Assessment of Landfill Gas Recovery and Utilization

Development of the Vratsa Municipal Landfill

BUSINESS PLAN

PREPARED FOR:
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1. EXECUTIVE SUMMARY

The main purpose of this U.S. Environmental Protection Agency (USEPA) Global Methane Initiative project is to establish conditions for the estimation of LFG potential of municipal landfills and to demonstrate the profitability of future projects based on LFG by: (1) extending the comprehensive assessment of the potential for methane recovery in Bulgaria, made within the first assessment report in Bulgaria, funded by Methane to Markets program and the Agency, (2) surveying as many as possible landfills in the region (C&E Europe); (3) developing business cases for several landfills in the region, showing the potential for cost-effective recovery and use of methane resource; (4) increasing the capacity of municipalities and private investors to identify and implement LFG projects, through increase of their technical capability.

During the project period new EPA LandGem software, reflecting the conditions in Central & Eastern Europe, will be developed.

The municipal landfill of Vratsa (Mezdra) was the business case developed to prove that even the middle size municipalities in Bulgaria can implement economically feasible projects in spite of the comparatively small amount of waste disposed (about 23,000 t/yr in Vratsa landfill). The business case is focused on technical proposal, cost analyses, and financial analyses.

The Vratsa landfill is well secured with fence and guards. An electronic scale is installed at the entrance. On the territory of the landfill are situated administrative building, garages, workshop, water treatment plant, leachate pump station, monitoring wells for underground waters, and gas wells in the facility. The facility is divided into three cells, Cell 1 consists of two areas 1-1 and 1-2. Currently Cell 1 is under reclamation and Cell 2 is under exploitation. The total amount of waste in Cell 1 is 231,404 tons. Due to the regular compacting the waste density is reported to be 0.75 t/m^3. The cells are insulated with clay, 2 mm foil and geotextile. There is a drainage system for the leachate and devices for environmental monitoring.

Three approaches were considered in the analyses: a) the municipality gets a loan without support from the Operational programmes; b) the municipality gets a loan and participates in the Operational programmes receiving 50% grant after the project completion; c) the municipality gets a loan and participates in the Operational programmes receiving 75% grant after the project completion. The three cases are as follow:

Case #1: The municipality gets a loan and does not participate in an Operational Programme (grant is not expected)

The municipality puts in EUR 53,299 as its equity contribution and gets EUR 159,896 as a loan from the EERSF. The Fund provides low interest rate loans to municipalities without any additional credit conditions (taxes) and a payment schedule structured in accordance with the municipality needs. The price of the produced electricity sold to the Natsionalna Elektricheska Kompaniya EAD (NEK) will be 124.46 EUR/MWh in accordance with Decision No 018/28.06.2012 of the State Energy and Water Regulatory Commission.

Case #2: The municipality gets a loan and participates in an Operational Programmme (50% grant is expected)

The same conditions (equity contribution/loan) as in Case #1, but the municipality participates in an Operational Programme and gets 50 % incentive payments (EUR 106,597) after the project completion. The price of the produced electricity sold to the NEK will be 110.86 EUR/MWh in accordance with Decision No – 018/28.06.2012 of the State Energy and Water Regulatory Commission. The incentives will be used to partly cover the loan repayment.

Case #3: The municipality gets a loan and participates in an Operational Programme (75% grant is expected)

The same conditions (equity contribution/loan) as in Case #1, but the municipality participates in an Operational Programme and gets 75 % incentive payments (EUR 159,896) after the project completion. The price of the produced electricity sold to the NEK will be 101.73 EUR/MWh in accordance with Decision No 018/28.06.2012 of the State Energy and Water Regulatory Commission. The incentive will be used to cover the loan and only interest will be paid by the municipality.

Comparison of the final results for the investigated cases is presented in Table 1.1.

Table 1.1 Comparison of the results

Parameter	Case 1	Case 2	Case 3
Incentive	0%	50%	75%
Payback Period (yr)	4.64	2.67	1.34
IRR	19%	31%	48%
NPV	171,607	213,092	262,904

The business plan includes cost and financial analyses. Three financial approaches were considered. In all cases it is assumed that the loan interest amounts to 7% and remains constant until the end of the loan period. The loan repayment starts in July 2014, while

during the project implementation the borrower pays monthly interest on the outstanding principle only.

In summary, the financial viability of the project depends on the amount of incentive payment. For the three investigated cases the payback period (PBP) ranges from 4.64 to 1.34 years and the respective internal rate of return (IRR) ranges from 19% to 48%.

Based on the developed Business Plan, the following conclusions were done:

- Low risk project – the technology and equipment have been implemented all over the world. The modeling results can be confirmed with none or minor investments.
- Good financial parameters – PB = 4.64 years, IRR = 19%, NPV = 171,607 EUR in Case 1 without incentive payment.
- Environmental benefits – reduction of the greenhouse gas emissions is expected after the project implementation.

2. INVESTOR

Vratsa is a district centre and the biggest settlement in Northwestern Bulgaria. Vratsa Municipality covers an area of 679 km^2. About 370 km^2 are agricultural lands and 117 km^2 - forests and fields. Its territory includes part of the Danube plain and the foothills of the Balkan Mountain – the Predbalkan (the mountain of Vratsa is included in the Natural Park "Vratchanski Balkan"). It borders with the municipalities of Varshetz, Mezdra, Krivodol, Borovan, Byala Slatina and Svoge. The total length of its borders is 150 km. The climate is mild continental.

During the different historical periods the Region of Vratsa has been developing as an important social, trading and cultural centre. Traces from human activities in these lands date back from the New Stone Age. The first inhabitants - the Thracian tribe of the Tribals developed high level of material culture, traces of which are still available in the region.

The infrastructure and communications of the town are good. District heating is available for about 15,352 apartments and lots of trade establishments. There are three substations built in the Municipality. The textile and food industries, a building materials production and metalworking are well developed.

The town of Vratsa spreads out from the mountain down to the wide spaces of the plain on an area of 12.5 km^2, covering 2% of the territory of the municipality. It is situated in the North West part of Bulgaria, at about 110 km from Sofia.

Main railway and road corridors of national and international importance cross the territory of the Municipality. Vratsa is the cross point of two of the biggest European transport corridors – Corridor 4 and Corridor 7. Its strategic location will become even more important with the commissioning of the Danube Bridge 2 at Vidin.

- Corridor No. 4 – Dresden / Nurnberg – Prague – Vienna / Bratislava – Budapest Krayova / Konstanca – Vidin – Vratsa – Sofia – Solun / Plovdiv – Istanbul
- Corridor No. 7 – Rein – Maine – Danube (the Danube water-way). Road II-15, which passes trough Vratsa, is the backbone of the road infrastructure of Vratsa District. It goes to Oryahovo – a town on the Danube River, where the busiest Bulgarian ferryboat is stationed, which completes the connection to Corridor 7.

2.1 Management and Budget

Bulgaria is a parliamentary republic with local governance. According to the Constitution, the territory of the country is divided into municipalities and regions. There are 264 municipalities and 28 regions. The municipalities consist of one or more built-up areas. The municipality has internal administrative structures called mayoralties The municipality is an independent legal entity with property rights and its own budget; it is the main administrative and territorial unit, entitled to carry out the local government. The citizens can participate in the municipal government in two ways (1) indirectly, through local elections and (2) directly, through referendums and general meetings. Through the local authorities elected by them, they decide all issues of local importance with regard to:

- Municipal property, municipal enterprises, municipal finances, taxes and fees, municipal administration.
- Organization and development of the municipal territory and its built-up areas;
- Education - pre-school education, elementary and secondary school education.
- Culture - community centers, theatres, orchestras, libraries, museums and museum collections, amateur art activities, rituals, local traditions and customs.
- Organization of public utilities and communication activities – water-supply, sewerage, electricity and heat supply, streets and squares, parks, gardens, street lighting, planting and grassing, correction of rivers and gullies, waste treatment, municipal public baths, dry cleaning, garages, graveyards.
- Social services.
- Health service regarding health prevention, medical and social care, and sanitary and hygiene activities.
- Environment protection and rational use of natural resources of local importance.
- Maintenance and preservation of the cultural, historical, and architectural monuments of local importance.
- Development of sports, tourism and recreation centers of local importance.

Municipal budget:
The separation of the state and municipal activities was established with the beginning of the financial decentralization process in 2003. Education, social activities, culture, health services, delegated by the state to the municipalities on the basis of set standards, are financed by the state budget. The municipal income is utilized for municipal activities from two separate sources:

- Own income - local taxes and fees, proceeds from municipal property management and other non-tax income. The municipalities independently define the rate of local fees including kindergarden and play group fees, waste taxes,

fees for municipal and administrative services, etc. The type and rate of local taxes are defined by law.
- State transfers – transferred state taxes and subsidies.

According to the Law on Municipal Budgets (LMB), the municipal budget is approved by the Municipal Council. The budget's implementation is organized by the mayor of the municipality, assisted by elected and appointed mayors of villages and regions, and the heads of budget units, financed by the municipal budget. The collection of the municipality's own income is carried out by the municipal administration.

The Municipal Council is the local government authority that:

- Defines the general policy for municipal building and development.
- Approves and controls the implementation of the budget.
- Defines the rate of local fees.
- Makes decisions regarding acquiring, managing and arranging of municipal property.
- Makes decisions in regard to drafting and approval of architectural plans on the municipal territory and their further amendments.
- Approves the structure of the municipal administration.
- Makes decisions for carrying out of administrative changes regarding the municipal territory, holds local referendums and performs better municipal work.

The Mayor is the executive authority of the municipality. He/She:

- Manages the executive work of the municipality coordinates and controls the work of the separate departments.
- Appoints and dismisses the employees of the municipal administration.
- Organizes the execution of the Municipal Council's decisions.
- Organizes the implementation of the municipal budget and reports to the Municipal Council and the local community.
- Represents the municipality before individuals and legal entities, public organizations, political parties and the court.

Bulgarian legislation gives the municipalities the right to cooperate to defend their interests. The Bulgarian local authorities are united in the National Association of Municipalities of the Republic of Bulgaria (NAMRB). There are also regional municipal associations established for solving common regional problems in Bulgaria. According to the Law on Local Government and Local Administration, NAMRB has the right to:

- Represent the municipalities before the central authorities and foreign organizations.

- Protect municipal rights and interests.
- Develop proposals for changes in the local government legal base.
- Conduct annual consultations with the Ministry of Finance on the state draft budget concerning the Municipalities chapter.

2.2 Municipal Structure

The structure and number of municipal administration are approved by the Municipal Council upon proposal of the Mayor of the municipality. The administration consists of general and specialized administration:

A) The general administration provides technically the activities of the local authorities and performs administrative servicing of the population, the physical persons and the legal entities.
B) The specialized administration supports the realization of the powers of state authorities related to its competence.

STRUCTURE OF THE VRATSA MUNICIPAL ADMINISTRATION
IN OFFICE 2011 – 2015

MANAGEMENT:

1. Mayor.
2. European funding and public procurement Deputy mayor.
3. Spatial planning and construction Deputy mayor.
4. Education, culture, sports and tourism Deputy mayor.
5. Health and social care Deputy mayor.
6. Chief Secretary.

UNITS EXTERNAL TO THE GENERAL AND SPECIALIZED ADMINISTRATION:

1. Internal Audit Department.
2. Financial supervisor.

GENERAL ADMINISTRATION:

Mayor`s Office Department

1. Administrative services and information technologies Directorate

1.1 Civil status Department
1.2 Working with mayoralties, services to the Municipal council, and administrative and economic issues Department

1.3 Administrative services center and information technologies Department
1.4 Human resources Department

2. Finance, economic analyses, local revenue and municipal property Directorate

2.1 Accounting Department
2.2 Local revenue Department
2.3 Municipal property and economy Department

3. Administrative and legal works Directorate

4. Protocol, project administration and international cooperation Directorate

SPECIALIZED ADMINISTRATION:

Chief Architect

1. Spatial planning and construction, public infrastructure and environmental protection Directorate

1.1 Spatial planning and construction control Department
1.2 Public infrastructure and environmental protection Department

2. Education, culture, sports and tourism Directorate

2.1 Education, educational activities and sports Department
2.2 Culture, cultural-historical heritage and tourism Department

3. Healthcare, social care and youth activities Directorate

3.1 Healthcare Department
3.2 Social care and youth activities Department

MAYORS OF MAYORLALTIES AND DEPUTY-MAYORS
CHIEF EXPERTS IN MAYORALTIES

3. PROJECT BACKGROUND

The regional landfill is in operation since October 2000 and is designed to serve both Vratsa and Mezdra municipalities.

The municipality of Vratsa consists of 23 settlements (Vratsa town and 22 villages) with total population of 72,877 (59,700 in the town and 13,177 in the villages). The municipality of Mezdra consist of 28 settlements (Mezdra town and 26 villages) with total population of 21,436 (10,789 in the town and 10,647 in the villages).

For the construction and operation of the landfill a contract between Vratsa and Mezdra municipalities was signed. The share of Vratsa municipality is 75 %, and the share of Mezdra municipality is 25%. The facility is operated by Ecoproect Ltd., registered both in Vratsa and Mezdra municipalities. The company was granted with complex permission No KP 5 in 2004, issued by the Ministry of Environment and Water.

The landfill covers an area of 13.2 ha, and is situated 4 km away from the town of Vratsa. The oldest part, that operated until the year 2000, is 3.3 ha and reclamation was performed. Due to lack of data and missing bottom linear, this part is not taken into consideration for the current analysis. Cell 1, that was put in operation in the year 2000, is with total area of 1.95 ha. Currently a project for reclamation of Cell 1 is performed. Cell 2, with total area of 2 ha, has been put into operation in 2013. A third cell (Cell 3) with total area of 2 ha, will be designed in the future. The average depth of the landfill is 12 meters and the designed site capacity is 491,481 tons. A general view of the landfill is shown in Figure 3.1.

Figure 3.1
General View of Vratsa Landfill

The generated leachate is captured and through a pump station and pusher station is lead to a treatment plant. All cells are designed in accordance with the EU requirements and bottom linear, drainage layer, gas collection system are or will be constructed. Soil cover and compacting in Cell 1 are performed on regular base. 98 % of the disposed waste is municipal and only 2 % comes from nearby industrial facilities. A scale at the entrance measures the disposed waste. There are no evidences of fire in Cell 1. The landfill is considered as well secured.

It is expected that Cell 1 will be fully capped in 2013 and its gas collection system will be attached to the existing flare. Modeling of Cell 1 of Vratsa landfill, with the Ukrainian version of LandGEM, was performed. The modeling results are presented in Appendix A. The start up of the flare is expected in the second half of the year 2013, and the actual results will show the accuracy of the software modeling and prove the feasibility of the project. The real data expected in the second half of the year 2013 can be compared not only with the results from the Ukrainian version of LanfGEM, but also with the results generated by the new version of LandGEM, specially modified for Central & Eastern Europe. This new version will also be available in the second half of the year 2013.

Close to the site (at about 2000 meters) is situated Himko AD, the largest producer and trader of urea on the Balkan Peninsula. The company produces also NPK, potash, liquid fertilizers and soil improvers. Currently, the factory is not operating, but can be considered as potential future consumer of the heat energy that will be generated by a CHP unit to be installed at the landfill. There is also brickworks factory near the facility.

Other potential consumers of heat energy can be greenhouses if situated close to the landfill.

On the base of the data generated by the Ukrainian version of LandGEM, technical and financial analyses were made.

The main technical characteristics of the CHP proposed for implementation are presented in Table 3.1.

Table 3.1 CHP module characteristics

Parameter	Value
Electrical output	80 kW
Heat output	116 kW
Fuel inpit	228 kW
Electrical efficiency	35.0%
Heat efficiency	50.9%
Total efficiency	85.9%
Fuel consumtion at 100% load	35.1 m^3/h
Fuel consumtion at 75% load	28.5 m^3/h
Fuel consumtion at 50% load	21.9 m^3/h

3.1 Project Cost

The project cost for the implementation of the CHP unit is based on preliminary research of the costs of the equipment and construction works needed (Table 3.2).

Table 3.2 Base Project Costs

Acticity/Equipment	*EUR*
Project management	12,676
Legal services, consultant	10,372
Electrical integration	17,286
CHP unit	115,240
Gas generator set (pumps, fans, etc.)	23,048
Substructure, civil works	28,810
Contingency	5,762
Capping and gas collection system Cell 2	25,000
Total cost	**238,194**

The capping and the gas collection system for Cell 2 is expected to be done in the year 2021, when the generated LFG in Cell 1 will be insufficient for the operation of the CHP unit at nominal load. Only half of the cell can be capped and its collection system

connected to the unit. This should be taken into consideration during the first years of exploitation of the cell to make it technically possible in the future. Therefore the actual investment cost in the first two years of the project is in the amount of EUR 213,194.

The investment schedule suggested and used for the cash flow analyses, as well as the debt-equity are presented in Table 3.3.

Table 3.3 Funding scheme, debt-equity

Expenses	*2013*		*2014*		*2021*	***Total***	
	Vratsa	*EE Fund*	*Vratsa*	*EE Fund*	*Vratsa*	***Vratsa***	***EE Fund***
Project management	6,338			6,338		**6,338**	**6,338**
Legal services, consultant	5,186			5,186		**5,186**	**5,186**
Electrical integration	4,322			12,965		**4,322**	**12,965**
CHP unit	13,829	32,267		69,144		**13,829**	**101,411**
Gas generator set (pumps, fans, etc.)	9,219			13,829		**9,219**	**13,829**
Substructure, civil works	14,405	8,643		5,762		**14,405**	**14,405**
Contingency				5,762			**5,762**
Capping and gas collection system Cell 2					25,000	**25,000**	
Total by funding source	**53,299**	**40,910**	**0**	**118,985**	**25,000**	**78,299**	**159,896**
Total by year	**94,209**		**118,985**		**25,000**	**238,194**	

The minimum equity contribution from the project developer that is required by the Energy Efficiency and Renewable Sources Fund is least 25%. The calculated investments needed in the first two years amount to EUR 213,194. The debt financing is calculated at EUR 159,896.

3.2 Project Cash Flow

3.2.1 Operational costs breakdown

The operational and maintenance costs after project implementation include:

- Cost for salaries and social security payments of the operational staff amount to 14,725 EUR per year.
- Costs for materials (oil/filters, lubrication, etc.) and equipment maintenance amount to 2,000 EUR per year.

The total annual operational and maintenance cost is estimated to EUR 16,725, including the salaries of three additional employees that will be responsible for the proper system operation. The implemented CHP unit will be fully automatic and regular manual control will not be required.

3.2.2 Revenues from electricity sales

The revenues from the project implementation are achieved by the sale of 510.64 MWh of electricity to the Natsionalna Elektricheska Kompaniya EAD (NEK) annually. Table 3.4 presents the project specifications for the three investigated cases. According to the current Decision No 018/28.06.2012 of the State Energy and Water Regulatory Commission, the feed-in-tariffs for electricity generated by LFG vary, depending on the incentive payment granted to the project. Table 3.5 summarizes the three scenario results from the implementation of the project from 2014 through 2028.

Table 3.4 Project Specifications, Revenues and Savings

Implementation of CHP module at Vratsa landfill				
		no grant	***50% grant***	***75% grant***
Revenues				
	Dimension		Value	
Installed capacity	kW	80	80	80
Working hours	h/yr	6,500	6,500	6,500
Produced electricity	kWh/yr	520,000	520,000	520,000
Electricity for auxiliary needs	%	1.8	1.8	1.8
Electricity for auxiliary needs	kWh/yr	9,360	9,360	9,360
Electricity sold to the grid	kWh/yr	510,640	510,640	510,640
Electricity price	EUR/MWh	124.46	110.82	101.73
Annual income from sold electricity	EUR/yr	63,556	56,588	51,946
Operational & Maintenance costs	EUR/yr	16,725	16,725	16,725
Total annual income	**EUR/yr**	**46,831**	**39,863**	**35,220**
Investment costs				
Project management	EUR	12,676	12,676	12,676
Legal services, consultant	EUR	10,372	10,372	10,372
Electrical integration	EUR	17,286	17,286	17,286
CHP unit	EUR	115,240	115,240	115,240
Gas generator set (pumps, fans, etc.)	EUR	23,048	23,048	23,048
Substructure, civil works	EUR	28,810	28,810	28,810
Contingency	EUR	5,762	5,762	5,762
Grant	EUR	0	106,597	159,896
Total investments	**EUR**	**213,194**	**213,194**	**213,194**
Payback	**yr**	**4.6**	**2.7**	**1.5**

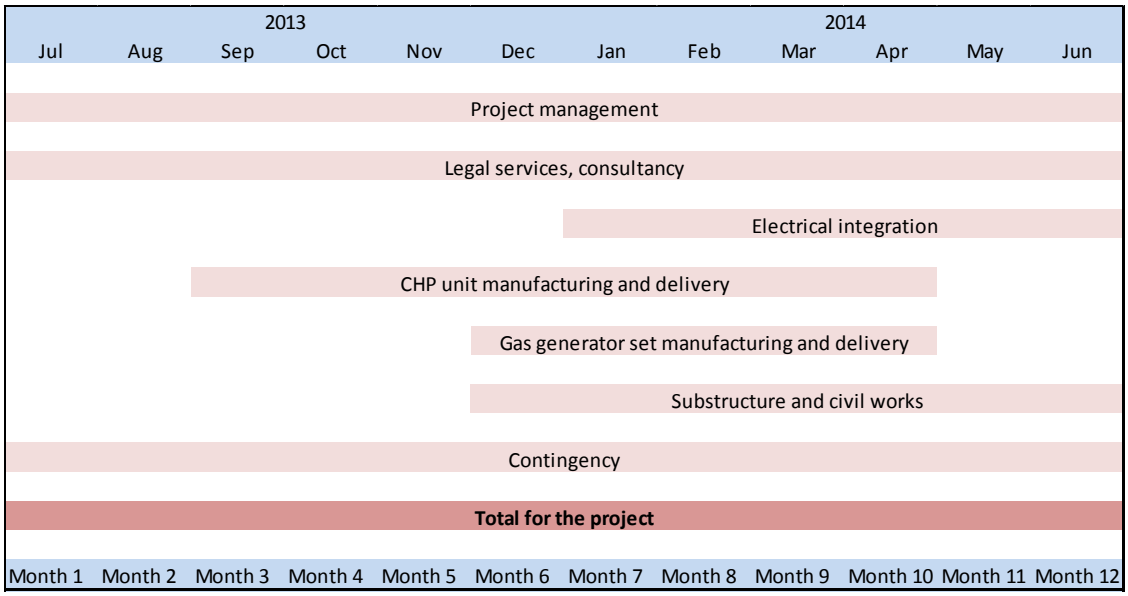
Table 3.5 Total Project Revenues and O&M Cost

Case 1 (No Grant)		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Revenues																
Produced electricity	MWh/yr.	511	511	511	511	485	461	438	511	511	511	511	511	511	511	511
Electricity feed-in-tariff	EUR/MWh	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124
Income from sold electricity	EUR/yr.	63,556	63,556	63,556	63,556	60,378	57,359	54,491	63,556	63,556	63,556	63,556	63,556	63,556	63,556	63,556
Expenses																
Operational & Maintenance Costs	EUR/yr.	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725
Total project revenues	EUR/yr.	46,831	46,831	46,831	46,831	43,653	40,634	37,766	46,831	46,831	46,831	46,831	46,831	46,831	46,831	46,831
Case 2 (50% Grant)		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Revenues																
Produced electricity	MWh/yr.	511	511	511	511	485	461	438	511	511	511	511	511	511	511	511
Electricity feed-in-tariff	EUR/MWh	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
Income from sold electricity	EUR/yr.	56,588	56,588	56,588	56,588	53,758	51,070	48,517	56,588	56,588	56,588	56,588	56,588	56,588	56,588	56,588
Expenses																
Operational & Maintenance Costs	EUR/yr.	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725
Total project revenues	EUR/yr.	39,863	39,863	39,863	39,863	37,033	34,345	31,792	39,863	39,863	39,863	39,863	39,863	39,863	39,863	39,863
Case 3 (75% Grant)		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Revenues																
Produced electricity	MWh/yr.	511	511	511	511	485	461	438	511	511	511	511	511	511	511	511
Electricity feed-in-tariff	EUR/MWh	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
Income from sold electricity	EUR/yr.	51,946	51,946	51,946	51,946	49,348	46,881	44,537	51,946	51,946	51,946	51,946	51,946	51,946	51,946	51,946
Expenses																
Operational & Maintenance Costs	EUR/yr.	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725	16,725
Total project revenues	EUR/yr.	35,220	35,220	35,220	35,220	32,623	30,156	27,812	35,220	35,220	35,220	35,220	35,220	35,220	35,220	35,220

3.3 Project Implementation Schedule

Table 3.6 shows the implementation schedule for the Vratsa landfill project.

Table 3.6 Project Implementation Schedule



The project starts in July 2013 with advance payments for management, legal services, consultancy and part of the equipment. The CHP unit and the auxiliary equipment will be delivered in April 2014. The start up of the installation is expected in June 2014.

4. FINANCING PLAN (PROJECT PROJECTION)

The general approach to finance the Vratsa landfill gas recovery project is through municipal ownership, as currently the municipally owned Ecoproect Ltd. manages to operate the landfill successfully. The investments are considered within the reach of the municipal budget.

4.1 Type and Amount of Requested Financing

The total base project cost amounts to EUR 213,194 (the expenses for partly capping Cell 2 and connecting its gas collection system to the implemented CHP unit will be done in the year 2021 and the financing will be provided by the project revenues). The proposed financial scheme includes the debt financing from the EERSF in the amount of EUR 159,896 and the contribution of the municipality in the amount of EUR 53,299. The debt equity ratio is 75% to 25%. The municipality will pay interest during the construction in the amount of EUR 3,953. The proposed financial scheme is presented in Table 4.1.

Table 4.1 Project Cost and Proposed Financial Scheme

Expenses	EUR	%
Base Projcet Cost	213,194	98.2%
Interest during construction	3,953	1.8%
Total Project Cost	**217,147**	**100.0%**
Capital Structure	EUR	%
Debt	159,896	75.0%
Equity	53,299	25.0%
Total Investments	**213,194**	**100.0%**
Financial Scheme	EUR	%
Loan amount	159,896	73.6%
Municipal contribution		
Own investments	*53,299*	*24.5%*
Interest during construction	*3,953*	*1.8%*
Total contribution of the municiplaity	57,251	26.4%
Total	**217,147**	**100.0%**

4.2 Loan Disbursement Scheme

The preliminary loan disbursement scheme, including the borrower's own contribution, is presented in Table 4.2 and in Appendix A, with breakdown of the investments.

However the final disbursement scheme is subject to negotiations between the bank and the borrower.

Table 4.2 Loan Disbursements and Own Contribution Scheme

EUR	2013		2014			
	Jul	Oct	Feb	Jun	**Total**	**Share**
EERSF	32,267	8,643	83,549	35,436	**159,896**	**75%**
Municipality	47,537	5,762			**53,299**	**25%**
Total	**79,804**	**14,405**	**83,549**	**35,436**	**213,194**	**100%**

4.3 Proposed Terms and Conditions of Finance

The conditions of financing suggested in Table 4.3 are based on preliminary conversations with the financial expert of EERSF. The interest rate is assumed at 7%, although a lower interest rate can be negotiated between the municipality and the Fund. The loan repayment starts on 30th of July 2014, after the project completion; before that the borrower pays only monthly interest on the outstanding principal, during the project construction period.

Table 4.3 Loan Parameters

Project	
Construction begins	01 July 2013
Construction ends	30 June 2014
Operations begins	01 July 2014
Operation ends	31 December 2028
Loan	
Total loan amount	159,896 €
Interest Rate	7%
Loan disbursment begins	31 July 2013
Loan disbursment ends	30 June 2014
Grace period	12 months
Interest payment begins	30 August 2013
Loan principal payments begin	30 July 2014
Loan principal payments end	30 July 2018
Number of payments per year	12

In case the municipality participates in an Operational programme and incentive payment is negotiated, the loan repayment period will be shorter as the incentive will be used for payment of the outstanding principle, immediately after project completion.

5. PROJECT CASH FLOW ANALYSIS AND FINANCIAL INDICATORS

Three approaches were considered in the analyses: a) the municipality gets a loan without participating in an Operational programme; b) the municipality gets a loan and participates in an Operational programme receiving 50% grand after the project completion; c) the municipality gets a loan and participates in an Operational programme receiving 75% grand after the project completion. The three cases are as follow:

Case #1: The municipality gets a loan and does not participate in an Operational Programme (grant is not expected)

The municipality puts in EUR 53,299 as its equity contribution and gets EUR 159,896 as a loan from the EERSF. The Fund provides low interest rate loans to municipalities without any additional credit conditions (taxes) and a payment schedule structured in accordance with the municipality needs. The price of the produced electricity sold to the Natsionalna Elektricheska Kompaniya EAD (NEK) will be 124.46 EUR/MWh in accordance with Decision No 018/28.06.2012 of the State Energy and Water Regulatory Commission.

Case #2: The municipality gets a loan and participates in an Operational Programmme (50% grant is expected)

The same conditions (equity contribution/loan) as in Case #1, but the municipality participates in an Operational Programme and gets 50 % incentive payments (EUR 106,597) after the project completion. The price of the produced electricity sold to the NEK will be 110.86 EUR/MWh in accordance with Decision No – 018/28.06.2012 of the State Energy and Water Regulatory Commission. The incentives will be used to partly cover the loan repayment.

Case #3: The municipality gets a loan and participates in an Operational Programme (75% grant is expected)

The same conditions (equity contribution/loan) as in Case #1, but the municipality participates in an Operational Programme and gets 75 % incentive payments (EUR 159,896) after the project completion. The price of the produced electricity sold to the NEK will be 101.73 EUR/MWh in accordance with Decision No 018/28.06.2012 of the State Energy and Water Regulatory Commission. The incentive will be used to cover the loan and only interest will be paid by the municipality.

The capital budgeting indicators, resulting from the project cash flow projection and analysis, are presented in Tables 5.1, 5.2, and 5.3.

Table 5.1 Project Cash Flow – Case 1

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cash Flow Sources																	
Revenues																	
Produced electricity	MWh/yr.		255	511	511	511	485	461	438	416	511	511	511	511	511	511	511
Electricity feed-in-tariff	EUR/MWh		124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46	124.46
Income from sold electricity	EUR/yr.		31,778	63,556	63,556	63,556	60,378	57,359	54,491	51,767	63,556	63,556	63,556	63,556	63,556	63,556	63,556
Expenses																	
Operational & Maintenance Costs	EUR/yr.		-8363	-16725	-16725	-16725	-16725	-16725	-16725	-6725	-16725	-16725	-16725	-16725	-16725	-16725	-16725
Investments																	
Investments Loan	EUR/yr.	40,910	118,985														
Municipality Contribution	EUR/yr.	-53,299								-25000							
Loan servicing																	
Payments to EE Fund	EUR/yr.	-773	-25,563	-44,767	-44,767	-44,767	-22,384										
Cash																	
Cash (beginning of year)		0	-54,072	-56,219	-54,155	-52,091	-50,027	-28,758	11,877	49,643	69,685	116,516	163,347	210,178	257,009	303,840	350,670
Cash (end of year)		-54,072	-56,219	-54,155	-52,091	-50,027	-28,758	11,877	49,643	69,685	116,516	163,347	210,178	257,009	303,840	350,670	397,501
Cash Flow Analysis																	
Net Free Cash Flow		-94,209	-95,570	46,831	46,831	46,831	43,653	40,634	37,766	20,042	46,831	46,831	46,831	46,831	46,831	46,831	46,831
Discounted Free Cash Flow		-94,209	-89,318	40,904	38,228	35,727	31,124	27,076	23,519	11,664	25,473	23,806	22,249	20,794	19,433	18,162	16,974
Cumulative Cash Flow		-94,209	-189,779	-142,948	-96,117	-49,286	-5,632	35,002	72,768	92,810	139,641	186,472	233,303	280,134	326,965	373,796	420,627
Payback Period (yr)	4.64																
IRR	19%																
NPV	171,607																

Table 5.2 Project Cash Flow – Case 2

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cash Flow Sources																	
Revenues																	
Produced electricity	MWh/yr.		255	511	511	511	485	461	438	416	511	511	511	511	511	511	511
Electricity feed-in-tariff	EUR/MWh		111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
Income from sold electricity	EUR/yr.		28,294	56,588	56,588	56,588	53,758	51,070	48,517	46,091	56,588	56,588	56,588	56,588	56,588	56,588	56,588
Expenses																	
Operational & Maintenance Costs	EUR/yr.		-8,363	-16,725	-16,725	-16,725	-16,725	-16,725	-16,725	-6,725	-16,725	-16,725	-16,725	-16,725	-16,725	-16,725	-16,725
Investments																	
Investments Loan	EUR/yr.	40,910	118,985														
Municipality Contribution	EUR/yr.	-53,299								-25,000							
Incentive payment	EUR		106,597														
Loan servicing																	
Payments to EE Fund	EUR/yr.	-773	-12,766	-19,172	-19,172	-9,586											
Cash																	
Cash (beginning of year)		0	-54,072	59,691	80,382	101,072	131,349	168,382	202,727	234,519	248,885	288,748	328,610	368,473	408,335	448,198	488,061
Cash (end of year)		-54,072	59,691	80,382	101,072	131,349	168,382	202,727	234,519	248,885	288,748	328,610	368,473	408,335	448,198	488,061	527,923
Cash Flow Analysis																	
Net Free Cash Flow (including grant)		-94,209	7,543	39,863	39,863	39,863	37,033	34,345	31,792	14,366	39,863	39,863	39,863	39,863	39,863	39,863	39,863
Discounted Free Cash Flow		-94,209	7,050	34,818	32,540	30,411	26,404	22,886	19,798	8,361	21,683	20,264	18,938	17,699	16,542	15,459	14,448
Cumulative Cash Flow		-94,209	-86,666	-46,803	-6,941	32,922	69,955	104,301	136,092	150,458	190,321	230,183	270,046	309,909	349,771	389,634	429,496
Payback Period (yr)	2.67																
IRR	31%																
NPV	213,092																

Table 5.3 Project Cash Flow – Case 3

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cash Flow Sources																	
Revenues																	
Produced electricity	MWh/yr.		255	511	511	511	485	461	438	416	511	511	511	511	511	511	511
Electricity feed-in-tariff	EUR/MWh		111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
Income from sold electricity	EUR/yr.		28,294	56,588	56,588	56,588	53,758	51,070	48,517	46,091	56,588	56,588	56,588	56,588	56,588	56,588	56,588
Expenses																	
Operational & Maintenance Costs	EUR/yr.		-8,363	-16,725	-16,725	-16,725	-16,725	-16,725	-16,725	-6,725	-16,725	-16,725	-16,725	-16,725	-16,725	-16,725	-16,725
Investments																	
Investments Loan	EUR/yr.	40,910	118,985														
Municipality Contribution	EUR/yr.	-53,299								-25,000							
Incentive payment	EUR		159,896														
Loan servicing																	
Payments to EE Fund	EUR/yr.	-773	-3,180														
Cash																	
Cash (beginning of year)		0	-54,072	122,576	162,438	202,301	242,163	279,197	313,542	345,334	359,699	399,562	439,425	479,287	519,150	559,012	598,875
Cash (end of year)		-54,072	122,576	162,438	202,301	242,163	279,197	313,542	345,334	359,699	399,562	439,425	479,287	519,150	559,012	598,875	638,738
Cash Flow Analysis																	
Net Free Cash Flow (including grant)		-94,209	60,841	39,863	39,863	39,863	37,033	34,345	31,792	14,366	39,863	39,863	39,863	39,863	39,863	39,863	39,863
Discounted Free Cash Flow		-94,209	56,861	34,818	32,540	30,411	26,404	22,886	19,798	8,361	21,683	20,264	18,938	17,699	16,542	15,459	14,448
Cumulative Cash Flow		-94,209	-33,367	6,495	46,358	86,221	123,254	157,599	189,391	203,757	243,619	283,482	323,344	363,207	403,070	442,932	482,795
Payback Period (yr)	1.34																
IRR	48%																
NPV	262,904																

The project payback period for Case 1 is 4.64 years, the IRR is 19%, and the NPV amounts to EUR 171,607. In cases 2 and 3, where the municipality participates in an Operational Programme and is awarded with incentive grant, in spite of the lower feed-in-tariffs, the project payback period decreases to 2.67 and 1.26 years respectively. The IRR in Case 2 is 31% and in Case 3 – 48%. The calculated NPV for Case 2 amounts to EUR 213,092, and for Case 3 to EUR 262,904.

Comparison of the financial indicators for the three cases is presented in Table 5.4.

Table 5.4 Financial Indicators – Comparison

Parameter	Case 1	Case 2	Case 3
Incentive	0%	50%	75%
Payback Period (yr)	4.64	2.67	1.34
IRR	19%	31%	48%
NPV	171,607	213,092	262,904

In conclusion it can be stated that the project cash flow analysis for the three investigated cases indicate that the projects' cash flows are sufficient to service the debt (pay loan interest and repay loan principal) under the loan terms negotiated with the EERSF.

6. RISK AND SENSITIVITY ANALYSIS

The scenarios, presented below, are based on reasonable assumptions for possible problems with equipment and/or operational parameters.

6.1 Capital cost overrun

The investment costs for this specific project are determined on the basis of the preliminary offers, price information and information gathered from similar projects. The design expenses are included in the equipment costs. Possible reasons for underestimation of the equipment costs are:

- Incorrect sizing.
- Omitted equipment, necessary for the conservation options.
- Incorrectly interpreted offers.

The results of the sensitivity analysis in case of 10% increase of the total project costs are presented in Table 6.1.

Table 6.1 Cost Overrun Scenario

IRR, %	Decrease, %	NPV, EUR	Decrease, EUR	PB, years	Increase, years
17%	2%	151,683	19,925	5.16	0.52

As a result of the above-mentioned assumption the IRR decreases by 2% to 17%, NPV also decreases by EUR 19,925 to EUR 151,683. The payback period is 5.16 years. In this case the municipality will need additional cash recourses to service the debt (to pay the loan interest and to repay the loan principal) under the loan terms negotiated with the EERSF.

6.2 Start-up delay risk

The proposed in this business plan conditions are favorable for keeping the scheduled timetable. However, a two months start-up delay was analyzed due to the following risks:

- Equipment supply and installation delay.
- The assembling sites are not ready.

The changes in the project financial indicators, in case of a two months start-up delay, are presented in Table 6.2.

Table 6.2 Start-up Delay Scenario

IRR, %	Decrease, %	NPV, EUR	Decrease, EUR	PB, years	Increase, years
18%	1%	161,708	9,900	4.90	0.26

As a result of the above-mentioned assumption the IRR decreases by 1% to 18%, the NPV also decreases by EUR 9,900 to EUR 161,708. The payback period is 4.9 years.

6.3 Operational risk

The expected decrease of net cash generated by the project, compared to the basicc case scenario can be affected by the following circumstances:

- Incorrect impact definition during the design stage.
- The proposed technology cannot technically achieve the impact forecasted.
- The prescribed operation conditions are not adequate.

This sensitivity scenario shows the impact of the reduction of the net cash from operating activities by 10% compared to the basic case. The IRR decreases by 1% to 18% and the NPV decreases by EUR 17,797 to EUR 153,811. The payback period is 4.9 years. The results are summarized in Table 6.3.

Table 6.3 Cash from Operating Activities Decrease Scenario

IRR, %	Decrease, %	NPV, EUR	Decrease, EUR	PB, years	Increase, years
18%	1%	153,811	17,797	4.90	0.26

6.4 Worst case scenario

This worst case scenario tests the combination of all scenarios mentioned above. Under this scenario the capital cost overruns by 5%, start-up delays are two months and the expected reduction of cash from operating activities by 10%. The results of the cash flow analysis for the worst case scenario are presented in Table 6.4.

The analysis show that IRR decreases by 4%, the NPV reduces by EUR 47,126 and the payback period increase by 1.08 years. In this case the municipality will need additional cash recourses to service the debt (to pay the loan interest and to repay the loan principal) under the loan terms, negotiated with the EERSF.

Table 6.4 Worst Case Scenario

IRR, %	Decrease, %	NPV, EUR	Decrease, EUR	PB, years	Increase, years
15%	4%	124,481	47,126	5.72	1.08

For all scenarios with incentive grant the indicators are significantly improved. The results in the worst case scenario with 50% and 75% incentive are presented in Tables 6.5 and 6.6.

Table 6.5 Worst Case Scenario – 50% incentive

IRR, %	Decrease, %	NPV, EUR	Decrease, EUR	PB, years	Increase, years
24%	8%	168,948	44,144	3.62	0.95

Table 6.6 Worst Case Scenario – 75% incentive

IRR, %	Decrease, %	NPV, EUR	Decrease, EUR	PB, years	Increase, years
36%	12%	218,760	44,144	2.21	0.87

7. CONCLUSION

This business plan includes a cost and financial analysis and a risk sensitivity assessment. It is considered that the municipality gets a loan and owns and operates the landfill. Three variants on this scheme are analyzed based on different amounts of incentive payments:

Case I: No incentive payment is expected.
Case II: Incentive payment in the amount of 50 % (106,597 EUR) is expected after the project completion.
Case III: Incentive payment in the amount of 75% (159,896 EUR) is expected after the project completion.

The methane collection system cost is not included in the total project costs as it is responsibility of the municipality to ensure the gas capture and disposal after the closure of landfill cells.

For this business plan, it is assumed that the loan interest rate amounts to 7%, although a lower interest rate can be negotiated as well. The loan repayment starts in July 2014; before that the borrower pays monthly interest on the outstanding principal during the 12-months grace period.

The cost and financial analyses include a risk sensitivity analysis resulting from a reasonable estimate of the capital cost overrun, start-up delay, and operational delays that decrease the net revenue generation.

In summary, the financial viability of the project depends on the amount of the incentive payment. For the three investigated cases the payback period (PBP) ranges from 4.64 to 1.34 years and the respective internal rate of return (IRR) ranges from 19% to 48%.

Based on the developed Business Plan, the following conclusions were done:

- Low risk project – the technology and equipment have been implemented all over the world. The modeling results can be confirmed with none or minor investments.
- Good financial parameters – PB = 4.64 years, IRR = 19%, NPV = 171,607 EUR in Case 1 without incentive payment. For the worse case risk sensitivity the PBP is 5.72 years and the IRR is 15%.
- Environmental benefits – reduction of the greenhouse gas emissions is expected after the project implementation.

APPENDIX A

Vratsa (Mezdra) Landfill Modeling

Vratsa (Mezdra) Landfill Modeling

The recovery of the methane from the Vratsa landfill was assessed, using a USEPA landfill model for Ukraine, that is a modified version of the USEPA LandGem model that is used for landfills in the USA. Specific morphological and waste data for the Vratsa landfill were used (considering a pessimistic approach) for input to the model. Where meteorological data was needed for model input, , Ukraine and Bulgarian data were compared and Ukraine model regional data, that most matched Bulgarian data, was used. Modeling results for Cell 1 are shown in Tables A.1, A.2 and Figure A.1 below. Modeling results for partly capped Cell 2 are shown in Tables A3, A4, and Figure A2. They indicate that an 80 kilowatt gas generator could be used for 6,500 hours/year to produce an annual electricity output of 520 megawatt-hours (MWh). After deduction of the internal consumption of electricity by the facility, 510.64 MWh remain for sale to the national utility, NEK.

Table A.1 Model Input Table (Cell 1)

PROJECTION OF LANDFILL GAS GENERATION AND RECOVERY INPUT WORKSHEET			
1	Landfill name:	Vratsa landfill	
2	City:	Vratsa	
3	Province:	Kiev	3
4	Site-specific waste composition data?	Yes	
5	Year opened:	2000	
6	Annual disposal for latest year with data in tonnes per year (Mg/yr)	23,000	Mg
7	Year of annual disposal estimate	2012	
8	Waste in place estimate available in tonnes (Mg)?	Yes	
9	Waste in place estimate for end of 2008 or most recent year:	231,404	Mg
10	Estimated in-place waste density in Mg per m^3 (typical range: 0.5-1.0):	0.75	Mg/m^3
11	If waste in place estimate is in volume (m3), convert to Mg:	231,404	Mg
12	Year of waste in place estimate:	2012	
13	Projected or actual closure year:	2012	
14	Estimated growth in annual disposal:	0.0%	
15	Average landfill depth:	11	m
16	Site design and management practices:	2	
17a	Has site been impacted by fires?	No	
17b	If 13a answer is Yes, indicate % of landfill area impacted:	0%	
17c	If 13a answer is Yes, indicate the severity of fire impacts:	1	
18	Year of initial collection system start-up:	2014	
19	Percent of waste area with wells:	75%	
20	Percent of waste area with final cover:	100%	
21	Percent of waste area with intermediate cover:	0%	
22	Percent of waste area with daily cover:	0%	
23	Percent of waste area with no soil cover:	0%	
24	Percent of waste area with clay or synthetic liner:	100%	
25	Is waste compacted on a regular basis?	No	
26	Is waste delivered to a focused tipping area?	Yes	
27a	Does the landfill experience leachate surface seeps or surface ponding?	No	
27b	If 23a answer is yes, does this occur only after rainstorms?	Yes	
28	Collection efficiency estimate:	65%	

Table A.2 Model Output Table (Cell 1)

PROJECTION OF LANDFILL GAS GENERATION AND RECOVERY Vratsa landfill Vratsa, Kiev, Ukraine													
Year	Disposal (Mg/yr)	Refuse In-Place (Mg)	LFG Generation			Collection System Efficiency (%)	Predicted LFG Recovery			Maximum Power Plant Capacity* (MW)	Baseline LFG Flow (m3/hr)	Methane Emissions Reduction Estimates**	
			(m^3/hr)	(cfm)	(MJ/hr)		(m^3/hr)	(cfm)	(MJ/hr)			(tonnes CH_4/yr)	(tonnes CO_2eq/yr)
2000	2,368	2,368	0	0	0	0%	0	0	0	0.0	0	0	0
2001	11,419	13,787	2	1	34	0%	0	0	0	0.0	0	0	0
2002	12,918	26,705	10	6	193	0%	0	0	0	0.0	0	0	0
2003	13,696	40,401	19	11	356	0%	0	0	0	0.0	0	0	0
2004	17,591	57,992	27	16	513	0%	0	0	0	0.0	0	0	0
2005	19,093	77,085	38	22	708	0%	0	0	0	0.0	0	0	0
2006	20,699	97,784	48	28	904	0%	0	0	0	0.0	0	0	0
2007	20,110	117,894	58	34	1,102	0%	0	0	0	0.0	0	0	0
2008	21,676	139,570	67	40	1,271	0%	0	0	0	0.0	0	0	0
2009	22,979	162,549	77	45	1,445	0%	0	0	0	0.000	0	0	0
2010	23,095	185,644	86	51	1,620	0%	0	0	0	0.000	0	0	0
2011	22,760	208,404	94	56	1,780	0%	0	0	0	0.000	0	0	0
2012	23,000	231,404	102	60	1,919	0%	0	0	0	0.000	0	0	0
2013	0	231,404	109	64	2,048	0%	0	0	0	0.000	0	0	0
2014	0	231,404	97	57	1,837	65%	63	37	1,194	0.105	0	198	4,168
2015	0	231,404	88	52	1,652	65%	57	33	1,074	0.094	0	178	3,748
2016	0	231,404	79	46	1,490	65%	51	30	968	0.085	0	161	3,380
2017	0	231,404	71	42	1,347	65%	46	27	876	0.077	0	146	3,056
2018	0	231,404	65	38	1,222	65%	42	25	794	0.070	0	132	2,772
2019	0	231,404	59	35	1,112	65%	38	23	723	0.063	0	120	2,522
2020	0	231,404	54	32	1,014	65%	35	21	659	0.058	0	110	2,301
2021	0	231,404	49	29	929	65%	32	19	604	0.053	0	100	2,107
2022	0	231,404	45	27	853	65%	29	17	554	0.049	0	92	1,935
2023	0	231,404	42	25	786	65%	27	16	511	0.045	0	85	1,782
2024	0	231,404	38	23	726	65%	25	15	472	0.041	0	78	1,647
2025	0	231,404	36	21	673	65%	23	14	438	0.038	0	73	1,527
2026	0	231,404	33	20	626	65%	22	13	407	0.036	0	68	1,420
2027	0	231,404	31	18	584	65%	20	12	380	0.033	0	63	1,325
2028	0	231,404	29	17	546	65%	19	11	355	0.031	0	59	1,240

Figure A.1 Model Output Graph (Cell 1)

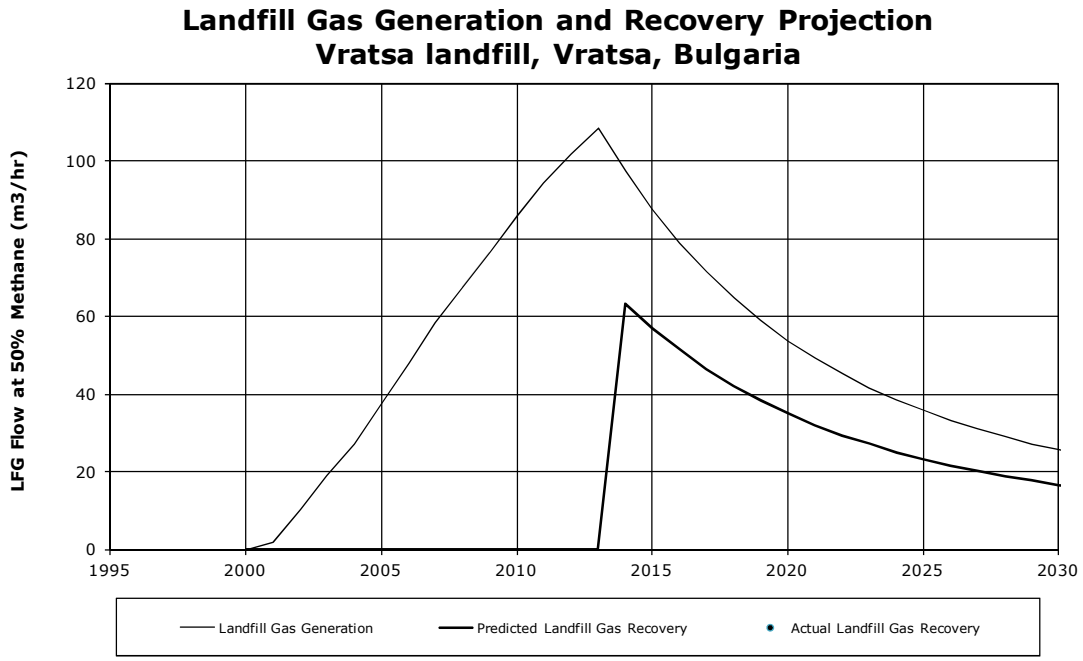


Table A.3 Model Input Table (Cell 2)

PROJECTION OF LANDFILL GAS GENERATION AND RECOVERY INPUT WORKSHEET			
1	Landfill name:	Vratsa landfill	
2	City:	Vratsa	
3	Province:	Kiev	3
4	Site-specific waste composition data?	Yes	
5	Year opened:	2013	
6	Annual disposal for latest year with data in tonnes per year (Mg/yr)	23,000	Mg
7	Year of annual disposal estimate	2013	
8	Waste in place estimate available in tonnes (Mg)?	Yes	
9	Waste in place estimate for end of 2008 or most recent year:	23,000	Mg
10	Estimated in-place waste density in Mg per m^3 (typical range: 0.5-1.0):	0.35	Mg/m^3
11	If waste in place estimate is in volume (m3), convert to Mg:	23,000	Mg
12	Year of waste in place estimate:	2013	
13	Projected or actual closure year:	2027	
14	Estimated growth in annual disposal:	0.0%	
15	Average landfill depth:	11	m
16	Site design and management practices:	2	
17a	Has site been impacted by fires?	No	
17b	If 13a answer is Yes, indicate % of landfill area impacted:	0%	
17c	If 13a answer is Yes, indicate the severity of fire impacts:	1	
18	Year of initial collection system start-up:	2022	
19	Percent of waste area with wells:	75%	
20	Percent of waste area with final cover:	25%	
21	Percent of waste area with intermediate cover:	75%	
22	Percent of waste area with daily cover:	0%	
23	Percent of waste area with no soil cover:	0%	
24	Percent of waste area with clay or synthetic liner:	100%	
25	Is waste compacted on a regular basis?	Yes	
26	Is waste delivered to a focused tipping area?	Yes	
27a	Does the landfill experience leachate surface seeps or surface ponding?	No	
27b	If 23a answer is yes, does this occur only after rainstorms?	Yes	
28	Collection efficiency estimate:	62%	

Table A.4 Model Output Table (Cell 2)

PROJECTION OF LANDFILL GAS GENERATION AND RECOVERY Vratsa landfill Vratsa, Kiev, Ukraine													
Year	Disposal (Mg/yr)	Refuse In-Place (Mg)	LFG Generation			Collection System Efficiency (%)	Predicted LFG Recovery			Maximum Power Plant Capacity* (MW)	Baseline LFG Flow (m3/hr)	Methane Emissions Reduction Estimates**	
			(m^3/hr)	(cfm)	(MJ/hr)		(m^3/hr)	(cfm)	(MJ/hr)			(tonnes CH_4/yr)	(tonnes CO_2eq/yr)
2013	23,000	23,000	0	0	0	0%	0	0	0	0.000	0	0	0
2014	23,000	46,000	17	10	329	0%	0	0	0	0.000	0	0	0
2015	23,000	69,000	33	19	621	0%	0	0	0	0.000	0	0	0
2016	23,000	92,000	47	27	881	0%	0	0	0	0.000	0	0	0
2017	23,000	115,000	59	35	1,113	0%	0	0	0	0.000	0	0	0
2018	23,000	138,000	70	41	1,321	0%	0	0	0	0.000	0	0	0
2019	23,000	161,000	80	47	1,507	0%	0	0	0	0.000	0	0	0
2020	23,000	184,000	89	52	1,675	0%	0	0	0	0.000	0	0	0
2021	11,500	195,500	97	57	1,826	0%	0	0	0	0.000	0	0	0
2022	0	195,500	95	56	1,798	62%	59	35	1,115	0.098	0	185	3,891
2023	0	195,500	85	50	1,612	62%	53	31	999	0.088	0	166	3,487
2024	0	195,500	77	45	1,448	62%	48	28	898	0.079	0	149	3,134
2025	0	195,500	69	41	1,305	62%	43	25	809	0.071	0	134	2,824
2026	0	195,500	62	37	1,179	62%	39	23	731	0.064	0	122	2,552
2027	0	195,500	57	33	1,069	62%	35	21	663	0.058	0	110	2,313
2028	0	195,500	51	30	971	65%	33	20	631	0.055	0	105	2,204

Figure A.2 Model Output Graph (Cell 2)