CDM/JI Feasibility Study Programme
initiated in 2005-2006
sponsored by GEC, executed by Shimizu Corporation

Feasibility study on effective using of methane gas at the waste water treatment plant in Kiev, Ukraine

Summary of the Report

March 2006
Shimizu Corporation

1. Basic Elements concerning Project Implementation

1.1. Outline of the Proposed Project and Background to the Planning

Kiev is the capital city of Ukraine. Sewage in the city is treated at Bortnichi Water Treatment Plant operated by the company “Kievvodokanal,” which is owned by the city. This treatment plant currently treats wastewater of 1,300,000 m3/day and discharges treated effluent into Dnepr River.

Large quantities of sludge are generated in line with wastewater treatment at Bortnichi Water Treatment Plant. This sludge consists of raw sediments discharged from primary settlement tanks, and surplus sludge (surplus of activated sludge) that is propagated in the aeration tanks and is discharged from the secondary settlement tanks.

Some of the raw sediments are treated in the existing closed anaerobic digester, whereas all the surplus sludge (including raw sediments not treated in the closed anaerobic digester) is decomposed by oxidation in an aerobic stabilizer. The treated sludge is then pumped to a sludge field that covers an area of 272 ha.

The inherent purpose of the sludge field is to dry out the sludge. Usually, sludge is removed from the sludge field when the water content of sludge reaches 70~80%, however, in reality the sludge is left as it is in the field. The reason for this is because Ukraine currently does not possess the technology to effectively utilize sludge as organic fertilizer, etc., i.e. composting technology, nor the social institutions for doing this.

As a result, sludge in the sludge field is left to ferment in the field, thereby generating odor. The fermentation process in the sludge field specifically consists of an aerobic reaction on the sludge field surface and an anaerobic reaction below the surface, and these reactions result in the generation of CH_4, which has an adverse impact in contributing to global warming.

The project aims to install a new closed anaerobic digester with a view to treating all the sludge that cannot currently be handled by the existing closed anaerobic digester, and thereby reducing the volume of sludge transported to the sludge field. At the same time, the project proposes to utilize

CH_4 (digestion gas/bio gas) generated in digestion as fuel in a cogeneration system.

1.2. Outline of the Host Country

Ukraine, located furthest west of the former Soviet states, borders Russia, Belarus and Poland and faces onto the Black Sea in the south. The national land of Ukraine covers 603,700 km2, approximately 1.6 times larger than Japan, making Ukraine the second largest country in Europe behind Russia. Ukraine is almost totally composed of level plains and mean altitude is no more than 300 m. The only mountain ranges in Ukraine are the Carpathian Mountains in the far west and the Crimean Mountains in the Crimean Peninsula. Major rivers are the Dnepr running through the center of the country, the Yujin Boug and Dniester in the west, the North Donetsk in the east, and the Donau in the south. Almost all the country has a mild continental climate, but the Crimean Peninsula has a Mediterranean climate. Average temperature is 17-25 ℃ in summer and –8-2 ℃ in winter. The Black Sea freezes over in winter. Annual precipitation is highest in the Carpathian Mountains at 1,500 mm or more and lowest along the Black Sea coast at less than 300 mm. Almost all the level plains in the center and south that cover approximately two-thirds of the country are covered in chernozem (black soil) and form a rich gain belt. In terms of vegetation, the north is composed of forest belt, and this changes to forest and steppe and finally steppe moving southwards, i.e. vegetation becomes more arid moving towards the Black Sea.

Ukraine has an estimated population of 48,001,000 in 2004, making it the second most populous country of the former Soviet Union. However, the annual population growth rate is negative and the population is declining. The main reason for this is emigration out of the country. The population is composed of 73% Ukrainians, 22% Russians and 5% other races. The capital city, Kiev has the highest population with 2,600,000, and this is followed by Kharkov with 1,450,000 and Dnepropetrovsk with 1,200,000.

The official language is Ukrainian, which belongs to the Eastern Slav family of languages, but Russian is also widely used. Ukrainian Orthodoxy is the main religion, but Ukrainian Catholicism is practiced in the west of the country. The literacy rate is high at 98% and average life span is around 68 years. In terms of working population, which is around 23,000,000, 24% are engaged in primary industry, 32% in secondary industry and 44% in tertiary industry. It can be seen that much of the working population is engaged in the secondary and tertiary industries, and this is also reflected in the high urban population of approximately 70%.

1.3. Local Policies Regarding CDM/JI, i.e. Criteria for CDM/JI Acceptance and DNA Establishment, etc.

The Order of Consideration, Approval, and Realization of JI Projects, which forms the basis of JI policy in the host country, is currently at the stage of examination by the government. The draft order was presented to the Cabinet by the Ministry of Environmental Protection in September 2005, and it is now awaiting the signature of the Prime Minister. Since the political situation in Ukraine is somewhat in flux in the runup to the elections planned for March 2006, it is surmised that it may take a little more time for this order to become official policy.

1.4. Project Contribution to Sustainable Development and Technology Transfer in the Host Country

Utilization of biomass energy has hardly been implemented at all in Ukraine until now. Fossil fuels account for the major portion of energy use, however, if utilization of digestion gas as proposed in the project becomes widespread, this will promote greater awareness and technical development regarding utilization of agricultural waste products and woody biomass as well as contribute to energy saving in Ukraine.

The project will also make a contribution in terms of energy security. For Ukraine as a whole, it is essential to promote energy saving in order to effectively utilize energy resources and improve energy security; moreover, dissemination of on-site power source technology will realize two-tiered energy sources and contribute to higher energy security in the cities.

The Project will contribute to the sustainable development of Ukraine in the following ways:

- Odor prevention on the target sludge field
- Promotion of land use on the target sludge field
- Securing of additional employment at Bortnichi Water Treatment Plant through project implementation (in both the construction and operation stages)
- Securing of a private energy source at Bortnichi Water Treatment Plant (improvement in reliability as a water treatment plant)
- Substitution of deteriorated power generation systems
- Improvement in Ukraine’s energy security
- Opening of possibilities for effective utilization of biomass energy in Ukraine

1.5. Implementation Setup of the Study (in Japan, the Host Country and Elsewhere)

The Study was implemented with cooperation from the following agencies in Ukraine:

- Open joint stock company "Kievvodokanal:" This company manages and operates Bortnichi Water Treatment Plant. It will cooperate in the feasibility study (collection and provision of operating data, cooepration with site tests to measure methane generation from sludge), and will become a partner when the project enters the implementation stage (it may also help finance the project).
- Scientific Engineering “Centre Biomass:” A local consultant, this organization will collect data on site and also implement site tests to measure methane generation from sludge, etc.

2. Project Formulation

2.1. Specific Contents of the Project

The project aims to install a new closed anaerobic digester (in place of the existing closed anaerobic digester and aerobic stabilizer) with a view to treating all the sludge that cannot currently be handled by the existing closed anaerobic digester, and thereby reducing the volume of sludge transported to the sludge field. At the same time, the project proposes to utilize CH_4 (digestion gas/bio gas) generated in digestion as fuel in a cogeneration system. Electric power and heat produced in the said system will then be used in the water treatment plant. By utilizing electric power generated in cogeneration, the plant will purchase less electricity from the grid, and this will contribute to reduction in consumption of fossil fuels and emission of greenhouse gases at grid power stations.

The project system can broadly be divided into the following three technologies:

(1) Digester (closed anaerobic digester)

The digester serves the purpose of anaerobically digesting and decomposing sludge. This type of digester is already well established in water treatment plants in Japan, Europe and America, however, it has hardly been adopted at all in Ukraine. The closed anaerobic digester at Bortnichi Water Treatment Plant has very low digestion efficiency. For example, digestion efficiency at Bortnichi Water Treatment Plant is only between 30~40%, Japanese technology (appropriate digester tank shape, mixing method, temperature maintenance, retention time, etc.) can realize 60% efficiency.

(2) Biogas-powered cogeneration system

The GEG system is composed of a gas engine, generator, heat recovery boiler, control panel, system inter-connection line and measurement instruments that allow stable operation using even sparse methane gas such as CH_4. The gas engine has generating efficiency of 30~40%, equivalent to or better than the conventional types of steam turbine that currently exist in Ukraine. In addition, high-level technology is needed to stably operate the gas engine using sparse gas fuel such as digestion gas/bio gas.

(3) Flaring technology

The flaring equipment combusts CH_4 contained in the digestion gas and biogas that cannot be combusted in the GEG system, thereby breaking the CH_4 down into CO_2.

2.2. Setting of the Project Boundary and Baseline and Demonstration of Additionality

In the project, a new baseline methodology is constructed in order to identify the baseline scenario, demonstrate additionality and set the project boundary.

(1) Identification of the baseline scenario

List all scenarios that are legal and plausible in Ukraine. Include the project scenario among these. Next, conduct barrier analysis on the listed scenarios; then conduct investment analysis on the scenarios with the fewest barriers, and adopt the baseline scenario from the one that has the highest investment effect.

As a result of the examination, it was demonstrated that maintenance of status quo is the baseline scenario.

(2) Demonstration of additionality

In order to demonstrate additionality, it was decided to adopt the method to demonstrate that GHG emissions will be additionally reduced by project implementation.

(3) Setting of the project boundary

The project boundary is indicated below.

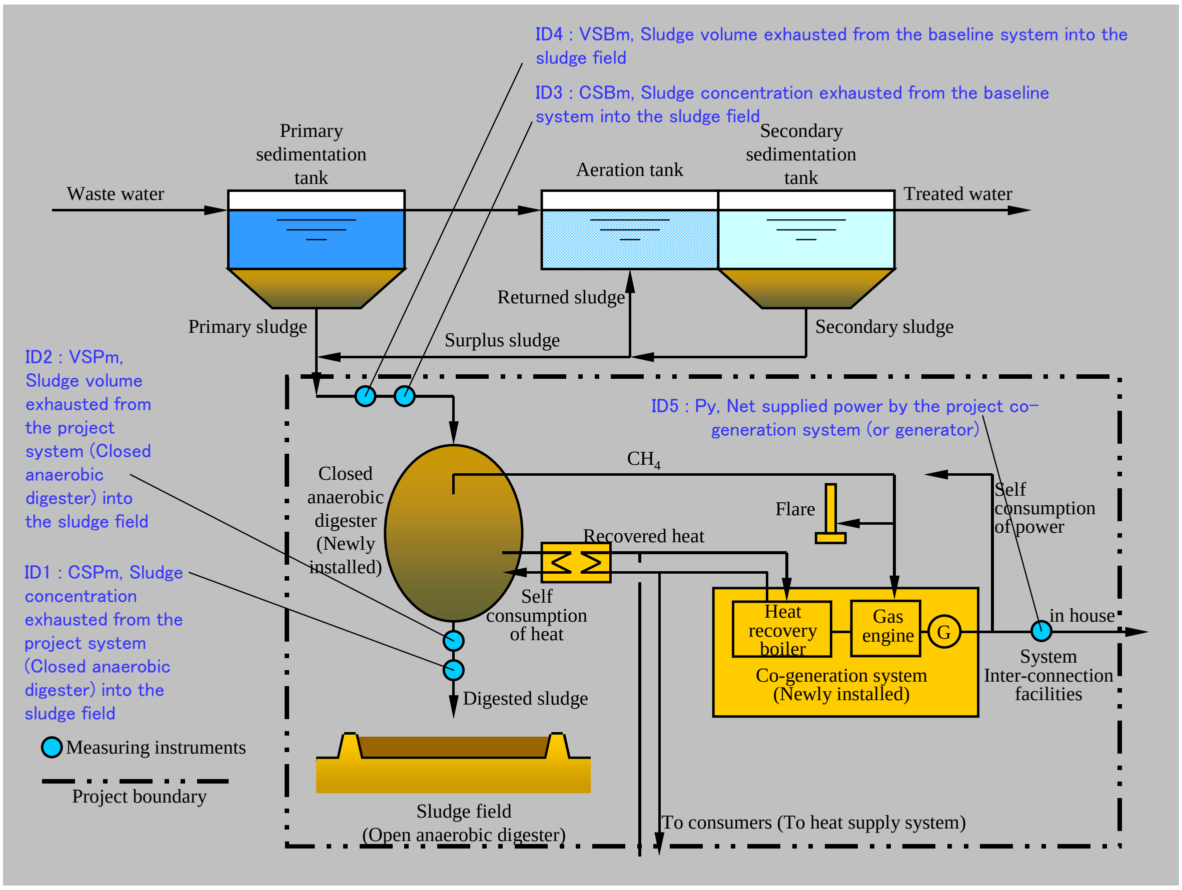

Figure 1 Project Boundary and Monitoring Plan

2.3. GHG Emission Reductions and Leakage Arising from the Project

(1) Baseline Emissions

Baseline emissions can be calculated by means of the following equation:

(Equation-2) Baseline emissions (ton-CO2/y) = Sum (MSByi * EFsi) * GWPm

Where,

MSBy1 (amount of sludge treated in the digester) = 116,800 ton-RDS/y * 14.7％＝17,170

MSBy2（amount of sludge not treated in the digester）= 116,800 ton-RDS/y * (100 - 14.7%)＝99,630

EFs1（emission factor of the sludge treated in the digester） = $2.42*10^{-2}$ ton-CH_4/ton- RDS

EFs2（emission factor of the sludge not treated in the digester） = $7.80*10^{-2}$ ton-CH_4/ton- RDS

GWPm（CH_4のGWP）＝21.0

Accordingly, the amount of baseline emissions works out as follows:

$$17{,}170 * 2.42*10^{-2} * 21.0+ 99{,}630 * 7.80*10^{-2} * 21.0 = 1.72*10^{5} \text{ ton-}CO_2\text{/y}$$

(2) Project Emissions

Project emissions can be calculated by means of the following equation:

(Equation-4) Project emissions (ton-CO_2/y) = MSPy * EFs * GWPm

Where,

MSPy (amount of sludge) = 116,800 ton-RDS/y

EFs（emission factor of sludge） = $2.42*10^{-2}$ ton-CH_4/ton- RDS

GWPm＝21.0

Accordingly, the amount of project emissions works out as follows:

$$116{,}800 * 2.42*10^{-2} * 21.0 = 5.93*10^{4} \text{ ton-}CO_2\text{/y}$$

(3) Leakage (baseline leakage)

Baseline leakage can be calculated by means of the following equation:

(Equation-3) Baseline leakage (ton-CO_2/y) = EFPy * Py

Where,

Py: net supplied power from cogeneration (MWh/y)

EFPy: grid emission factor in the baseline (ton-CO2/MWh)

Concerning EFPy here, the value given in the "Operational Guidelines for Project Design Documents of Joint Implementation Projects Volume 1": General Guidelines Version 2.3 Ministry of Economic Affairs of the Netherlands May 2004, P42 Table B1, shall be adopted. As for the emissions factor from 2013 that is not given in these guidelines, it is set on the conservative side in line with the purport of these guidelines.

Moreover, concerning Py, assuming that cogeneration capacity is 8,900kW, annual operating time is 8,040 hours and own consumption rate is 10%, this is calculated as follows:

8,900kW * 8,040 hr * (1-0.1) = 64,400 MWh/y

Accordingly, baseline leakage values are as shown in Table 1.

(4) Leakage (Project Leakage)

There is no leakage in the project.

(5) Emission Reductions

Table 1 shows the emission reductions calculated according to the method indicated above.

Table 1 Estimated Emission Reductions

			Baseline emission			Project emission	
Year	Emission factor of the grid	Net power supply	CO_2 emission from the grid (Baseline leakage)	Methane emissions from sludge field (Methane emission from the sludge that is digested at the existing digester)	Methane emissions from sludge field (Methane emission from the sludge that is not digested at the existing digester)	Methane emissions from sludge field	Emission reduction
-	ton-CO2/MWh	MWh/y	ton-CO2/ y	ton-CO2/ y	ton-CO2/ y	ton-CO2/ y	ton-CO2/ y
2007							
2008							
2009	6.80E-01	6.44E+04	4.38E+04	8.72E+03	1.63E+05	5.93E+04	1.56E+05
2010	6.66E-01	6.44E+04	4.29E+04	8.72E+03	1.63E+05	5.93E+04	1.55E+05
2011	6.51E-01	6.44E+04	4.19E+04	8.72E+03	1.63E+05	5.93E+04	1.55E+05
2012	6.36E-01	6.44E+04	4.10E+04	8.72E+03	1.63E+05	5.93E+04	1.54E+05
2013	6.21E-01	6.44E+04	4.00E+04	8.72E+03	1.63E+05	5.93E+04	1.53E+05
2014	6.06E-01	6.44E+04	3.90E+04	8.72E+03	1.63E+05	5.93E+04	1.52E+05
2015	5.91E-01	6.44E+04	3.81E+04	8.72E+03	1.63E+05	5.93E+04	1.51E+05
2016	5.76E-01	6.44E+04	3.71E+04	8.72E+03	1.63E+05	5.93E+04	1.50E+05
2017	5.61E-01	6.44E+04	3.61E+04	8.72E+03	1.63E+05	5.93E+04	1.49E+05
2018	5.46E-01	6.44E+04	3.52E+04	8.72E+03	1.63E+05	5.93E+04	1.48E+05
2019	5.31E-01	6.44E+04	3.42E+04	8.72E+03	1.63E+05	5.93E+04	1.47E+05
2020	5.16E-01	6.44E+04	3.32E+04	8.72E+03	1.63E+05	5.93E+04	1.46E+05
2021	5.01E-01	6.44E+04	3.23E+04	8.72E+03	1.63E+05	5.93E+04	1.45E+05
2022	4.86E-01	6.44E+04	3.13E+04	8.72E+03	1.63E+05	5.93E+04	1.44E+05
2023	4.71E-01	6.44E+04	3.03E+04	8.72E+03	1.63E+05	5.93E+04	1.43E+05
Total	-	9.66E+05	5.56E+05	1.31E+05	2.45E+06	8.90E+05	2.25E+06

2.4. Monitoring Plan

In the project a new monitoring methodology is constructed and the monitoring plan is compiled based on this. Table 2 shows the monitoring items and Figure 1 shows the monitoring plan diagram.

Table 2 List of Monitoring Items

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	CSPm Sludge concentration exhausted from the project system (Closed anaerobic digester) into the sludge field	RDS analysis method	ton-RDS/ m3,	m	Once a month (if unstable, once a week (if unstable once a day))	Monitored only once a month (if unstable, once a week or once a day)	Electric Monitored data shall be archived for 2 years following end of the crediting period.	If the weekly monitored data are not different by 5%, this item can be monitored once a month. If the daily monitored data are not different by 5%, this item can be monitored once a week.
2	VSPm Sludge volume exhausted from the project system (Closed anaerobic digester) into the sludge field	Flow meter	m3/month or m3/week or m3/day	m	Once a month (if unstable, once a week (if unstable once a day))	100%	Electric Monitored data shall be archived for 2 years following end of the crediting period.	This item should be monitored at the same time as ID3
3	CSBm Sludge concentration exhausted from the baseline system into the sludge field	RDS analysis method	ton-RDS/ m3,	m	Once a month (if unstable, once a week (if unstable once a day))	Monitored only once a month (if unstable, once a week or once a day)	Electric Monitored data shall be archived for 2 years following end of the crediting period.	If the weekly monitored data are not different by 5%, this item can monitored once a month. If the daily monitored data are not different by 5%, this item can be monitored once a week.
4	VSBm Sludge volume exhausted from the baseline	Flow meter	m3/month or m3/week or m3/day	m	Once a month (if unstable, once a week (if unstable	100%	Electric Monitored data shall be archived for 2	This item should be monitored at the same time as ID3

	system into the sludge field				once a day))		years following end of the crediting period.	
5	Py Net supplied power by the project co-generation system (or generator)	Watt hour meter	MWh	m	Once a year	100%	Electric Monitored data shall be archived for 2 years following end of the crediting period.	This item can be measured by using watt hour meter for sold power and watt hour meter for bought power. In order to know net supplied power, calculate as follows, net supplied power = sold power - bought power
7	EFPy Emission factor of the baseline grid	Data calculated in accordance with the baseline methodology	ton-CO_2/MWh	c	Once a year	100%	Electric Monitored data shall be archived for 2 years following end of the crediting period.	This item is determined by using the technique stated in the baseline methodology.

2.5 Environmental Impact and Other Indirect Effects

The project will have no negative impacts on the environment. On the other hand, positive effects of the project are as follows:

- Economic effects: Since labor-intensive works will arise during the project construction stage, there will be an employment creation effect. Moreover, in the operating stage, additional operating staff will be employed and business with local companies will increase because of the need for maintenance work and so on, thereby leading to vitalization of the local economy.
- Social effects: Through permeating awareness of waste products as resources, in social terms the project will contribute to construction of a society based on reuse and recycling, etc. that has a minor environmental impact.
- Contribution to sustainable development: As described in section 1.4
- Energy saving effect: Utilization of biogas in the cogeneration system will enable consumption of fossil fuels to be reduced.

- GHG emissions reduction effect: As described in section 2.3

2.6 Stakeholders' Comments

In the case of JI projects in Ukraine, it is not obligatory for comments from stakeholders to be compiled. Here, it was assumed that the stakeholders are Kiev City and Kievvodokanal Co. The comments of Kiev City and Kievvodokanal Co. regarding the project are positive and support realization of the project.

3. Towards Project Realization

3.1 Project Implementation Setup (in Japan, Ukraine and Elsewhere)

(1) Outline of the Project Participants

The project participants are briefly introduced as follows.

- Shimizu Corporation: the Japanese corporation that aims for realization of the project. This is a general construction and engineering firm. It will prepare the PDD. It will finance the project (including purchase of ERUs) and in return acquire ERUs.
- Municipality of Kiev City: the public entity that owns Bortnichi Water Treament Plant. Together with Kievvodokanal, it owns the project site, and it will implement the project in a joint effort with Kievvodokanal and the Japan side.
- Kievvodokanal: the Ukrainian corporation that aims for realization of the project. This public waterworks corporation is managed by Kiev City. It is responsible for running Bortnichi Water Treatment Plant. Although it is a private company with open stocks, since all of its funding is provded from the state budget, it is in reality a public operator. It operates the project site, and it will implement the project in a joint effort with Kiev City and the Japan side. It may also take part in financing the project.

(2) Outline of the Project Implementing Organization

Ukraine is a mature state and has investors who are endowed with ample funds. Many investors exist in the private sector, but Kiev City also has an investment department that supervises public investments and unearths new projects to invest in.

Furthermore, since JI projects in Ukraine are greatly influenced by projects previously implemented by the Netherlands and Austria, many project participants in the host country assume pay-on-delivery type projects including some pre-payment (the scheme whereby investor nations purchase (for example, through tender) projects developed by the host country).

This JI project entails a fairly large initial investment with respect to the generated ERUs (compared to landfill projects, etc). Moreover, a lot of funding is required to improve the water treatment plant as a public infrastructure. For this reason, Kiev City is currently negotiating with the Government of Ukraine with a view to implementing the project based on a combination of JI funds and public funding (ODA, etc).

Incidentally, borrowing from Ukrainian city banks is not being considered at all. That is, since the interest rate of city banks in Ukraine as of January 2006 is 18% or more, it would be impossible to borrow funds from this source in the project.

Accordingly, there is a strong necessity to raise funds from various sources, for example, JI funds and public funding such as ODA, etc. Since this project cannot be treated as a simple initial investment type project in which the JI project participants on the Japan side bear the full initial investment, it is considered more appropriate to adopt the pay-on-delivery approach.

In this case, the JI funds will be retrieved through selling ERUs and saving on power costs as a result of cogeneration, etc. As for the method for retrieving the public funding (ODA, etc.) portion, Kiev City is considering raising the sewerage tariff for this purpose.

(3) Role of the Japan Side

In the case where the pay-on-delivery type project is adopted, the main roles of the participants on the Japan side will be composition of the project and purchase of ERUs.

Project composition refers to project unearthing, feasibility study implementation, PDD preparation, EIA implementation, implementation of the eligibility determination (ordering to the review agency), and implementation of verification (ordering to the review agency).

Concerning purchase of ERUs, purchasing will be done according to issue at a preset price. Depending on the outcome of future negotiations, some ERUs may be purchased for an advance payment to the Ukraine side.

Meanwhile, concerning the equipment procurement (EPC) portion, it is likely that foreign products will be procured under the engineering supervision of a Japanese firm. For example, concerning the gas engine cogeneration system, in consideration of maintenance in Ukraine, it may be a good idea to procure equipment from Europe. However, judging from technical levels in Ukraine, it should also be possible to procure some equipment and instruments in Ukraine.

Services to be borne by the Japan side comprise the dispatch of engineers to supervise from the installation and trial operation of the gas engine cogeneration system (EPC) through to commissioning and training of local personnel. This will enable a gas engine cogeneration system utilizing digestion gas to be operated in Ukraine.

(4) Role of the Ukraine Side

The major roles of the participants on the Ukraine side will be the securing of funds, acquisition of LOE and LOA as a JI project, ordering of EPC, operation of the project, and approach to the Government of Ukraine regarding the transfer of ERU.

As was mentioned above, concerning the securing of funds, it is possible that part of the payment for ERUs by the Japan side will be made in advance. Meanwhile, public funding such as ODA, etc. will also be obtained through advance payments. As for any deficit, the investment department of Kiev

City may be able to raise funds. In future, based on the findings of this feasibility study, Kiev City plans to commence concrete activities aimed at securing ODA (in particular, low interest environmental loans, etc.).

Concerning the procurement of auxiliary equipment and instruments for the gas engine cogeneration system and implementation of installation works on site, this work will be exclusively contracted to operators in Ukraine.

Other services to be borne by the Ukraine side will be ordering of EPC and project operation. The EPC will likely be ordered to the Japan side since it possesses the technology. Concerning project operation, since Ukraine is an industrialized nation and has a high level of engineers, there shouldn't be a problem.

(5) Project Implementation Schedule

The rough project implementation schedule is indicated below. Moreover, this is the fastest schedule in the case where the Ukrainian JI approval criteria are appropriately implemented upon obtaining the official signature of the prime minister. However, it is thought that a fairly long time will be required in order to acquire public funding (ODA, etc). In that case, funds could otherwise be procured from the investment department of Kiev City. Moreover, depending on the progress of discussions in the Joint Implementation Supervisory Committee (Article 6 committee), there is a strong possibility that it will be necessary to register with the committee. The following schedule does not include the time required for such registration:

- April 2006: Submission of the PIN to the Government of Ukraine
- May 2006: Acceptance of the LOE
- June ~ July 2006: Preparation of the final PDD and implementation of the EIA
- August ~ September 2006: Implementation of eligibility determination
- October ~ November 2006: Acceptance of the LOA
- January 2007: Binding of the ERU purchase agreement and start of design
- June 2007: Start of construction works
- January 2009: Start of the credit period
- December 2023: End of the credit period

3.2 Fund Plan for Project Implementation

Initial investment in the project is approximately 28,363,000 EURO (approximately 4 billion yen). As was mentioned earlier, it is considered that funds will be raised from the Japan side through the pay-on-delivery approach, from public funding such as ODA, etc., and from funding by the Ukraine side (funds from the investment department of Kiev City). Issues to be determined in future negotiations concern what level to set the ERU purchase price and what ratio to pay in advance.

Moreover, as a result of examining IRR assuming the full amount of initial investment required for the project, assuming that the sewerage tariff and electricity tariff remain the same, the project will have low feasibility unless the economic value of ERUs is at least 30 EURO/ton-CO_2. This is linked to the large initial cost and also the wide scope of newly installed equipment in the project. Moreover, in terms of running costs, the high cost of thickening sludge in pretreatment to make it ready for digestion is a factor. In any case, a price of 30 EURO-ton-CO_2 is close to the penalty (40 EURO/ton-CO_2) for non-compliance under the current EUETS and is slightly high compared to the current EUETS market rate (approximately 22~27 EURO/ton-CO_2 as of January 2006).

Accordingly, consideration must be given to reviewing the scope of funding in the project, for example, implementing the project partially as a public works undertaking and introducing ODA funds (environmental yen loan, etc). The local counterpart and project participant Kievvodokanal is also well aware of this approach and has already submitted the necessary paperwork proposing the project as a promising undertaking for an environmental yen loan to the Ukrainian government.

Accordingly, in future it will be necessary to discuss and negotiate how far the project will be covred by private funds and how far will be covered by public funds (including funds from the investment department of Kiev City).

There is another possibility that GIS funding is considered as public funds instead of ODA. But, because (1) it is necessary to forward more AAUs from Ukraine to Japan than ERUs generated by this project, (2) Ukraine has not yet been ready for GIS and there is no consensus in the government, It will need some more time to make it come true.

In addition, because of strong request from Kievvodokanal, we studied a plan that includes incineration of digested sludge and closure of sludge field. But this plan has come out to be unrealistic because it needs more public funds.

3.3 Cost vs. Effect

The following table shows the results of calculating the internal rate of return in the project. These results indicate that it is infeasible to cover all the initial investment with JI funds; rather it is desirable to cover only the cogeneration portion using JI funds and implement the remainder of the project using ODA funding.

Table 3 Internal Rate of Return (IRR) in Each Scenario

(In case of covering all the necessary initial investment with private sector JI funds)

CO_2 Credits		IRR Before tax	IRR After tax
Without CO2 credits	0 EURO /ton-CO_2	Irretrievable	Irretrievable
With CO_2 credits	5 EURO /ton-CO_2	Irretrievable	Irretrievable
	10 EURO /ton-CO_2	Irretrievable	Irretrievable
	20 EURO /ton-CO_2	4.39%	2.61%
	30 EURO /ton-CO_2	11.22%	8.88%
	40 EURO /ton-CO_2	16.94%	13.86%

Table 4 Internal Rate of Return (IRR) in Each Scenario

(In case of limiting JI funding to just the cogeneration part of the necessary initial investment)

CO_2 Credits		IRR Before tax	IRR After tax
Without CO2 credits	0 EURO /ton-CO_2	Irretrievable	Irretrievable
With CO_2 credits	5 EURO /ton-CO_2	Irretrievable	Irretrievable
	10 EURO /ton-CO_2	4.83%	3.02%
	20 EURO /ton-CO_2	19.12%	15.70%
	30 EURO /ton-CO_2	30.24%	24.98%
	40 EURO /ton-CO_2	40.09%	33.08%

3.4 Prospects and Issues Towards Concrete Project Realization

It is scheduled to advance the project with a view to operation from January 2009, when ERUs can be acquired. Following completion of the feasibility study, the LOE will be acquired, official determination of eligibility will be implemented (including IE site visit), the LOA will be acquired, and so on.

Now that the Kyoto Protocol has come into effect, it is certain that the project will generate the required ERUs providing that, 1) the amount of CH_4 gas generated in the sludge field is clarified in advance and 2) digestion gas from the digester is generated, recovered and utilized as forecast. For this reason, the project is deemed to be well worth implementing as a JI project. However, the following risks still remain and will need to be carefully monitored when it comes to implementing the project in future.

(1) Risk concerning the generated amount of CH_4 gas in the sludge field

The advantageous point about the amount of CH_4 generated from the sludge field is that it can be clarified by seeking the emission factor in preliminary testing and can be used to accurately assess project feasibility. Once this emission factor is stated in the PDD and receives LOA from the Government of Ukraine following the determination of eligibility, the ERUs can be calculated simply by monitoring the amount of sludge. Accordingly, it is necessary to minimize the risk upon implementing tests over a sufficiently long period, scrutinizing the test results, determining eligibility and then receiving the LOA.

(2) Risk concerning the partners

It is anticipated that the Municipality of Kiev City and Kievvodokanal will be the project counterparts, however, Ukrainian legislation does not permit local governments to take part in private sector investment activities.

As for Kievvodokanal, even though it is fully financed from the state budget, there is still a chance it may go out of existence (as a result of administrative reorganization and so on).

The way in which partners on the local side are selected is a major factor in project realization.

(3) Risk concerning works

Since the project entails comparatively large initial cost and numerous civil engineering elements such as the digesters and so on, there is a risk of costs becoming inflated and works being delayed. Shimizu Corporation, which has experience of works in former Soviet countries, can avoid these risks by forming relationships with reputable local companies and receiving the orders for the project EPC.

(4) Risk concerning project approval by Ukraine

The framework for Ukraine's JI approval criteria was almost finalized in 2005, however, since the criteria have not yet received the signature of the prime minister, they are still not official as of January 2006. Even if the approval criteria are established, there will still be a major risk concerning their smooth application because Ukraine has no experience in this area. In future it will be necessary to carefully watch how these approval criteria are put into actual practice.

(5) Risk concerning the JI participation qualifications of Ukraine

Ukraine has ratified the Kyoto Protocol and has thereby satisfied one of the requirements for JI eligibility. Moreover, its assigned amount has been determined and it has submitted its most recent required inventory. However, it must wait until the end of 2006 for completion of the national registry. It will be necessary to carefully watch Ukraine's JI eligibility requirements in the future too.

(6) Risk concerning systems from the second commitment period onwards

In the case of a CDM project, since CERs are issued by the CDM Executive Board, even assuming that CERs from the second commitment period onwards have no economic value, CERs can still be obtained. Meanwhile, in the case of a JI project, many points are unclear including whether or not ERUs will even be issued from the second commitment period onwards. According to the JI approval criteria of Ukraine, only the first commitment period is subject to approval. It will be necessary to examine the future approach upon carefully watching the international situation, institutional developments and the stance of the Ukrainian government.

In spite of the risks described above, it is thought that these can be overcome in future examination. Following completion of the feasibility study, it is planned to start concrete activities aimed at early project realization, i.e. presentation of the PIN to the Government of Ukraine, acquisition of LOE, implementation of eligibility determination, presentation of PDD, implementation of EIA, acquisition of LOA, and so forth.