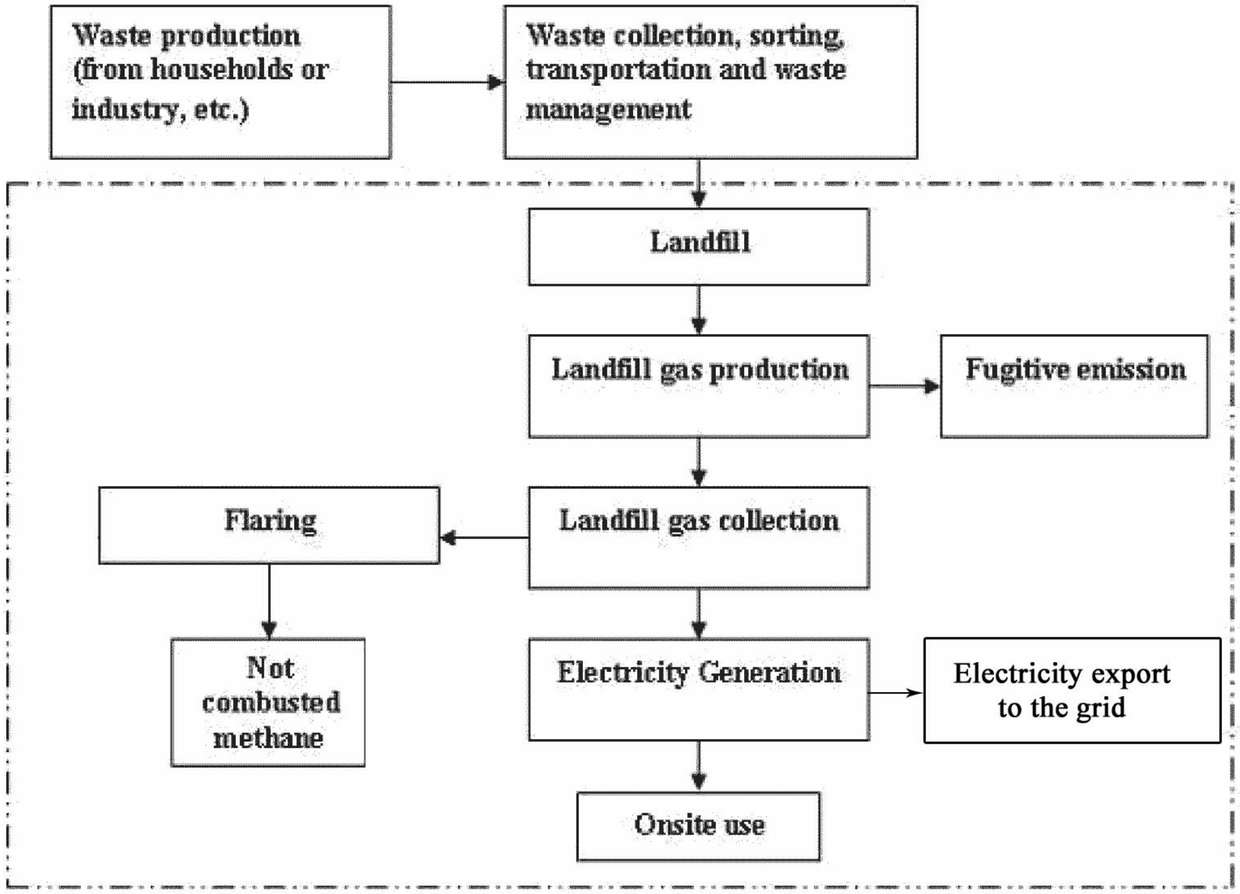

Figure 4 Project boundary for the LFG-to-electricity option

Summary of system and project boundaries

Emissions	Project scenario	Baseline scenario
Direct on-site	**CH_4:** Emissions associated with fugitive LFG emissions. **CH_4:** Emissions from methane not combusted in the flare (default value of 10%) **CO_2:** Emissions from LFG combustion either in flare or in power engine – not applicable. When combusted, methane is converted into CO_2. As the methane is organic in nature these emissions are not counted as project emissions. The CO_2 released during the combustion process was originally fixed via biomass so that the life cycle CO_2 emissions of LFG are zero. The CO_2 released is carbon neutral in the carbon cycle.	**CH_4:** Uncontrolled release of LFG generated.
Direct off-site	Transportation of equipment to project site – non-significant *(LFG-to-electricity option)* Use of electricity generated from landfill gas, replacing more carbon intensive electricity, thus reducing CO2 emissions in the electricity grid.	*(LFG-to-electricity option)* Emissions associated with the use of grid electricity replaced by electricity from landfill gas in the Project

	(only considered in case of LFG flaring) Emissions from diesel generator used for production of electricity for the needs of the plant.	scenario. None identified
Indirect on-site	None	None
Indirect off-site	None	None

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: 31 March 2007
Person/entity determining the monitoring methodology:

Scientific Engineering Centre "Biomass"
Contact person: Alexandra Pukhnyuk
P.O. Box 66, Kiev-67, 03067, UKRAINE
Tel: (+380 44) 453 2856; 456 9462
Fax: (+380 44) 453 2856; 456 9462
E-mail: pukhnyuk@biomass.kiev.ua
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SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

01/12/2007

C.2. Expected operational lifetime of the project:

15 years

C.3. Length of the crediting period:

During the first commitment period:
5 years (2008-2012)

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

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The approved monitoring methodology applied to this project activity is the **ACM0001 "Consolidated monitoring methodology for landfill gas project activities"** (Ver 05)**.** The methodology also refers to **"Tool to determine project emissions from flaring gases containing methane"** (Ver 01).

The monitoring methodology is based on direct measurement of the amount of methane captured and destroyed in the flare and, optionally, the electricity generating units. The main variables that need to be determined are the quantity of methane actually captured, quantity of methane flared, quantity of methane used to generate electricity.

The actual tonnage of methane emissions reduced by the project is calculated based on flow rate of the landfill gas, methane concentration, and destruction/conversion efficiency of the combustion equipment. The monitoring plan provides for the continuous measurement of both quantity and quality of LFG captured and fed to the combustion equipment using a continuous flow meter and on-line LFG analyzer. Temperature and pressure of the landfill gas will also be measured.

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

In case the LFG is flared and no electricity is produced for meeting the Project requirements, electricity for operation of the methane collection system will be produced on-site by diesel power station. Therefore, CO_2 emissions from diesel combustion will be accounted for as Project emissions and continuous metering of diesel consumption will be provided for their determination.

(Optional, applicable for LFGTE option) For the purpose of monitoring of emission reductions from displacement of grid electricity, the quantity of electricity generated from landfill gas and exported out of the project boundary will be continuously measured.

(Optional, applicable for LFGTE option) Baseline emission factors for Ukrainian electricity grid will be fixed for crediting period (please refer to the baseline study ***"Standardized emission factors for the Ukrainian electricity grid",*** presented in the Annex 2. Baseline Information) and therefore will be monitored.

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

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

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

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

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

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

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

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

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

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

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

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

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

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:									
ID number *(Please use numbers to ease cross-referencing to D.2.)*	**Data variable**	**Data variable**	**Source of data**	**Data unit**	**Measured (m), calculated (c), estimated (e)**	**Recording frequency**	**Proportion of data to be monitored**	**How will the data be archived? (electronic/ paper)**	**Comment**
1.	$LFG_{total,y}$	Total amount of landfill gas captured	On-line LFG flow meter	m^3	m	Continuously	100%	electronic	Measured by a flow meter. Values to be averaged hourly. Data to be aggregated monthly and yearly.
2.	$LFG_{flared,y}$	Amount of landfill gas flared	On-line LFG flow meter	m^3	m	Continuously	100%	electronic	Measured by a flow meter. Values to be averaged hourly. Data to be aggregated monthly and yearly.
3.	$LFG_{electricity,y}$ (optional)	Amount of landfill gas combusted in power plant	On-line LFG flow meter	m^3	m	Continuously	100%	electronic	Measured by a mass flow meter. Values to be averaged hourly. Data to be aggregated monthly and yearly.
4.	$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year y	Various	tCO2e	m/c	see comments	n/a	electronic	The parameters to determine project emissions from flaring will be monitored as per "Tool to determine project emissions from flaring gases containing Methane"
		Volumetric flow rate of the residual gas in dry basis at normal conditions	Flow meter in the residual gas conducts	Hour	m	Continuously	100%	electronic	Measured by a flow meter.

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:									
ID number *(Please use numbers to ease cross-referencing to D.2.)*	**Data variable**	**Data variable**	**Source of data**	**Data unit**	**Measured (m), calculated (c), estimated (e)**	**Recording frequency**	**Proportion of data to be monitored**	**How will the data be archived? (electronic/ paper)**	**Comment**
		Thermocouple Type N	Measure the temperature of the exhaust gas stream in the flare	K	m	Continuously	100%	electronic	
		Measure volumetric fraction of O2 and CH4 in the exhaust gas (s)	Gas analyser(s)	%	m	Continuously	100%	electronic	
		Measure volumetric fraction of components “i” in the residual gas	Gas analyser(s)	%	m	Continuously	100%	electronic	
5.	$W_{CH4,y}$	Methane fraction in LFG	On-line gas analyser	m^3 CH_4 /m^3 LFG	m	Continuously	100%	electronic	Measured by continuous gas quality analyser.

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:									
ID number ***(Please use numbers to ease cross-referencing to D.2.)***	**Data variable**	**Data variable**	**Source of data**	**Data unit**	**Measured (m), calculated (c), estimated (e)**	**Recording frequency**	**Proportion of data to be monitored**	**How will the data be archived? (electronic/ paper)**	**Comment**
6.	T	Temperature of the landfill gas	Temperature probe	^oC	m	Continuously	100%	electronic	Temperature of the landfill gas will be measured to determine the density of methane in the landfill gas
7.	P	Pressure of the landfill gas	Pressure gauge	Pa	m	Continuously	100%	electronic	Pressure of the landfill gas will be measured to determine the density of methane in the landfill gas
8.	D_{CH4}	Methane density of the LFG	Calculated	t_{CH4}/m^3_{CH4}	c	Continuously	100%	electronic	Data will be used to calculate the mass flow rate of methane
9.	$EL_{EX,LFG}$ (optional)	Total amount of electricity exported out of the project boundary	Electricity meter	MWh	m	Continuously	100%	electronic	*Applicable for LFG-to-electricity option only.* Required to estimate the emission reductions from electricity generation from LFG. Double checked with receipts of sales.
10.	EL_{IMP} (optional)	Total amount of electricity imported to use in the project for gas pumping	Electricity meter	MWh	m	Continuously	100%	electronic	*Applicable for LFG-to-electricity option only.* Required to determine CO_2 emissions from use of electricity to operate the project activity in periods when the project activity is not generating its own electricity).

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

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
11.	CEF (optional)	CO_2 emission intensity of the electricity and/or other energy carriers	Baseline study[4]	t_{CO2}/ MWh	c	Once	100%	electronic	*Applicable for LFG-to-electricity option only.* The default data for CEF is fixed before the Project start.
12.	ET_y	Thermal energy used in landfill during project	Calculated	TJ	c/m	Annually	100%	electronic	The quantity of fossil fuel (diesel) used on-site for electricity production in order to cover pumping system power consumption. Based on this figure Et_y will be calculated.
13.	$CEF_{thermal}$	CO_2 emission intensity of the thermal energy	Calculated	t_{CO2}/ TJ	c	Annually	100%	electronic	Will be specific to the fossil fuel used on-site (diesel)

[4] *"Standardized emission factors for the Ukrainian electricity grid"*, version 5, 02 February 2007, (please refer for details to the Annex 2. Baseline Information)

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:									
ID number ***(Please use numbers to ease cross-referencing to D.2.)***	**Data variable**	**Data variable**	**Source of data**	**Data unit**	**Measured (m), calculated (c), estimated (e)**	**Recording frequency**	**Proportion of data to be monitored**	**How will the data be archived? (electronic/ paper)**	**Comment**
14.		Regulatory requirements relating to landfill gas projects	National regulations	Text	n/a	Annual	100%	electronic	Required for any changes to the adjustment factor (AF) or directly MDreg,y.

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

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

$$ER_y = (MD_{project,\ y} - MD_{reg})*GWP_{CH4} + EL_y*CEF_{electricity,\ y} - ET_y * CEF_{thermal,\ y} \quad (1)$$

Step 1

ER_y	GHG emissions reduction (in year y), in tonnes of CO_2 equivalents (tCO_2) as a result of project implementation
$MD_{project,\ y}$	The amount of methane that will be destroyed/combusted during the year, in, tonnes of methane (tCH_4)
$MD_{reg,\ y}$	The amount of methane that would have been destroyed/combusted during the year in absence of the project, in, tonnes of methane (tCH_4)
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/CH_4.
EL_y	Net quantity of electricity exported during year y, in megawatt hours (MWh).
$CEF_{electricity,\ y}$	The CO_2 emissions intensity of the electricity displaced, tCO_2e/MWh. Baseline emission factor for Ukrainian electricity grid will be taken from the baseline study *"Standardized emission factors for the Ukrainian electricity grid"*, version 5, 02 February 2007, (please refer for details to the Annex 2. Baseline Information)
ET_y	Incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y, in TJ.
$CEF_{thermal,\ y}$	CO_2 emissions intensity of the fuel used to generate thermal / mechanical energy, in tCO_{2e}/TJ

Step 2

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

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

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

Step 3

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

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

In Project activity following formulas can be applied:
Flaring option: In Project activity methane is destroyed through flaring only

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

(optional) LFG-to-electricity option: The Project activity does not include thermal energy generation from LFG, then the amount of methane that would have been destroyed / combusted during the year will be the addition of the following terms:

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

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

Step 4

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

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

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

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

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

Step 6

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

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

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

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

Step 6

(optional) LFG-to-electricity option: In the second phase of the project where excess power generation will be exported to the grid, the emissions reductions are claimed for displacing or avoiding energy from other sources net of any electricity imported.

$$EL_y = EL_{EX,\ LFG} - EL_{IMP} \quad (8)$$

$EL_{EX,LFG}$	Net quantity of electricity exported during year y, produced using landfill gas, in Megawatt hours.
EL_{IMP}	Net Incremental electricity imported, defined as difference of project imports less any imports less any imports of electricity in the baseline, to meet the requirements, in MWh

Step 7

Flaring option: For calculation of the amount of fossil fuel (diesel) used to generate electricity for own needs of LFG plant (ET_y, TJ) the measurement of diesel flow rate will be applied.

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

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

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

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

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

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

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

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

Please see Section D 1.2.2 for details.

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

Not applicable.

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.
Table D.1.2.1 #1. $LFG_{total,y}$	Low	Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #2. $LFG_{flared,y}$	Low	Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #3. $LFG_{electricity,y}$	Low	Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #4. $PE_{flare,y}$	Low	All equipment used to collect data will be subject to regular maintenance and calibration according to the manufacturer's recommendation to ensure accuracy.
Table D.1.2.1 #5. $W_{CH4,y}$	Low	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #6. T	Low	The temperature probe should be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #7. P	Low	The pressure gauge should be subject to a regular maintenance and testing regime to ensure accuracy.
Table D.1.2.1 #9 T_{flare}	Low	Thermocouples should be replaced or calibrated every year.
Table D.1.2.1 #12, 13 EL_{imp}, $EL_{ex,lfg}$	Low	Electricity meters will be periodically calibrated according to the manufacturer's recommendation.
Table D.1.2.1 #14 CEF	Low	Default data for emission factors will be used. All sources where data is obtained are cited and come from reputable sources.

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

All continuously measured parameters (LFG flow, CH_4, CO_2, N_2, O_2 concentrations, flare temperature, and flare operating hours), will be recorded electronically via a data logger, which will have the capability to aggregate and print the collected data at the frequencies as specified above.

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

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

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

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

Date of conclusion: 31 March 2007

Person/entity determining the monitoring methodology:

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

The estimate of ex-ante emissions reduction is given in this section for reference purpose only, since direct monitoring of methane destroyed in the Project scenario will be applied according to the ACM0001 methodology version 5.

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 approx. 64% of the total amount of gas released by the landfill in the baseline scenario. This figure is obtained from considering the percentage of the landfill covered by LFG extraction wells (in

average 80% for both landfills), well efficiency (80%) and well availability (100%). Therefore the remaining 36% of fugitive emissions will be considered as Project emissions.

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. Default value of flare efficiency of 90 % is used. If the LFG electricity is produced, efficiency of LFG combustion in power engines is 100%.

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

3. CO_2 emissions resulting from electricity used by LFG pumping equipment *(applicable for LFG flaring option only)*

a) LFG flaring option: If only LFG flaring is applied, emissions from diesel power station represent Project emissions.

b) LFG-to-electricity option: in the event that LFG electricity is temporarily not produced due to the technical failure the emissions from electricity import will be considered and monitored as Project emissions.

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

$$PEy_1 = CH_{4,y} * D_{CH4} * (1\text{-}CE) * GWP_{CH4} \quad \text{(ton } CO_{2\text{-}eq}/\text{/year)}$$

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

$$PE_{y2} = CH_{4,y} * D_{CH4} * (1\text{-}CE) * (1\text{-}FE) * GWP_{CH4} \quad \text{(ton } CO_{2\text{-}eq}/\text{year)}$$

where:

- PE_{y1} estimated project emissions from non captured methane [tons CO_{2eq}]
- PE_{y2} estimated project emissions from non combusted methane in [tons CO_{2eq}]
- $CH_{4,y}$ is the total methane generated at the landfill in [m^3 of CH_4] and is obtained by using the USEPA model as explained in section E.4
- D_{CH4} is the methane density in [kg/m³ of CH_4][5]
- CE is the LFG collection efficiency
- FE is the flare efficiency
- GWP_{CH4} is the global warming factor of methane (GWP = 21).

Landfill gas collection efficiency is estimated at the level of ***CE= 64%*** for both landfills.

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

[5] At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4.

3a) Emissions from fossil fuel (diesel) 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:

$$PEy_3 = ET_y * CEF_{thermal, y}$$

where:

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

$CEF_{thermal, y}$ CO2 emissions intensity of the diesel ($CEF_{thermal, y}$=0.0741 kton CO2/TJ)

For the flaring option: the sum of the Project emission is equal to:

$$PE_y = PE_{y1} + PE_{y2} + PE_{y3}$$

For the LFGTE option: the sum of the Project emission is equal to:

$$PE_y = PE_{y1}$$

Results of calculation of the Project emission are given below.

1) Flaring option

	Project emission (flaring) Yalta landfill				Project emission (flaring) Alushta landfill				Total Project emission (flaring) Yalta and Alushta landfills
Years	PE_{y1}	PE_{y2}	PE_{y3}	Total $PE_{y, Yalta}$	PE_{y1}	PE_{y2}	PE_{y3}	Total $PE_{y,Alushta}$	$PE_{y, Yal+Al}$
	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr
2008	25 137	4 469	140	29 745	11 634	2 068	94	13 796	**43 542**
2009	25 966	4 616	140	30 722	11 980	2 130	94	14 204	**44 926**
2010	26 813	4 767	140	31 720	12 335	2 193	94	14 622	**46 341**
2011	27 677	4 920	140	32 738	12 699	2 258	94	15 050	**47 788**
2012	28 560	5 077	140	33 778	13 072	2 324	94	15 490	**49 268**
2008-12	**134 153**	**23 849**	**701**	**158 703**	**61 721**	**10 973**	**468**	**73 161**	**231 865**

2) LFGTE option

	Project emission (LFGTE) Yalta landfill	Project emission (LFGTE) Alushta landfill	Total Project emission (LFGTE) Yalta and Alushta landfills
Years	PE_{y1}	PE_{y1}	$PE_{y,\,Yal+Al}$
	t CO2/yr	t CO2/yr	t CO2/yr
2008	25 137	11 634	36 771
2009	25 966	11 980	37 946
2010	26 813	12 335	39 148
2011	27 677	12 699	40 376
2012	28 560	13 072	41 633
2008-12	**134 153**	**61 721**	**195 874**

E.2. Estimated leakage:

No leakage needs to be accounted for by this methodology.

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

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

For the flaring option: $PE_y = PE_{y1} + PE_{y2} + PE_{y3}$

For the LFGTE option: $PE_y = PE_{y1}$

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:

1. **LFG flaring option**

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

2. **LFG utilisation option.**

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

1. Methane release into the atmosphere from the open-air waste decay;
2. CO2 emissions from generation of 1.8 MW grid electricity to be replaced with the power produced from CO2 neutral fuel – landfill gas.

Usually the quantity of the methane (landfill gas) generated at the landfill in the given year is calculated based on the known first order decay model of the US Environmental Protection Agency (USEPA):

$$Q(t) = L_0 \cdot M \cdot \left(e^{(-k \cdot c)} - e^{(-k \cdot t)}\right)$$

where:

$Q(t)$	-	a quantity of methane, generated on the landfill in the given year t (m³/year)
L_o	-	Potential of the methane generation (m³/t municipal solid waste (MSW))
M	-	Average MSW quantity, collected to the landfill during the year (t/year)
k	-	Methane generation rate (1/year)
c	-	Time from the moment of closing the landfill (years) = 0 for the acting landfill
t	-	Time since the beginning of the operation of the landfill (years)

The amount of methane generated in the baseline scenario was estimated based on data on amount of waste delivered to the Sites in the previous years (please refer to the Annex 2. Baseline Information for details). The GhG emissions from the LFG release are estimated using the average default value of 50 % methane content in the LFG and the Global Warming Potential factor for the methane of 21 t CO2-eq./t CH4.

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

$$BE_{y,\,el} = EL_y * CEF_{electricity,\,y}$$

Where:

EL_y Net quantity of electricity exported during year y, in megawatt hours (MWh)

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

Baseline carbon emission factors for JI projects generating electricity in Ukraine are taken from the baseline study ***"Standardized emission factors for the Ukrainian electricity grid"*** (Version 5, 02 February 2007) developed by Global Carbon B.V (please refer to the Annex 2. Baseline Information for details).
For the years 2008-2012: $CEF_{electricity,\,y} = 0.807$ ***tCO2e/MWh***

Estimation of LFG generation and the related GhG emissions in the baseline scenario, as well as baseline grid electricity emissions is given below.

1) Flaring option

	Baseline emission Yalta landfill		Baseline emission Alushta landfill		Total baseline emission (flaring) Yalta and Alushta landfills
	Methane release, ths. tones	Emission from CH4 release, t CO2/yr	Methane release, ths. tones	Emission from CH4 release, t CO2/yr	t CO2/yr
2008	3 325	69 824	1 539	32 317	102 141
2009	3 435	72 128	1 585	33 279	105 407
2010	3 547	74 480	1 632	34 265	108 744
2011	3 661	76 881	1 680	35 275	112 156
2012	3 778	79 334	1 729	36 312	115 646
2008-12	**17 745**	**372 647**	**8 164**	**171 448**	**544 095**

2) LFGTE option

	Baseline emission Yalta landfill					Baseline emission Alushta landfill					Total baseline emission (LFGTE) Yalta and Alushta landfills
	Methane release, ths. tones	Power produc-tion, MWh/yr	Emissions from CH4 release, t CO2/yr	Emissions from power produc-tion, t CO2/yr	Total emissions (CH4 and power)	Methane release, ths. tones	Power produc-tion, MWh/ya	Emissions from CH4 release, t CO2/yr	Emission from power productio n, t CO2/yr	Total emissions (CH4 and power)	t CO2/yr
2008	3 325	9 600	69 824	7 745	77 569	1 539	4 800	32 317	3 873	36 190	113 759
2009	3 435	9 600	72 128	7 745	79 873	1 585	4 800	33 279	3 873	37 152	117 025
2010	3 547	9 600	74 480	7 745	82 225	1 632	4 800	34 265	3 873	38 138	120 362
2011	3 661	9 600	76 881	7 745	84 626	1 680	4 800	35 275	3 873	39 148	123 774
2012	3 778	9 600	79 334	7 745	87 080	1 729	4 800	36 312	3 873	40 185	127 264
2008-12	**17 745**	**48 000**	**372 647**	**38 726**	**411 373**	**8 164**	**24 000**	**171 448**	**19 363**	**190 813**	**602 184**

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

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

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

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

Years	Total baseline emission *(flaring option)*	Total baseline emission *(LFGTE option)*	Total project emission *(flaring option)*	Total project emission *(LFGTE option)*	Emission reduction *(flaring option)*	Emission reduction *(LFGTE option)*
		t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr	t CO2/yr
2008	102 141	113 759	43 542	36 771	58 600	76 988
2009	105 407	117 025	44 926	37 946	60 481	79 078
2010	108 744	120 362	46 341	39 148	62 403	81 214
2011	112 156	123 774	47 788	40 376	64 368	83 398
2012	115 646	127 264	49 268	41 633	66 378	85 631
2008-12	**544 095**	**602 184**	**231 865**	**195 874**	**312 230**	**406 309**

SECTION F. Environmental impacts

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

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

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

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

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

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

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

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

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

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

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

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

Conclusions
The landfill collection and flaring system has a significant positive impact on the environment. The system reduces emissions of greenhouse gases, odours and gases causing explosions as well as open fires and damage to wildlife. Additionally, the project will produce the following:

- positive effects on climate and local air quality;
- positive effects on flora and fauna in the surroundings; and
- improved conditions for local inhabitants and site workers.

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:

According to the Ukrainian legislation, assessment of environmental impact of the planned activity should follow the procedure of Environmental Impact Assessment (EIA). EIA in Ukraine is not the tool for decision-making on project implementation, but an essential component of the design documentation. Thus, an EIA is carried out after the decision on implementation of the certain economic activities has been already taken. Requirements for the content of EIA are specified in the State Construction Norms of Ukraine "DBN A.2.2-1-2003". Consequently, an EIA was conducted for the Yalta and Alushta landfill sites. The EIA concluded that no significant negative environmental impacts are related to the project activity.

SECTION G. Stakeholders' comments

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

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

The following activities were conducted by the Project participants in the framework of a stakeholder consultation for the Yalta and Alushta Projects:

1. Stakeholders meeting in Republic Committee of The Environment and Natural Resources of the Autonomous Republic of Crimea (RCENR), March, 21st, 2007. The participants of the meeting included:
   - Head and deputy head of RCENR;
   - Head of department of the RCENR for waste management,
   - Head of department of the RCENR atmospheric air protection
   - Heads of other relevant departments of RCENR;
   - Deputy head of Crimean Regional subdivision of the Green Party of Ukraine;
   - Head of NGO "Environment and the World", head of the Crimean subdivision of National Academy of Sciences of Ukraine.

2. Stakeholders meeting in municipality of Alushta City, March, 22, 2007.

The meeting participants included:
   - Deputy Mayor of The Alushta Municipality;
   - Director of Municipal Transportation Company (Landfill Operator)

3. Stakeholders meeting in municipality of Yalta City, March, 22, 2007.
The participants of the meeting were:
   - Deputy Head of Municipal Services Department of Yalta Municipality
   - Head of Environmental Protection Department of Yalta Municipality

4. Publication of the information article on the Project activities in the web mass media

Yalta and Alushta landfills were visited and opinions of waste pickers were collected.
Stakeholders were informed, according to their group, about:

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

During the period for public commenting, questions on mainly technical and organizational issues have arisen and were properly explained. There are no open concerns remaining. All the discussions resulted in positive comments from the Stakeholders.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

LANDFILL CALCULATION PARAMETERS			
Parameter	Units	**Data**	
Landfill data			
		Yalta landfill	**Alushta landfill**
Year landfill started operation		1973	1960
Waste in place at the beginning of project	Tonnes	1.3 mln.	0.72 mln
Density of waste (non-compacted)	tonne/m3	0.25	0.25
Area of site	Ha	5.7	6.9
Average daily waste rate	Tonnes/day	165	80
Date gas collection project starts		2008	2008
Project operational data			
Gas collection efficiency	%	64%	64%
Flare efficiency	%	90%	90%
Flare capacity (estimated)	m3/h	800	500
LFG pump&flaring station capacity	kW	20	11
Diesel consumption by pumping & flaring system	l/h	6	4
Diesel CO2 emission factor	kton CO2/TJ	0.0741	
Diesel calorific value	MJ/L	36	
General data			
Lo	m3 LFG/tonne	206.3	
k	1/yr	0.05	
Methane content of landfill gas	%	50%	
CH4 GWP	T CO2/T CH4	21	
Density of Methane	Tonne/CH4/m3	0.0007168	
Baseline data			
Proportion of methane flared in Baseline (AF)		0%	

INPUT DATA FOR THE ELECTRICITY GENERATION COMPONENT OF THE PROJECT ACTIVITY	
PROJECT DATA	
Date project starts operating (year)	2008
Installed capacity (MW)	Yalta landfill: 1.2 Alushta landfill: 0.6
Estimated on-line availability of equipment (%)	0.9
Operating period (h/yr)	7890
BASELINE DATA	
Country	Ukraine
CEF country (t CO2e/MWh)	807
Crediting period (years) In the 1st commitment period (2008-2012): and further beyond the 1st commitment period but no longer than project operational lifetime	5
FINANCIAL PARAMETERS	
Electricity tariff (USD/MWh)	40
Income tax	25%
Discount rate	10 %
Depreciation (quarterly)	6.75%
Price of carbon (US$/tCO2)	11

STANDARDIZED EMISSION FACTORS FOR THE UKRAINIAN ELECTRICITY GRID

Introduction

Many Joint Implementation (JI) projects have an impact on the CO2 emissions of the regional or national electricity grid. Given the fact that in most Economies in Transition (IET) an integrated electricity grid exists, a standardized baseline can be used to estimate the amount of CO2 emission reductions on the national grid in case of:

a) Additional electricity production and supply to the grid as a result of a JI project (=producing projects);
b) Reduction of electricity consumption due to the JI project resulting in less electricity generation in the grid (= reducing projects);
c) Efficient on-site electricity generation with on-site consumption. Such a JI project can either be a), b), or a combination of both (e.g. on-site cogeneration with partial on-site consumption and partial delivery to the grid).

So far most JI projects in EIT, including Ukraine, have used the standardized Emission Factors (EFs) of the ERUPT programme. In the ERUPT programme for each EIT a baseline for producing projects and reducing projects was developed. The ERUPT approach is generic and does not take into account specific local circumstances. Therefore in recent years new standardized baselines were developed for countries like

Romania, Bulgaria, and Estonia. In Ukraine a similar need exist to develop a new standardized electricity baseline to take the specific circumstances of Ukraine into account. The following baseline study establishes a new electricity grid baseline for the Ukraine.

This new baseline has been based on the following guidance and approaches:
- The "Guidance on criteria for baseline setting and monitoring" for JI projects, issued by the Joint Implementation Supervisory Committee[26];
- The "Operational Guidelines for the Project Design Document", further referred to as ERUPT approach or baseline [22];
- The approved CDM methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" [23];
- Specific circumstances for Ukraine as described below.

ERUPT
The ERUPT baseline was based on the following main principles:
- Based mainly on indirect data sources for electricity grids (i.e. IEA/OECD reports);
- Inclusion of grid losses for reducing JI projects;
- An assumption that all fossil fuel power plants are operating on the margin and in the period of 2000-2030 all fossil fuel power plants will gradually switch to natural gas.

The weak point of this approach is the fact that the date sources are not specific. For example, the Net Calorific Value (NCV) of coals was not determined on installation level but was taken from IPCC default values. Furthermore the IEA data included electricity data until 2002 only. ERUPT assumes that Ukraine would switch all its fossil-fuel plant from coal to natural gas. In Ukraine such an assumption is unrealistic as the tendency is currently in the opposite direction.

ACM0002
The ACM0002 methodology was developed in the context of CDM projects. The methodology takes a combination of the Operating Margin (OM) and the Build Margin (BM) to estimate the emissions in absence of the CDM project activity. To calculate the OM four different methodologies can be used. The BM in the methodology assumes that recent built power plants are indicative for future additions to the grid in the baseline scenario and as a result of the CDM project activity construction of new power plants is avoided. This approach is valid in electricity grids in which the installed generating capacity is increasing, which is mostly the case in developing countries. However, the Ukrainian grid has a significant overcapacity and many power plants are either operating below capacity or have been moth-balled.

Nuclear is providing the base load in Ukraine
In Ukraine nuclear power plants are providing the base load of the electricity in Ukraine. To reduce the dependence on imported fuel the nuclear power plants are running at maximum capacity where possible. In the past five years nuclear power plants provide almost 50% of total electricity generation:

Year	2001	2002	2003	2004	2005

[21] Guidance on criteria for baseline setting and monitoring, version 01, Joint Implementation Supervisory Committee, ji.unfccc.int

[22] Operational Guidelines for Project Design Documents of Joint Implementation Projects. Ministry of Economic Affairs of the Netherlands, May 2004

[23] Consolidated baseline methodology for grid-connected electricity generation from renewable sources, version 06,19 May 2006, cdm.unfccc.int

Share of AES	44%	45%	45%	48%	48%

Table 26: Share of nuclear power plant in the annual electricity generation

All other power stations are operating on the margin. This includes hydro power plants which is show in the table below.

	Minimum; 03:00	Maximum; 19:00
Consumption, MW	21,287	27,126
Generation, MW	22,464	28,354
Thermal power plants	*10,049*	*13,506*
Hydro power plants	*527*	*3,971*
Nuclear power plants	*11,888*	*10,877*
Balance imports/export, MW	-1,177	-1,228

Table 27: Electricity demand in Ukraine on 31 March 2005[24]

Development of the Ukrainian electricity sector

The National Energy Strategy[25] sets the approach for the overall energy complex of Ukraine and the electricity sector in particular. The main priority of Ukraine is to reduce the dependence of imported fossil fuels. The strategy sets the following priorities[26]:

- increased use of local coal as a fuel;
- construction of the new nuclear power plants;
- energy efficiency and energy saving.

Due to the sharp increase of imported natural gas prices a gradual switch from natural gas to coal at the power plants is planned in the nearest future. Ukraine possesses a large overcapacity of the fossil-powered plants of which many are mothballed. These moth-balled plants might be connected to the grid in case of growing demand.

In the table below the installed capacity and load factor is given in Ukraine.

	Installed capacity (GW)	Average load factor, %
Thermal power plants	33.6	28.0
Hydro power plants	4.8	81.4
Nuclear power plants	13.8	26.0
Total	**52.2**	**39.0**

Table 28: Installed capacity in Ukraine in 2004[27]

According to IEA's estimations, about 25% of thermal units might not be able to operate (though there is no official statistics). This means that still at least 45% of the installed thermal power capacity could be

[24] Ukrenergo, http://www.iikrenergo.energy.gov.ua/iikrenergo/control/iik/publish/article?art_id=39047&cat_id=35061

[25] http://mpe.kmu.gov.ua/fuel/control/uk/doccatalog/list?currDir=50505

[26] Energy Strategy of Ukraine for the Period until 2030, section 16.1, page 127.

[27] Source: Ukraine Energy Policy Review. OECD/IEA, Paris 2006. p. 272, table 8.1

utilized, but is currently not used. In accordance with the IEA report the 'current capacity will be sufficient to meet the demand in the next decade'[28].

In the table below the peak load of the years 2001- 2005 are given which is approximately 50% of the installed capacity.

	2001	2002	2003	2004	2005
Peak load (GW)	28.3	29.3	26.4	27.9	28.7

Table 29: Peak load in Ukraine in 2001 - 2005[29]

New nuclear power plants will take significant time to be constructed will not get on-line before the end of the second commitment period in 2012. There is no nuclear reactor construction site at such an advanced stage remaining in Ukraine, it is unlikely that Ukraine will have enough resources to commission any new nuclear units in the foreseeable future (before 2012)[30].

Latest nuclear additions (since 1991):
- Zaporizhzhya NPP unit 6, capacity 1 GW, commissioned in 1995;
- Rivne NPP unit 4, capacity 1 GW, commissioned in 2004;
- Khmelnitsky NPP unit 2, capacity 1 GW, commissioned in 2004.

Nuclear power plants under planning or at early stage of construction:
- South Ukraine NPP one additional unit, capacity 1 GW;
- Khmelnitsky NPP two additional units, capacity 1 GW each.

Approach chosen
In the selected approach of the new Ukrainian baseline the BM is not a valid parameter. Strictly applying BM in accordance with ACM0002 would result in a BM of zero as the latest additions to the Ukrainian grid were nuclear power plants. Therefore applying BM taking past additions to the Ukrainian grid would result in an unrealistic and distorted picture of the emission factor of the Ukrainian grid. Therefore the Operating Margin only will be used to develop the baseline in Ukraine.

The following assumptions from ACM0002 will be applied:
1) The grid must constitute of all the power plants connected to the grid. This assumption has been met as all power plants have been considered;
2) There should be no significant electricity imports. This assumption has been met in Ukraine as Ukraine
is a net exporting country as shown in the table below;
3) Electricity exports are not accounted separately and are not excluded from the calculations.

	2001	2002	2003
Electricity produced, GWh	175,109	179,195	187,595
Exports, GWh	5,196	8,576	12,175

[28] Source: Ukraine Energy Policy Review. OECD/IEA, Paris 2006. p. 269
[29] Ministry of Energy, letter dated 11 January 2007
[30] http://www.xaec.org.ua/index-ua.html

Imports, GWh	2,137	5,461	7,235

Table 30: Imports and exports balance in Ukraine[31]

ACM0002 offers several choices for calculating the OM. Dispatch data analysis cannot be applied, since the grid data is not available[32]. Simple adjusted OM approach is not applicable for the same reason. The average OM calculation would not present a realistic picture and distort the results, since nuclear power plants always work in the base load due to the technical limitations (and therefore cannot be displaced) and constitute up to 48% of the overall electricity generation during the past 5 years.

Therefore, the simple OM approach is used to calculate the grid emission factor. In Ukraine the low-cost must-run power plants are nuclear power stations. Their total contribution to the electricity production is below 50% of the total electricity production. The remaining power plants, all being the fossil-fuel plants and hydro power plants, are used to calculate the Simple OM.

%	2001	2002	2003	2004	2005
Nuclear power plants	44.23	45.08	45.32	47.99	47.92
Thermal power plants	38.81	38.32	37.24	32.50	33.22
Combined heat and power	9.92	11.02	12.28	13.04	12.21
Hydro power plants	7.04	5.58	5.15	6.47	6.65

Table 31: Share of power plants in the annual electricity generation of Ukraine[33]

The simple OM is calculated using the following formula:

$$EF_{OM,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum GEN_{j,y}}$$

(Equation 19)

$F_{i,j,y}$ is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power source y in year(s) *y* (2001-2005);

J refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid;

[31] Source: State Committee of Statistics of Ukraine. Fuel and energy resources of Ukraine 2001-2003. Kyiv, 2004

[32] Ministry of Energy, letter dated 11 January 2007

[33] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

$COEF_{i,j}$ is the CO2 emission coefficient of fuel / (tCO2 / mass or volume unit of the fuel), taking into
account the carbon content of the fuels used by relevant power source y and the percent oxidation of the fuel in year(s) *y;*

$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source.
The CO2 emission coefficient $COEF_i$ is obtained as:

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i$$

(Equation 20)

Where:
NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel *i;*
$OXID_i$ is the oxidation factor of the fuel;
$EF_{CO2,i}$ is the CO2 emission factor per unit of energy of the fuel *i.*

Data for power generation and fuel properties was obtained from the individual power plants[34]. The majority of the electricity (up to 95%) is generated centrally and therefore the data is comprehensive[35].

The Net Calorific Value (NCV) of fossil fuel can change considerably, in particular when using coal. Therefore the local NCV values of individual power plants for natural gas and coal were used. For heavy fuel oil, the IPCC36 default NCV was used. Local CO2 emission factors for all types of fuels were taken for the purposes of the calculations and Ukrainian oxidation factors were used. In the case of small-scale power plants some data regarding the fuel NCV is missing in the reports. For the purpose of simplicity, the NCV of similar fuel from a power plant from the same region of Ukraine was used.

The Simple OM is applicable for additional electricity production delivered to the grid as a result of the project (producing JI projects). However, reducing JI projects also reduce grid losses. For example a JI project reduces on-site electricity consumption with 100,000 MWh and the losses in the grid are 10%. This means that the actual reduction in electricity production is 111,111 MWh. Therefore a reduction of these grid losses should be taken into account for reducing JI projects to calculate the actual emission reductions.

The losses in the Ukrainian grid are given in the table below and are based on the data obtained directly from the Ukrainian power plants through the Ministry of Energy.

Year	Technical losses %	Non-technical losses %	Total %
2001	14,2	7	21,2

[34] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006.

[35] The data for small units (usually categorized in the Ukrainian statistics as 'CHPs and others') is scattered and was not always available. As it was rather unrealistic to collect the comprehensive data from each small-scale power plant, an average CO2 emission factor was calculated for the small-scale plants that provided the data. For the purpose of simplicity it was considered that all the electricity generated by the small power plants has the same average emission factor obtained.

[36] IPCC 1996. Revised guidelines for national greenhouse gas inventories.

2002	14,6	6,5	21,1
2003	14,2	5,4	19,6
2004	13,4	3,2	16,6
2005	13,1	1,6	14,7

Table 32: Grid losses in Ukraine[37]

As one can see grid losses are divided into technical losses and non-technical losses. For the purpose of estimating the EF only technical losses[38] are taken into account. As can been seen in the table technical grid losses are decreasing. The average decrease of grid losses in this period was 0.275% per annum. Extrapolating these decreasing losses to 2012 results in technical grid losses of 12% by 2012. However, in order to be conservative the grid losses *over the full period 2006-2012* have been taken as 10%.

Further considerations

The "Guidance on criteria for baseline setting and monitoring" for JI projects requires baselines to be conservative. The following measures have been taken to adhere to this guidance and to be conservative:

- The grid emission factor is actually expected to grow due to the current tendency to switch from gas to coal;
- Hydro power plants have been included in the OM. This is conservative;
- With the growing electricity demand, out-dated fossil fired power plants are likely to come on-line as existing nuclear power plants are working on full load and new nuclear power plants are unlikely to come on-line before 2012. The emission factor of those power plants is higher as all of them are coal of heavy fuel oil fired[39];
- The technical grid losses in Ukraine are high, though decreasing. With the current pace the grid losses in Ukraine will be around 12% in 2012. To be conservative the losses have been taken 10%;
- The emissions of methane and nitrous oxide have not taken into consideration, which is in line with ACM0002. This is conservative.

Conclusion

An average CO2 emission factor was calculated based on the years 2003-2005. The proposed baseline factors is based on the average constituting a fixed emission factor of the Ukrainian grid for the period of 2006-2012. Both baseline factors are calculated using the formulae below:

$$EF_{grid,produced,y} = EF_{OM,y}$$

(Equation 21)

$$EF_{grid,reduced,y} = \frac{EF_{grid,produced,y}}{1 - loss_{grid}}$$

(Equation 22)

Where:

$EF_{grid,produced,y}$ is the emission factor for JI projects supplying additional electricity to the grid (tCO2/MWh);

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[37] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31 October 2006 and 16 November 2006

[38] Ukrainian electricity statistics gives two types of losses -the so-called 'technical' and 'non-technical'. 'Nontechnical' losses describe the non-payments and other losses of unknown origin.

[39] "Overview of data on electrical power plants in Ukraine 2001 - 2005", Ministry of Fuel and Energy of Ukraine, 31October 2006 and 16 November 2006.

$EF_{grid,reduced,y}$ is the emission factor for JI projects reducing electricity consumption from the grid (tCO2/MWh)factor of the fuel;

$EF_{OM,y}$ is the simple OM of the Ukrainian grid (tCO2/MWh);

$loss_{grid}$ is the technical losses in the grid (%).

The following result was obtained:

Type of project	**Parameter**	**EF (tCO2/MWh)**
JI project producing electricity	$EF_{grid\text{-}produced\text{-}v}$	0.807
JI projects reducing electricity	$EF_{grid\ reduced,v}$	0.896

Table 33: Emission Factors for the Ukrainian grid 2006 - 2012

Monitoring
This baseline requires the monitoring of the following parameters:
- Electricity produced by the project and delivered to the grid in year y (in MWh);
- Electricity consumption reduced by the project in year (in MWh);
- Electricity produced by the project and consumed on-site in year y (in MWh);

The baseline emissions are calculated as follows:

$$BE_y = EF_{grid,produced,y} \times EL_{produced,y} + EF_{grid,reduced,y} \times (EL_{produced,y} + EL_{consumed,y}) \quad \text{(Equation 23)}$$

Where:

BE_y	are the baseline emissions in year y (tCO_2);
$EF_{grid,produced,y}$	is the emission factor of producing projects (tCO_2/MWh);
$EL_{produced,y}$	is electricity produced and delivered to the grid by the project in year y (MWh);
$EF_{grid,reduced,y}$	is the emission factor of reducing projects (tCO_2/MWh);
$EL_{produced,y}$	is electricity consumption reduced by the project in year y(MWh);
$EL_{consumed,y}$	is electricity produced by the project and consumed on-site in year y (MWh).

This baseline can be used as ex-ante (fixed for the period 2006 - 2012) or ex-post. In case an ex-post baseline is chosen the data of the Ukrainian grid have to be obtained of the year in which the emission reductions are being claimed. Monitoring will have to be done in accordance with the monitoring plan of ACM0002 with the following exceptions:

- the Monitoring Plan should also include monitoring of the grid losses in year y;
- power plants at which JI projects take place should be excluded. Such a JI project should have been approved by Ukraine and have been determined by an Accredited Independent Entity.

Acknowledgements

The development of this new baseline has been made possible by funding of the EBRD and the Netherlands' Ministry of Economic Affairs. The authors would further like to thank the Ukrainian Ministry of Energy for supplying the data and the Ministry of Environmental Protection for their support. This baseline study can be used freely in case of proper reference.

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Version 5, 2 February 2007

Annex 3

MONITORING PLAN

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

- Total flow of captured landfill gas [Nm3]
- Landfill gas flow to flares [Nm3]
- *(optional)* Landfill gas flow to power plant [Nm3]
- LFG temperature [°C] and pressure [Pa]
- Methane content in the landfill gas [%]
- Flare operation time [h]
- Temperature of the flare exhaust gases [°C]
- Flare efficiency [%]
- Gross electricity production [MWh]
- Gross electricity consumption [MWh]]

Landfill gas flows and methane content will be determined on a continuous basis. The same applies for the flare operation time and the gross electricity production. 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. Equipment used to monitor emissions reductions from the project activity

Equipment	Variables Monitored	Operational range	Calibration procedures	Parties responsible for operating equipment	Procedure in case of failure	Default value to use in case of failure	Comments
LFG flow meter	1. $LFG_{total,y}$ 2. $LFG_{flare,y}$ 3.$LFG_{electricity,y}$		Equipment will be calibrated 18-24 months after initial installation by the equipment supplier on site	Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.	Daily average of the volume in the previous month minus 5%, per day of flow meter failure	
Various	4. $PE_{flare,y}$		Equipment will be calibrated annually by the equipment supplier on site	Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. Repeat procedure within one month and if not possible contact other external company.	90% based on manufacturer's specifications	
Fixed Gas Analyser	5. $W_{CH4,\ y}$		Equipment will be calibrated annually by the equipment supplier on	Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log	Average of the measured methane content in the previous month minus 5%, per day of gas analyser failure	

			site		book.		
Electricity meter	Total amount of electricity generated by the project and electricity consumed for gas pumping (not derived from the LFG)		Equipment will be checked monthly by the Lead Engineer	Project Developer	Failure reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book.	Daily average of the electricity generated in the previous month minus 5%, per day of electricity meter failure	