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

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## SECTION A. General description of the project

### A.1. Title of the project: Debrecen landfill gas mitigation project

Landfill gas mitigation project on Debrecen landfill
Version 06
Date: 02.04.2008.

### A.2. Description of the project:

The Debrecen landfill is the old landfill of the city of Debrecen. It was operated between 1978 and 1996 and accepted annually 288 000 tones of waste, the total disposed waste is 5 200 000 tonnes[1]. The landfill was closed due to the opening (1996) of the new regional waste management site with a modern waste treatment system. Debrecen old landfill was developed in several phases during the period of 1978-96, four separated trays was built.

- 1. tray: 114.000 $m^2$
- 2. tray: 101.000 $m^2$
- 3. tray: 36 000 $m^2$
- 4. tray: 45 000 $m^2$

After the closure of the landfill in the year 1996 the cover layer was installed but setting up the landfill gas collection and treatment system was failed due to the lack of available financial sources. In the last ten years, no significant changes occurred as per management of the old landfill.

The objective of the project is to install and operate a new landfill gas collection system to capture and flare the methane content of the landfill gas. The installed collection system is high efficient and meet all technical and environmental required standards. Without implementation of the present project the landfill gas would emit uncontrolled in the atmosphere like in the last 10 years. Landfill gas contains 50 % methane; therefore it has a high GHG emission effect. The strategic objective of the project is to develop an EU standard landfill gas collection system and to capture not only GHG emission but other hazardous gas emissions. The project minimizes the chance of fire or explosion from uncontrolled landfill gas emission and results better air quality in surrounding area. The proposed project serves as an example and best practise, how the landfill gas collection and destruction can be managed on already closed landfills.

[1] According to information of Municipality Debrecen that was responsible for operation of the old landfill and waste collection system.

The Civis Biogaz has entered into a contract with the municipality of the City of Debrecen for the period between 2008 and 2012. This contract ensures exclusive right to use of the landfill gas of the old landfill area. The contract provides a detailed regulation of the rights and obligations of the involved parties. Civis Biogáz is responsible for project implementation including planning, choosing the subcontractors and the applied technology and organizing necessary financial resources. After finishing the project execution, this company will be responsible for the safe and appropriate operating of the installed gas collecting and disturbing system and the entire monitoring system.

Celius Anstalt (9491 Ruggell, Industriestrasse 26., Lichtenstein, Reg. ID No.: FL-0002.165.604-3) takes part in the project as the buyer of the ERUs. It does not take part in the realization and future operation of the project.

The landfill gas project brings new investment in the North-Eastern Hungary and increases the economic activity. The construction of landfill gas collection system increases the number of high volume purchases and also generates the income for local companies via subcontracting. Local companies will carry out the majority of construction works. The installed technology will be purchased from national and local sources.

In Hungary there are more than 3200 landfills of various size and type in operation, of which around 2/3 do not meet the necessary environmental requirements. In addition, there are approximately 1100 illegal landfill sites. Waste management is one of the most important challenges for Hungary both in the mid and a long run period. Waste issue has to be managed on the national, regional and local level. According to the accepted waste management plan, the emphasise should be made on the development of macro-regional centres. In consequence the pressure on owners and operators of waste disposals are continuously increasing in order to fulfil the requirements of the waste management plan in addition there are limited available EU and national financial resources also the environmental “heritage” of the former socialist era, changing consumption behaviours made the developments more challenging. Financing waste management is a complicated issue, as in most of the cases fees don’t even cover 50% of the operation costs, neither enough for the accumulation for later site-rehabilitation.

## A.3. Project participants:

| Name of party involved | Private or public entities, project participants | Kindly indicated if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Hungary | Civis Biogaz Kft. | No |

## A.4. Technical description of the project:

### A.4.1. Location of the project:

The old landfill is located on an estate owned by the Municipality. Operation of the old landfill area and gathering litter were duties of the Municipality, until it was closed down in 1996. The owner of the old landfill and all related rights is the Municipality. After establishing the new regional landfill, AKSD Kft. became responsible for gathering litter and operating the new regional landfill. This activity is regulated by an agreement arranged by AKSD and the municipality of Debrecen. Operation and utilization of the old, closed landfill is not involved into this or in another treaty between the Municipality and AKSD Kft.

#### A.4.1.1. Host Party(ies):

Hungary

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

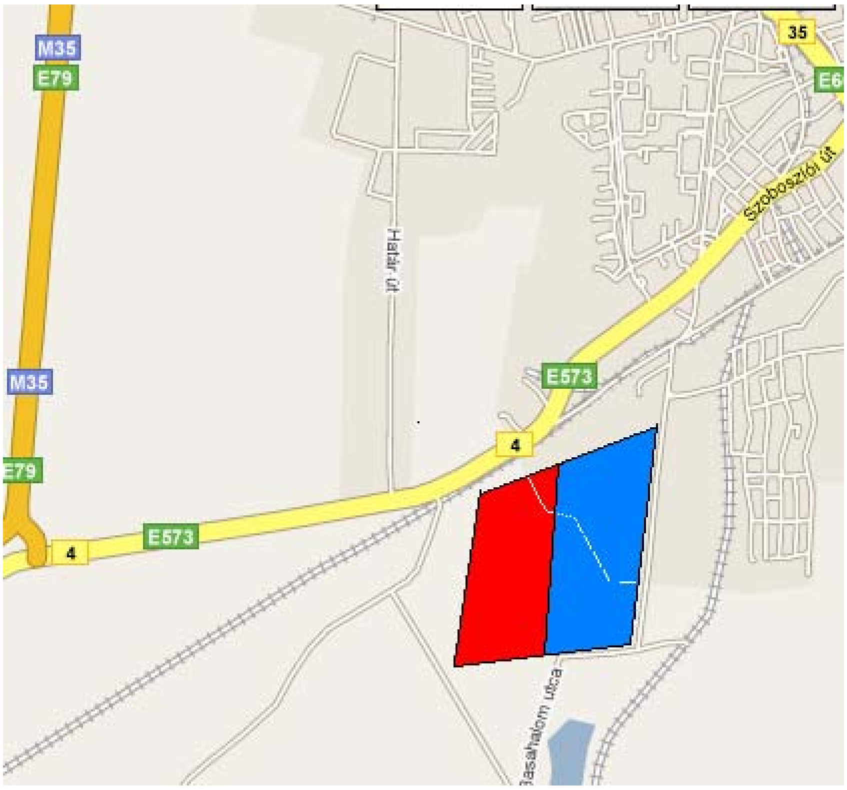
Hajdú-Bihar County

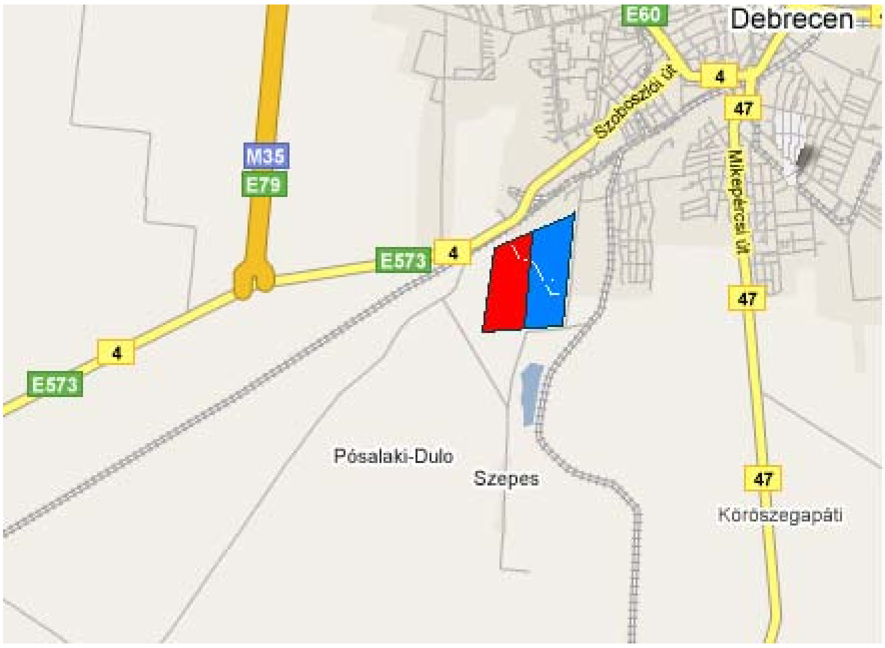
#### A.4.1.3. City/Town/Community etc.:

City of Debrecen

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

Debrecen old landfill is located on the south edge of City of Debrecen. The landfill is part of the Solid waste utilisation plant, because next to the old landfill the new regional landfill is located. The two landfills are visibly distinguished and separated by a road and a ditch. The landfills are in the southern part of the city near to the airport of Debrecen surrounded by inhabited areas. The picture below shows the position and surrounding area of the landfill.




The GPS coordinates are following: E 47° 29' 48,81"; N 21° 36' 56,62"

The blue part is the old landfill and the red part is the new regional waste management site.

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

The technology proposed for the extraction and flaring of landfill gas is a standard BAT technology. It is in compliance with EU legislation.

The realization of the project takes four month upon completion of the planning and preparation phase of the project.

The main steps are the followings:

- Groundwork
- 119 gas domes installation
- Gas collection network
- Drain network
- De-watering units
- Installation of bowler
- Landfill gas monitoring and control equipment
- Installation of two flare

During the project period 119 gas domes will be installed, the configuration of the gas collection domes will be sensitive to landfill characteristic such as varying depths. In the 1st. tray will be built 40 domes, in 2nd tray 36 domes, in 3rd. tray 21 domes and in 4th. tray 22 domes. The vertical gas extraction domes are connected with horizontal gas extraction drains. The horizontal drains are laid in the upper cover layer of the landfill in order to connect the domes with compressor station. The landfill gas collection system includes de-watering units and monitoring and measurement system that is located directly in front of the compressor station. The compressor station includes two vacuum compressors and they are directly connected to the flare station. The flare station comprises of four high-temperature enclosed flares and the flare monitoring system. Main components of flare system are the followings:

- Flame arrestor device: to avoid flashback of a flame to the fuel feed pipe.
- Burner(s): to provide controlled mixing of the fuel and air and ensure controlled combustion over a range of landfill gas flow rates.
- Ignition system: to provide safe, controlled ignition of the landfill gas.
- Air inlet dampers and thermocouples in the stack: control flame temperature.
- Combustion air system: to provide air for combustion support, depending on burner load. The additional air is drawn into the chamber by natural draught via control louvers or open vents.
- Stack: the stack height of the flares will be specified to provide sufficient residence time for destruction of compounds in the gas at high temperature and in a controlled environment to destroy extracted methane.

- Control panel: houses all of the flare controls, motor starters, alarms and interlocks that ensure safe operation of the flare.

The landfill gas monitoring system will be comprehensively described in the following sections and is briefly listed below:

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

The project owner will be responsible for project development, design, implementation, realisation, operation and local management. The project's implementation and operation will take place under strict environmental regulations.

Civis Biogáz Kft. will employ national subcontractors and technology providers while realizing the project. However, contracting a German manufacturer is possible in case of the flare (a crucial part of the system), but it will only be decided after evaluating the offers of the technology providers. The investor insists on mainly Hungarian technology.

**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:**

Waste treatment and management is one of the biggest environmental and environment related socio-economic challenge for Hungary both in the mid and long terms. The challenge is created by the volume and structure of generated waste on the one hand and by the regulation that gets stricter due to EU harmonization on the other hand. In Hungary there are 3200 waste disposals out of which 2100 does not meet the standards and there are an additional estimated 1100 illegal landfills of various sizes. The milestone of the Hungarian waste policy being in line with the EU harmonization is the creation of regional waste management centres. Total annual $CO_2$e emission from waste management is about 2200 Gg but only on few landfills was installed gas colle1ction and burning facility, mainly on new regional waste management centres.

The rehabilitation and upgrading of landfills and abolition of illegal and outdated landfills are an enormous burden on both on the central government and on the municipalities, and requires huge financial investment in this sector. The improvement of already closed municipal landfills has to be financed by the local municipality from the waste treatment fee. But at the same time the municipality has to use this income to co-finance the construction of new regional waste management centre, maintain the waste collecting fleet and attend the closed landfill. The collected fee covers partly the total costs of the waste management company.

Debrecen old landfill was closed in year 1996 and the cover layer was built. After closing the municipality has implemented a small pilot gas utilization system on tray II. This system was composed of 12 domes, the belonging pipes, squeezer and a buffer tank. The landfill gas was burned in a boiler to provide hot water to the maintenance yard, which had municipal jobs at that time. There is an illustration of the implemented boiler in the appendix. In year 2000, the system has been closed down and the squeezer has been removed due the closing the maintenance yard. In November last year, the new renter of the maintenance yard has implemented a new squeezer illegally, i.e. without municipal permission that has operated the above-mentioned boiler. This illegal action is also proven by written information of the municipality.

The gas collection system has been operating illegally, without municipal permission for the last seven months. For this reason, a similar operation of the system between 2008 and 2012 is not possible in the scope of BAU. This illegal gas utilization and the belonging landfill gas burning are not calculated into the baseline. This gas utilization system will be abolished, due to a contract between Civis Biogáz and the Municipality.

The facts of last ten years demonstrate the landfill gas collection system would not be realized from municipal sources, the financial sources are enough to conserve only the current state. So the total landfill gas amount arose in the landfill will be vented to the atmosphere between 2008 and 2012 due to the lack of financial sources.

Legislative background:
During the EU accession process waste management was amongst the priorities set by the EU. Hungary got significant temporal exemptions regarding the application of EU legislation on waste. Generally speaking we can say that by the EU accession the Hungarian waste legislation complied with the EU standards. In this section we give an overview of the most important pieces of legislation:

- Waste framework directive (91/156/EEC)
- The main tool of the harmonization is the Act no. XLIII. of 2000 on waste management.
- Hazardous waste directive (91/689/EEC). It is very much interrelated to the list of hazardous wastes described in 94/904/EC that deals with authorization, monitoring, selective treatment, labelling, etc. as well.
- In the regulation of disposed waste (1999/31/EC (EULFD), methane emission, and re-cultivation of disposals are also dealt with. Target percentages appear here that are also built into the National Waste Management Plan. The earliest date of full implementation for Hungary is 2012.
- For not-new disposals landfill gas utilization is not a requirement. Only in case, if the landfill operates beyond 2008.
- 94/62/EC directive sets some aims on packages waste in order to decrease the volume and promote reuse, and recycle.

The review of the legislation evidences there are not any legal obligation to utilize the arose landfill gas on the Debrecen old landfill.

The emission reduction is generated through the flaring of extracted landfill gas with a high methane content in period 2008-2012. By calculation the reduction we are taking into account the efficiency of extraction system and the enclosed high temperature flare. These emission sources are calculated in project line emission.

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

| | Emission reduction (tCO2e) |
|---|---|
| 2008 | 91 320 |
| 2009 | 86 832 |
| 2010 | 82 561 |
| 2011 | 78 505 |
| 2012 | 74 648 |
| Total | **413 866** |

### A.5. Project approval by the Parties involved:

- The Letter of Endorsement (LoE) for Landfill Gas mitigation project on Debrecen landfill is available.

- The Letter of Approval (LoA) is requested and will be issued when the draft validation report will be submitted to Ministry of Environment.

## SECTION B. Baseline

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

The baseline calculation and monitoring methodology of the proposed project activity follow the ACM0001 , version 4. ***"Consolidated baseline methodology for landfill gas project activities"*** and ***"Consolidated monitoring methodology for landfill gas project activities"***. as a guideline.

Referring to ACM0001, the equitation to determine the emission reductions in LFG mitigation projects could be expressed as

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) * GWP_{CH4}$$

Where $ER_y$ is the greenhouse gas emission reduction in tonnes $CO_2e$ achieved by the project activity during a given year "y". $ER_y$ is calculated as the difference between the amount of methane actually destroyed during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed during that same year in absence of the project activity ($MD_{reg,y}$) times the approved Global Warming Potential factor for methane ($CH_4$).

The project boundary is the site of the project where the landfill gas is captured and destroyed. According to ACM0001 no leakage effects need to be taken into account. The model used to determine the baseline is the USEPA Landgem model[2], a First Order Decay model. ACM0001 methodology requires a publicly known model, to estimate the baseline emission of the project.

ACM0001 is applicable to this Project because the Project baseline is the atmospheric release of landfill gas and the project activity is gas capture and flaring. At the present time exists a small boiler (76 kW capacity) that burns illegally landfill gas collected with the old not maintained small gas collection system. The gas collection system was installed 10 years ago and was closed down in year 2000. Since November 2006 illegally it extracts landfill gas to burn in this boiler to provide warm water. The yearly maximal landfill gas destruction potential of this boiler is calculated in the following table.

[2] See Appendix

| Boiler capacity | Working Hours | Annual capacity | Landfill gas consumption | Landfill gas caloric value | Landfill gas consumption |
|---|---|---|---|---|---|
| kW | hour/year | kWh/year | MJ/year* | MJ/m3 | m3/year |
| 76 | 3000 | 228000 | 820800 | 16 | 51300 |

* 1 kWh = 3,6 MJ

The illegal boiler would destroy 51 300 $m^3$ landfill gas annually and the total amount of landfill gas produced the landfill is over 14 000 000 $m^3$ annually. The current illegal system's emission reduction is under the 1 % but towards the more conservative baseline calculation we take it into account. The following table shows the calculation.

| | Total landfill gas production | Boilers landfill gas consumption | Burned Methane | Burned Methane |
|---|---|---|---|---|
| | m3/year | m3/year | m3/year | CO2et/ year |
| 2008 | 15657266 | 51300 | 25 650 | 386 |
| 2009 | 14893652 | 51300 | 25 650 | 386 |
| 2010 | 14167280 | 51300 | 25 650 | 386 |
| 2011 | 13476334 | 51300 | 25 650 | 386 |
| 2012 | 12819085 | 51300 | 25 650 | 386 |
| **2008-2012** | **71013617** | **256500** | **128 250** | **1 931** |

The $MD_{reg}$ is 1931 tonnes for the 2008-2012 period.

**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 landfill gas with no capture and utilization. ACM0001 requires the use of the "*Tool for demonstration and assessment of additionality*" agreed by the CDM Executive Board, to show the project is not the baseline scenario. This tool is applied as follows.

**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 and probabilities**

1.) Continuation of current situation: no landfill gas extraction and utilization

***Most probable***

Review of regulatory background shows that the landfill gas destruction is not obligatory on already closed landfill sites in Hungary. In addition, the financial source to install the LFG collection and utilization system is not available by Municipality of Debrecen. Therefore, it is not expected that the landfill gas project from municipal sources will be realized in period 2008-2012.

2.) Landfill owner invests in the landfill gas extraction and flaring system (as non-JI project);

***Not probable***

The main barrier of this scenario is the lack of financial sources to realize the collection system and the flaring station. In absence of the JI income the project will not have any revenue in 2008-2012 periods that could cover the expenses of investment. In this case no IRR is applicable. This option is economically unattractive given the high upfront investment costs of recovery of landfill gas and no financial revenue in the operation period.

3.) The municipality invests in the landfill gas extraction network and landfill gas based power generation equipment for electricity production and feeds in the public grid (as JI project);

***Not probable***

Power generation systems require significantly more investment than landfill gas capture and flaring systems. The main barrier is financial nature, since the revenues from power sales do not outweigh the high investment, and the included risks. The project's IIR is applicable and significantly higher than a landfill gas extraction and utilization system without a JI project, but the IRR do not cover the higher risks. Main uncertainty is the expectation of landfill gas flow and quality that is crucial by planning of gas engine's capacity and the economic feasibility of the project. The main argument to demonstrate the economic barriers of landfill gas extraction and electricity production system on Debrecen landfill is that in the last 6 years, since start of the supported renewable electricity production in Hungary, the project was not realized with existents of renewable electricity support and possible JI co-financing.

4.) A different use of landfill gas offsite

***Not probable**:*

Heat off-take*:* No significant off-takers for heat energy are within reasonable distance, this scenario is economically unattractive.

Fuel production*:* Landfill gas-to-fuel technology is not yet commercially available and economically viable, in particular the LFG enrichment/cleaning technology bears significant technical risks.

Summary

The analysis of different scenarios show the alternative 4 is absolute not probable, because the alone-standing heat production would be realistic if the project could sign a long term heat purchase agreement with a trustable client. But this option has no chance due to lack of heat off takers in economic feasible radius. The fuel production from the extracted landfill gas needs a special technology that is currently not common. The market of this fuel type is much undeveloped and so the pricing and demand site is presently unpredictable.

The alternative 2 is not probable, because it is economically not feasible. The project has a 1 million Euro investment cost and it does not generate earnings in the project lifetime. The project has negative NPV and a not applicable IRR

The alternative 3 seems economically feasible if the IRR and the NPV is the only basis of the evaluation. However the related risks are assessed and are incorporated like the landfill gas quality and quantity fluctuation and risks related to the renewable electricity support system, the project has to have a higher IRR figure. By these financial figures the municipality or other investors will not start a gas engine project.

The alternative 1 is the keeping up the current status-quo. The municipality does not require investing in landfill gas collecting and destruction system on the old landfill to match the environmental obligations. This scenario is the best from economic point of view and has the lowest financial risk. The Municipality will take this option in the future, because it wants to avoid all gratuitous financial and economic risks. After the analysis of these options and discussion with the Municipality we find the business-as-usual scenario is the alternative 1, it means the continued uncontrolled release of landfill gas to the atmosphere at the site.

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

The basis of Hungary's waste management policy is the Act XLIII of 2000 on waste management. National waste management policy is laid down in the National Waste Management Plan (NWMP) approved by Parliament by Resolution No. 110/2002. (XII.12.) OGY. The program of the NWMP is implemented by regulatory instruments, a large set of lower-level legislation that codifies the details:

- utilisation of effluent sludge in agriculture, Government Decree 50/2001 (IV.3) Korm.
- technical requirements of municipal solid waste landfills, Decree 5/2002 ( X.25) KvVM

- technical requirements of composting and treatment of biological wastes (Decree 20/2003 (XII.29) KvVM)

In Hungary is obligatory the destruction of landfill gas on new regional waste management sites and on landfills that operate beyond 2008. The landfills not complying with the standards should be stopped or re-constructed by 2009. The landfill's Environmental Permit stipulates the specific regulation of landfill gas collection and utilisation. Landfill that already finished waste disposal and covered with a cover layer, landfill gas extraction and flaring or utilization is not mandatory. On majority of closed landfill sites are planned venting system that hinders the explosion and firing of landfill gas.

The Debrecen Landfill is closed since 1996. The stabilization and coverage works are completed. The construction of the degassing installation is not realized except few domes. The system was closed down and the squeezer has been removed, as well in year 2000. Since November 2007 these domes extract illegally a small amount of landfill gas to produce warm water, without any permission or contract with the Municipality[3]. The system has been operating illegally for seven months. For this reason, a similar operation of the system between 2008 and 2012 is not possible in the scope of BAU.

**Step 2. Investment analysis**

Sub-step 2a. Determine appropriate analysis method

Apply simple cost analysis

***Sub-step 2b – Option I. Apply simple cost analysis***

Calculations Internal Rate of Return

a.) The proposed project, landfill gas extraction and flaring through a newly implemented landfill gas collection network and two flares, is not economically attractive without the sale of ERUs. In absence the JI project, the project has not financial return with more than 1 million Euro investment cost. In scenario "Landfill gas flaring without JI project" IRR is not applicable, because the project scenario do not have income. The details of the calculation are following:

[3] This illegal action is also proven by written information of the municipality.

| all amounts of money in thousand Forint | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | | | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| **Turnover** | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Earnings CO2 certificates | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Costs** | | | | **262 900** | **10 300** | **10 609** | **10 927** | **11 255** | **11 593** | **11 941** | **12 299** | **12 668** | **13 048** | **13 439** |
| - investment | | | **0,0%** | **258 900** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| - insurance | 1 500 | increase | 3,0% | 600 | 1 545 | 1 591 | 1 639 | 1 688 | 1 739 | 1 791 | 1 845 | 1 900 | 1 957 | 2 016 |
| - maintenance | 5 000 | p.a. | 3,0% | 2 000 | 5 150 | 5 305 | 5 464 | 5 628 | 5 796 | 5 970 | 6 149 | 6 334 | 6 524 | 6 720 |
| - office and administration | 2 500 | | 3,0% | 1 000 | 2 575 | 2 652 | 2 732 | 2 814 | 2 898 | 2 985 | 3 075 | 3 167 | 3 262 | 3 360 |
| - landfill gas | 0 | | 3,0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - other costs | 1 000 | | 3,0% | 400 | 1 030 | 1 061 | 1 093 | 1 126 | 1 159 | 1 194 | 1 230 | 1 267 | 1 305 | 1 344 |
| **EBDIT** | | | | -262 900 | -10 300 | -10 609 | -10 927 | -11 255 | -11 593 | -11 941 | -12 299 | -12 668 | -13 048 | -13 439 |
| **EBT** | | | | **-262 900** | **-10 300** | **-10 609** | **-10 927** | **-11 255** | **-11 593** | **-11 941** | **-12 299** | **-12 668** | **-13 048** | **-13 439** |
| **EAT** | | | | **-262 900** | **-10 300** | **-10 609** | **-10 927** | **-11 255** | **-11 593** | **-11 941** | **-12 299** | **-12 668** | **-13 048** | **-13 439** |
| **CASHFLOW** | **p.a. after taxes** | | | -262 900 | -10 300 | -10 609 | -10 927 | -11 255 | -11 593 | -11 941 | -12 299 | -12 668 | -13 048 | -13 439 |
| | **accum.** | | | -262 900 | -273 200 | -283 809 | -294 736 | -305 991 | -317 584 | -329 525 | -341 823 | -354 491 | -367 539 | -380 978 |
| **IRR (Cah flow)** | | **0** | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| **Internal rate of return after 10 years** | | #ZÉRÓOSZTÓ! | **0** | **-262900** | **-10300** | **-10609** | **-10927,3** | **-11255,1** | **-11592,7** | **-11940,52** | **-12298,7** | **-12667,7** | **-13047,7** | **-13439,16** |

b.) In case "Landfill gas extraction and flaring in JI project" the single income is the revenue of ERU's sale in period 2009-2013. The majority of investment cost has to be financed by the project owner, because no project financing or bank loan is available for this kind of project. The project owner calculates with 5 Euro/tonnes sale price and with an 18% upfront payment from the total price of ERU. The result of the IRR calculation is 14,95 % for 10 years period. The details of calculation are following:

| all amounts of money in thousand Forint | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | | | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| **Turnover** | | | | 93 591 | 0 | 85 272 | 85 272 | 85 272 | 85 272 | 85 272 | 0 | 0 | 0 | 0 |
| Earnings CO2 certificates | | | | 93 591 | 0 | 85 272 | 85 272 | 85 272 | 85 272 | 85 272 | 0 | 0 | 0 | 0 |
| **Costs** | | | | **262 900** | **10 300** | **10 609** | **10 927** | **11 255** | **11 593** | **11 941** | **12 299** | **12 668** | **13 048** | **13 439** |
| - investment | | | **0,0%** | **258 900** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| - insurance | 1 500 | increase | 3,0% | 600 | 1 545 | 1 591 | 1 639 | 1 688 | 1 739 | 1 791 | 1 845 | 1 900 | 1 957 | 2 016 |
| - maintenance | 5 000 | p.a. | 3,0% | 2 000 | 5 150 | 5 305 | 5 464 | 5 628 | 5 796 | 5 970 | 6 149 | 6 334 | 6 524 | 6 720 |
| - office and administration | 2 500 | | 3,0% | 1 000 | 2 575 | 2 652 | 2 732 | 2 814 | 2 898 | 2 985 | 3 075 | 3 167 | 3 262 | 3 360 |
| - landfill gas | 0 | | 3,0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| - other costs | 1 000 | | 3,0% | 400 | 1 030 | 1 061 | 1 093 | 1 126 | 1 159 | 1 194 | 1 230 | 1 267 | 1 305 | 1 344 |
| **EBDIT** | | | | -169 309 | -10 300 | 74 663 | 74 344 | 74 017 | 73 679 | 73 331 | -12 299 | -12 668 | -13 048 | -13 439 |
| **EBT** | | | | **-169 309** | **-10 300** | **74 663** | **74 344** | **74 017** | **73 679** | **73 331** | **-12 299** | **-12 668** | **-13 048** | **-13 439** |
| **EAT** | | | | **-169 309** | **-10 300** | **74 663** | **74 344** | **59 213** | **58 943** | **58 665** | **-12 299** | **-12 668** | **-13 048** | **-13 439** |
| **CASHFLOW** | **p.a. after taxes** | | | -169 309 | -10 300 | 74 663 | 74 344 | 59 213 | 58 943 | 58 665 | -12 299 | -12 668 | -13 048 | -13 439 |
| | **accum.** | | | -169 309 | -179 609 | -104 947 | -30 602 | 28 611 | 87 554 | 146 219 | 133 920 | 121 253 | 108 205 | 94 766 |
| **IRR (Cah flow)** | | **0** | | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| **Internal rate of return after 10 years** | | **14,96%** | **0** | **-169309,2** | **-10300** | **74662,66** | **74344,39** | **59213,25** | **58943,13** | **58664,91** | **-12298,7** | **-12667,7** | **-13047,7** | **-13439,16** |

**Step 4. Common practice analysis**

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

There are some active degassing installations implemented in Hungary but these installations are mainly on new regional waste management sites. The extracted landfill gas is generally flared and only on few locations is planned renewable energy production in gas engines. The closed landfills are in a poor state and require modernization or complete overhaul. The Debrecen landfill project will be a unique project meaning that there is no similar project being carried out in Hungary presently without JI registration. This will be, in fact, the second JI project of its kind in Hungary.

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

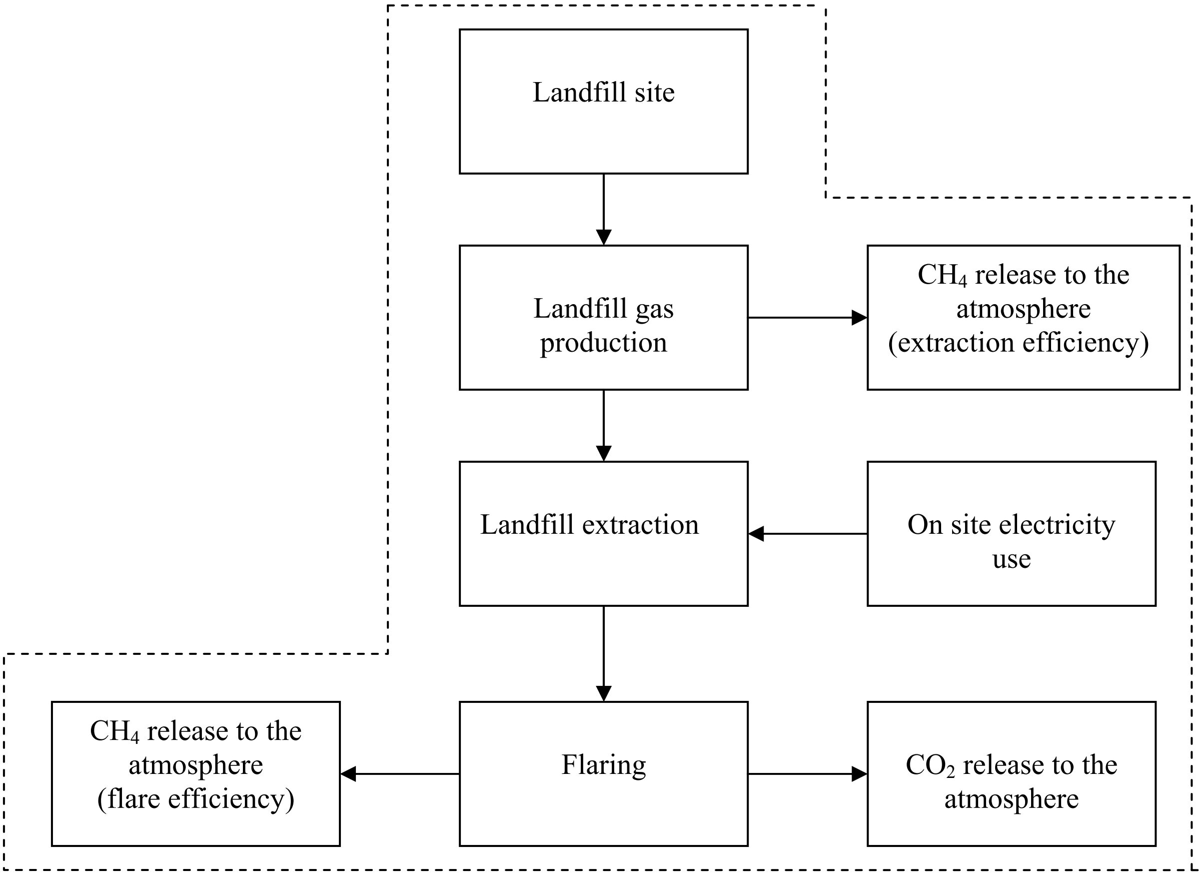
Considering there are no **similar** activities widely observed and commonly carried out, it is not necessary to perform an analysis at this point.

***Step 5. Impact of JI-registration***

At this moment no progress takes place in degassing of Debrecen Landfill compared to 1996 when the landfill was closed. The lack of financial resources is the main reason that the project has not been developed yet and will not be developed in the near future without the JI-registration. Once the project is registered as a JI project, extraction of the landfill will take place and the project will be entitled to sell emission reductions from methane destruction. Such revenue will contribute to realize and to operate the project that will help the monitoring and re-cultivation of the landfill.

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

The flow chart below provides the project with its main components and connections where the project boundaries are drawn, excluding processes beyond control or influence of the project. The dashed line indicates the project boundaries:




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

The baseline is set on 17.07.2007.

Carbon-Aero Kft.
H-1027 Budapest
Varsanyi Iren str. 12
Hungary

Contact person: A. Juhasz

Phone. +36 1 225 1306
Fax. +36 1 225 1307
e-mail: juhasz_a@t-online.hu

## SECTION C. Duration of the project / crediting period

### C.1. Starting date of the project:

30th November 2007.

### C.2. Expected operational lifetime of the project:

10 years

### C.3. Length of the crediting period:

01.01.2008-31.12.2012

## SECTION D. Monitoring plan

### D.1. Description of monitoring plan chosen:

The Monitoring Plan (MP) for the Project "Landfill gas mitigation project on Debrecen landfill" was developed according to the approved consolidated monitoring methodology **ACM0001**: ***"Consolidated monitoring methodology for landfill gas project activities".***

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

N/A as. 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 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

N/A as. 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):**

N/A as. 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* | 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? | Comment |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *cross-referencing to D.2.)* | | | | | | | (electronic/ paper) | |
| | | | | | | | | |
| | | | | | | | | |

N/A as 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):**

N/A as. Option 2 was selected.

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

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

| ID number *(Please use numbers to ease cross-referencing to D.2.)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| 1. $LFG_{total,y}$ | Total amount of landfill gas captured | *Flow meter in front of the flare station* | $Nm^3$ | m | Continuously | 100% | Electronic | Measured by a flow meter. Data to be aggregated monthly and yearly. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2. $LFG_{flare,y}$ | Amount of landfill gas flared | *Flow meter in front of the flare station* | $Nm^3$ | m | Continuously | 100% | Electronic | Measured by a flow meter. Data to be aggregated monthly and yearly. |
| 3. FE | Flare/ combustion efficiency determined by the operation hours(1) and the methane content in exhaust gas (2) ear *y* | *Various* | % | m /c | The operation hours will be monitored continuously though the run time meter connected to the flame detector (1) Enclosed flares efficiency shall be monitored quarterly (2).. | (1) 100 %<br>(2) n/a | Electronic | The enclosed flares shall be operated and maintained as per the specifications prescribed by the manufacturer. |
| 4. wCH4,y | Methane fraction in the landfill gas | *Gas analyzer* | $m^3$ CH4/ $m^3$ LFG | m | Continuously | 100% | Electronic | Preferably measured by continuous gas quality analyser. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5. T | Temperature of the landfill gas | *Flow meter in front of the flare station* | °C | m | continuously | 100% | Electronic | No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters. |
| 6. p | Pressure of the landfill gas | *Flow meter in front of the flare station* | Pa | m | continuously | 100% | Electronic | No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7. $EL_{IMP}$ | Total amount of electricity imported to meet project requirement | *Electricity meter* | MWh | m | continuously | 100% | Electronic | Required to determine $CO_2$ emissions from use of electricity or other energy carriers to operate the project activity. The records of any electricity. |
| 8. CEF | $CO_2$ emission intensity of electricity used during the project | *Baseline study* | tCO2/MWh | c | Annually | 100% | Electronic | The default data for CEF is fixed before the project start by Hungarian Ministry of Environment. |

**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):**

$$ER_y = ((MD_{projekt,y} - MD_{reg,y}) * GWP_{CH4}) - (EL_{IMP} * CEF_{electricity,y})$$

Where: $ER_y$ are the emission reductions; $MD_{project,y}$ is the amount of methane actually destroyed during the year; $MD_{reg,y}$ is the methane that would have been destroyed in the absence of the project activity; $GWP_{CH4}$ is the approved global warming potential value for methane (this value is set on 21), $EL_{IMP,y}$ Is the net quantity of electricity imported during year y, in MWh, and $CEF_{electricity,y}$ is the CO2 emissions intensity of the grid electricity used. Due to both common practice and the legal framework in the future no treatment of landfill gas is expected for the Debrecen landfill. We incorporated in the calculation the small boiler emission reduction potential therefore the $MD_{reg,y}$ is 1931 tonnes for the entire Kyoto period (2008-2012).

According to ACM0001 the $MD_{project,y}$ equals the amount of methane flared. In this situation:

$MD_{project,y} = MD_{flare,y}$

$MD_{flare,y}$ is the quantity of methane destroyed by flaring, it is calculated as follows:

$$MD_{flared,y} = LFG_{flared,y} * D_{CH_4} * w_{CH_4} * FE$$

Where

- $MD_{flared,y}$ is the quantity of methane destroyed by flaring,
- $LFG_{flared,y}$ is the quantity of landfill gas flared measured in cubic meters ($m^3$),
- $D_{CH4}$ is the density of methane expressed in tonnes of methane per cubic meter of methane (0.0007168 $tCH_4/m^3$ $CH_4$ at standard temperature and pressure: 0 °C and 1.013 bar).
- $w_{CH4}$ is the average methane fraction of the landfill gas (in $m^3$ $CH_4/m^3$ LFG).
- FE is the flare efficiency (the fraction of methane destroyed)

The Flare Efficiency (FE) related to flaring activity ($PE_{flare}$) will be calculated as a product fraction of time the gas is combusted in the flare; and the efficiency of the flaring process. Efficiency of the flaring process is defined as fraction of methane completely oxidized by flaring process. Related to the information of the technology suppliers the proposed enclosed flares will work over 1000°C and the landfill gas will stay over 0,3 sec in the flare (follow the TA-Luft instructions) the 100 % of the methane will be destructed. In the calculation we use FE = 0.9 towards more conservative estimation of emission reduction and we did not use the information of technology supplier (MVM ERBE KFT). Flare Efficiency will be monitored quarterly by analysis of methane content of the exhaust gas. The used technology is not yet decided because of the preparation phase of the project, but the project owner will use state of the art technology and measurement tools to measure the exhaust gas methane content quarterly. The measurements likely will be carried out an independent specialized company.

The flares will work 8760 hours annually, according the technology suppliers and the opartion practice. The chance of lfall out a flare is infinitesimal. The flare operation hours will be monitored though the run time meter connected to the flame detector. The used enclosed flare technology and the quarterly good practice monitoring of flare efficiency secure the necessary accuracy of the monitoring system with the ACM001 ver4.

The project emission of on-site electricity use will be calculated as follows:

$PE_{electricity} = EL_{IMP} * CEF_{electricity}$

Where

- $PE_{electricity}$ is the Project Emission related to on site electricity use
- $EL_{IMP}$ is the annually used electricity for landfill gas extraction and destruction (in MWh)
- $CEF_{electricity}$ is the $CO_2$ intensity of Hungarian electricity set by Ministry of Environment

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

No leakages under ACM0001

| **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 the applied 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 D1.2.2

**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. |
| 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 |

| | | |
|---|---|---|
| 2. $LFG_{flare,y}$ | *Low* | Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy |
| 3. FE | *Low* | Regular maintenance will ensure optimal operation of flares. |
| 4. wCH4,y | *Low* | The gas analyser will be subject to a regular maintenance to ensure accuracy. |
| 5. T | *Low* | Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy |
| 6. p | *Low* | Flow meters will be subject to a regular maintenance and periodical calibration according to the manufacturer's recommendation to ensure accuracy |
| 7. $EL_{IMP}$ | *Low* | Electricity meters will be periodically calibrated according to the manufacturer's recommendation |
| 8. 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:**

The landfill gas extraction and destruction installation of Debrecen will have a specific operator in charge of checking the complete process. This operator is responsible for getting relevant information from the monitoring system. Monthly reports will consider the main factors as well as emission reductions calculated in accordance with this PDD. Measured data will be stored five years after the project activity. The operator will be trained for the operation and maintenance of monitoring system before the project. The operator checks continuously the installation.

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

Carbon-Aero Kft.
H-1027 Budapest
Varsanyi Iren str. 12
Hungary

Contact person: A. Juhasz

Phone. +36 1 225 1306
Fax. +36 1 225 1307
e-mail: juhasz_a@t-online.hu

## 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 4.**

### E.1. Estimated project emissions:

The Project emissions are potentially represented by three sources:

**1. Methane emissions due to not captured LFG.**

The main emission source of project identified within the system boundary is the 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. 80% of the total amount of gas released by the landfill in the baseline scenario. This figure is obtained by considering the well efficiency (80%) and well availability (100%). Therefore 20% of baseline emissions will be considered as Project emissions.

The methane emission from not captured LFG will be estimated as follows:

$PE_{not\ captured} = LFG * C_{ch4} * D_{ch4} * (1-CE) * GWP_{ch4}$

Where

$PE_{not-captured}$ is estimated project emission from not captured LFG
LGF is total landfill gas generated at the landfill site ($m^3$)
$C_{ch4}$ is the methane content of landfill gas (50%)
$D_{ch4}$ is the methane density ($t/m^3$)
CE is LFG collection network efficiency
$GWP_{ch4}$ is the global warming potential of methane (21)

**2. Methane emissions in the flare due to the flare efficiency**

Another relevant source of project emissions is methane not combusted in the flare. This source is covered through the parameter "flare efficiency" (FE), which enters the calculation of the emission reductions. Default value of flare efficiency of 90 % is used because of conservative calculation.

The methane emission from burning efficiency of the flare will be estimated as follows

$PE_{flare,y} = LFG_{flared,y} * D_{CH4} * w_{CH4} * (1-FE) * GWP_{CH4}$

Where

$PE_{flare,y}$ is the estimated emission from non combusted methane

$LFG_{flared,y}$ is the quantity of landfill gas flared measured in cubic meters ($m^3$),

$D_{CH4}$ is the density of methane expressed in tonnes of methane per cubic meter of methane (0.0007168 $tCH_4/m^3$ $CH_4$ at standard

temperature and pressure: 0 °C and 1.013 bar).

$w_{CH4}$ is the average methane fraction of the landfill gas (in $m^3$ $CH_4/m^3$ LFG).

FE is the flare efficiency (the fraction of methane destroyed)

$GWP_{ch4}$ is the global warming potential of methane (21)

**3. CO2 emissions resulting from electricity used by LFG pumping equipment**

Marginal source is the $CO_2$ emission from on site electricity use. The project emission is the average $CO_2$ intensity of used electricity.

The $CO_2$ emission from on-site electricity use will be estimated as follows:

$PE_{electricity} = EL_{IMP} * CEF_{electricity}$

$PE_{electricity}$ is the Project Emission related to on site electricity use

$EL_{IMP}$ is the annually used electricity for landfill gas extraction and destruction (in MWh)

$CEF_{electricity}$ is the CO2 intensity of Hungarian electricity set by Ministry of Environment[4]

**The total project emission is**

$PE_{total} = PE_{non\ captured} + PE_{flare} + PE_{electricity}$

[4] See Annex 2

| | Total generated CH4 | CE* | $PE_{non\ captured}$ | Total collected CH4 |
|---|---|---|---|---|
| | m3CH4/year | - | m3CH4/year | m3CH4/year |
| 2008 | 8 488 879 | 0,8 | 1 697 776 | 6 791 103 |
| 2009 | 8 074 872 | 0,8 | 1 614 974 | 6 459 897 |
| 2010 | 7 681 056 | 0,8 | 1 536 211 | 6 144 844 |
| 2011 | 7 306 446 | 0,8 | 1 461 289 | 5 845 157 |
| 2012 | 6 950 106 | 0,8 | 1 390 021 | 5 560 085 |

| | Total collected CH4 | FE* | $PE_{flare}$ |
|---|---|---|---|
| | m3CH4/year | - | m3CH4/year |
| 2008 | 6 791 103 | 0,9 | 679 110 |
| 2009 | 6 459 897 | 0,9 | 645 990 |
| 2010 | 6 144 844 | 0,9 | 614 484 |
| 2011 | 5 845 157 | 0,9 | 584 516 |
| 2012 | 5 560 085 | 0,9 | 556 009 |

| | $PE_{non\ captured}$ | $PE_{flare}$ | $PE_{electricity}$ | $PE_{total}$ |
|---|---|---|---|---|
| | tCO2e | tCO2e | tCO2e | tCO2e |
| 2008 | 25 556 | 10 223 | 297 | 36 076 |
| 2009 | 24 310 | 9 724 | 298 | 34 332 |
| 2010 | 23 124 | 9 250 | 300 | 32 674 |
| 2011 | 21 996 | 8 799 | 296 | 31 091 |
| 2012 | 20 924 | 8 369 | 291 | 29 584 |

**E.2. Estimated leakage:**

No leakage needs to be accounted in ACM0001 methodology.

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

The sum of E1 and E2 is equal to E1.

**E.4. Estimated baseline emissions:**

The estimated quantity of the methane generated at the landfill in the Kyoto period is calculated based on the first order decay model of the US Environmental Protection Agency (USEPA):

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left( \frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where

$Q_{CH4}$ = annual methane generation in the year of the calculation *($m^3$/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
$L_o$ = potential methane generation capacity (*$m^3$/Mg*)
$M_i$ = mass of waste accepted in the $i^{th}$ year (*Mg*)
$t_{ij}$ = age of the $j^{th}$ section of waste mass $M_i$ accepted in the $i^{th}$ year (*decimal years*, e.g., 3.2 years

The amount of methane generated in the baseline scenario was estimated based on data on amount of waste disposed on the Debrecen Landfill (please refer to the Annex 2. Baseline Information for details). The GHG emissions from the Landfill gas 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. We adjust the results of EPA model with parameters ($\varphi$ ,MCF), so we incorporate important factors that help us receive more conservative data from the EPA model. The value of $\varphi$ represents the uncertainties of the model calculation, it is a model correction factor that we set $\varphi$=0,9 following the EB26 Annex 14. The value of MCF (Methane correction factor) represents the total ratio of waste that produces landfill gas. We set MCF=1, because the Debrecen old landfill is anaerobic managed solid waste disposal site. The OX oxidation factor is reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste. We consider the OX factor is incorporated in the CE (collection efficiency of the landfill gas collection system), since the IPCC guidelines chapter 3 "Solid Waste Disposal" determines, based on field and laboratory $CH_4$ and $CO_2$ measurements, that CH4 oxidation from uniform and homogenous soil layers should not be used directly to determinate oxidation factor since in reality only a fraction of CH4 generated will diffuse through such a homogenous layer. Another fraction will escape through cracks/fissures or via lateral diffusion without being oxidised.

In our calculation we use 80% CE (collection efficiency) that represents the escaped methane through cracks/fissures and the oxidised methane as well. In the project emission calculation we consider the 20 % of the total generated $CH_4$ as non captured methane emission. We use by the calculation of GHG impact of this project line emission the 21 GWP factor for the total amount of methane that is non captured by the collection system, however we know the part of the non captured methane is oxidised and leave the cover layer as $CO_2$. These figures represent a more conservative project line emission calculation.

Estimation of LFG generation and the related methane emission in the baseline scenario is given below:

| | EPA result | φ | MCF | EPA result*φ* MCF |
|---|---|---|---|---|
| | m3CH4/year | - | - | m3CH4/year |
| 2008 | 9 432 088 | 0,9 | 1 | 8 488 879 |
| 2009 | 8 972 080 | 0,9 | 1 | 8 074 872 |
| 2010 | 8 534 506 | 0,9 | 1 | 7 681 056 |
| 2011 | 8 118 273 | 0,9 | 1 | 7 306 446 |
| 2012 | 7 722 341 | 0,9 | 1 | 6 950 106 |

| | Generated methane | Generated methane | Generated methane |
|---|---|---|---|
| | $m^3$ / year | tCH4 / year | $tCO_2e$ / year |
| 2008 | 8 488 879 | 6 085 | 127 781 |
| 2009 | 8 074 872 | 5 788 | 121 549 |
| 2010 | 7 681 056 | 5 506 | 115 621 |
| 2011 | 7 306 446 | 5 237 | 109 982 |
| 2012 | 6 950 106 | 4 982 | 104 619 |

| | Generated methane | MD reg | Baseline emission |
|---|---|---|---|
| | $tCO_2e$ / year | $tCO_2e$ / year | $tCO_2e$ / year |
| 2008 | 127 781 | 386 | 127 395 |
| 2009 | 121 549 | 386 | 121 163 |
| 2010 | 115 621 | 386 | 115 235 |
| 2011 | 109 982 | 386 | 109 596 |
| 2012 | 104 619 | 386 | 104 233 |

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

ER= Baseline – Project line

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

The estimated results of the emission reduction calculation are the following:

| | Baseline emission | Project line emission | Emission Reduction |
|---|---|---|---|
| | $tCO_2e$/year | tCO2e/year | tCO2e/year |
| 2008 | 127 395 | 36 076 | 91 320 |
| 2009 | 121 163 | 34 332 | 86 832 |
| 2010 | 115 235 | 32 674 | 82 561 |
| 2011 | 109 596 | 31 091 | 78 505 |
| 2012 | 104 233 | 29 584 | 74 648 |
| 2008-2012 | 577 623 | 163 757 | 413 866 |

**The total Emission Reduction in Kyoto Period is 413 866 t$CO_2$e**.

## SECTION F. Environmental impacts

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

The degassing installation will not have any negative environmental impacts. Positive impacts are the reduction of GHG emissions and also $H_2S$ and other odorous compounds are reduced, which leads to a cleaner environment in the surroundings of the landfill.
Following environmental impacts could be identified:

Air
Landfill gas produced while waste decomposition and it has a negative impact on the environment. At this landfill gas production, methane content of the landfill gas is of particular importance, since this is considered to increase greenhouse effect. These environmental impacts can be decreased by implementing a landfill gas collection system. This represents a safe solution in the long run, as long as landfill gas is produced. The negative impact of the old landfill on Air is minimized through the collecting and burning of landfill gas.

Water
Leakage water might represent hazard on the landfill of Debrecen. Depending on the former technical installation and on its groundwater protection system, it might affect groundwater.
Landfill gas collection and destruction systems do not affect leakage water production, i.e. it does not represent additional environmental load.

Soil
Soil quality of the surrounding areas had been slightly affected by the former operation of the landfill of Debrecen. Compared to the former situation, the project will not have any influence.

Inhabited Environment
The project improves inhabited environment circumstances considerably, since smell of the landfill gas will be eliminated almost entirely.

**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:**

Currently there is no need for performing any additional environmental impact assessment.

## SECTION G. Stakeholders' comments

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

The Project owner contacted E-MISSZIO local Environmental Association active member of the Friend of the Earth global environmental association, start the stakeholder communication related to Debrecen landfill gas mitigation project. The Hungarian PDD was submitted to the Association that has a chance to gather detailed information about the project from different aspects (environmental, technical and economic) and its benefits. After the review of the documentation the E-MISSZIO and the project owner had a personal discussion to discuss the occurring issue related to the project. Providing a wide scale Hungarian stakeholder communication the summary of the Hungarian PDD was announced on the web site of E-MISSZIO Environmental Association for twenty days (www.e-misszio.hu). The comment could be sent on the e-mail address of the association. The NGO and the result of the 20 days open stakeholder discussion had a positive outcome and the stakeholders support the project.

The AKSD Kft. is the operator of the new regional landfill on the same ground owned by municipality, it has the rights to long term operation of the regional landfill site, but it is not the owner of the area of the landfill site. The AKSD was detailed informed about the project and the related contract between the Municipality and Civis Biogas Kft. and they accepted the planned investment with every detail.

A family inhabits illegally close to the landfill in the old weight measurement building direct on the old entrance. They scavenge on the landfill. The married couple Mr. Lakatos József and Ms. Lakatos Józsefné was asked to offer an opinion about the project, but they did not want to say anything, because they are illegal inhabitants and did not want to be mentioned in a written documentation.

Annex 1

## CONTACT INFORMATION ON PROJECT PARTICIPANTS

| | |
|---|---|
| Organisation: | Civis Biogaz Kft. |
| Street/P.O.Box: | Simai u. 4. |
| City: | Nyíregyháza |
| Postal code: | 4400 |
| Country: | Hungary |
| Phone: | +36 1 225 1306 |
| Fax: | +36 1 225 1307 |
| E-mail: | juhasz_a@t-online.hu |
| Salutation: | Mr. |
| Last name: | Juhasz |
| First name: | Andras |
| Phone (direct): | +36 30 250 8765 |
| Fax (direct): | +36 1 225 1307 |

Annex 2

**BASELINE INFORMATION**

## Landfill gas calculation parameters

| | | | |
|---|---|---|---|
| ***Landfill site*** | | | |
| | | | |
| Start of operation | | | 1978 |
| End of operation | | | 1996 |
| Aera of landfill site | | ha | 29,6 |
| Disposed waste | | tonnes | 5,2 million |
| | | | |
| ***Landfill gas collection and destruction network data*** | | | |
| | | | |
| Installed domes | | | 119 |
| Gas collection efficiency | | % | 80% |
| Installed flares | | | 4 |
| Flare capacity | | $m^3$/h | 500 |
| Flare efficiency | | % | 90% |
| | | | |
| ***LANDGEM data*** | | | |
| | | | |
| $L_0$ | | $m^3$ LFG / tonne | 100 |
| k | | 1/year | 0.05 |
| Methane content of LFG | | % | 50% |
| Density of methane | | tonne / $m^3$ | 0.0007168 |
| | | | |
| ***Basline data*** | | | |
| | | | |
| Proportion of destructed LFG in baseline scenario | | | 0% |

The chosen Lo and k value is the inventory default value of the US EPA. We use these default numbers by already working Nyiregyhaza landfill JI project. The two years operation practice of the Nyiregyhaza landfill project confirm the use of these default values. The monthly average of the destroyed landfill gas amount shows a minimal difference to the EPA LANDGEM model results.

Annex 3

## MONITORING PLAN

From the monitoring methodology, it could be seen that the following main variables are to be measured:

- Methane flow from the landfill
- Methane flow into flares
- Methane content in the landfill gas
- Flare efficiency

The landfill gas collection network will be installed with most up-to-date equipment to perform measures continually and allow for remote access to equipment and data. The system equipment will be connected through a Programmable Logic Control tool that will let operators quickly check the unit's main variables through a user-friendly interface. Through the PLC, users will also have access to continuously measured data, such as methane content in the landfill gas and the methane flows. This way of continuous monitoring secures all the data needed for the verifications.

**Methane flows:**

There will be a flow meter installed for operation in the main line straight after the blowers. The type of flow meter is likely the same as used at other landfill gas projects that will be calibrated prior operation. The flow meter in the main line will be connected to the gas facilities PLC, and data will be recorded continuously. Moreover, the meter will be sealed, which prevent data manipulation. Attached to each of the flow meter will be an electronic volume conversion device, which converts the volume measured by the flow meter to volume at $0_oC$ and 1,01325 bar, i.e., the STP. These devices will also be calibrated.

**Methane content in LFG:**

Methane content in the LFG is critical, for measuring this information, a continuous analyser will count. The analyser will also be connected to the data system through the PLC, with information easily accessible through a desktop computer.

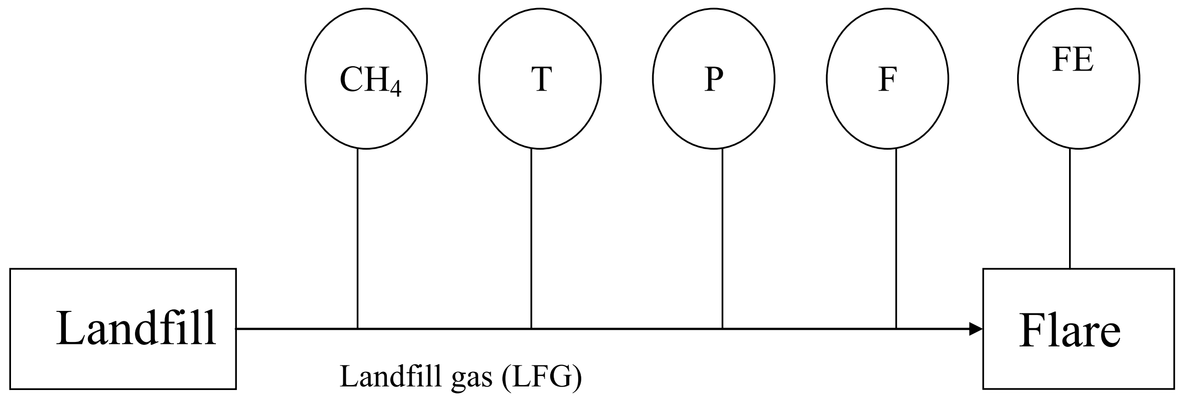
**Flare efficiency:**

Complying with the monitoring methodology applied in this case, the project owner will follow the technical parameters provided by the flare manufacturer.

The used technology for the exhaust gas $CH_4$ content measurement is not yet decided because of the preparation phase of the project, but the project owner will use state of the art technology and measurement tools to measure the exhaust gas methane content quarterly. The measurements will be carried out an independent specialized company.

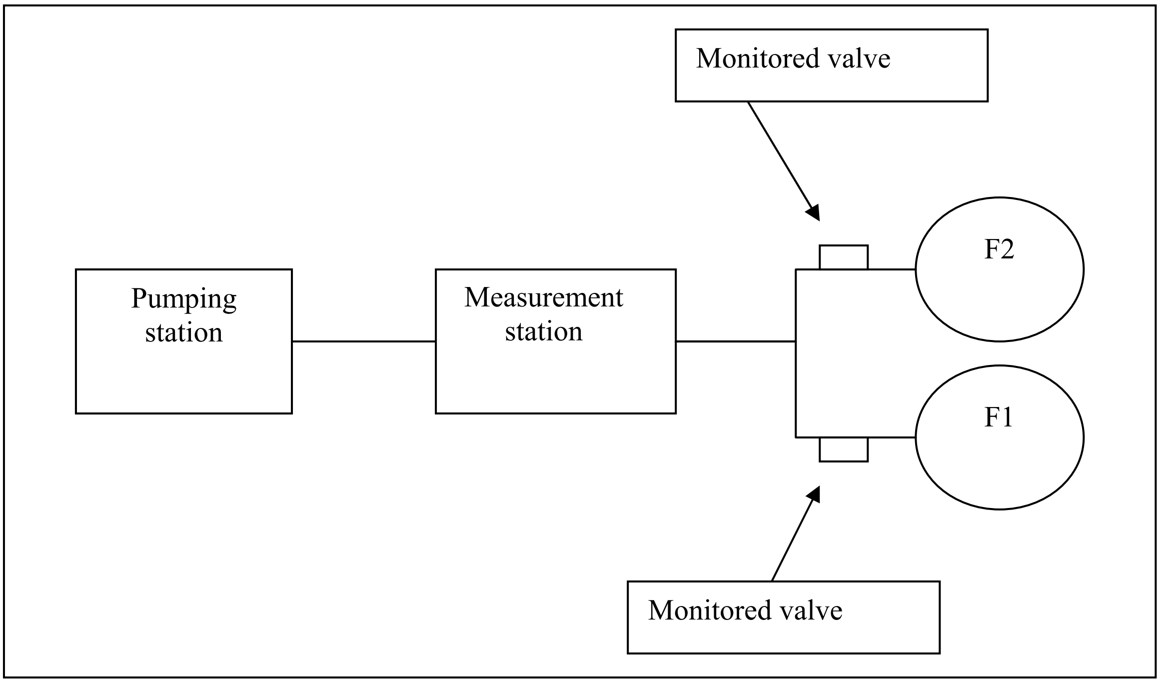
Some of the included information will be:

- Internally consumed energy
- Total extracted landfill gas
- Total landfill gas destroyed in flares
- Monthly average methane content of landfill gas
- Monthly average extracted volumes of landfill gas
- Emission reductions from destroyed methane




Measurements:

$CH_4$ = Fraction of $CH_4$
T = Temperature
P = Pressure
F = Flow of LFG ($m^3$)
FE = Flare efficiency




The valves will be closed in case of emergency if one of the two flares is stopped. In other cases the valves will be fully open, it means the valves are fully open or fully close, incomplete closure of a valve is not possible. The cases when the valves are closed will be monitored directly.

In case of emergency the given valve and the given compressor will be closed and stopped immediately after the signal of the flare. The incomplete closure of a valve is not possible.

**Operation**

The operation will be carried out by one trained personal that will be responsible for the daily control of the compressor station and flare station. The flare and compressor station will have a remote control as well through mobile phone like by gas engines or wind turbines. In case of emergency the person will be responsible to inform the management and the maintenance team of the flares and compressors. The maintenance of both equipments will be carried out by a contracted maintenance firm suggested by the technology suppliers. The reading of the monitoring equipment will be carried out by the same trained personal and the usual monthly and unexpected checks by the management of the company.

**QA/QC procedures**

In order to guarantee stable conditions of monitoring, a protocol must be developed for quality assurance and control. The instruments that determine CO2e-reductions and gas flows are the instruments that must be calibrated and checked. Listed below are the instruments that are installed.

Flow meters

The two flow meters will be state of the art and highly reliable. They will be calibrated by the Hungarian Authority (OMSZ). After three years a new calibration must be made. This is performed again by the above mentioned Authority.

The accuracy of this meter is +/- 1%. Official reports will be provided on request.

Responsible for operation is the project owner. In case of failure, it has to be reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. The project owner will use the daily average of the volume in the previous month minus 5%, per day of flow meter failure.

Flow computer

This device will be installed in order to convert $m^3/h$ into $Nm^3/h$ by using STP figures. This device will be also calibrated and has accuracy within the range of +/- 0.2%. Official reports will be provided on request.

Responsible for operation is the project owner. In case of failure it has to be reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. The project owner will use the average of measured methane content in the previous month minus 5%, per day of flow meter failure.

Gas Analyser

This device will check the quality of the gas. It will be calibrated at delivery and should be calibrated yearly using a sample gas of known quality (independent supplier), these calibrations are registered. Official reports will be provided on request

Responsible for operation is the project owner. In case of failure it has to be reported to equipment supplier and repairs carried out. If repair is not possible, equipment will be replaced by equivalent item within one month. Failure events will be recorded in the site events log book. The project owner will use the average of measured methane content in the previous month minus 5%, per day of gas analyzer failure.