Fiscal 2007 Project consigned
by the Ministry of Environment

Fiscal 2007 CDM/JI Project Study

STUDY INTO UTILIZATION OF METHANE GAS AT BELA-TSERKOV LANDFILL SITE IN UKRAINE

Report - Summary Version

MARCH, 2008

SHIMIZU CORPORATION

Summary

1. Background of the Project

The Study entailed implementation of a feasibility study on a project to conduct boiler operation and gas combustion using landfill gas (LFG) comprising mainly methane gas generated from Bela-Tserkov Landfill Site in Bela-Tserkov City, Ukraine, and to link this to realization of a JI project in the future.

Bela-Tserkov City is situated approximately 80 km from the capital Kiev in the southern part of Kiev Province. Bela-Tserkov landfill site, which is owned by the city, is located approximately 10 km south of central Bela-Tserkov City It is located on the outskirts of the city, and there are no residential districts nearby.

The landfill site covers a total area of around 11 ha, and of this landfilling has already been completed on 9 ha. Landfilling is currently taking place on a new area known as Area 1, however, this is scheduled to become filled up by the end of 2008. Earth covering is carried out on the parts where landfilling has been finished, however, because no progress is being made on the search for new landfill area, there are plans to carry new waste once again onto areas that were landfilled before. Waste is landfilled to depths of between 15~20 m, and it is estimated that between 16~20 million tons of waste have been carried onto the site since the start of landfilling in 1983.

In the Study, a plan for introducing gas collection pipes and gas treatment equipment to Bela-Tserkov Landfill Site supplying gas to an existing boiler plant was compiled, and feasibility as a private sector project was assessed from the viewpoints of project effect and profitability, etc. In order to increase the feasibility of realization as a JI project, the Study was conducted on the assumption that flare stack treatment is combined with gas supply to the boiler plant.

Since the project will contribute to prevention of global warming and improvement of the global environment, Bela-Tserkov City Municipality is very keen to see its advancement. Moreover, since Ukraine has hardly any experience of technology utilizing renewable energy, the project technology will contribute to the sustainable development of Ukraine.

Ukraine ratified the Kyoto Protocol in 2004. Its DNA is the Ministry of the Environmental Protection and the approval procedures and scheme for JI projects are already in place.

2. Contents of the Project Plan

The project proposes to install landfill gas (LFG) collection pipes on the landfill site, and to collect and treat LFG before sending it to a district heating plant roughly 2 km away, where it will be used in a boiler for supplying hot water to the local area. Meanwhile, LFG that cannot be used in the boiler will be combusted and destroyed via flare stacks.

Since the utilization of heat from this system will lead to reduction in use of natural gas as fuel for the boiler house, the project can be expected to have an energy saving and a greenhouse gas reduction effect. Moreover, since methane gas in the LFG that cannot be used in the boiler can be converted to carbon dioxide through combustion and destruction in the flare stacks, further reduction in greenhouse gas emissions can be expected even if it doesn't directly link to energy saving.

Figure 1 shows the schematic of the overall project system.

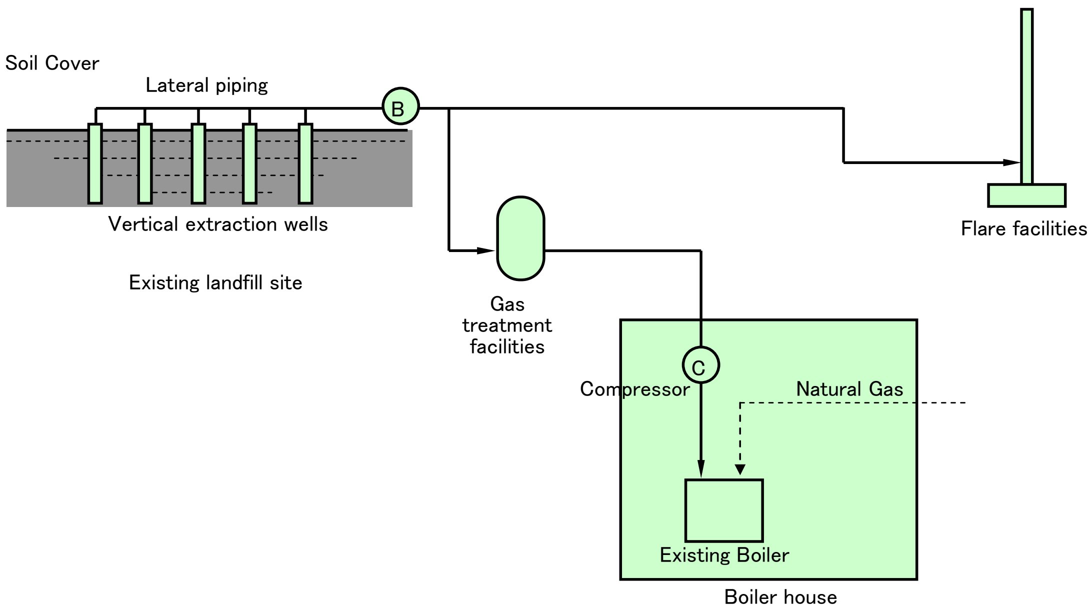

Figure 1 Project System Schematic

As the method for calculating the generated amount of methane gas on the landfill site, the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"* will be used. According to this, the generated amount of methane gas ($BE_{CH4,SWDS,y}$) is calculated as follows:

$$BE_{CH4,SWDS,y} = 0.9 \times (1 - f) \times GWP_{CH4} \times (1 - OX) \times 16 / 12 \times F \times DOC_f \times MCF \times \sum_{(x=1 \sim y)}\sum_j W_{j,x} \times DOC_j \times e^{-k (y-x)} \times (1 - e^{-kj})$$

$BE_{CH4,SWDS,y}$	tCO_2e	Methane emissions potential of landfill site (SWDS)
f	-	Fraction of methane captured at the landfill site (SWDS)
OX	-	Oxidation factor
F	-	Fraction of methane in the LFG (SWDS gas)
DOC_f	-	Fraction of DOC that can decompose
MCF	-	Methane correction factor
$W_{j,x}$	t	Mass of waste type *j* deposited in the year x
DOC_j	-	Fraction of DOC in the waste type *j*
k_j	-	Decay rate for the waste type *j*
j	-	Waste type category

f: Fraction of methane captured at SWDS

On the project site, since landfill gas (methane) is not collected for purposes other than the project, neither is it scheduled to be in future, $f = 0$ shall be assumed.

OX: Oxidation factor

Since the project site is a managed landfill site, according to the *"IPCC 2006 Guidelines," OX* = 0.1 shall be assumed.

F: Fraction of methane in the SWDS gas

$F = 0.5$ shall be adopted as recommended in the *"IPCC 2006 Guidelines."*

DOC_f: Fraction of DOC that can decompose

$DOC_f = 0.5$ shall be adopted as recommended in the *"IPCC 2006 Guidelines."*

MCF: Methane correction factor

Since the project site is a managed landfill site, $MCF = 1.0$ shall be assumed.

$W_{j,x}$: Mass of waste type j deposited in the year x

The landfill amount and composition of solid waste on the project implementation site are as indicated in the following table. The amount of solid waste type j can be calculated through seeking the product of a) the landfill amount of solid waste and b) the composition of solid waste.

The results of estimating the generating amount of methane gas are as indicated in Table 1.

Table 1　Results of Estimating the Generated Amount of Methane Gas

Year	Generated Amount of Methane Gas (Nm^3CH_4)	Year	Generated Amount of Methane Gas (Nm^3CH_4)
2000	1,626,343	2012	1,951,377
2001	1,703,735	2013	1,860,919
2002	1,777,554	2014	1,774,907
2003	1,851,119	2015	1,693,114
2004	1,921,300	2016	1,615,322
2005	1,988,264	2017	1,541,328
2006	2,055,926	2018	1,470,937
2007	2,122,380	2019	1,403,965
2008	2,187,684	2020	1,340,239
2009	2,251,917	2021	1,279,593
2010	2,146,614	2022	1,221,871
2011	2,046,524	2023	1,166,926

The collected landfill gas will be used in the boiler of the district heating plant.

The district heating plant supplies hot water during the summer and heating and hot water during the winter, and the boiler operates throughout the year.However, taking maintenance and so on into account, the annual operating rate is assumed to be 90%.

The boiler will be operated by operators of the district heating plant (as always). Since operation of the landfill gas collection system and blower doesn’t require any particular starting and stopping work, it is not necessary to have skilled operators, however, five members will be required. All methane gas that cannot be used in the boiler will be destroyed in the flare stack.

Figure 2 shows the estimated amounts of methane gas that will be used in the boiler and combusted in the flare.

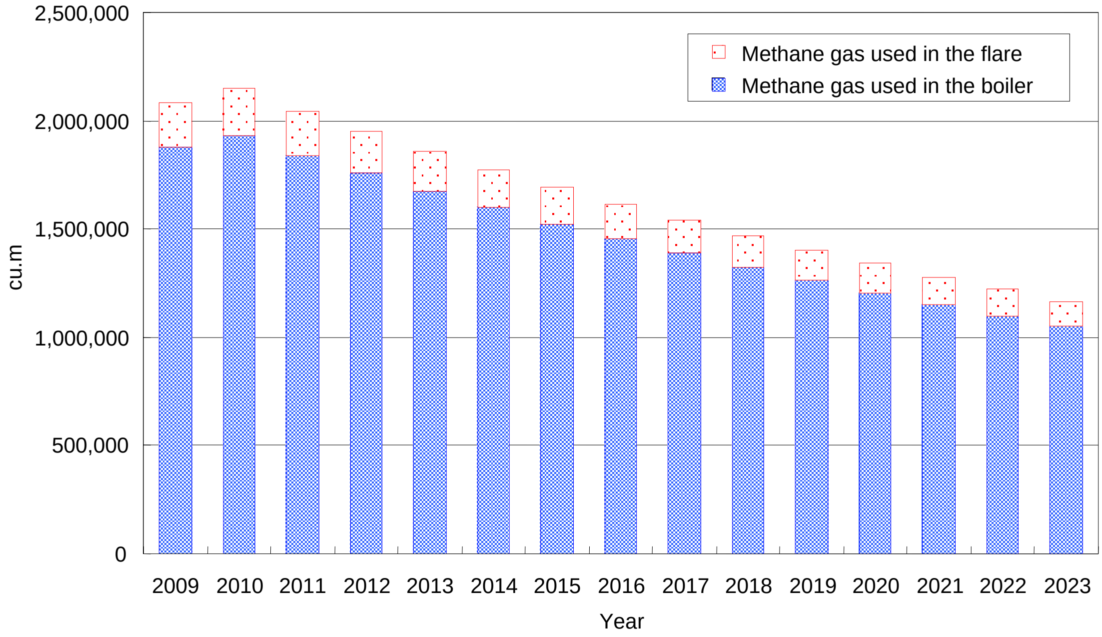

Figure 2 Usage of the Colleted Methane Gas

3. Project Implementation Plan

The participants on the Japan side will raise funds corresponding to the initial project investment, while Bela-Tserkov Municipality and the project implementing enterprise will be responsible for ordering of construction works and all other aspects of project operation (monitoring, operation and maintenance of instruments, accounting work, ERU management, subcontracting, personnel affairs, reporting, etc.).

Since this is a rather small-sized project, when considered from the viewpoint of CO_2 credit acquisition, it may be better to adopt the pay-on-delivery approach for averting project risk. However, since the project implementing enterprise cannot easily raise funds, in order to resolve the shortage of funds in the initial stage, it will be necessary to pay a major share of the carbon credits in advance. Meanwhile, since there is still a possibility the project will be implemented based on 100% direct investment (without specifying the method of fund raising in particular), the implementation scheme will be determined in discussions over conditions with the implementing enterprise.

Project profitability is greatly affected by the economic value of ERUs. If ERUs have no economic value, project profitability is low even before funds are raised and realization becomes near impossible. On the other hand, if it is assumed that ERUs do have economic value, assuming that the project period is 15 years and price of ERUs is US\$9.33/t-CO_2 (equivalent to 7EURO/tCO_2), the IRR (after tax) will be 13.37%, indicating that the project will be worth investing in. Advertisement for

Japanese participants other than Shimizu Corporation will take place from now, but it is thought that numerous corporations will be willing to invest in such a project.

The implementation schedule is as indicated in Table 2. It is planned for the governments of Ukraine and Japan to advance procedures for approval in the first half of 2008. At the same time, it is scheduled to install the SPC and conduct detailed design, then to start the construction works in the second half of 2008 and commence the project from January 2009. The Project implementation period is scheduled for 15years.

Table 2 Project Implementation Schedule

Work item	2007	2008	2009	2010	2011	2012		2023
FS implementation								
PIN submission		February						
Receipt of LOE from the Government of Ukraine		April						
PDD preparation and EIA implementation		April-June						
IE decision		June						
Receipt of LOA from the Government of Ukraine		August						
SPC establishment and start of detailed design		June						
Start of construction works		August						
Start of credit period			January		Credit period: 15 years			

4. Baseline Setting

The project is a JI undertaking, however, it was examined using baseline methodology approved by a previous CDM Executive Board meeting.

The latest version (Version 08) of ACM0001 “Consolidated baseline and monitoring methodology for landfill gas project activities” shall be applied to the project.

Moreover, the following tools that are recommended for referral shall be used:

- “Tool for the demonstration and assessment of additionality” (Version 04)
- “Tool to determine project emissions from flaring gases containing methane” (Version 01)

- “Tool to calculate project emissions from electricity consumption” (Version 01)
- “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site” (Version 01)

ACM0001 states the following concerning its applicability: “This methodology is applicable to LFG collection projects where all or part of gas in the baseline scenario is discharged into the atmosphere and the following conditions are satisfied:

a) The recovered gas is flared,

b) The recovered gas is used in the production of energy (e.g. electric power and heat), and

c) The recovered gas is supplied to consumers via the natural gas supply network. If transfer of natural gas is included in the emission reductions, AM0053 can be utilized.

In addition, the conditions of applicability included in the above tools must be satisfied.”

Meanwhile, conditions in the Project are as follows:

① Currently, LFG collection is not carried out on Bela-Tserkov Landfill Site and all LFG is released into the atmosphere. (Baseline)

② The project proposes to collect LFG on Bela-Tserkov Site and the captured gas is flared.

③ The captured gas is supplied to an existing boiler house and is used as a source of thermal energy.

Therefore, since the project falls under applicability of (a) and (b) for the approved consolidated baseline methodology ACM0001, this methodology is applicable.

Also, according to ACM0001, the Tool for Demonstration of Additionality is used to demonstrate the fact that the project is additional to the baseline, which is set as maintenance of the status quo.

The baseline emissions, project emissions and emission reductions in the project were calculated based on ACM0001. In the project, formulae were arranged assuming that there will be no production of thermal energy or supply to the natural gas pipeline in the project.

Tables 3 and 4 show the estimated emission reductions in the project. It was estimated that aggregate reduction of emissions during the credit period (2009~2023) will be 410,063 ton -CO_2.

Table 3 Outline of Emissions and Emission Reductions

Year	Project Emissions	Baseline Emissions	Leakage	Emission Reductions
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2009	2,809	37,652	0	34,844
2010	301	36,177	0	35,877
2011	301	34,491	0	34,190
2012	301	32,887	0	32,586
2013	301	31,363	0	31,062
2014	301	29,913	0	29,612
2015	301	28,534	0	28,234
2016	301	27,223	0	26,923
2017	301	25,976	0	25,676
2018	301	24,790	0	24,489
2019	301	23,661	0	23,361
2020	301	22,587	0	22,287
2021	301	21,565	0	21,265
2022	301	20,593	0	20,292
2023	301	19,667	0	19,366
Total	7,018	417,080	0	410,063

Table 4　Results of Estimating Emission Reductions

			2009	2010	2011	2012	2013	2014	2015	2016
	$BE_{CH4,SWDS,y}$	tCO_2e	33,898	32,313	30,806	29,374	28,012	26,717	25,486	24,315
	collected LFG	tCO_2e	31,390	32,313	30,806	29,374	28,012	26,717	25,486	24,315
	EqC	-	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	BE_y	tCO_2e	37,652	36,177	34,491	32,887	31,363	29,913	28,534	27,223
	$MD_{project,y}$	tCH_4	1,614	1,539	1,467	1,399	1,334	1,272	1,214	1,158
	$MD_{reg,y}$	tCH_4	0	0	0	0	0	0	0	0
	AF	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ex-ante	$ET_{LFG,y}$	TJ	67	69	66	63	60	57	55	52
	$CEF_{ther,BL,y}$	tCO_2e/TJ	55.8	55.8	55.8	55.8	55.8	55.8	55.8	55.8
	PE_y	tCO_2e	2,809	301	301	301	301	301	301	301
	$PE_{EC,y}$	tCO_2e	301	301	301	301	301	301	301	301
	$EC_{PJ,y}$	MWh	193	193	193	193	193	193	193	193
	$EF_{grid,y}$	tCO_2e/MWh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	TDL_y	-	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
	not collected LFG	tCO_2e	2,508	0	0	0	0	0	0	0
	ER_y	tCO_2e	34,844	35,877	34,190	32,586	31,062	29,612	28,234	26,923

			2017	2018	2019	2020	2021	2022	2023	TOTAL
	$BE_{CH4,SWDS,y}$	tCO_2e	23,201	22,142	21,134	20,174	19,261	18,393	17,565	372,791
	collected LFG	tCO_2e	23,201	22,142	21,134	20,174	19,261	18,393	17,565	370,283
	EqC	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	BE_y	tCO_2e	25,976	24,790	23,661	22,587	21,565	20,593	19,667	417,080
	$MD_{project,y}$	tCH_4	1,105	1,054	1,006	961	917	876	836	17,752
	$MD_{reg,y}$	tCH_4	0	0	0	0	0	0	0	0
	AF	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ex-ante	$ET_{LFG,y}$	TJ	50	47	45	43	41	39	38	793
	$CEF_{ther,BL,y}$	tCO_2e/TJ	55.8	55.8	55.8	55.8	55.8	55.8	55.8	
	PE_y	tCO_2e	301	301	301	301	301	301	301	7,018
	$PE_{EC,y}$	tCO_2e	301	301	301	301	301	301	301	4,510
	$EC_{PJ,y}$	MWh	193	193	193	193	193	193	193	2,891
	$EF_{grid,y}$	tCO_2e/MWh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
	TDL_y	-	0.200	0.200	0.200	0.200	0.200	0.200	0.200	
	not collected LFG	tCO_2e	0	0	0	0	0	0	0	2,508
	ER_y	tCO_2e	25,676	24,489	23,361	22,287	21,265	20,292	19,366	410,063

5. Monitoring Plan, etc.

Monitoring items in the project have been decided based on ACM0001.

Figure 3 shows the monitoring plan in schematic form.

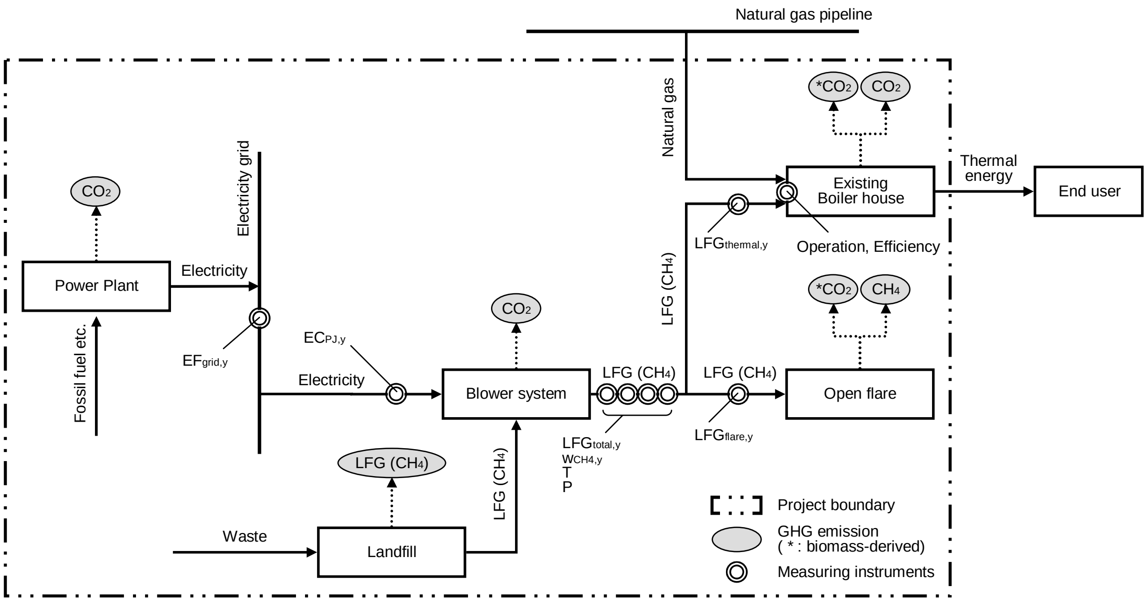

Figure 3 Monitoring Plan Schematic

6. Profitability

Project profitability is assessed according to the investment payback period and the internal rate of return (IRR). Theconstruction cost is estimated as 1,355,065 US$ (initially 1,262,039 US$ plus an additional investment of 93,026 US$ after 1 year), and the running cost is approximately 24,000 US$ per year. Incidentally, the running cost includes annual verification cost of 20,000 US$.

As for taxation, corporate profit tax is equivalent to 15% of ordinary profit. Plant and equipment depreciation was calculated assuming a depreciation rate of 90%. The exchange rate used in the calculations was: 1US$ = 116.00 yen.

Finally, the project implementation schedule was set as 15 years (2009~2023) assuming the start of operation in 2009.

Concerning the investment payback period, as is shown in Table 5, the number of years from the start of the project (start of construction) to the time when aggregate project balance enters the black was calculated for the case where ERUs have no economic value and the two cases where the economic value of ERUs is 5 US$/t-$CO_2$ and 9.33US$/t-$CO_2$ (7EURO/tCO_2) respectively.

Table 5 Investment Payback Period in Each Case

Economic Value of ERUs		Investment Payback Period
Case where ERUs have no economic value	0 US$/$tCO_2$	Irrecoverable (Irrecoverable)
Cases where ERUs have economic value	5 US$/$tCO_2$	Irrecoverable (Irrecoverable)
	9.33 US$/$tCO_2$ (7EURO/tCO_2)	6 years

* Figures in parentheses indicate pretax values.

As for the internal rate of return (IRR), as is shown in Table 6, comparative examination was carried out for three different cases, i.e. the case where ERUs have no economic value and the two cases where the economic value of ERUs is 5 US$/t-$CO_2$ and 9.33US$/t-$CO_2$ (equivalent to 7 EURO/tCO_2) respectively.

Since this assessment of project profitability based on IRR is sought as an indicator for determining the propriety of investment, the project IRR not taking into account interest and loan repayments was used. As is shown in table 6, the project IRR is negative in the case where ERUs have no economic value, however, since an IRR (after tax) of 13.37% can be expected when the economic value of CERs is 9.33US$/t-$CO_2$ (equivalent to 7 EURO/tCO_2), the project is sufficiently lucrative to merit investment even after taking the country risk into account.

Table 6 Internal Rate of Return (IRR) in Each Case

Economic Value of ERUs		IRR
Case where ERUs have no economic value	0 US$/$tCO_2$	Minus (Minus)
Cases where ERUs have economic value	5 US$/$tCO_2$	Minus (Minus)
	9.33 US$/$tCO_2$ (7EURO/tCO_2)	13.37 (14.16)

* Figures in parentheses indicate pretax values.

As was mentioned earlier, the initial cost of the project is approximately 1,355,065US$. On the other hand, the total reduction in greenhouse gas emissions over the project credit period (2009-2023) is 410,063 t-CO^2.

The cost of reducing greenhouse gas emissions was calculated by dividing CO^2 emissions over the credit period (2008~2022) by the initial cost. Table 7 shows the results.

Table 7 CO_2 Reduction Cost

Item	Amount
GHG Emission Reduction（t- CO_2）	410,063
Cost (US$)	1,355,065
CO_2 Reduction Cost (US$/t$CO_2$)	Approx. 3.3

7. Conclusion and Future Work

The F/S conducted examination of the project to collect LFG from Bela-Tserkov Landfill Disposal Site and use this in a boiler house in order to reduce atmospheric emissions of methane gas from the landfill site and reduce consumption of natural gas at the boiler gas, and thereby reduce CO_2 emissions.

In addition to collecting and utilizing methane gas from the target landfill site and thereby reducing emissions of greenhouse gases, the project is a co-benefit undertaking that will also lead to improvements in terms of the local environment, sanitary situation and disaster prevention through preventing odor, flies and pests, and fires, etc. The host country is also very hopeful that the project will be realized.

The Government of Ukraine has already completed the JI project approval scheme including the JI project approval procedure. More than 70 projects have already been granted LOE and 10 have already been approved, and there is a strong possibility that this project will be approved in the host country.

Bela-Tserkov Municipality, the project counterpart, welcomes implementation of this CDM project from the viewpoints of environmental improvement and acceptance of overseas investment, etc., and it gave immense cooperation in the course of the FS.

In the project plan, it is envisaged that landfill gas collection equipment and a pipeline for supplying gas to the neighboring district heating boiler plant will be installed and acquisition of carbon credits will be aimed for from 2009. As a result, it was concluded that the project can be sufficiently profitable so long as it is approved by the government as a JI undertaking and the market price of carbon credits is 10 US$/t-$CO_2$ or higher.

In future, it is hoped to promptly acquire the LOE, implement determination, obtain approval from the governments of Japan and Ukraine, conclude project contracts with a view to the more detailed equipment planning and project implementation, and thereby actualize the project at as early a point as possible.

The consolidated methodology can be applied to JI projects for the collection and utilization of methane gas from landfill sites, and this is extremely advantageous from the viewpoint of certainly and quickly realizing the project in readiness for the initial commitment period from 2008.

Meanwhile, when it comes to forming LFG projects, unlike chlorofluorocarbon destruction and N_2O destruction projects, it is essential to conduct detailed examination in the survey stage because numerous factors such as the following have an impact:

- Weather conditions in the host country;
- Shape of the landfill site;
- Composition of solid waste depending on lifestyles; and
- Waste collection system

Based on detailed investigation of such elements, it is possible to gauge the effect and profitability of the project.

Moreover, interpretations of LFG projects differ according to the host country, and it is sometimes difficult to coordinate the opinions of central government agencies and local governments (counterparts) regarding project realization. As competition to acquire projects heats up between countries, this coordination of views is the most important theme in the project development stage. In this case, the host country is enthusiastic about realizing the project under Japanese support and it holds the FS in high regard.

Through this study, it was possible to examine a promising JI project and understand trends and advertise policies of the Government of Japan in Ukraine, which has high potential as a target for JI and GIS. It will be necessary to immediately actualize the project in order to bolster Japan’s relations with Ukraine, and moreover, to continue developing projects in the Eastern European region and linking these to realizing the objectives of Japan.