CDM/JI PROJECT FS IN 2003

DALIAN ECONOMIC AND TECHNOLOGICAL DEVELOPMENT AREA
FEASIBILITY STUDY ON UTILIZATION OF BIOGAS GENERATING FROM METHANE FERMENTATION OF ORGANIC WASTES

SUMMARY

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CONTENTS

1. Background and Purpose of the Project

1.1 The Municipal Solid Waste (MSW) Management Policy of the Chinese Government

In the tenth five-year (2000-2004) plan, the Chinese government has set a target at an improvement in the integrated disposal level of domestic sewage and the disposal capacity of rendering city waste harmless and carried policies into execution in order to increase the level requirement about "Environmental protection and infrastructure building". The Chinese government has put importance on pluralization of investment, privatization of operations, domestication of technology related, recycling of waste materials and sewage as policy challenges to achieve the target. Also, environmental protection and recycling-oriented economy have been promoted as two wheels toward sustainable urban growth.

In 2000, the Construction Department selected Beijing and seven other cities as "Model cities for separated collection of domestic garbage" and started separated collection of waste batteries, paper trash and waste plastic. In June of 2000, "Municipal Waste Disposal and Pollution Control Technology Policy" regarding reduction in waste and general use of waste, collection and transportation of garbage, sanitary landfill, incineration and composting was promulgated.

In September of 2002, a notification which is regarded as a kind of finishing measure of the above-mentioned policies was issued by the National Development and Return Commission (NDRC), Ministry of Construction and the National Environmental Protection Administration, which is "Opinion on industrialized development promotion of sewage and garbage disposal in cities". This is an action policy to separate the city sewage and waste disposal operations from the conventional public service sector and to industrialize them as an environmental business using the private sector including foreign investments. This policy also specifies that the tariff charge on sewage and waste disposal should be started as soon as possible.

1.2 States of Energy Supply

The capacity of electrical power generation facilities in China reached 220 million kW in 2003 and the amount of electric generating power: 1.6 trillion kWh (2002) was ranked second in the world. The domestic energy supply-demand situation at peak hour, however, has been tight. In the provinces of the mid-southern area, the peak supply in summer was reduced in both 2002 and 2003, which affected the operation of manufacturing plants in some areas. It is

said that the situation was brought as a result of the incentive policy for electric power consumption and the restrictive policy of the new thermal power plant construction permission beginning in 1998, which caused a short-term gap in the electric power supply-demand adjustment. Water started to fill the filling Three Gorges dam, the world's largest dam, and the amount of generated electricity has been increasing gradually. Still it takes time to expand the vast electric power transmission facility. Consequently, in some areas, a sufficient capacity of electrical power generation facilities consistent with economic growth has not been secured.

In three northeastern provinces (Liaoning, Jilin and Heilongjiang) which includes Dalian city in Liaoning province, however, the capacity of electrical power generation facilities outstrips the demand and further regional development is planned and promoted by the state.

1.3 MSW Management in Dalian City

Dalian city set up "Municipal Waste Control Regulation" in September of 1999 and established a basic structure of environmental health administration. According to this regulation, local (special) administration organs such as an administration committee of economic and technological development area were entrusted as a main management entity of environmental health in the relevant regions and had to put separated taking-out/collection/transportation/disposal of wastes into effect in stages, but steadily. Dalian city has modernized its municipal garbage collection system, transportation and landfill site (city's largest Maoyingzi landfill site) with financing from the World Bank since 1994. In line with the previous notification of Opinion issued by the NDRC, et al. (September of 2002), however, Dalian city has decided to proceed with preparation for incinerator construction though BOT (built, operation and transfer). In December of 2003, the construction contract was awarded by a Japanese and Chinese joint venture and the construction of this incinerator was formally decided. Completion of the incinerator is planned for the end of 2005 and operation start is planned for the early 2006.

1.4 Dalian Economic and Technological Development Area and Waste Management Issues

Dalian economic and technological development area is the first-approved national-level economic and technological development area in China and it was established in 1984. It boasts one of the largest production scales in China and its total domestic turnout, 24.3 billion yuan, is ranked third in the development areas and its total export value, 3.24 billion dollars, is ranked third in the development areas. Dalian economic and technical development area has

taken on the urban character steadily since the latter half of the 1990s and it has a permanent population of 170 thousand people, 100 thousand employees and over 1,800 companies advancing into the area. The municipal administration and business management for invitation of foreign enterprise to the development area is controlled by the administration committee, which also supervises water supply, sewage system, electricity/gas/heat supply, garbage collection and transportation and company groups related to infrastructure building. It has an environment management system (EMS) and acquired ISO14001 accreditation in 1999.

The administration committee notified the implementation of separated taking-out of city waste in model residential areas in May of 2003. This is a development of the achievements in 8 national model cities (1.1). Separated collection is conducted by the environmental sanitation company, etc. and garbage is collected on the day and disposed into Maoyingzi landfill site in Dalian city. Dehydrated cake (its water contents: 85% approximately) of waste sludge discharged from two sewage works in the development area (disposal capacity: about 160 thousand m^3/day, activated sludge method) is disposed of in landfill, too.

The issue on MSW management faced in the development area is being in urgent need of its own treatment according to the city's "Waste Control Regulation". Also, population and economy of the development area show remarkable growth and the development area is precluded from the target areas of the planned incinerator for city waste in Dalian city. Therefore, urgent treatment by its own is required. For reference sake, the population growth of the development area is 11.4% (for the past 10 years), while that of Dalian city is 3.3%. So, it is unreasonable from the technical viewpoint that the development area is included in the target areas of the municipal incinerator.

2. Field Survey

Three field surveys in total were conducted in November and December of 2003 and February of 2004. Along with the surveys, field hearings to relevant government offices and companies, amount measurement and chemical composition analysis of landfill gas in Maoyingzi site and heavy-metal analysis for dehydrated cake of waste sludge in sewage works were conducted.

3. Summary of the Study

3.1 Project Activity

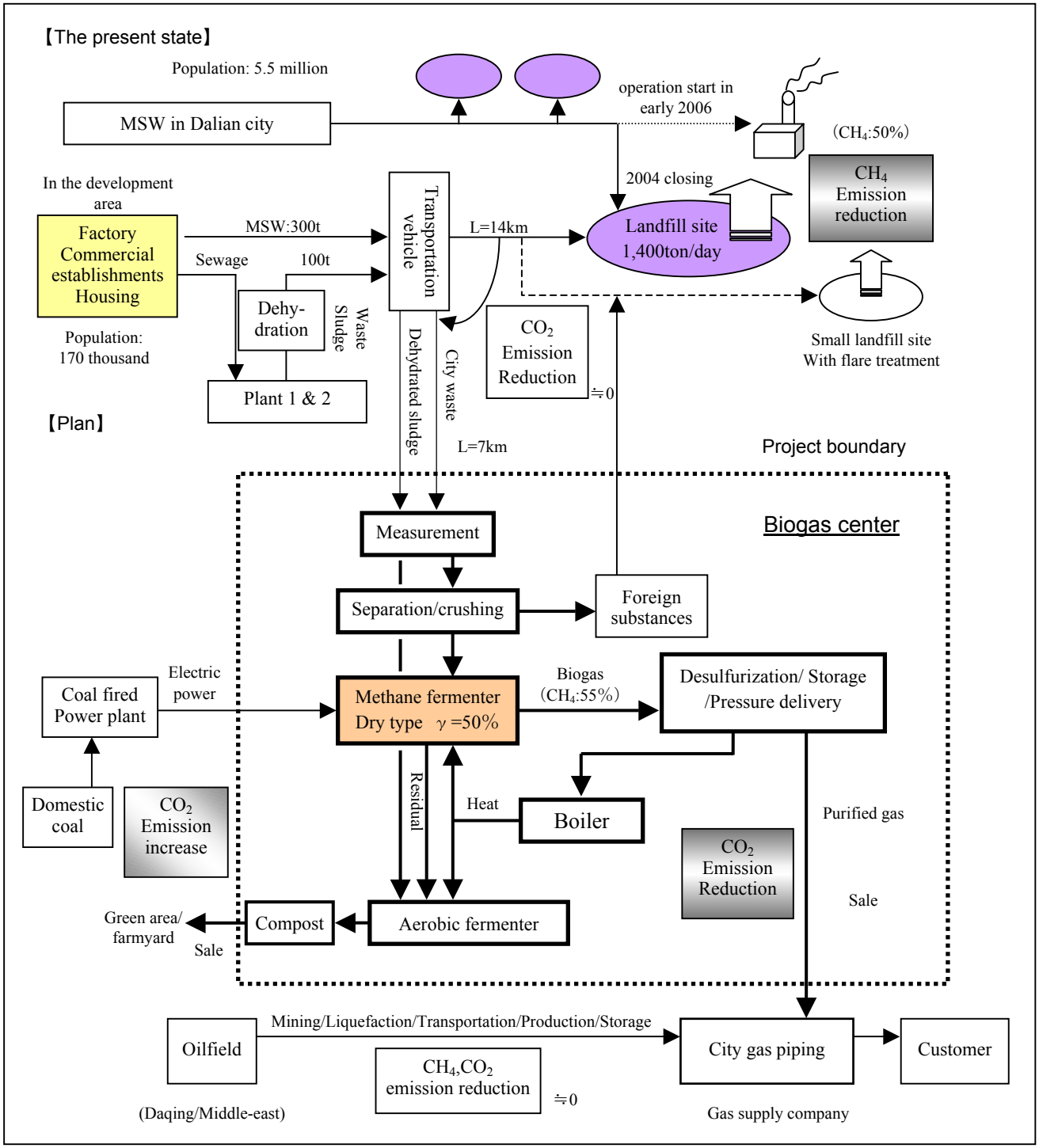

Fig. 1 Overview of Project Activity

A proposed biogas center receives municipal solid waste in the development area (collection and transportation are conducted by environmental sanitation companies as before), and the waste is stored after measurement and selected by manpower in the course of belt conveyors. Nonorganic wastes such as metals, plastics and wood chips are removed as foreign matters. Organic wastes are crushed in size under 5mm and put into a methane fermenter, maintaining a constant temperature (55°C) by steam. These organic materials generate biogas in anaerobic condition during the stored period of about 20 days and residuals are discharged from the lower part of the fermenter. Generated biogas contains about 55% concentration of methane gas and CO_2 which makes up most of the rest of the gas. Sulfide is not suitable for city gas fuel, so the generated biogas is desulfurized and dehumidified. Then, after calorie adjustment with other city gas fuels (propane (C_3H_8) and methane (CH_4)), it is pressed into city gas mainline for sales and usage. Residuals and dehydrated cakes of sludge with high water content are sent to composting cells to be made into compost products through 2 months aerobic fermentation and are marketed.

By the project, landfill gas at a landfill site (CH_4: approximately 50%) can be inhibited completely. Accordingly, GHG emission can be reduced drastically through this project, compared to the conventional baseline.

3.2 Target Wastes and Its Amount

Target wastes	Organic matters	:	Food waste, fruit peel, wood/bamboo/leaf/grass, paper, fabric/cloth Waste sludge (after dehydration) of sewage works
Non-target wastes	Nonorganic matters	:	Brick/stone tile, seashell, animal bone, soils
	Scraps	:	Plastics, metals, glasses, waste rubber

The past statistics on wastes cannot be found, but in 2003 the amount of municipal solid waste is 200 ton per day in the development area. The increasing rate of future garbage generation based on population growth factor in the development area was estimated to be 8.1% and that based on economic growth factor was estimated to be 1.53% (Refer to the IPCC standard), resulting in the annual growth rate of 10%. It was estimated that the amount of garbage would be 400 ton per day in the fifth year from the operation start, which is regarded as a planned disposal amount. The breakdown is as follows: sewage sludge: 100 ton and city waste: 300 ton.

3.3 Disposal System and Production of Biogas

The kinds and biogas generating potentials of organic wastes in decreasing order are as follows:

340Nm^3/ton= flammable garbage (paper trash, etc.) > kitchen wastes > sludge = 50Nm^3/ton

Therefore, sludge which contains much water and generates less biogas has a demerit of requiring a fermenter in larger scale and it shall be put directly into a composting sub-system. Thus, the rest of wastes consist of mainly garbage with relatively low water content and so a dry type methane fermentation system was adopted. This system has high scale efficiency and doesn't require disposal facility cost and operation cost because of no generation of drainage.

About half amount of generated biogas can be marketed as surplus biogas.

	Biogas	For steam	For composting	Surplus biogas
Biogas (Nm^3/day)	40,950	5,220	16,000	19,730
Calorie (GJ/day)	806	103	315	388

3.4 Project Cost and Operating Balance

Items	Quantity	Amount (thousand yuan)	Remark
Construction cost	One set	306,600	
Engineering service cost	4 %	19,500	
Total		326,000	

Estimation of project operating balance

	Expense item	Amount (yuan/year)		Revenue item	Amount (yuan/year)
1	Labor cost	1,089,600	1	Sales of compost	1,854,000
2	Electricity expense	2,703,500	2	Sales of biogas	9,362,000
3	Machine fuel cost	1,099,000	3	Reduction effect of waste transportation	1,533,000
4	Chemical agent cost: desulfurization agent	1,100,000	4	Reduction effect of disposal cost	1,460,000
5	Equipment maintenance cost, etc.	1,861,100	5	Collection of garbage disposal charge	4,380,000
	Total expenditure	7,749,000		Total revenue	18,589,000
		Operating profit		＋10,840,000 yuan/year	

3.5 GHG Emission Reduction

#	Item	Yearly emission: t-CO_2/year	Remark
1	Baseline emission amount	224,000	In case a planned waste generation amount is 400t/day
2	Reduction amount by city gas fuel alternative	7,200	
3	Emission increase by usage of electric power for plant facility/lighting	-6,400	
4	Emission increase by fuel consumption for composting facility	-910	
	Baseline emission amount – Project emission amount =	**224,000**	

The methane recovery amount at a landfill site of 2,860 t -CO_2 is subtracted from #1.

3.6 Project Period and Acquisition Period of CER

The project period was set as 15 yeas based on the useful life of methane fermentation system which is a main facility and the acquisition period of certified emission reduction (CER) was set as 10 years (fixed). A longer period setting tends to increase a project risk and it was judged that a period of 7 years is too short and 14 years (with one renewal) is too long.

3.7 Economic Assessment

In this project, if price expectation value of CER equal to US$15, the project IRR is estimated to become 18.9% and a payout time to be 5 years. In case of 10% reduction of construction cost through VE (Value Engineering), IRR becomes 15.5% (6-year payout time) at US$13 level and the effect of cost reduction is large.

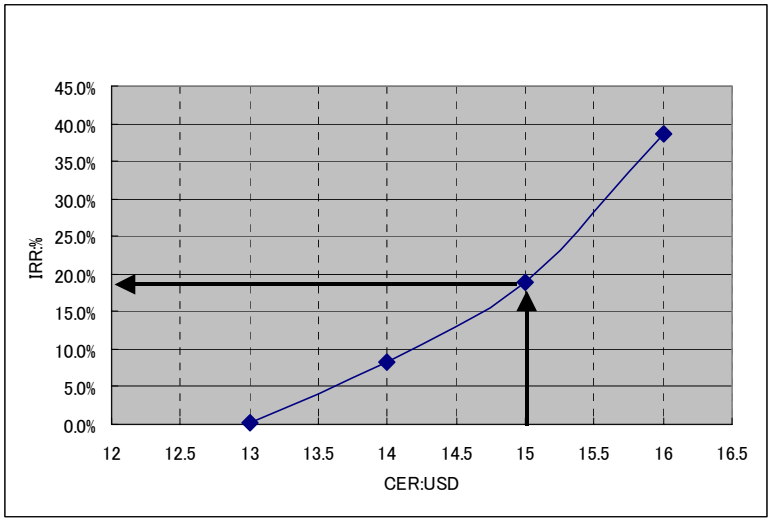

Fig.2 CER and IRR

3.8 Planning of Project Finance

The allocation for lamp sum advance payment of funds of acquiring CER at US$15.0 is estimated at 270 million yuan (83% of the total amount) of 2,284,000 t -CO_2, and at 56 million yuan (17%) for host side funds. Loans shall be obtained for the funds from Japanese government-affiliated financial institutions. Under the terms of 6-year repayment (grace period: one year), annual interest of 1.5% (Grant element is less than 25%), co-financing with private financial institutions is possible. Japanese investments consist of Japanese government business subsidiary system (purchase of CER), (provisional) Japanese Carbon Foundation and private companies. The private companies longing for CER belong to industries such as electric power supply, oil, automotive parts and electrical and electronics, as well as finance, securities and trading companies. Depending on economic situation (if the economy shows a remarkable growth), it can be expected that the car industry and the steel industry, too, may long for CER.

3.9 Project Implementation Plan

The implementation of CDM project in a foreign-capital-enterprise form through BOT method based on ”Opinion on industrialized development promotion of sewage and waste disposal in cities” by NDRC et al. and the law concerning foreign-affiliated companies is advantageous for both investors and the development area. Japanese investors shall co-establish a local company, through which they shall invest in a foreign-capital-enterprise. Preferably, this investment should be made in the form of upfront payment on the premise of future delivery of CER. The rest of project funds shall be obtained by use of co-financing of public and private financing institutions. CDM project can be regarded as a “special project” and the percentage of total investment amount and registered capitals should be discussed with Department of Foreign Investment Administration, Ministry of Commerce, etc. The administration committee and the CDM project entity shall conclude a contract for special permitted management, set a period for transferring the project within 8 years and conduct the project. Concerning collection of garbage disposal charges, methane gas supply/sales, grid electric power supply and technical transfer, too, the administration committee shall mediate an agreement for applying a necessary price preferential treatment. Technical transfer is one of important requirements of CDM project and must be implemented within 1-2 years from operation start without fail.

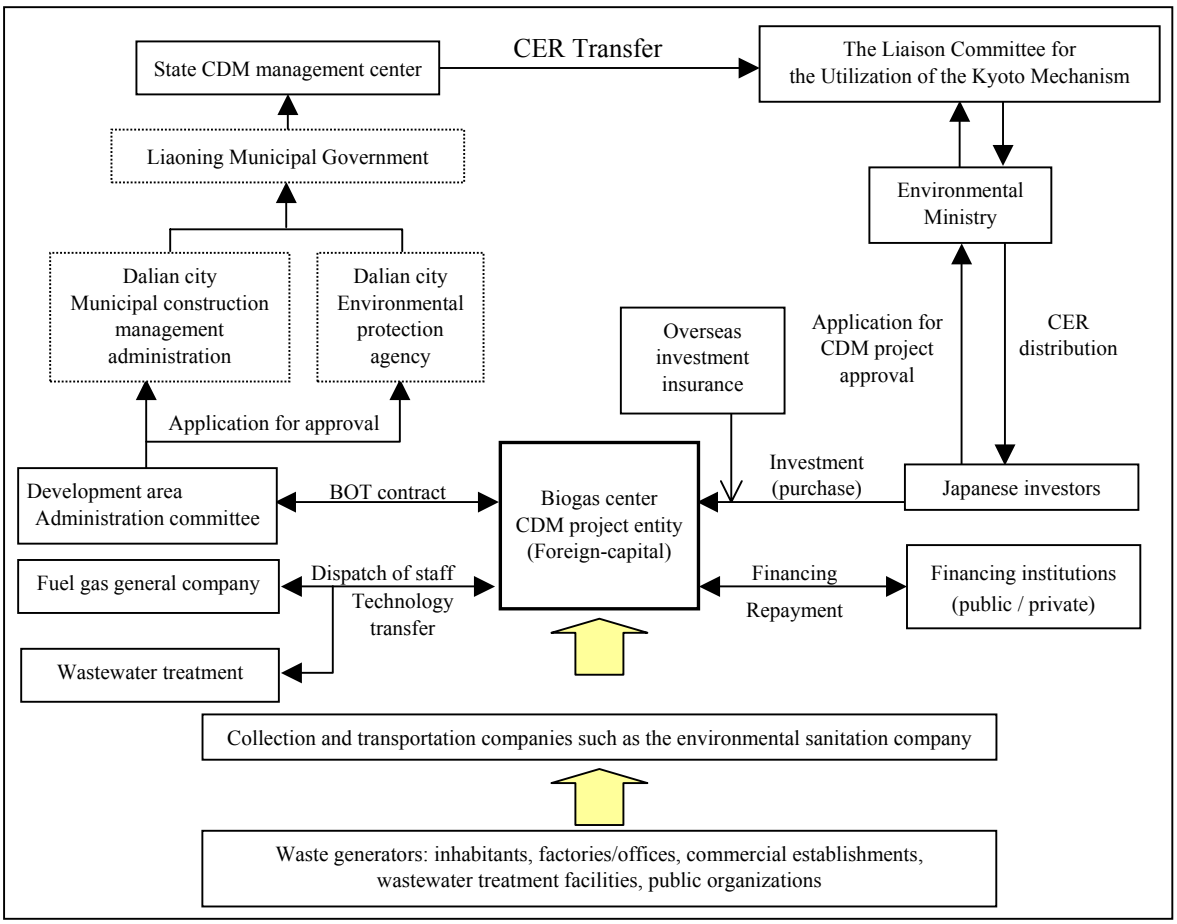

Fig.3 Proposed project implementation system

3.10 Project Implementation Schedule

Project implementation schedule is as follows: the project shall be started in about half a year after full operation start of the incineration and electric power generation project of Dalian city. It is considered that it will take about half a year to get an approval of the government and a validation which are peculiar to CDM project.

#	Operation item Year	2004	2005	2006	2007
1	Preparation of FS-PDD proposal	3			
2	PDD finalization	(2)			
3	Approval and validation of PDD	(6)			
4	Invitation of project plans & investors		(5)		
5	FS application, register of operating companies		(6)		
6	CDM project approval by the Japanese and Chinese governments		(2)		
7	Detailed design (DD)		(5)		
8	Construction, test operation		(12)		
9	Operation start			10	
*	(Test operation of Dalian city incineration facility)		10		

The numbers in ( ) show the required number of months.

* After about 6-month test operation adjustment, a full operation is scheduled to start. #3, #5, #6 show the minimum required months.

3.11 Risk and Measures on Implementation of the Project

In the CDM project, not only the normal project risks but also the Kyoto Protocol risks can be recognized. For the government approval risk, if the Chinese government formalizes the provisional regulation on CDM project management and operation as it is and put it into strict operation, it is highly possible that the form of BOT method – Foreign-capital-enterprise on which this project is predicated will become a stumbling block for this project. The project, however, accords with the opinion on "Industrialization of City Waste Disposal" issued by the National Council. Accordingly, from the viewpoint of hedging risk, it would be important to submit an in-advance application to the relevant department in charge of CDM at the stage of the provisional regulation to convey the importance of the project including local needs in Dalian and the development area. There is a high possibility that Japanese investors hesitate to invest in Chinese companies or CDM project entities with over 51% Chinese investments.

In addition, risks on UNFCCC approval for the new methodology, validation by DOE and registration procedures can be expected. Specifically, they may require time and a smaller emission reduction than expected. With delay of the project start, the administration committee would have troubles with waste disposal. To reduce the risk at the host side, it is effective to approach the Dalian municipal authorities on the proposal that in case of delay of

operation start of the waste facility run by the development area, municipal waste disposal facilities will receive waste and to get a prior consent for waste receiving.

The conceivable project risks peculiar to a waste disposal project are as follows:, the planned amount of waste is not collected due to a slowdown in economic growth, the compositions are different from the expected ones (organic carbon rate is lower, gas generation is reduced, etc.), the separation cost increases because separated taking-out of garbage is not carried out generally, and so on. It is necessary to promote cooperation with the Dalian municipal incinerator, to confer on interchange of organic waste (from the city) and plastics (from the development area) and to try to promote a separated taking out of garbage.

4. Overview of Proposed Project Design Document (PDD)

4.1 Baseline Methodology

- Methodology name: Biogas production and switching of city gas fuel partially in MSW management, China
- Selection of methodology: Marrakesh Accord48 (b)
  "Emission from a technology that represent an economically attractive course of action, taking into account barriers to investment"
- Application of methodology

Since 1984, Dalian city economic and technological development area, as a state-level economic and technical development area established for the first time in China, has exercised administrative functions and industrial complex administrative functions such as infrastructure building/operation/management of industrial complex, enticement of enterprises, introduction of foreign capital and tax collection. By the City Waste Control Regulation, it has been pressed to build its own waste disposal system. The technical guideline on waste disposal of Chinese Ministry of Construction consists of three elements; "Sanitary landfill" "incineration" and "composting". The development area will have to select the most economically attractive technology from the three elements.

As the result of comparing economical efficiency of the three elements, the total amount of construction cost + operation cost (for 10 years) for sanitary landfill is the smallest. The collection charge on disposal cost for sanitary landfill which can compensate the above total cost is the smallest.

	Sanitary landfill	Composting	Incineration	Incineration w. electric power generation
Construction cost + operation cost (million yuan)	119.1	182.2	198.4	338.8
Disposal cost which can be compensated: yuan/t	82	125	136	232
Amount with an addition of loading/transportation cost: yuan/t	105	148	159	255

The amount with an addition of 23 yuan/t for the current loading/transportation cost to the above disposal cost is the total cost of waste disposal.

Concerning the other two methods except sanitary landfill, the existing average cost (100 yuan/t) of area's industrial waste disposal must be increased drastically. In other words, there is a concern that the methods except sanitary landfill may result in increase of waste disposal management of companies moving in the development area, which may affect adversely on international competitiveness. Therefore, it is presumable that without project the administration committee of the development area would conduct its own disposal by adopting sanitary landfill. In addition, according to the construction standard set by Ministry of Construction, collection and flare treatment of landfill gas is recommended and this method has been already adopted in the World Bank aid case in Dalian city. Therefore, concerning recovery of methane gas, it is reasonable to follow the level of this practical example and the actual measurement was adopted.

The baseline is that MSW is disposed of in landfill, generated methane is emitted into air while a part of methane is treated by flare combustion.

In this project, organic methane fermentation technology which has already been adopted in Europe and Japan shall be introduced to China, the generated biogas shall be utilized as city gas fuel alternative in Dalian, and fermentation residuals as by-product shall be composted to utilize for promotion of organic farming in the surrounding areas. The tariff system in city waste disposal, which has been already adopted in part of Dalian city, shall be introduced to the development area, too.

- Calculation equation of GHG emission reduction

  GHG emission reduction amount

  = Baseline emission amount – emission amount by the project

  = (Total methane generation amount from organic waste landfill – methane recovery amount (50 years))

  – (GHG generation amount by city gas supply alternative (–)
  + GHG generation amount by use of plant electric power
  + GHG generation amount by machine fuel consumption)

  For baseline emission amount, IPCC Default method was adopted as equation.

  $CH_4=MSW_T \times MSW_F \times MCF \times DOC \times DOC_F \times F \times Conv - R$

  Concerning Methane Correction Factor (MCF) in the above formula, MCF = 1.0 was adopted on the assumption that disposal is conducted in a well-managed site. Methane recovery amount (R) was calculated on condition that the period for long-term anaerobic decomposition of organic waste is 50 years.

- GHG emission reduction amount during the CER acquisition period is as follows:

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
(1)	293	322	354	390	409	430	452	474	497	522
(2)	176	193	212	234	245	258	271	284	298	313
(3)	163,900	180,100	198,000	218,100	228,700	240,500	252,800	265,100	268,400	268,400
Total CER			2,284,000 t – CO2							

(1) Planned waste amount (t/day), (2) Amount of pure organic matters after removal of foreign substances (20%) (t), (3) Planned CER (t - CO_2)

4.2 Monitoring Methodology

Target data for monitoring are shown in the following table. The data shall be stored both in electronic media and paper media, and the recorded documents shall be kept during the CER acquisition period of 10 years.

Kind of data	Data variable	Unit for the left column	Measured value/calculated value/estimated value	Recording frequency	Ratio of data for monitoring
GHG emission amount	Incoming sewage sludge amount	t/day	Measured value/	Every day	100%
	City domestic garbage	t/day	Measured value/	Every day	100%
	Reduction amount of foreign substances	t/day	Measured value/	Every week	100%
	Percentage of organic carbon in sludge	%	Measured value/ calculated value	Every month	Sample
	Percentage of organic carbon in garbage	%	Measured value/ calculated value	Every month	Sample
	Usage amount of system electric power	kWh/y	Measured value	Every month	100%
	Consumption amount of machine fuel	liter/day	Measured value	Every week	100%
	Biogas generation amount	Nm^3/day	Measured value	Every day	100%
	Rate of gasification	%	Calculated value	Every week	100%
	Biogas supply amount	Nm^3/day	Measured value	Every day	100%
	Compost production amount	t/day	Measured value	Every day	100%
	Component of fertilizer in compost	%	Measured value	4 times a year	Sample

4.3 Contribution to Sustainable Development

CDM project requirement stipulated in Article12 of Kyoto Protocol is to contributing to sustainable development of countries not included in Annex I, and the adaptability of this project is as follows:

1. By introducing and transferring biogas generation technology in addition to technical system for MSR disposal in China: landfill, incineration and composting, urban environmental infrastructure and recycling-oriented economy model are built and promoted, thereby contributing to development of Chinese cities.
2. By promoting industrialization in MSW disposal by use of private sector and foreign capital, the project can contribute to local job security and progress in waste disposal industry. Also, by supplying organic compost to the rural area surrounding the

development area, it promotes organic farming and contributes to development of cities and rural areas.

3. The project contributes to reduction of waste disposal cost for 1,800 companies moving into the development area and enhances international competitiveness of these companies, which leads to sustainable economic development in the development area.
4. With renewable energy technology though the use of biomass, it contributes to scientific and technological development in China and reduces fossil fuel consumption.
5. With the project, waste landfill disposal in the coastal areas around Dalian city can be reduced, thereby leading to marine pollution prevention, and sustainability of local fisheries industry can be enhanced.

5. Project Promotion

We are going to hold consultations on details for realization of this project with the administration committee of Dalian economic and technological development area, Dalian city (its municipal construction administration and environmental protection agency), Liaoning Province Environmental Administration and NDRC of the National Council.

Large cities in Chinese coastal area are showing remarkable economic growth and are establishing a closer relationship with Japan. By promoting the project based on these survey results, we hope to contribute to solution of environmental and energy problems and realization of the CDM project by Japan and China in those Chinese cities.