Landfill gas mitigation through the Hungarian Nyíregyháza-Oros landfill gas project

Project Design Document

2005. 03.08.

1 General information

1.1 Project host

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1.2 Projekt partner

Technology supplier and ERU's buyer

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1.3 Project summary

Project title:

- Landfill gas mitigation through the Hungarian Nyíregyháza-Oros landfill gas project

Host country:

- Hungary

Location:

- Municipal landfill at Nyíregyháza-Oros

Emission reduction:

- 137 927 tonnes of CO_2e in the first commitment period (2008-2012)

1.4 Abstract:

Waste treatment and management is one of the biggest environmental and environmental related socio-economic challenge for Hungary both in the mid and long terms. The challenge is crated 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 do not meet the standards and there are an additional estimated[1] 1100 illegal landfills of various sizes. Total annual CO_2e emission is about 2200 Gg but until mid-2004 only half dozen landfill gas mitigation projects have been planned. The main line of Hungarian waste policy due to EU harmonization is the creation of regional waste management centres.

The rehabilitation and upgrading of landfills and abolition of illegal and outdated landfills puts an enormous burden on both the central government and on the municipalities, demanding an approximate investment of euro/year.

[1] Tájsebészet project of Humusz Environmental Association and Ministry of Environment and Water

The development of waste management/treatment legislation was a slow process. Due to EU accession rules have been significantly changed, it often leads to situations when a waste management site applies a relatively high technical solution, but faces new and additional authorization but not technical requirements.

From the 1,2 million tonnes of waste disposed until 2004, 4 Gwh/year electricity will be generated. In this way the project will reduce the GHG emission on site (based on GWP) and the average carbon intensity of the Hungarian energy generation off site. During the period of 2008-2012 the project will realize 137 927 tonnes of CO_2e emission reduction. In addition the technologies and methods used will be organized in a single operational system.

History of the landfill

Nyíregyháza-Oros landfill (Ny-O) was developed in several phases in the period of 1983-85. Until 2002 it met all Hungarian requirements, in addition it was among the firsts to apply forerunner technologies and methods.

Due to EU harmonization and changing rules, the Site is going under new authorization processes. In addition to these requirements, support schemes to renewable technologies create new opportunities as well. Being an old landfill, Ny-O site is not obliged to capture and utilize landfill gas, such project would have cleared additional environmental benefits. Emission Reduction Unit (ERU) sales are needed for two main purposes. The operator would not be able to finance neither the investment costs, nor the production risks in the first years that come from the nature of technology.

Project partners

Landfill is owned by the municipality of Nyíregyháza. Városüzemeltetési Kht[2] – the operator of the landfill- is a municipal, non-profit organization. It carries out the public utility obligations of sewage and waste management including the maintenance of these systems. The Városüzemeltetési Kht will keep maintaining the landfill itself and sells the landfill gas to the investor for utilization. The EXIM-INVEST Biogáz Kft. and Városüzemeltetési Kht. formed a syndicate for this project with the agreement of Nyíregyháza for the purpose of LFG utilization.

Buyer of the produced green electricity is the regional electricity utility TITÁSZ. Planning The KEVITERV Kft. planned the system and the TECHNO-KER Kft. is the general constructor that is responsible for execution of the system. The grid connection will be built by Elektrovit Kft.

1.5 Background and justification

In this section the project is put into a broader context: after the short description of the Hungarian waste management situation we examine the relationship of the project to this general picture. We overlook the main justification elements, key factors and steps to be taken, aims to be achieved and concrete results and activities.

Background and history of the project

In Hungary there are more than 3200 landfills of various size and type in operation, of which around 2/3 do not meet the environmental requirements. In addition there are around 1100 illegal landfill sites. Waste management is one of the biggest challenge for Hungary both in the mid and long run. Waste issue is to be treated on the national, regional and local level. The mainstream of the recently formed waste management plans is the development of macro-regional centres. It is due to the availability of EU funds led by the notion of economics of scale. The pressure owners and operators of waste disposals keep increasing due to limited availability of EU and national financial resources, the environmental "heritage" of the former socialist era, changing

[2] Non profit organization owned by the Municipality of Nyíregyháza

consumption behaviours. Financing waste management is not an easy task, 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.

Regarding green waste collection the national aim is to gradually decrease its proportion in the disposed waste to 75-50-35 % by 2006, 2009, 2016 respectively, on the basis of the total amount of biologically degradable waste of 1995.

This particular project of Nyíregyháza-Oros landfill is located in one of the most backlogged areas of Hungary: in Szabolcs-Szatmár-Bereg County, East Hungary.

The situation of the county can be described with the following numbers from 2003:

- Its 3,8% out-migration rate is the highest in Hungary.
- Activity rate is just 42%, while the national average is 49,9%.
- Unemployment rate is 8,4% compared to the national average of 5,2.

1.6 Project's location

The landfill was developed in several phases from 1980 on, when the decision was made. Start up of the site is mainly due to the environmental, social, health pressure created by the Nyíregyháza-Borbánya landfill to be replaced. The landfill is owned by the municipality of Nyíregyháza, operated by the municipal Városüzemeltetési Kht. Its roles are to maintain the waste collection and treatment systems and the sewage system as well.

Location of site:	- Nyíregyháza-Oros
Starting date of operation:	- 1985
Ending date of operation:	- 2010
Gross size:	- 34 acre

Landfill size:	- 17,46 acre
Number of settlements served:	- 21
Total no. of population:	- Approx. 200 000
Quantity of waste disposed (tonnes):	- 1,2 million tonnes
Volume of waste disposed (m3):	- 4,3 million m3
Proportion of green components:	- 35%
Type of site:	- Protected, with impermeable cover, two trays
Role in waste management :	- Complex treatment site

1.7 Description of the landfill site

Construction got started in 1985 based on a decision in 1980. Operation started in 1985, the projected lifetime was 25 years, until 2010.

I. tray

The first tray (gross 11 acres, net 8,8 acres) was designed to take 68-77 thousand tonnes of waste annually. Despite the fact that the time of construction regulation and requirements were incomplete and unclear, forerunning, advanced technologies and methods (partial selection, artificial watertight bottom of 30 cm grit and 40 cm betonies layer, drainage system, etc.) were applied that can meet even current standards.

FTV method[3]

From 1986 waste with oil content was disposed. This has a positive effect on landfill gas formation.

[3] FTV method: controlled disposal of oil vitiated soil (After the average of Barátság II. oil pipeline in 1986.

Hazardous waste

For the temporally storage of hazardous waste a separated unit was formed. This activity in not part of the project, it does not have any effect on the baseline and it is separated by all means.

Landfill gas utilization:

Got a start in 1992 – among the fists in Hungary. 16 of the original 30 gas domes still working. These are located where the FTV takes place. Both the still functioning 16 gas domes and valuable experience will be part of the project.

II. Tray

It was constructed in 1993-94 in two phases. Phase A – on 3,08 acres started in 1994; phase B – on 3,38 acres started in 1997. The site got the operational permit for an undefined period. This time – again among the firsts in Hungary- partial selection was started. III. ranking was given due to methods used, that are as follows:

- 25 cm grit stratum with drainage for leakage
- 2 mm HDPE membrane
- Geophysical sensor system
- 30 cm CONSOLID mineral impermeable layer

Changes in legislation

Until the EU accession the Hungarian waste management legislation was being formed slowly but at this point rapid and significant changes took place[4]. These changes may result in situations when technically appropriate disposals face authorization procedures and problems. Changes in the waste legislation together with political commitments for promotion of renewable energy technologies create new motivation and initiatives for the operators that result in the decision on this development[5]. The utilization of landfill gas at such old landfills is well beyond legal requirements.

[4] Act no. XLIII of 2000 on waste management and its regulations98/2001. (VI.15.) governmental decree;
[5] Some permits awarded on the basis of b102/1996. (VII.12.) gov. decree expired

Disposed waste

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Disposed municipal waste	kt / year	30	33	36	39	42	45	48	50	56	59	62	66	69	72	75	78	81	84	87	90
Disposed municipal waste	Σ kt	30	63	99	138	180	225	273	323	379	438	500	566	635	707	782	860	941	1 025	1 112	1 202

Nyíregyháza-Oros development milestones

Year of event	**What happened?**	**Main elements of the changes**
2003	Served settlements 14+7	
2003	Decision on landfill gas utilization	Planning of drainage, monitoring systems, etc
2002	Changes in legislation	Environmental impact assessment, application for new permits
2002	Changes in legislation	Pause in the reception of not directly, locally utilized waste
1997	II. tray B phase 3,38 acre	Like in case of II/A phase
1994	II. tray A phase 3,08 acre	25 cm grit stratum with drainage for leakage 2 mm HDPE membrane geophysical sensor system 30 cm CONSOLID mineral impermeable layer
1992	Landfill gas utilization	30 as wells, utilization on site
1988	Hazardous waste : temporal disposal at a separated site	No treatment, just storage
1986	Barátság II. havaria	FTV technology introduced
1983	Beginning of construction 8,8 acre	30 cm grit and 40 cm bentonite layer, drainage system
1980	Decision on the construction	

1.8 Important factors of the project:

- According to the original permits and available capacities the site can operate till 2010.

- Due to changing legislative environment, new permits are to be gained.
- Technologies and methods used comply with higher standards, but do not form a single operational system.
- The landfill became a landfill "fulfilling regional waste management roles".
- The macro-regional landfill is not ready, yet.
- The current Electricity Act and its lower level regulations promote renewable electricity through higher prices.
- In order to increase the share of renewable electricity, in the Electricity Act (2001) and the lower level pieces of legislation a fixed tariff promotion system was set up.
- Exim-Invest Biogáz Kft. enabled its official type of business for landfill gas utilization.
- The municipality of Nyíregyháza supports the projects.
- Agreement with the regional electricity utility on the purchase of green electricity has been reached[6], details have been fixed.
- According to Hungarian legislation in case of old landfills landfill gas utilization is not required, just recommended. Purely on this fact the project itself is clearly additional from environmental point of view.
- Based on the baseline calculation and on the financial plan the project would not be financially feasible just with the sales of electricity. ERU revenue is needed.

1.9 Intervention

Aims

Main aims of the project are as follows:

[6] Act no. CX of 2001 on electricity (2001. XII. 18.)

On the national level the primary aim is to decrease the amount of GHG released: by reducing the methane emission directly from the landfill and by reducing the carbon intensity of the Hungarian electricity sector. Further aims:

- To promote the achievement of BAT as soon as possible but till 2007 the latest in case of great number of such landfills with regional level roles.
- To promote selective waste collection through such positive feedback (utilization of the developed mixture of municipal waste).
- To enforce integrated environmental approach. (Waste issue is interrelated with energy and climate change.)
- The demonstration effect of successful small-scale projects of this kind is significant. To increase the number of such projects.
- To contribute to the renewable target of Hungary[7].
- "Testing" of a new form of finance. Carbon finance attracts additional sources in this field.
- Decrease the electricity import dependency.

At the local level the primary aim of the operator is to use the full capacity of the landfill and to ease the financial burden of it on the municipality.

- The county of Szabolcs-Szatmár-Bereg is among the less developed and poorest in Hungary. The main source of municipal income is the tax on economic activities: that are rare in the region, with little value added. This project generates income for the municipality on one hand, and frees scare sources by financing from external sources on the other hand.
- To satisfy waste management tasks at the highest possible quality at the local level.
- To apply a quite advanced technology in the less developed region.

[7] 3,6% by 2010 in total energy supply.

- To integrate the existing and new methods and technologies at the site into a single integrated operation system.
- Maintain and enforce the effectiveness of selective waste collection that was introduced here among the firsts in Hungary.
- Improve local environment. (Technology development, elimination of illegal and public place landfills.)
- To cover maintenance costs from the sales of electricity.

Purpose

Changing legislative environment requires (re)new(al of) permits and licences. In spite of these changes with the sales of ERUs generated, this project carries out advanced methods and technologies beyond requirements.

With this project the operator and investor can move to long term strategic developments with the relatively early action of the utilization of landfill gas for electricity production. As part of the gas utilization developments the waste collection and the gas monitoring system will be enhanced. With the necessary additional measures and steps a single, integrated operation system will be created. With the additional sources of carbon revenues, additional tasks can completed

Results

- A simple cost (of waste management) earlier, become an income generator activity:
- 1,2 million waste become a useful “raw material”
- 4 GWh green electricity will be produced
- Energy demand of the landfill operation will be covered (heat needs directly, electricity demand indirectly)
- Advance, more complex monitoring system of gas release will be used so and advanced monitoring system will be created
- Health risks of employees decrease.

- All major steps of construction will be planned and executed by experienced Hungarian companies. By such successful projects the environmental service market will develop. Costs and risks of this kind of projects would decrease.
- The landfill becomes a waste management system.
- Rehabilitation at the time of operation end would be realized at lower costs.

Activities

At the landfill a 25*25 meter net of drainage net will be built. It will connect the 169 gas domes (out of which 16 exist). Two section pumps[8] will pump the LFG to the 511 kW capacity Jenbacher[9] gas-engine. The system will be equipped with all necessary measuring and monitoring equipments (gas-meters[10] to the pumps, oxygen meters to the pumps, flicker controller, gas alarm, vacuum meters, pressure meters, etc.). The engine will be served by a 23 m^3 buffer tank. (Storage is not needed as pumping can be controlled.)

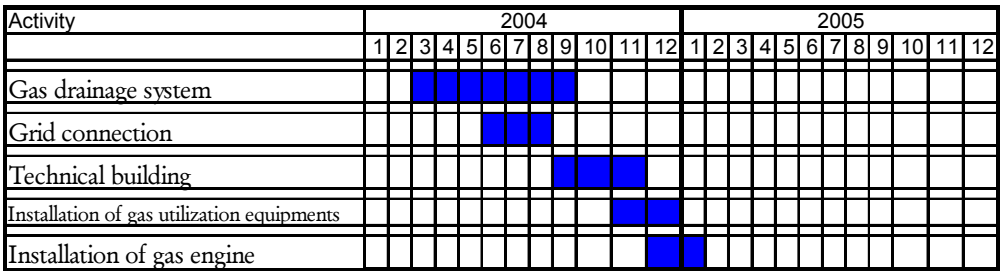
- Planning:
    - Technical planning:
    - Measure of the volume and components of the extractable gas (three measurements took place by Komplementer Kft, Energocoop Kft, MOL Research – Production Division: Mining Laboratory Department)
    - Gas collection drainage system
    - Design of gas utilization systems and equipments
    - Technical buildings
    - Access to the 20 kV grid
    - Monitoring system
    - Financial planning:
- Authorization, licences:

[8] AERZENER GM 7L
[9] Jenbacher JGS212GS
[10] Dresser TQM 100

- According to the requirement of current legislation in line with recommendation of the environmental impact assessment (2002)

- Execution/construction
  - Gas drainage system
  - Technical building
  - Installation of gas utilization equipments
  - Access to the grid (executed by TITÁSZ and ELEKTROVIT Kft.)
  - Construction and testing of the monitoring system
  - Promotion of selective waste collection
  - Education of employees
  - Gradual update of vehicles

Implementation plan



2 Current situation

The Nyíregyháza-Oros landfill has a regional role both in terms of means of waste management and in terms of settlements served. From 2003 7 more settlements joined the 14 previous served ones. From 1985 around 1,2 million tones of waste (approximately 4,3 million m^3) was disposed at the landfill. The average green content is 35% in line with national average. (According to measures and samples taken the share of components may vary. This variation can be solved with the net of gas domes.)

A sample from the 2002 report of the Városüzemeltetési Kht on the waste components

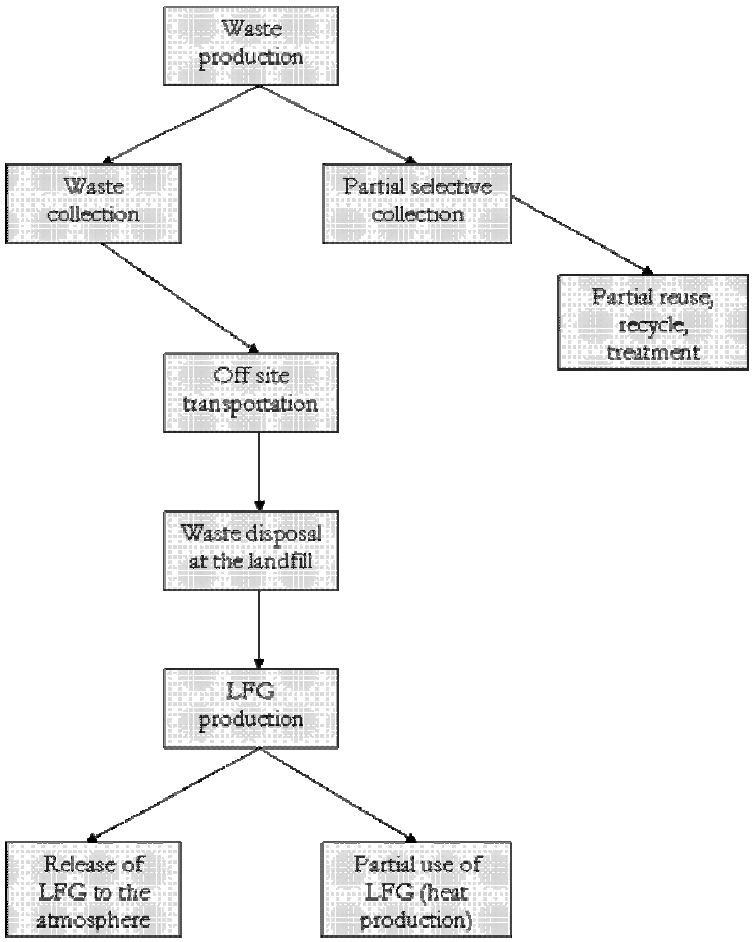
Type of waste	Total amount of waste (t)	Green content (t)	% of green content
Municipal/household waste	40826	14289	30
Municipal/institutional waste	49004	14701	30
Industrial solid waste	3743	1123	30
Waste with oil-content	6736	3704	55
Total	**100309**	**33817**	**34**

According to the two technologies used at the two trays, waste was disposed with two methods. 60% was treated with tractors (membrane protection), 40% with compactor. The result of the first type of treatment : 1 m3 ≈ 0,6 t; while due to compacting technology 1 m3 ≈1 t.

- Hoosegow building and road construction waste is treated separately and the materials are used in onsite road construction.
- Important to notice that disposal of waste with oil content has positive effect on landfill gas production (approximately 20% increase)[11].
- No venting and flaring takes place at the site.
- The landfill is professionally treated the I. tray got a soil top-layer.

Current situation (Flow-chart)

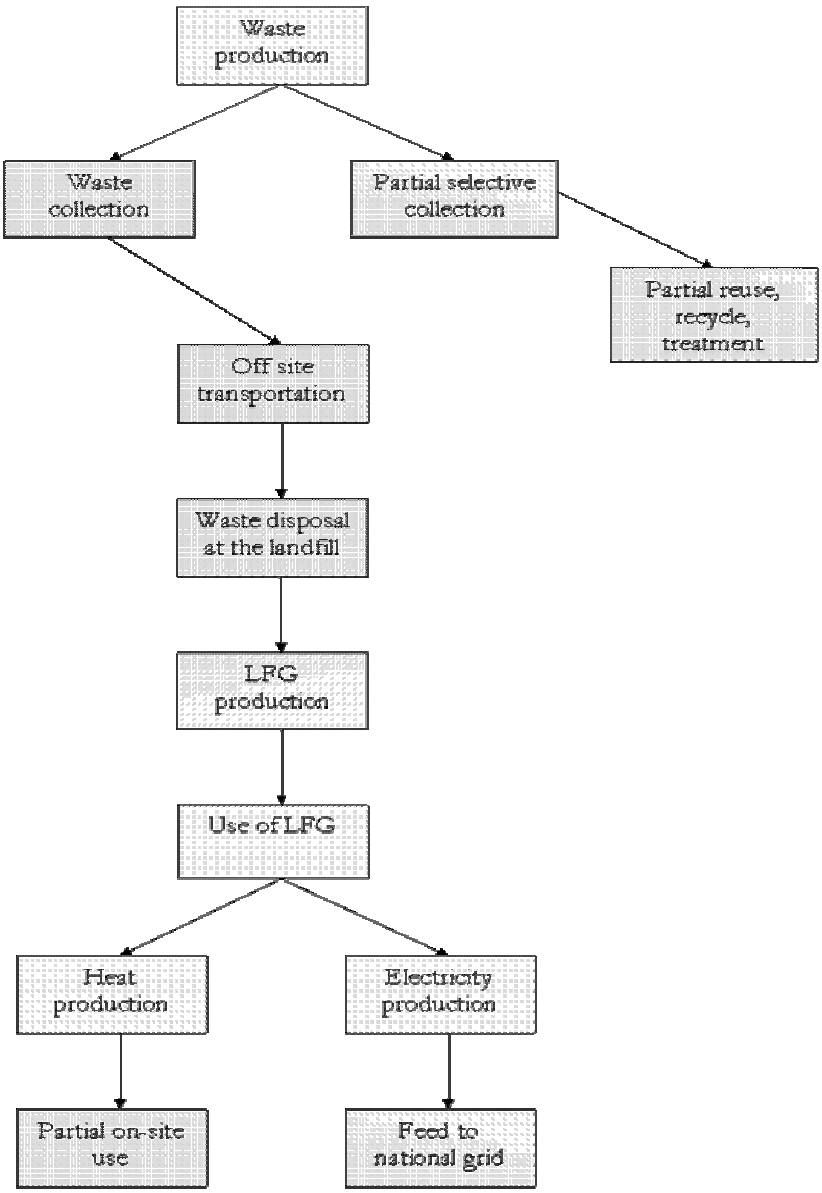
[11] Analysis of ENERGOCOOP Kft , 2002



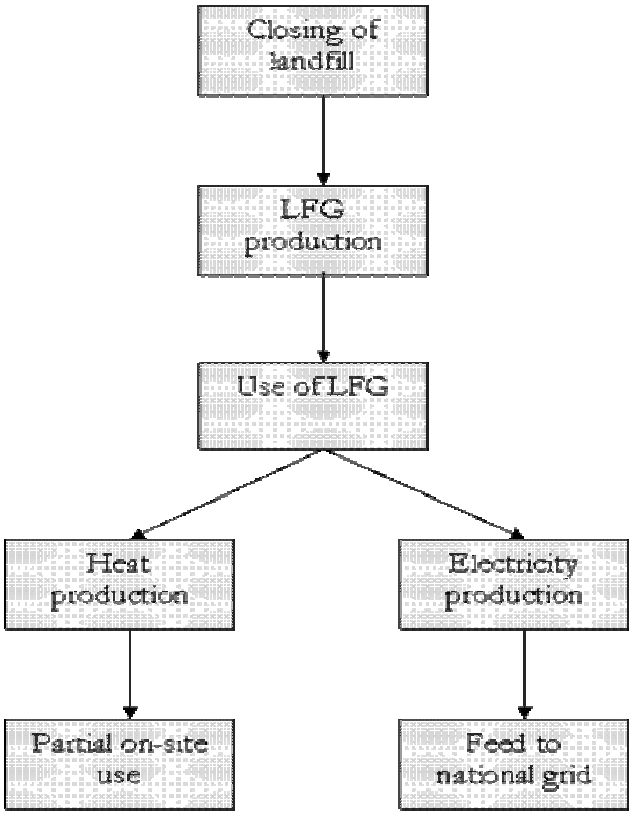
2.1 Situation of the Landfill, after the finishing of the planned Project

After the finalizing of the project, the current mainly unused LFG will be utilized to produce heat and electricity. The produced electricity will feed to the national grid as renewable electricity and the connected produced heat will use partly for on site purposes but the majority of heat will be condensate because of the undeveloped heat market in local area. The status of the landfill will change in 2010 because the waste disposal will be finished at this time but the landfill gas production will be continuous, only the size of LFG will not increase.

Situation until 2010 (Flow-chart)



Situation beyond 2010 (Flow-chart)



3 GHG sources scope of the project

3.1 Emission points- flow chart

However in the early 90s partial extraction of landfill gas got a start, the scope of this trial was very limited. Only 30 gas domes were constructed that could partly cover the energy demand of landfill. This technology was connected to the FTV method. Excluding the 16 wells still in operation, for the larger scale of gas utilization the drainage net and additional wells are to be built.

3.2 Direct and indirect (off – on site) emissions

All GHG emissions included within the project boundaries will be taken into account in the baseline calculation and in the monitoring. Only carbon-dioxide and methane are included out of the GHG-s listed in Kyoto Protocol, as no other GHG are released.

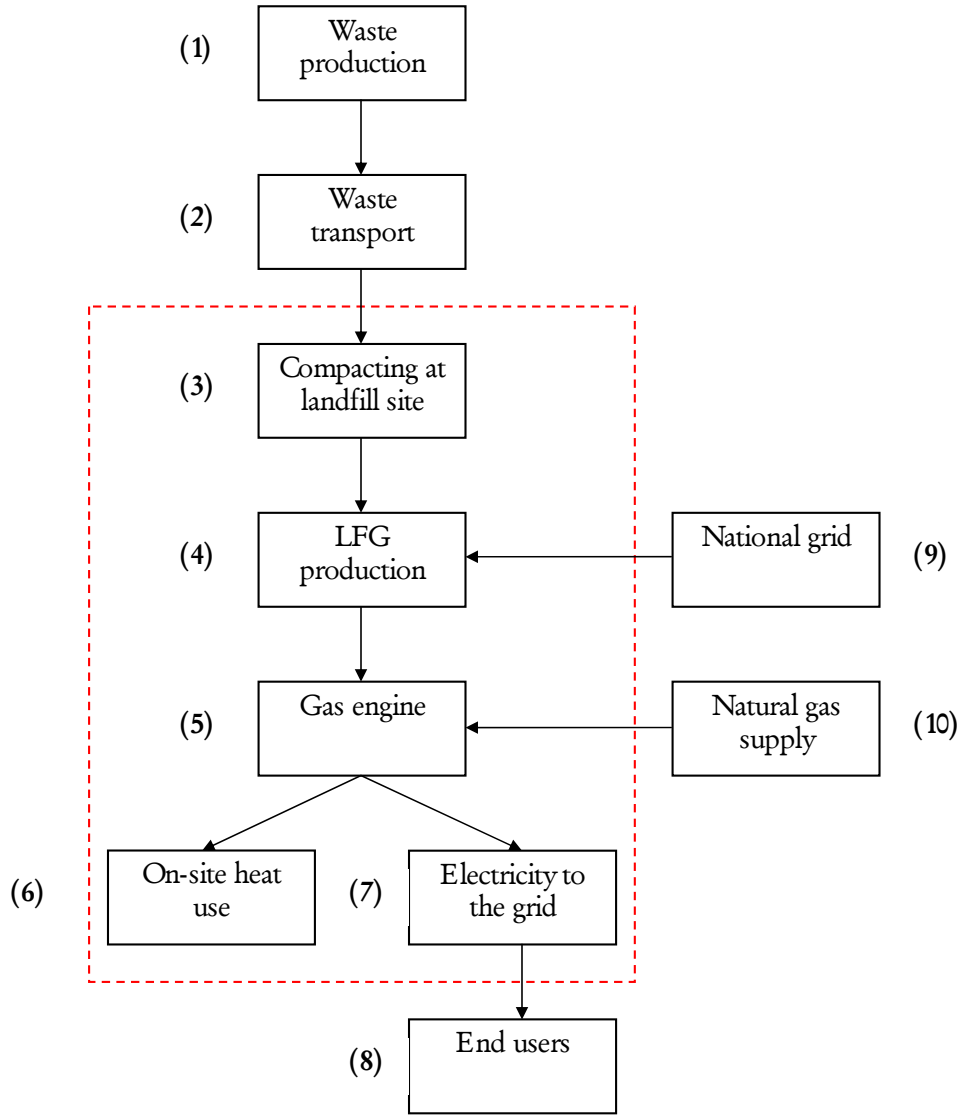
Emissions not exceeding 1% of the total project emissions are classified as insignificant. As the volume of waste transported will not be effected by the project, nor will be the transport emissions. (However some decrease might occur due to vehicle update.) Practically all methane produced will be used for electricity production. According to IPCC inventory guidelines carbon-dioxide produced from LFG burning is classified as biogas, consequently does not count. Emissions are classified as follows:

GHG sources

On site emissions		
Direct		
Extracted landfill gas	CH_4	Significant
Venting of landfill gas	CH_4	Non-existing
Released landfill gas	CH_4	Significant
Flaring of landfill gas	CO_2	Non-existing
Emissions from ignition	CO_2	Insignificant
Emissions from back up	CO_2	Non-existing
Emissions from co-firing	CO_2	Significant
Energy used for processing	CO_2	Insignificant
Energy used for monitoring, analysis	CO_2	Insignificant
Emissions from on-site transport	CO_2	Insignificant
In-direct		
-		
Off-site emissions		
Direct		
Replacement of electricity (by the grid)	CO_2	Significant
Waste transport to the site	CO_2	Insignificant
In-direct		
-		

3.3 Scope of the project/project boundaries

Project boundaries



4 The GHG emission sources of the project

4.1 Direct on site GHG emissions

Landfill gas combustion

The CO2 emission from the combustion of landfill gas in gas engine is not taken into consideration according to IPCC inventory guidelines carbon-dioxide produced from LFG burning is classified as biogas and the CO2 emission of biogas is not considered an anthropogenic GHG emission.

Natural gas co-firing

For the stabilization of the landfill gas combustion of the gas engine could use significant amounts of natural gas. The amount of natural gas used is at most 10% of the LHV of the landfill gas, maximum 42,6 GJ annually. This is the maximum size of the allowed co-firing by renewable electricity generation according to the Energy Act.

Released landfill gas

By the project line calculation we use 85% landfill gas utilisation efficiency for the installed landfill gas capture system. Thus the 15 % of the evolving methane will release to the atmosphere and mitigate the total emission reduction of the project.

Electricity used for landfill gas production, monitoring and analyzing

During the extraction of landfill gas special pumps will be used and electricity consumption will occur that will be covered by the project electricity production.

On-site transport and treatment

The on-site transport of waste is irrelevant, mainly connected to the compacting of landfill. For this purpose the waste management company use special equipped tractors and compactors. These special machines will use diesel oil as fuel and result in CO2 emissions through combustion.

4.2 Direct off-site GHG emissions

Waste transportation

Emissions from waste transportation include the transport of waste from storage sites to the Landfill. Transportation is done by special trucks that will use diesel oil as fuel and result in CO2 emissions through combustion.

Sold electricity

The produced renewable electricity will be sold trough the national grid and will replace fossil fuel based electricity due to the obligatory off take, regulated in the Electricity Act.

5 Identification of baseline and the associated GHG emissions

5.1 Analysis of key factors

Legal factors[12]

Three levels of legislation effect the operation of the landfills.

During the EU accession process waste management was among the priorities. Hungary got significant temporal exemptions regarding the application of EU legislation on waste[13]. The monitoring reports of the EU Commission highlighted the challenges and tasks to be completed both in the field of harmonization and implementation. . In spite of this, generally speaking we can say that by 1st May 2004 the Hungarian waste legislation complied with the EU standards. In this section we

[12] Most important relevant pieces of legislation in the appendix

[13] recovery and recycling of packing waste – 2005
treatment of urban waste water – 2015
air pollution from large combustion plants – 2004
incineration of hazardous waste - 2005

give an overview of the most important fields of legislation: EU waste, Hungarian waste, EU – Hungarian green energy.

Waste regulation:

- 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 landfilling waste 1999/31/EC (EULFD), methane emission, and recultivation 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. .
- Important issue, but not in relationship with the project- the waste export regulation.
- Treatment and disposal of waste with oil content requires a permit.
- 94/62/EC directive sets some aims on packages waste in order to decrease the volume and promote reuse, and recycle.

Energy regulation:

The 2001/77/EC directive on renewables affects the support schemes of member states. It is especially important in the new accession states were these technologies are even more backlogged.

On the national level the environmental act creates the framework. It serves as a basis for the lower level of horizontal operational regulation, for regulation of activities and of vertical regulation :

- In 2003-2004 three partly new eco-taxes appeared. These are production charge (on waste generation associated with production) , environmental usage (based on the activities that put pressure on elements of environment) and deposit regulation (to promote reusable glasses, etc).
- For the project the municipal solid waste definition and treatment rules. Are very important.
- As a precondition of activity continuation until the end of 2002 full environmental impact assessments had to be compiled. Based on these EIAs the regional environmental authorities may act. , require further steps to be taken. In case of landfills continuing their activities: treatment, monitoring, controlling, etc. must stay in place until 1st January 2009 .
- Relevant regulation at the energy sector: the energy efficiency and conservation program deals with renewables as well. The above mentioned electricity act and related lower level pieces of legislation created a feed in tariff based support scheme. Important to notice that the possible introduction of green certificates might create definitely different circumstances.
- Local level of regulation defines several obligations for the municipalities. These regulations are not consistent :
- Local waste management plans have to be in line with the National Waste Management Plan and the National Environmental Plan. The project fulfils this requirement.
- As the disposal is owned by the municipalities all permits are to be get by Városüzemeltetési Kht. These permits define the volume and components of disposable waste, treatment methods, etc.

Physical conditions of the landfill

According to the 2002 EIA[14], both the I and II. landfills have all the necessary technical protective tools of different types, though. The fields have a soil cover that might result in slight acidification of the waste that might hinder temporarily the bio-degradation process.

Risks, uncertainties

By the old landfills useable technology has a risk in the first two years the landfill gas output could significant fluctuates and causes a significant cash-flow risk in this period that could be lowered through the carbon financing.

5.2 Baseline scenarios- identification of the baseline and associated GHG emissions

The main purpose of this section is to deliver all necessary data and facts that help determine the additionality of the project. Firstly we assess the different decision/scenario options, than choose the most likely one.

In case of LFG utilization, baseline and project-line calculations it is important to emphasize that in contradiction with power plant project, the end of waste disposal (practically the end of the activity) does not result in the stop GHG emission. Based on the key factor analysis the following scenarios are constructed:

1. No more disposal- no landfill gas utilization:

Assessments of permit applications are on the way. NOT getting permits is not dependant on operators. It is important to note, that the landfill meets the technical requirements. Most permits are procedural issues. In 2004, the landfill obtained got

[14] Globál 2000 KFT: Teljeskörű környezetvédelmi felülvizsgálat a Városüzemeltetési Kht Nyíregyháza-Oros térségi hulladékkezelő telepének környezeti hatásáról, 2002 (Overall Environmental Impact Assessment, 2002)

regional level tasks. The planned macro-regional waste management centre has not been constructed yet. In this scenario the amount and the components of the waste do not change.

Not probable

2. No more disposal –a landfill gas is utilized:

In addition to above circumstances (in 1.scenario) that still stand: capital needs of landfill gas utilization are partly financed from waste disposal fees. End of such activities would result in further decrease of scare sources.

In this scenario the amount and the components of the waste do not change.

Not probable

3. Carried on disposal -no landfill gas utilization – no intervention for gas production increase:

Reasons to carry on activities as in 1.and 2. scenarios.

Physical conditions of landfill gas utilization are given. Owners and investors would partly finance the project form own sources. Capital need of the first investment is higher than the acceptable for investors. There are no foreseeable future regulations that would require landfill gas utilization.

Very probable

4. Carried on disposal -no landfill gas utilization –selective waste collection affects the share of green waste

In small scale, but in the region, selective waste collection has been in use for quite a while. At the site there is pre-selection. Taking into account the full capacities and amount of waste disposed in the past, it is not likely that – even in case of rapid success in the field of selective waste collection – the waste mixture could be significantly changed in mid and short run. Due to decomposition period, the firs appearance of possible effects would be expected in around 10-15 years. Due to these uncertainties we use a conservative estimation.
In this scenario amount and mixture of waste might change slightly. These are not affected by the project.

Probable

4.1. Carried on disposal – there is landfill gas utilization – actions to increase landfill gas production

Air of O2 injection would increase the investment and maintenance costs even more. In case of much more supportive legislation it might happen, but changes into such direction are not in the pipeline.

Not probable

4.2. Selective waste collection affects the share of green waste

See scenario 3.

Probable

4.3. Form landfill gas production point of view: worsening mixture.

In case of bigger amount of not-green waste disposal, that could not be treated by the current methods. See also scenario 3.

Not probable

4.4. Change in waste disposal methods

Method of already disposed waste would not be changed. These extreme costs are not feasible. Currently the disposal takes place vertically.

Not probable

4.5. Increased landfill gas extraction

Significant (over 30%) not short term increase would not be feasible for the balance of gas production process.

Not probable

4.6. Different use of LFG off-site

Alternative use would be e.g. upgraded to natural gas quality to feed in to the pipeline or for research purposes. Both of them would cause extreme costs.

Not probable

5. Project is deferred with five years

There are no political, legislative changes in the pipeline that would make investments more feasible in the future.

Not probable

5.3 Justification of the selected baseline scenario

After evaluation of above explained baseline scenarios, we were led to conclusion, the most probable baseline scenario is in point 3 described case . The principal argument for this case, that the relevant Hungarian regulation does not prescribe the burning of evolving LFG by the old landfills. By these landfills is sufficient building of venting system during the recultivation that ensures the safe release of LGF to the atmosphere. The municipality can not provide the necessary financial source for the high investment cost of LFG utilization nevertheless the successful 30 trial drilling.

Description of the baseline scenario

In the baseline scenario the Nyíregyháza-Oros landfill site the waste disposal will be continuous until 2010 after it will be recultivated and developed the venting system to release the landfill gas to the atmosphere. On the landfill will not take place any kind of landfill gas utilisation except the not significant use of landfill gas from the present operating 16 wells. But it is very probable that these 16 wells will not operate in the crediting time because of missing financial sources for the maintenance, it is proved by the fact, that currently 50 % of drilled wells are out of order. The amount of released landfill gas will increase until 2010-2012 and after it will be constant with the finishing of waste disposal at the site. In the current situation the municipality has financial source only for the operation according to the relevant regulation and they are not able to provide additional money for landfill gas utilisation.

Justification of the project line's additionality

Whilst the realization of the project increase the renewable electricity production, cut the GHG emission of Hungary, shows example for utilization of the old landfill sites, which are key issues for municipalities in the coming years and helps Hungarian companies gather relevant experience regarding LFG projects, the project owner is taking certain additional business risks. The Joint Implementation financing contributes to the realisation of this complex renewable project by creating additional incentives against these additional risks and capital requirements.

The two main cost elements are the gas engine and the technical connection to the national grid that is a crucial condition of the sale of electricity.
These risk areas are the followings:

Technical and fuel supply risk
While the natural gas technology is very widespread by gas engine, only limited references can be found in Hungary on landfill gas extraction and electricity production. This factor is representing technical and supply risk that is significantly higher than in the case of natural gas combustion. The amount of extracted LFG is not exact only a calculation on relevant experience and scientific basis, that means higher fuel supply risk until the first two years monitored and analysed data.

Volume risk
After 2010 the green electricity produced by the Project has to be sold on the open market. The highly likely introduction of the green certificate system means that, not only the price but also the volume of electricity sales would be subject to yet unknown market conditions.

Price risk
The current price of green electricity is a pure subject to regulation and thus inherently involves regulation risk. Before 2010 the price of renewable electricity is sold for a fixed price. According to the Electricity Act the off-take price could change even before 2010.
Evolving

5.4 Calculation of baseline emissions

By calculation of baseline we use the amount of waste (estimations and measuring), the content of evolving landfill gas (measuring) and the 21 GWP of methane (IPCC 1996).

Currently 1 022 000 tonnes of waste are disposed at the landfill site, and this will reach likely 1 800 000 tonnes in year 2010 at the closing of landfill. We use a 35 % average

green content for the disposed waste based on the measured data of Városüzemeltetési Kht. and the relevant Hungarian data.

By the calculation of landfill gas' amount and by the produced CH4 and CO2 we taken in account the 30 year long catabolism that happens without any LFG pumping. The amount of LFG producing waste will increasing until 2010 and after it will decrease until 2040 the end of LFG production.

By the 30 years long natural catabolism the content of the producing LFG is following: CO2 58 % CH 4 42 %. By the utilization of LFG the catabolism is twice so fast, and will occur in 15 years and the content of LFG also change, CO2 41 % CH 4 50 % other gases 9 %.

The parameters of landfill gas by 0 °C and by 101 kPa pressure

- Average landfill temperature: 23-27 °C
- Landfill gas collection efficiency 100 %
- Molecular weight CH4 16,03
- Absolute density (on 0° C) 1,2077 kg / m3
- Relative density (on 15° C) 0,9336 kg / m3
- Heating value (on 15° C) 18,86 MJ / m3
- Methane / carbon-dioxide 42% / 58%
- Expected landfill pressure in the landfill: 80 - 120 mBa
- Gas density of CH4 0,715 kg / m3
- Gas density of CO2 1,977 kg / m3

5.5 Electricity production for national grid

The project will feed renewable electricity to the national grid, and will replace fossil fuel based electricity because of obligatory off take regulated in the Electricity Act. The next table shows the amounts of the produced renewable electricity between 2008

2012, the numbers are based on a conservative estimate. By the calculation of baseline emission we use the specific CO2 emission factor of the Hungarian grid, the conservative calculation of the ERUPT tender of Netherlands.

6 Estimation of the project emissions

6.1 Calculation of total project emissions

The Project will produce electricity and heat by burning landfill gas with at most 10% natural gas co-firing, which is allowed in the Hungarian Electricity Act. The annual electricity production will be approximately 4 GWh by 7884 operating hours that will replace fossil fuel based electricity production. The heat output of Project will be used partly for on-site purposes at the start of the project because the absence of adequate heat market in the local area. The landfill gas extraction will be continuous and will fit fuel demand of gas engine and the project owner will not install large scale gas storage, because by the project's planning they use a conservative business model that calculate with a smaller gas engine. Due to this decision the gas-engine could reach a better utilisation factor and a safer fuel supply, in the meantime the risk of the LFG over extraction is much lower and the evolving of LFG to the atmosphere during the project is minimized through the negative pressure resulted by pumping. The relevant examples already prove that by 25% LGF extraction the evolving of LFG to the atmosphere is null, but in the project line emission calculation we used 85% capture efficiency for the sake of more conservative calculation.
By the calculation of project line first we set the project boundaries around the project after it we analysed the above mentioned possible direct and indirect on-site and off-site emissions and we receive the following result.

CO2 emission from LFG
The emitted CO2 connected to the renewable electricity production on landfill gas basis is not accounted for, according to the IPCC inventory guidelines where the LFG burning is classified as biogas burning and the CO2 emission of biogas combustion is not considered an anthropogenic GHG emission.

Natural gas co-firing

The natural gas co-firing is accounted for the project line, as it is the biggest source of CO2 emissions in the project line. The co-firing of fossil fuels in units producing renewable electricity is also controlled by the 56/2002 Ministerial Decree. The 10% NCV auxiliary natural gas firing is considered to be a conservative estimate and in the future will be well under this 10 % level.

Released landfill gas

By the project line calculation we use 85% landfill gas utilisation efficiency for the installed landfill gas capture system. Thus the 15 % of the evolving methane will release to the atmosphere and mitigate the total emission reduction of the project.

On-site transport and treatment

The on-site transport of waste is not accounted for the project line because the estimated CO2 emission of special tractor and compactor used to compact the landfill will be less than one percent of the project line's emission and so it can be eliminated.

Electricity used for landfill gas production, monitoring and analyzing

The on-site direct CO2 emission connected to electricity use (pumping, monitoring, analysing of LFG) from the production of the project is accounted for the project line.

Waste transportation

The CO2 emission of waste transportation is not accounted to the project line because it is outside of the project boundaries.

7 Estimation of emission reduction

Baseline emission

		2005	2006	2007	2008	2009	2010	2011	2012
Emission from waste disposal									
Disposed waste *	tonnes / years	93 000	95 000	98 000	101 000	104 000	107 000	0	0
Total disposed waste	∑in tonnes	1 295 000	1 390 000	1 488 000	1 589 000	1 693 000	1 800 000	1 800 000	1 800 000
Green content (35%)	∑in tonnes	453 250	486 500	520 800	556 150	592 550	630 000	630 000	630 000
Evolving LFG	m^3	4 166 667	4 459 524	4 752 381	5 042 857	5 328 571	5 611 905	6 109 524	6 047 619
CH_4 content of LFG	%	42%	42%	42%	42%	42%	42%	42%	42%
CO_2 content of LFG	%	58%	58%	58%	58%	58%	58%	58%	58%
Released CH_4 *	m^3	1 750 000	1 873 000	1 996 000	2 118 000	2 238 000	2 357 000	2 566 000	2 540 000
	tonnes	1 251	1 339	1 427	1 514	1 600	1 685	1 835	1 816
Released CO_2 *	m^3	2 416 667	2 586 524	2 756 381	2 924 857	3 090 571	3 254 905	3 543 524	3 507 619
	tonnes	4 778	5 114	5 449	5 782	6 110	6 435	7 006	6 935
GWP factor of methane	t / tCO2e	21	21	21	21	21	21	21	21
CO_2e emission **	**tCO_2e**	**26 276**	**28 123**	**29 970**	**31 802**	**33 604**	**35 390**	**38 528**	**38 138**
Electricity production									
Electricity production of the Project	GWh / year	3,00	4,03	4,03	4,03	4,03	4,03	4,03	4,03
Electricity use of the Project	GWh / year	0,21	0,28	0,28	0,28	0,28	0,28	0,28	0,28
Electricity feed to grid	GWh / year	2,79	3,75	3,75	3,75	3,75	3,75	3,75	3,75
Emission factor of national grid	tCO_2 / GWh	592	583	574	565	556	547	538	529
CO_2e emission	**tCO_2e**	**1 652**	**2 185**	**2 151**	**2 117**	**2 084**	**2 050**	**2 016**	**1 983**
Total CO_2e emission	**tCO_2e**	**27 928**	**30 308**	**32 121**	**33 919**	**35 687**	**37 440**	**40 545**	**40 121**

* We assume the landfill will be closed in 2010
** By natural catabolism of waste (30 years circle)
*** We do not take in account the evolving CO_2

Project line emission

		2005	2006	2007	2008	2009	2010	2011	2012
Electricity production									
Electricity feed to grid	GWh	2,79	3,75	3,75	3,75	3,75	3,75	3,75	3,75
Fuel heat use for electricity production	TJ	32	43	43	43	43	43	43	43
Landfill gas use	TJ	29,03	38,70	38,70	38,70	38,70	38,70	38,70	38,70
Natural gas use *	TJ	3,23	4,30	4,30	4,30	4,30	4,30	4,30	4,30
CO_2e emission factor for LFG	tCO_2e/TJ	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CO_2e emission factor for natural gas	tCO_2e/TJ	56,10	56,10	56,10	56,10	56,10	56,10	56,10	56,10
CO_2e emissions from LFG	tCO_2e	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CO_2e emissions from natural gas	**tCO_2e**	**180,92**	**241,23**	**241,23**	**241,23**	**241,23**	**241,23**	**241,23**	**241,23**
Landfill gas emission									
Evolving LFG	m^3	6 508 000	6 944 000	7 372 000	7 790 000	8 202 000	8 604 000	9 364 000	9 178 000
CH_4 content of LFG	%	50%	50%	50%	50%	50%	50%	50%	50%
CO_2 content of LFG	%	50%	50%	50%	50%	50%	50%	50%	50%
EvolvingCH_4	m^3	3 254 000	3 472 000	3 686 000	3 895 000	4 101 000	4 302 000	4 682 000	4 589 000
	tonnes	2 327	2 482	2 635	2 785	2 932	3 076	3 348	3 281
Evolving CO_2	m^3	3 254 000	3 472 000	3 686 000	3 895 000	4 101 000	4 302 000	4 682 000	4 589 000
	tonnes	6 433	6 864	7 287	7 700	8 108	8 505	9 256	9 072
Utilization efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%
Released CH_4	m^3	488 100	520 800	552 900	584 250	615 150	645 300	702 300	688 350
	tonnes	349	372	395	418	440	461	502	492
Released CO_2	m^3	488 100	2 013 760	2 137 880	2 259 100	2 378 580	2 495 160	2 715 560	2 661 620
	tonnes	965	3 981	4 227	4 466	4 702	4 933	5 369	5 262
Released CH_4	**tCO_2e**	**7 329**	**7 820**	**8 302**	**8 773**	**9 236**	**9 689**	**10 545**	**10 336**
Total CO_2e emissions	**tCO_2e**	**7 510**	**8 061**	**8 543**	**9 014**	**9 478**	**9 930**	**10 786**	**10 577**

* We calculate the highest (10%) natural gas co-firing level

Emission reduction

		2005	2006	2007	2008	2009	2010	2011	2012
Emission from waste disposal	tCO_2e	26 276	28 123	29 970	31 802	33 604	35 390	38 528	38 138
Electricity production	tCO_2e	1 652	2 185	2 151	2 117	2 084	2 050	2 016	1 983
Total baseline emission	**tCO_2e**	**27 928**	**30 308**	**32 121**	**33 919**	**35 687**	**37 440**	**40 545**	**40 121**
On-site fuel use	tCO_2e	181	241	241	241	241	241	241	241
Released CH_4	tCO_2e	7329	7820	8302	8773	9236	9689	10545	10336
Total project line emission	**tCO_2e**	**7 510**	**8 061**	**8 543**	**9 014**	**9 478**	**9 930**	**10 786**	**10 577**
Total emission reduction	**tCO_2e**	**20 418**	**22 247**	**23 578**	**24 905**	**26 210**	**27 510**	**29 758**	**29 544**

Total emission reduction (2005-2007)	tCO2e	**66 243**
Total emission reduction (2008-2012)	tCO2e	**137 927**

8 Monitoring

8.1 Flow diagram

Before the approach for the monitoring plan is described, the flow diagram below presents the technical equipment at a landfill. The monitoring of the emission reduction will be done by measurement of technical parameters at a number of locations. Monitoring will occur at the following locations:

1. Flow measurement of LFG (between the pumps and the gas engine, the pumps produce a constant gas pressure)
2. LFG analysis (CH_4, CO_2 and O_2)
3. Operating time of pumps
4. Operating time of the gas engines
5. Electricity produced

8.2 General monitoring approach:

The general monitoring principles are based on:

- Frequency
- Reliability
- Registration and reporting

8.3 Frequency of monitoring

In principle, the most important parameters will be monitored on-line. Examples are the measurement of landfill gas flow, landfill gas pressure and landfill gas composition. Data will be registered electronically and recorded digitally. Data will become available on the hourly, daily or weekly basis. As the amount of CH_4 will be the

dominant compound in the project, major part of the instruments will be focused on the measurement of the quantity and quality of the landfill gas. Furthermore, the electricity generated will be measured on-line.

8.4 Reliability

Monitoring of the landfill gas project is straight forward as there is a single parameter, that determines the larger part of the emission reduction achieved, namely the quantity of CH_4 extracted and fired. In case there will be no extraction of CH_4, there will be no emission reduction. Other parameters, except for the electricity production (kWh), are calculated on the basis of fixed parameters. For example: by measuring flow, temperature and pressure of the biogas, the exact quantity (in tonnes) is calculated.

The reliability of the monitoring will be determined by two factors, i.e. the accuracy of the measuring instruments and the technical quality of the equipment. The accuracy of the instruments can be regarded as high, because major part of he instruments is produced by German manufacturers and meet the highest DIN-standards or comparable. The estimate of the accuracy of the instruments is indicated below by the table.

8.5 Registration and reporting

Registration of data will be done electronically on-site and off-site. The control cabinet at the
landfill will store all data. The software will enable to produce reports at any interval that is
desired (on-line, daily, weekly, yearly).

For the purpose of monitoring by the Independent Entity (validating organisation), reporting will be done at regular intervals, but at least every 6 months. Reports will

present the data of the reporting period as well as the estimate for the entire crediting year. How to deal with missing data All flows relevant for the monitoring of the Project will be measured and therefore missing data is not relevant.

8.6 Key factor of the performance

Reporting format
For monitoring purposes a reporting format will be developed. This format will include data on:

- Waste disposed
- Landfill gas produced
- Electricity generated
- Technical and/or organizational problems encountered
- Key factors that might influence the envisaged emission reduction result

Formázott: Felsorolás és számozás

8.7 Baseline monitoring

Electricity supplied to the grid
In the baseline emissions calculation conservatively estimated electricity grid-end emissions factors were used. The uncertainties containing these factors are significant therefore the real electricity production connected emissions at the Hungarian power sector and the national grid losses need to be monitored for assessing real actual emissions figures. Monitoring of the grid-end emissions factors will be done yearly.

It is highly likely that between 2008 and 2012 annual production connected and grid-end emissions factors will be available from official sources such as MVM, the Ministry of Environment and Waters or from the Hungarian Energy Office connected to in year 2005 starting EU Emission Trading Scheme.

8.8 Project emissions monitoring

Formázott: Felsorolás és számozás

The project emissions will consists of the emissions connected to landfill gas firing and the natural gas co-firing.

Natural gas co-firing

During the operation of the Project significant amount of natural gas will be used for gas-engine co-firing. The assigned person will be responsible for reading the gas meter and reporting the natural gas consumption. The amount will be reported also on the attached reporting sheet.

MONITORING REPORT FORMAT

LANDFILL	
Location:	
Contact person:	
Name:	
Address:	
Zip code:	
City:	
Country:	
Telephone:	
Fax:	
E-mail:	

REPORTING PERIOD	
Start	
Finish	

EMISSION CALCULATION		
Emissions from landfill gas firing:		tonnes of CO_2
Emissions from natural gas firing:		tonnes of CO_2

LANDFILL GAS SUPPLY		
Volume of burned landfill gas:		m^3
Amount of burned landfill gas:		tonnes
Average NCV of landfill gas:		MJ/m^3

NATURAL GAS SUPPLY		
Volume of burned natural gas:		m^3
Average NCV of natural gas:		MJ/m^3

ELECTRICITY PRODUCTION		
Amount of produced electricity:		MWh
Electricity used on-site		MWh

WASTE DISPOSAL		
Disposed waste		tonnes/year
Total amount of waste at the landfill		tonnes
Volume of the disposed waste		m^3
Green content		%
Percentage of collectable landfill gas		%

LFG MEASUREMENT		
Yearly average		
Landfill gas flow		m^3/h
Pressure		Mpa
CH_4 content of landfill gas		vol.%
CO_2 content of landfill gas		vol.%
O_2 content of landfill gas		vol.%
Monthly average		
Landfill gas flow		m^3/h
Pressure		Mpa
CH_4 content of landfill gas		vol.%
CO_2 content of landfill gas		vol.%
O_2 content of landfill gas		vol.%

OPERATION HOURS		
Yearly total		
Landfill gas pumps		hours
Gas-engine		hours
Monthly total		
Landfill gas pumps		hours
Gas-engine		hours

9 Environmental Impact assessment

9.1 Environmental aspects of landfill gas extraction

Waste treatment and management is one of the biggest environmental and environmental related socio-economic challenge for Hungary both in the mid and long terms. The challenge is crated 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 do not meet the standards and there are an additional estimated 1100 illegal landfills of various size. Total annual CO_2eq. emission is about 2200 Gg but until mid-2004 only half dozen landfill gas mitigation projects have been planned. The main line of Hungarian waste policy due to EU harmonization is the creation of regional waste management centres. The rehabilitation and upgrading of landfills and abolition of illegal and outdated landfills puts an enormous burden on both the central government and on the municipalities, demanding an approximate investment of several billion Euro.
The development of waste management/treatment legislation was a slow process. Due to EU accession rules have been significantly changed, it often leads to situations when a waste management site applies a relatively high technical solution, but faces new and additional authorization but not technical requirements.

9.2 Environmental effect of the project

Air
Without the project on the landfill site would occur two type of air pollution:

- emission from the on-site transport and compacting
- emission of catabolism of waste and the stink

Emission of on-site transport and compacting

	specific emission kg/t	emission kg/h
SO_2	7,4	0,07
CO	63	0,63
NO_X	9	0,9

In the catabolism process produced gases are in majority stinky, i.e. ammonia) and has a negative effect on the ecosystem and the neighbouring settlements. The other important result of the catabolism the landfill gas that has high methane and CO_2 content these are Greenhouse gases and the methane is explosive and toxic, has a negative environment effect.

With the planned investment the above explained problems will be minimize because of the installation of the gas-engine and the connected landfill gas extraction system. In the project the landfill will receive a better soil layer to minimize the leakage of the landfill gas to the atmosphere. Through this will be decreased significantly the escape of other gases that are responsible for the stink. So the project has a positive effect on the environmental from this point of view.

The installed gas-engine will mean new air pollution, but the project owner will install an engine of Jenbacher that is experienced manufacturer of gas-engines for landfill gas burning and wide scale used technology in the European Union. The emission figures of this gas-engine are under the threshold limit of emission controlled through Hungarian regulation.

Water

By establishment of the landfill site the municipality of Nyíregyháza used a developed isolation system because of the leakage water can not leak in the ground water and it will be re-circulated the landfill to stimulate the landfill gas production. In the project the capture of leakage water will be as high as possible whilst it could positive influence the landfill gas production that affects the thrift of the project. So the investment has a positive effect on the quality of groundwater and the nearly produced agricultural products.

Climate

The project will have a positive effect on the climate and compliance of Hungary on GHG emission reduction target. The project will cut a significant amount of methane emission (GWP 23) in the first commitment period, in addition through the project the catabolism will be faster due to the landfill gas extraction and the landfill gas production will shorter , approximately half of the normal. In consequence of the project the methane emission from the disposed 1 200 000 tonnes waste will be minimize for the next 20 years.

Waste

The project does not influence of the amount of the future disposed waste but the current estimation shows a slow growth. After the investment the compacting of the waste will be higher and the layer system will be built up better.

Health and safety

The not utilized landfill gas production is a high risk for employee of the land fill because of the landfill gas high methane content that is highly explosive. Through the

project this kind of risks are minimized and the leakage of other toxic gases are also minimized that has a positive effect on health of inhabitants of the neighbouring villages.

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11 Appendix A.: Financial information

Balance sheet (without ERU's sale)

		2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Investment	in 000 HUF	303 000															
Income	**in 000 HUF**	**55 600**	**76 185**	**78 503**	**80 889**	**83 346**	**85 874**	**88 478**	**91 158**	**93 916**	**96 755**	**99 673**	**102 680**	**105 777**	**108 968**	**112 255**	**115 641**
Produced electicity	MWh / year	3 000	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030
Elelectricity price	HUF / kWh	17,8	18,3	18,9	19,5	20,0	20,6	21,3	21,9	22,5	23,2	23,9	24,6	25,4	26,1	26,9	27,7
Income of ERU's sale	in 000 HUF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O&M	**in 000 HUF**	**26 164**	**37 116**	**41 291**	**41 284**	**41 310**	**41 364**	**34 905**	**37 759**	**46 525**	**48 357**	**50 049**	**51 801**	**53 614**	**55 491**	**57 433**	**59 443**
		26 164	**37 116**	**41 291**	**41 284**	**41 310**	**41 364**	**34 905**	**37 759**	**46 525**	**48 357**	**50 049**	**51 801**	**53 614**	**55 491**	**57 433**	**59 443**
Amortisation		22 725	30 300	30 300	30 300	30 300	30 300	30 300	30 300	30 300	30 300	7 575	0	0	0	0	0
Operating income	**in 000 HUF**	**6 711**	**8 769**	**6 912**	**9 305**	**11 736**	**14 210**	**23 273**	**23 099**	**17 091**	**18 098**	**42 049**	**50 878**	**52 163**	**53 477**	**54 822**	**56 198**
Net income	**in 000 HUF**	**5 637**	**7 366**	**5 806**	**7 816**	**9 858**	**11 937**	**19 549**	**19 403**	**14 357**	**15 202**	**35 321**	**42 738**	**43 817**	**44 921**	**46 050**	**47 206**
Cash flow		-274 638	37 666	36 106	38 116	40 158	42 237	49 849	49 703	44 657	45 502	42 896	42 738	43 817	44 921	46 050	47 206
NPV	**in 000 HUF**	**86 697**															
IRR		**12,8%**															

Balance sheet (with ERU's sale)

		2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Investment	in 000 HUF	303 000															
Income	**in 000 HUF**	**55 600**	**76 185**	**78 503**	**80 889**	**83 346**	**85 874**	**88 478**	**91 158**	**93 916**	**96 755**	**99 673**	**102 680**	**105 777**	**108 968**	**112 255**	**115 641**
Produced electicity	MWh / year	3 000	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030	4 030
Elelectricity price	HUF / kWh	17,8	18,3	18,9	19,5	20,0	20,6	21,3	21,9	22,5	23,2	23,9	24,6	25,4	26,1	26,9	27,7
Income of ERU's sale	in 000 HUF	135 000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O&M	**in 000 HUF**	**26 164**	**37 116**	**41 291**	**41 284**	**41 310**	**41 364**	**34 905**	**37 759**	**46 525**	**48 357**	**50 049**	**51 801**	**53 614**	**55 491**	**57 433**	**59 443**
		26 164	**37 116**	**41 291**	**41 284**	**41 310**	**41 364**	**34 905**	**37 759**	**46 525**	**48 357**	**50 049**	**51 801**	**53 614**	**55 491**	**57 433**	**59 443**
Amortisation		22 725	30 300	30 300	30 300	30 300	30 300	30 300	30 300	30 300	30 300	7 575	0	0	0	0	0
Operating income	**in 000 HUF**	**141 711**	**8 769**	**6 912**	**9 305**	**11 736**	**14 210**	**23 273**	**23 099**	**17 091**	**18 098**	**42 049**	**50 878**	**52 163**	**53 477**	**54 822**	**56 198**
Net income	**in 000 HUF**	**119 037**	**7 366**	**5 806**	**7 816**	**9 858**	**11 937**	**19 549**	**19 403**	**14 357**	**15 202**	**35 321**	**42 738**	**43 817**	**44 921**	**46 050**	**47 206**
Cash flow		-161 238	37 666	36 106	38 116	40 158	42 237	49 849	49 703	44 657	45 502	42 896	42 738	43 817	44 921	46 050	47 206
NPV	**in 000 HUF**	**200 097**															
IRR		**24,4%**															

Sensitivity analysis without JI income

Case	IRR
Base case	12,8%
Energy prices	
10% lower	12,5%
10% higher	13,1%
Project costs	
10% lower	14,8%
10% higher	11,1%
O&M costs	
10% lower	14,5%
10% higher	11,0%
Energy generation	
10% lower	9,3%
10% higher	16,2%

Sensitivity analysis with JI income

Case	IRR
Base case	24,4%
Energy prices	
10% lower	23,7%
10% higher	25,1%
Project costs	
10% lower	29,8%
10% higher	20,5%
O&M costs	
10% lower	27,0%
10% higher	21,8%
Energy generation	
10% lower	19,3%
10% higher	29,5%

12 Appendix B: Stakeholder comments

The EXIM INVEST Biogáz Kft. ("EXIM") contacted E-misszio Environmental Association ("EEA") regarding the stakeholder communication connected to the Nyíregyháza-Oros landfill gas utilization JI project. The project owner sent preliminary documentation for the Association that had a chance to gather information about the project from different aspects (environmental, technical and economic) and its benefits.

After the EEA get acquainted with the project Mr. Gyurecskó from EXIM explained the connected issues in a personal meeting where the EEA could get further information about the investment and its environment.

The short summary of the presentation is the following:

In Europe is a common methodology to utilize the landfill gas on old landfill site, where the quality and quantity of landfill gas is adequate. The landfill gas from Nyíregyháza-Oros site was tested by MOL Rt. (Hungarian Oil Company) and the result was sufficient to start preparation of the project. The subcontractor engineer company has the relevant experience to create the best gas utilisation solution for the Nyíregyháza-Oros landfill. The project owner decided for the vertical landfill gas well system after recommendation of subcontractor. The single wells will be connected through a collector pipeline to the ridge pipeline and this will be connected to the pumps that will extract the landfill gas from the site. The landfill gas will enter directly in the gas-engine by continuous checking of quantity and quality of landfill gas. The gas-engine will be produce electricity through the generator and will be sold on the grid of TITÁSZ (one of Hungarian grid operator). The produced heat will be used partly on-site.

After the presentation the represents of EEA had following question:

1. What kinds of pipes are used by the wells?
2. What kind of significance has the landfill gas utilisation from environment aspect?
3. How long is the landfill gas production period?
4. How will happen to off-take of the produced electricity?
5. Does emit the gas-engine any damaging substance?

EXIM's answers were the following:

1.
By the wells will be applied DN 63*3,6 KPV plastic pipes to advance the landfill gas extraction. The pipes will be deployed 8 meter deep in gravel environment.

2.
The regulation regarding of landfill site rehabilitation set the venting of landfill gas as a necessary condition and release the landfill gas to the atmosphere without any utilization. Through the project the produced landfill gas will be used and will be not release to the atmosphere. So this investment has an important positive environmental impact.

3.
By the adequate layer, in the landfill disposed green content of waste will be catabolism through different circumstances (temperature, wetness) and produce landfill gas. The intensive catabolism takes approximately 15-20 years.
4.
With the gas-engine produced renewable electricity will feed in the grid of TITÁSZ though a transformer station and the TITASZ has to off-take according to the relevant Hungarian regulation.

5.
The gas-engine emission will be under the threshold limit of emission of damaging substances that are set in relevant Hungarian regulation.

The represent of E-misszion Environmental Association declare that the EEA had deeply review and understand the planned investment and support it because this project is under the few example in Hungary where the extracted landfill will be used for renewable electricity generation and not only flared.

Nyíregyháza, 2004.03.23.