Feasibility Study of Clean Development Mechanism/Joint Implementation Project

Summary Version Style

(1) Fundamental factors involved in project implementation

■ Overview of proposed project and background of planning

Operating activity at the Nanjing Pukou Landfill Site, which is the project site, began in 1995, receiving waste at the rate of about 700 tons per day. Two million tons have now been disposed of, and the plan allows for up to five million tons in the future. In areas where landfill has been completed, the masses of waste retain landfill gases (hereafter LFG) containing large amounts of methane produced in the fermentation of domestic waste and other such organic waste. As this poses a risk of fire, pipes are inserted into the masses of waste in order to vent the LFG into the atmosphere.

Methane has 21 times greater impact on green house effect than carbon dioxide. Therefore recovering and utilizing methane has a major impact. This project seeks to recover the methane gas from the landfill site and put it to effective use as fuel for gas engine generators. By generating electric power in this way, the project is intended to generate income from the sale of electric power (maximum output of the gas engine generators to be installed for the project is about 6,000 kW) and acquire carbon credits as a Clean Development Mechanism (hereinafter CDM) project. The project is designed for effective acquirement of carbon credits through the installation of flaring facilities to make effective use of surplus LFG that is not used by the gas engines and also LFG that is recovered when the gas engines are stopped.

Some projects envision taking advantage of the characteristically high percentage of organic waste in the host country's domestic waste by establishing facilities to force methane fermentation of separately collected organic waste. This possibility was shelved, however, because the customary practice of sorting waste for recovery and the related regulations are not in place at present.

The present feasibility study examined the possibility of implementing this project and was intended to encompass the formulation of project design documents (PDD).

■ Overview of the host country

The host country has experienced rapid economic growth at the annual level of 8–9%, particularly since joining the WTO in December 2001, by promoting trade and attracting an inflow of foreign capital. Its growth in 2003 (9.1%) was at the highest level since 1997. This fast-paced economic growth is being accompanied by increased consumption of energy, and the electric power supply has been unable to keep up. Many regions of the country are subject to large-scale restrictions on power consumption.

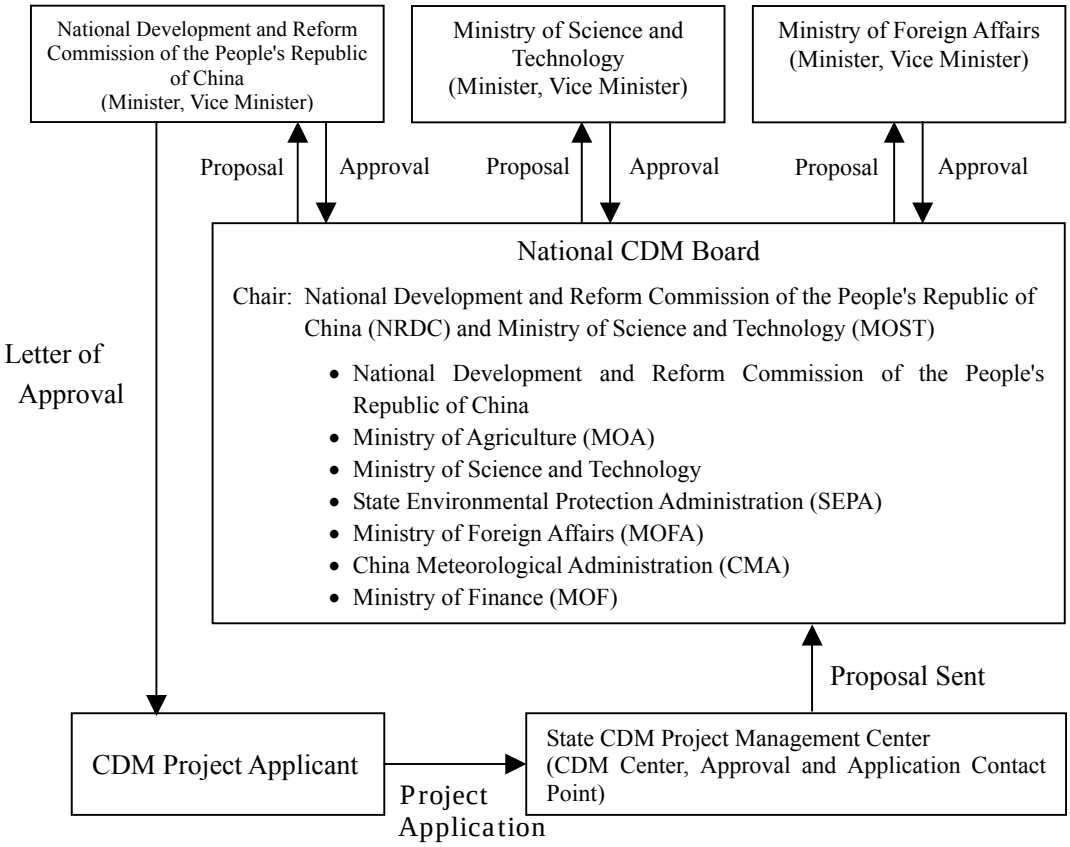
Future expansion of the economy is expected to lead to rapid growth of domestic energy demand. The host country understands this and is promoting development of the energy sector. Energy development is focused on electric power, which is based on coal, with attention also going to oil, natural gas, and nuclear power development. There are plans to actively expand new energy, renewable energy, and energy conservation, as well. The plans for energy saving include improving the energy utilization factor and environmental protection, and particularly seeking more efficient development and utilization of coal resources, while also actively expanding the production of hydroelectric power, wind power, and other renewable energy sources, and increasing their share of total energy production.

The waste treatment in the cities has also become a major problem. In 2004, annual generation of trash in the cities rose to 130 million tons. This is an increase at a rate of 8–10% per year on average, and this accounts for one quarter or more of the world's domestic waste. Only a very small amount of domestic waste in the host country is treated by sanitary incineration, and 95% or more is disposed of as landfill. There is, therefore, great interest in an LFG recovery and utilization project of the kind described in this feasibility study. This is identified as one of the CDM priority fields in the host country.

■ Criteria for host country acceptance of CDM/JI, status of Designated National Authority (DNA) establishment, and other such conditions and policies relating to CDM/JI

The host country, China, ratified the Kyoto Protocol on August 30, 2002, and has also completed establishment of its DNA (the National Development and Reform Commission of the People's Republic of China). The country initially approached CDM from the perspective of a developing country, and so was not especially positive in its engagement. The structure of the CDM scheme as part of the UN Framework Convention on Climate Change has advanced, however, and China has been shifting over to an increasingly active stance. The country has improved its approval system as shown below in Figure 1. The Chinese government has clarified its basic policy regarding CDM by formulating its Interim Measures for Operation and Management of Clean Development Mechanism Projects in China on May 31, 2004. The content of these measures is idiosyncratic in certain respects, such as making carbon credit price into one of the conditions for project approval. The country is, however, taking a positive stance to promotion of such projects.

Figure 1. CDM Approval System in the Host Country



■ Study implementation systems (Japan, host country, and other)

＜Agencies on the Japan side, and their roles＞

・ Chubu Electric Power Co., Inc.

PDD formulation, design of methane gas recovery facilities and gas engine generators, profitability analysis, and creation of written report to Global Environment Centre Foundation

・ Eco Securities & Center for Renewable Energy Development

Creation of PDD draft, collection of on-site information, collection of data for design of methane gas recovery facilities and gas engine generators

＜Host country cooperating agencies and their roles＞

・ Nanjin Waste Recovery Engineering Co., Ltd. (Local counterpart)

This company is the main project participants of the landfill methane recovery and utilization project, which was established as a local enterprise to examine the possibility of implementing the LFG project. It is funded 51% as a private sector

enterprise and 49% as a national enterprise.

The role of this company in the study is to collect stakeholder comments regarding the project and implement an environmental impact assessment.

・ Nanjing Municipal Government

The Nanjing Municipal Government manages and operates the landfill of project site. It is providing support across the board, such as implementing approval of the environmental impact assessment for this project and related matters.

・ Nanjin Grid Company

The Nanjin Grid Company owns and operates the power transmission and distribution facilities in the surrounding area that are involved in this project.

It is negotiating a power purchasing agreement (PPA) with the project participants.

For the present feasibility study, this organization has provided information on the conditions of power purchase agreements with regard to LFG power generation.

・ Hua Xia Bank

The Hua Xia Bank has expressed interest in this project and is slated to provide funding.

It has provided information on project funding terms and other such matters.

(2) Project Formulation

■ Specific Details of the Project

This project is conceived as a CDM project for the recovery and utilization of LFG that had been released into the atmosphere at waste landfill sites. Here a study was made of the LFG recovery systems, gas engine generator systems, and flaring systems to burn off surplus LFG that will be installed in order to achieve that purpose. The project is further intended to supply the electric power that it generates to the nearby electric grid system and earn a certain amount of income from electric power sales while it also acquires carbon credits. In this way, the project will be made cost-effective.

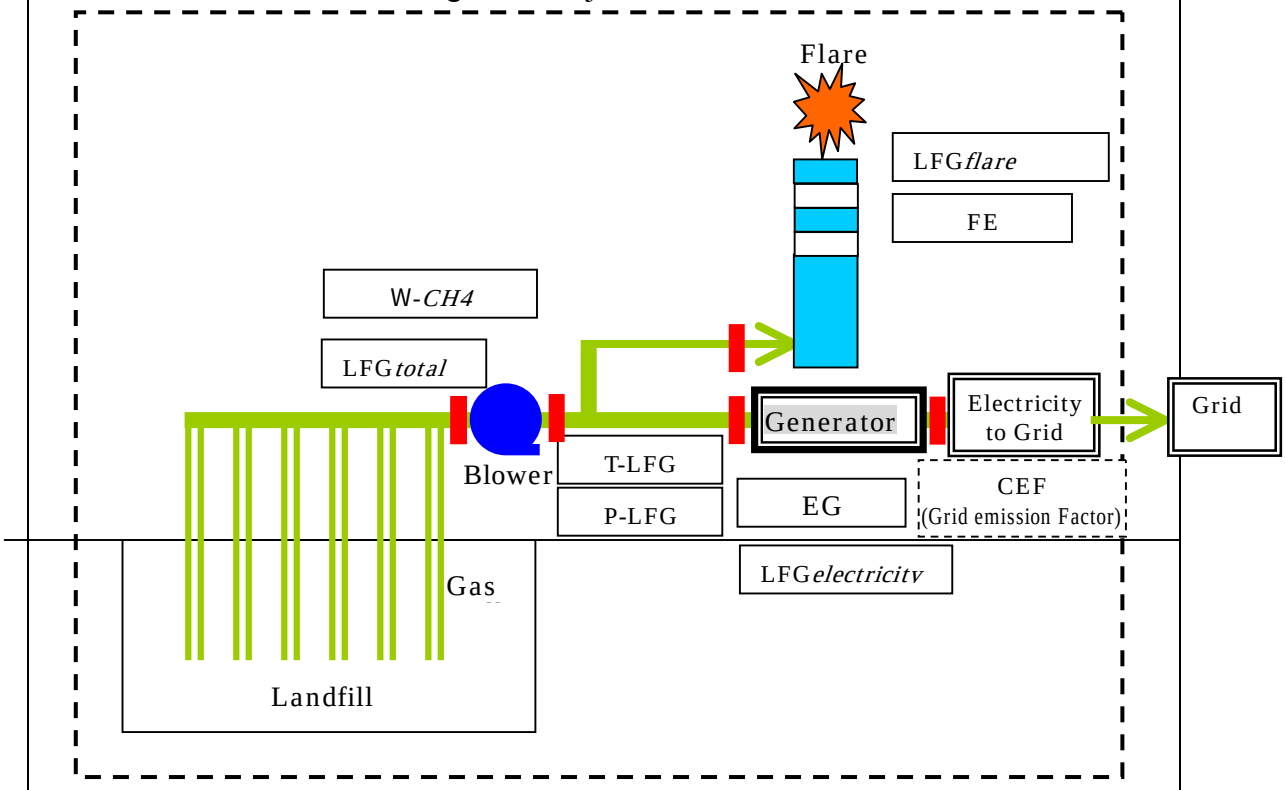
The projected volume of LFG produced, which is the most important factor in plant design, was calculated using the First Order Decay Model of the US EPA. The results of those computations indicate that it will be possible to introduce a maximum of 1,000kW-class six gas engine generators (Caterpillar G3516LE generators with an output of 1,030 kW). In the case of an LFG power generation project, the volume of LFG produced is difficult to measure accurately. Therefore the maximum effective utilization of the LFG that is generated in implementation of this project, and, conversely, not installing surplus equipment capacity, are crucial issues for assuring high profitability. The present project is distinctive because it seeks to overcome that shortcoming of the typical LFG project by designing it to allow increasing or

decreasing the number of gas engine generators installed according to increases and decreases in the volume of LFG. In other words, it has been designed so that if the volume of LFG diminishes in the future, the equipment can be sold to other project sites. Another distinctive feature of this project is that it has been given a large flaring capacity so that the total amount of LFG can be treated by flaring even when the gas engines are not operating. This is to process the recovered LFG fully in order to maximize the carbon credits revenue.

■ Project boundaries, setting of baselines, and demonstration of additionality

・ The project boundaries were defined as shown in Figure 2 below. The boundaries were defined around the site of the project that recovers and utilizes the LFG whose impact on the calculation of the baseline emission level must be taken into account, and the electric power grid for which the project serves as an alternative source of power.

Figure 2. Project Boundaries



・ Baseline:

The methodology used for the baseline this time was the Consolidated Baseline Methodology for Landfill Gas Project Activities (ACM0001), which had already been approved by the CDM Executive Board. This methodology is applicable to

projects for the recovery and utilization of landfill gases. There are presently almost no sites in the host country that are equipped for LFG recovery system, with the exception of some model sites supported by multilateral agencies, nor are there any LFG recovery controls in effect. Consequently, the release of almost all the LFG into the atmosphere without recovery was set as the baseline. There is virtually no likelihood that controls will be adopted in the future, and the effectiveness adjustment factor (AF) was therefore set at 5%. The emission reduction that is obtained by replacing energy from other sources with electric power generated by the project and transmitted to the grid was calculated by the methodology applicable to small-scale CDM projects for generating 15 MW or less power (Type 1.D).

・ Demonstration of additionality:

＜Investment Barrier＞ The rate of return would remain low if the project relied on income from electric power sales alone (assessed by benchmark methods using market money rates and government bonds). Moreover, power purchasing agreements in the short term (1–2 years) entail risks. Therefore this is not attractive as an investment project.

＜Technological Barrier＞ LFG power generation technology is not new in global terms, but the host country has not accumulated a record of experience operating such technology. Therefore this can be considered a project utilizing new technology.

＜Institutional Barrier＞ There are no laws and regulations that mandate obligatory LFG recovery.

■ Greenhouse gas reduction (CO_2 absorption) and leakage resulting from project implementation

The emission reduction to be realized by implementation of this project is calculated as the sum of two factors: One is the recovery and utilization of methane (utilization in gas engine generators and burning off in flaring equipment) so that release into the atmosphere is avoided. The other is the reduction in fossil fuels burned to generate the electric power that is replaced by the power generated in this project.

(Formula for Calculating the Reduction in Emissions)

Emission Reduction	=	Methane recovered and utilized by the project	x	Global warming potential of methane	—	Methane that would be recovered and utilized if the project were not implemented	x	Global warming potential of methane
ER_y ($t\text{-}CO_2$)		$MD_{project,y}$ ($t\text{-}CH_4$)		GWP_{CH4} (21)		$MD_{reg,y}$ ($t\text{-}CH_4$)		GWP_{CH4} (21)

	+	LFG Power output	x	Electric power grid Emissions Factor
		EG_y (MWh)		$CEF_{electricity,y}$ ($t\text{-}CO_2/MWh$)

Methane recovered and utilized by the project	=	(LFG utilized for power generation + LFG utilized in burning off)	x	Concentration of methane in the LFG	x	Specific gravity of methane	x	Flaring efficiency
$MD_{project,y}$ ($t\text{-}CH_4$)		($LFG_{electricity,y} + LFG_{flared,y}$) (m^3)		$W_{CH4,y}$ (%)		Density (t/m^3)		FE (%)

Methane that would be recovered and utilized if the project were not implemented	=	Methane recovered and utilized by the project	x	Adjustment Factor: Effectiveness adjustment factor
$MD_{reg,y}$ ($t\text{-}CH_4$)		$MD_{project,y}$ ($t\text{-}CH_4$)		AF (%)

(Calculation of the emission factor of the electric power grid)
The average emission factor (t-CO_2/MWh) of the Huadong electric power grid, where the project site is located, was calculated using data extracted from the 2002 China Year Book. (Result: 1.11 t-CO_2/MWh)
There is limited public disclosure of information concerning plans for the development of power generating capacity within this grid, and it is difficult to estimate an average grid emissions coefficient for the period in which credits are to be gained. Therefore this average emissions coefficient was used for ex-ante calculations to derive the future emission reduction. It was decided, however, that the average grid emission factor will be subject to monitoring, and the figures are to be subject to ex-post review on the basis of data that are revised annually.
(Result of calculation of reduction in emissions)
The results from calculation of the reduction in emissions during the initial project period are as shown in the below table.

Year	Emission Reduction (t-CO_2/yr) due to LFG recovery (power generation, burning off)	Emission Reduction (t-CO_2/yr) due to replacement of electric power on the grid	Total Emission Reduction (t-CO_2/yr)
2005	187,776	34,024	221,800
2006	198,175	34,024	232,199
2007	207,585	42,690	250,275
2008	216,099	42,690	258,789
2009	223,804	42,690	266,494
2010	230,775	42,690	273,465
2011	237,082	42,690	279,772
Total	1,501,296	281,500	1,782,796

This project is not envisioned to experience any LFG leakage.

■ Monitoring plans
Monitoring methodology and methods are adopted from the consolidated methodology for landfill gas project activities (ACM0001), which had already been approved by the CDM Executive Board. This methodology is applicable to projects that recover landfill gas for burning off or for power generation, and that connect to the power grid in order to replace the grid power source and thus reduce emissions of methane gas.

■ Environmental impact and other indirect effects (in the case of afforestation, risk management survey results are also to be included)

The environmental impact assessment (EIA) is to be implemented according to guidance received from the State Environmental Protection Administration in the host country. Approval is implemented by different agencies depending upon the size of the investment. Large-scale projects (100 million USD or more) are handled at the national level, and small-scale projects (under 100 million USD) are handled at the provincial level. This project is expected to come under the small-scale category, so approval is being handled at the provincial level.

LFG recovery and utilization for electric power generation constitutes an environmental improvement project. It is therefore considered to have basically no negative impact on the environment. There are, nevertheless, two conceivable headings for assessment of environmental impact, as shown below. Evaluation under these headings showed that no problems existed.

(1) NOx, noise, and vibration generated in the course of recovering methane, generating electric power, and burning off methane

(2) Problems of impact on scenic views in surrounding areas resulting from installation of equipment at the landfill site

■ Comments from Stakeholders

Explanations of project plans were provided to the following parties and summaries of their views were collected: Local municipal governments, local administrative agencies, provincial and municipal environmental agencies, environmental experts, representatives and legislators at the national government level, and representatives of local residents in the site vicinity. The summarized results are as shown below.

○This project will not have any negative impact on scenic views in the city of Nanjing.

○This project will contribute to the effective utilization of waste from the city of Nanjing.

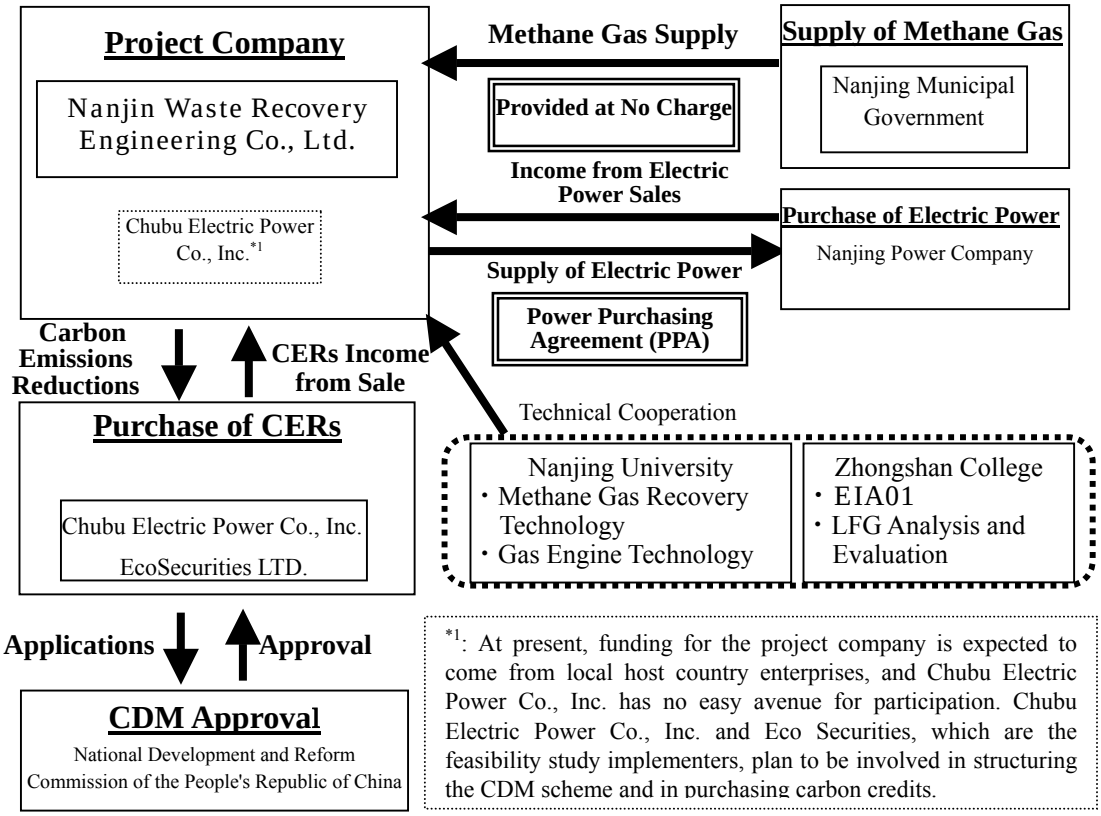
○This project will satisfy state industrial policy and improve the local environment.

○This project will contribute to the sustainable development of the regional economy.

(3) Toward the project implementation

■ Project Implementation Scheme (Japan, Host Country, Other)

The project implementation scheme is presently envisioned to be as shown in the figure below.



■ Financing plan for project implementation

Funds for the power plant construction costs and other such outlays needed in the initial stage of investment are expected to be obtained through financing primarily from the Nanjin Waste Recovery Engineering Co., Ltd., which at present is the project participant, together with other local enterprises, and by loans from local banks. This is probably possible because of the great interest shown by Chinese enterprises in the project. That interest probably arises because the present project is an environmental improvement project that is in line with state policy, and because there are prospects for additional profit from carbon credits. Consequently Chubu Electric Power Co., Inc., and EcoSecurities LTD., the feasibility study implementers, have shelved the idea of taking part in financing the project. They plan instead to participate in structuring the CDM scheme and in purchasing carbon credits. The approximate costs for the construction of plant and facilities required for this project are as shown below.

Exchange Rate: 13 yen/RMB

	Cost	
	(RMB)	(Japanese Yen)
Landfill Gas Recovery System Construction Costs	1.01 million RMB	13.13 million yen
Gas Engine Costs (6 units, installing cost included)	30 million RMB	390 million yen
Flaring Equipment (2 Units) Construction Costs	2.48 million RMB	32.24 million yen
Other Costs (Well Construction, Etc.)	840,000 RMB	10.92 million yen
Total	34.33 million RMB	446.29 million yen

■ Cost effectiveness

Main Underlying Assumptions of the Budget Plan

Item	**Description**
1. Exchange rate	1US$＝110JPY, 1RMB＝13JPY
2. Rate of price increase	
3. Period of Analysis	

7. Finance Procurement	Funds for the initial investment in plant and equipment necessary for implementation of the project are to be acquired in the form of investments by Nanjin Waste Recovery Engineering Co., Ltd and other local enterprises and loans from city banks.
8. Fixed Asset Costs	The gas engines (with buildings included) cost 65 million yen (5 million RMB) apiece. As six units are to be installed, the total cost comes to 390 million yen.
	The flaring equipment costs 16.20 million yen (1.25 million RMB) apiece. As two units are to be installed, the total is 32.40 million yen.
	Ten percent of the above costs are to be set aside for contingencies. (This includes import charges of 3% and other such costs.) Management of the landfill is being carried out by the city of Nanjing. Therefore it was decided not to anticipate any site acquisition costs.
9. CDM Transaction Costs (Initial Fiscal Year Costs)	Host country approval costs, baseline setting, validation, and registration costs were determined, on the basis of a local interview survey, as 6.60 million yen (0.51 million RMB).
10. Operating Costs	Labor costs for the employees who will be needed to operate the project, together with materials costs (operation and maintenance costs), were determined to be 0.2 RMB/kWh on the basis of a local interview survey. It was decided that the manufacturers would cover the operation and maintenance (OM) costs for the first fiscal year. An agreement was made to contract with the manufacturers to handle OM from the second year of operation.
	CDM verification and certification costs were determined to be 2.20 million yen/year.
	The costs of maintaining the company (contingencies) was set at 10% of sales.
11. Income from Sales of Generated Electric Power	Power output will be 1,030 kW per generator. This takes into account 5% for power generation losses. The generator operating time was set at 7,884 hours/year (utilization rate of 90%).

	The wholesale price for the sale of electric power generated at the landfill was set at 0.40 RMB/kWh based on local interview surveys.
12. Income from Sale of CO_2 Carbon Credits	The economic analysis considered four cases for CERs price; With no credit sold, and with credits at \$2/t-CO_2, \$4\$/t-CO_2, and \$10/t-CO_2.

Working from the assumptions noted above, the internal rate of return (IRR), the net present value (NPV), and the years to recovery of investment were calculated with the results as shown below.

CERs price / Evaluation Category	No Credits	\$2/t-CO_2	\$4.5/t-CO_2	\$10/t-CO_2
IRR (%)	－1%	13%	26%	51%
NPV	－138.06 million yen	6.58 million yen	199.60 million yen	6.24220 billion yen
Years to Recovery of Investment	11 years	6 years	4 years	3 years

The calculations show that when no credits are sold, both the IRR and the NPV are negative numbers. In this case, it would be better not to make the investment. On the other hand, examination of the cases where credits are sold shows that when the credit price is \$2/t-CO_2 then the IRR is 13% and the required rate of return approaches 12%. In cases when the price of credits rises to \$4.5/t-CO_2, the IRR becomes 26% and the NPV also rises to approximately 200 million yen. These results indicate that the project is more attractive to investment when the price of credits is \$4.5/t-CO_2 or more.

■ Specific prospects and issues for implementing the project

The host country has instituted Interim Measures for Operation and Management of Clean Development Mechanism Projects, and it imposes various restrictions on the investing country with respect to the price of credits, taking of profits, and other such matters in order to grant approval. The greatest issue for Chubu Electric Power Co., Inc. is whether the Chinese government will approve the project under conditions that will prevent it as a foreign-owned corporation from suffering unreasonable loss. At present, the project capital is anticipated to be composed of investments and loans from

local enterprises in the host country. These circumstances make it difficult for Chubu Electric Power Co., Inc., to participate as an investor. The company therefore aims to take part in the project by structuring the CDM scheme, carrying out the procedures to obtain credits, and purchasing carbon credits.
(4) Validation and determination (in the event these processes are carried out)
■ Overview of validation (determination) and desk review Not implemented yet ■ Course of Interaction with Operational Entity (OE) Not implemented yet