Study name:

Study of the Feasibility of Realizing a CDM Project to Generate Electric Power Using Waste Disposal Site Gas and Sewage Sludge Treatment Gas in the City of Amoy in China

Group Name

EJ Business Partners Co., Ltd.

1. Survey Implementation organization

Shanghai Weitai Environment Co., Ltd.	Support for PDD preparation
Xiamen Perfect New Energy Co., Ltd.	Partner in China
Xiamen Municipal Economic Development Co., Ltd.	Support for data collection
General Water of Xiamen Sewage Co., Ltd.	Wastewater treatment plant manager
Eastern Landfill site	Final waste disposal site manager

2. Outline of the Project

2.1 The project

This project will produce methane from gas recovered from anaerobic fermentation of sewage sludge discharged in the city of Amoy in China (below, “Amoy City”), and which until now has not been recoverable and usable as a resource, and from gas recovered from a landfill site in the eastern part of the city, use the methane to generate electric power, and use waste heat to dry the sludge. Surplus electric power not consumed by the project will be sold to the grid. It is estimated that the electric power generation capacity will be 6MW and that the project will cost 1.65 billion yen.

The project will be implemented by the Xiamen Perfect New Energy Co., Ltd. which has already been established as a joint partner to conduct the gas recovery and electric power generation CDM project at the Donfu Disposal site in Amoy City.

The base line scenario is; (1) power from the grid is consumed, (2) methane is produced from city garbage disposed of at the disposal site, and (3) methane is produced from sewage sludge also disposed of at the disposal site. The project scenario is the reduction of the consumption of fossil fuels by supplying the grid with electric power generated by a generator powered by methane obtained by anaerobic fermentation of sewage sludge (anaerobic digestion) and by recovering gas from the disposal site. Preventing the disposal of sewage sludge as landfill will avoid producing methane.

Implementing the project will reduce emissions of greenhouse gases (GHG) by an average of 298,610t-CO_2/year during the 10 year period from 2013 to 2022.

2.2 Applied methodologies

[ACM0001]: Integrated Methodology for Landfill Gas Project Activities

[AMS-I.D]: Grid Connected Renewable Electricity Generation

[AMS-III.H]: Methane Recovery in Wastewater Treatment

3. Description of the feasibility study

3.1 Study challenges

① State of approval by the host country

- State of approvals (number of approvals, similar projects etc.)
- Approval system of the Government of China

② State of waste landfill disposal sites and wastewater treatment plants

③ Application of the base line methodology

- Selection of the methodology
- Definition of the project boundary
- Specification of the base line scenario
- Calculation of greenhouse gas (GHG) emission reductions
- Establishment of monitoring method and plan

④ Study of the electric power generation system

- Study of the properties of sludge
- Preliminary study of the electric power generation system
- Selection of the electric power generation system

⑤ Project feasibility study

- Estimating plant construction cost
- Estimating plant maintenance cost
- Income earned by the project
- Setting the benchmark to evaluate project feasibility
- Proving additionality
- Funding plan

⑥ Commercialization consultation

- Project implementation organization
- Project implementation period/credit acquisition period
- Project implementation schedule

⑦ Environmental impact assessment

- Study of systems etc. for environmental impact assessments in the host country etc.
- Study of environmental impact of implementation of the project
- Study of other indirect impacts

⑧ Co-benefit realization method and indexing for warming prevention and pollution prevention measures

3.2 Description of the study

3.2.1 State of approvals by the CDM host country

The following describes the preparation of the CDM system in China

May 1998 Signing of the Kyoto Protocol

August 2002 Ratification of the Kyoto Protocol

June 2004 Enactment of the Provisional Measures of Operation and Management for this CDM Project

October 2005 Enactment of the Measures for Operation and Management

The system has been prepared as shown above, and in November 2004, CDM government approval (Anding Landfill Gas Recovery and Use Project) was given for the first time in China.

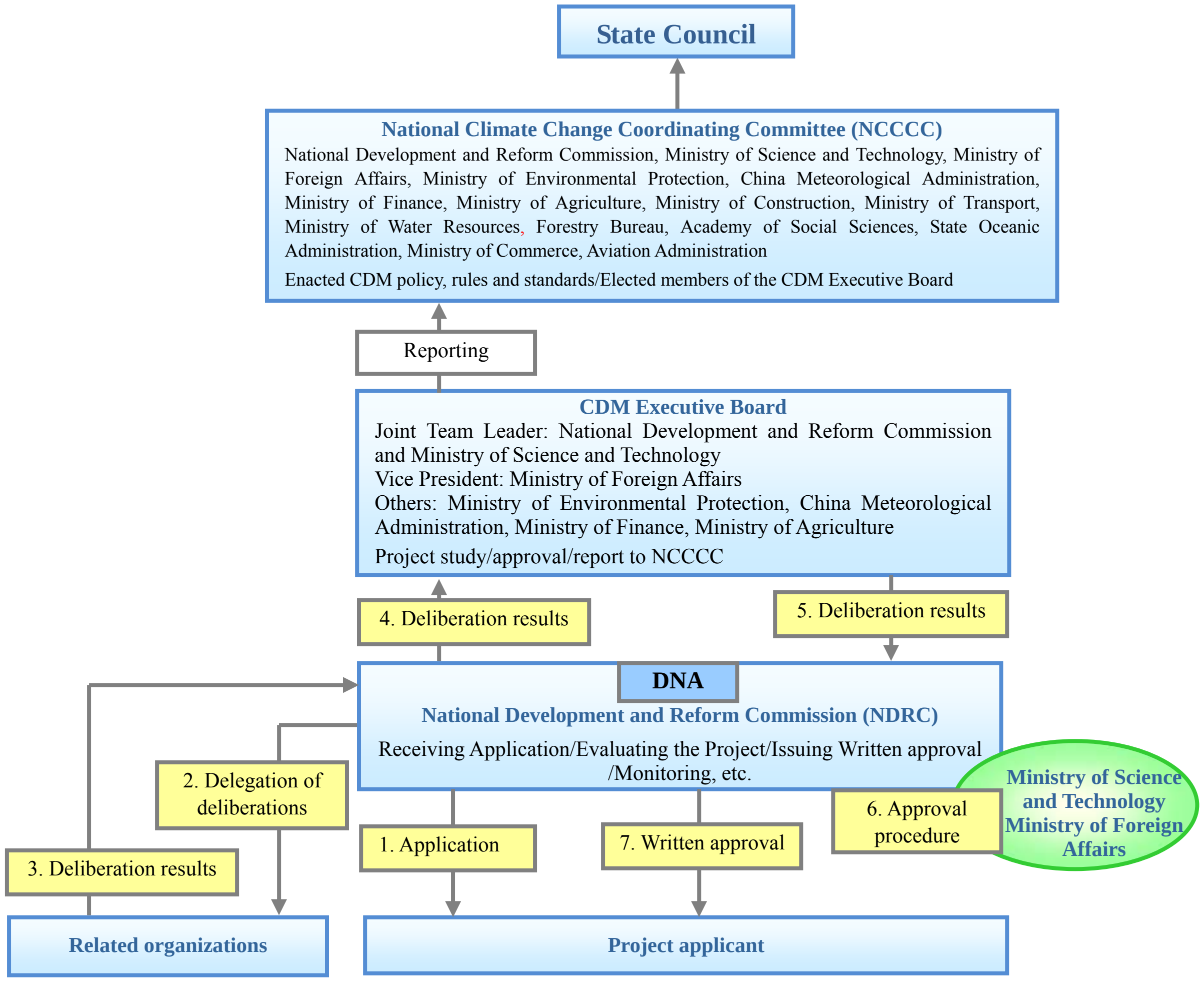


Figure 3-2-1 CDM Approval System in China

Source: Web site of the Kyoto Mechanism Information Platform (http://www.kyomecha.org/pf/china.html)

As of November 4, 2010, 2,472 projects were registered by the UN CDM-EB, and 1,010 of these were projects in China. And 23 were registered under the methodology: [ACM0001]: Integrated Methodology for Landfill Gas Project Activities. Another 6 were also registered [AMS-I.D]: Grid Connected Renewable Electricity Generation, while none applied [AMS-III.H]: Methane Recovery in Wastewater Treatment.

3.3 State of waste disposal and wastewater treatment

3.3.1. State of waste disposal

(1) Quantity of garbage produced

Table 3-3-1 shows the quantity of garbage produced in Amoy City from 2005 to 2008.

Table 3-3-1 Quantity of Garbage Produced

(Unit: t/year, t/day)

District name	2005	2006	2007	2008
Siming District	231,882.97	242,708.87	244,018.10	258,978.76
Huli District	214,278.21	251,332.70	307,094.21	310,948.39
Jimei District	78,209.46	76,838.61	94,790.12	104,442.59
Haicang District	38,322.33	62,102.69	96,384.55	81,604.51
Tongan District	39,666.37	44,526.93	61,360.03	88,017.26
Xiangan District	-	21,900.00	28,182.00	26,563.80
Gu Lang Yu	6,095.42	6,417.68	-	-
Totals	608,454.76	705,827.49	831,829.01	870,555.31
Average daily production	1,667.00	1,933.77	2,278.98	2,385.08

Document: Amoy City

(2) Predicted production of garbage

Table 3.3.2 shows predicted garbage production for 2010, 2015, and 2020 based on estimates by the Amoy City Council.

Table 3-3-2. Predicted Production of Garbage

(Unit: t/day, 10,000t/year)

District name	2010		2015		2020	
	Daily production	Annual production	Daily production	Annual production	Daily production	Annual production
Siming District	868.4	31.7	929.1	33.9	945.8	34.6
Huli District	563.3	20.5	602.5	21.9	614.7	22.5
Jimei District	219.3	8.0	235.4	8.6	239.4	8.8
Haicang District	405.2	14.8	432.5	15.9	441.7	16.0
Tongan District	470.7	17.1	503.1	18.4	512.3	18.6
Xiangan District	375.1	13.8	401.4	14.6	409.1	14.9
Totals	2,902.0	105.9	3,104.0	113.3	3,163.0	115.4

Document: Amoy City

(3) Outline of the landfill site

Table 3-3-3 shows an outline of the landfill site at the Amoy City East Garbage Disposal Base.

Table 3-3-3 Outline of Eastern Landfill Site

Name of Facility	Amoy City East Garbage Disposal Base, Waste Fill Disposal Site
Address	Amoy City, Xiangan District, Baiyunfei
Site area	207ha
Landfill capacity	20,060,000 m^3 (First phase: 6,630,000 m^3, second phase: 13,430,000 m^3)
Quantity of waste disposed of as fill	2,300 to 2,400 day (recent years)
Beginning of service	December 2008 (full-scale operation from April 2009)
Waste materials handled	Household garbage, sludge, incinerator ash (only small quantities of sludge and incinerator ash)

3.3.2 State of wastewater treatment

(1) Outline of the wastewater treatment plants

Table 3-3-4 presents an outline of the wastewater treatment plants in Amoy City. There are 7 wastewater treatment plants in Amoy City with design treatment capacity totaling 830,000 m^3/day of wastewater. But at this time, they only treat about 500,000 m^3/day. They are supplied by a total of 680 km of pipelines and 80 pumps.

Table 3-3-4 Outline of Wastewater Treatment Plants

Plant name	Beginning of service	Area of service region	Sewered population	Treatment method	Treatment capacity (design)	Quantity treated (present time)
Yundang Wastewater Treatment Plant	2006	70km^2	900,000	Biofiltration method	300,000m^3/day	230,000m^3/day
Shiweitou Wastewater Treatment Plant	2001	72km^2	480,000	AO method	200,000m^3/day	96,000m^3/day
Haicang Wastewater Treatment Plant	2000	170km^2	700,000	Standard activated sludge method	100,000m^3/day	46,000m^3/day
Tongan Wastewater Treatment Plant	2005	14.7km^2	140,000	OD method	100,000m^3/day	46,000m^3/day
Xiangan Wastewater Treatment Plant	2006	40km^2	150,000	OD method	25,000 m^3/day	4,000m^3/day
Xinglin Wastewater Treatment Plant	2007	45km^2	200,000	A20 method	60,000m^3/day	46,000m^3/day
Jimei Wastewater Treatment Plant	2000	26km^2	200,000	OD method	45,000m^3/day	34,000m^3/day
Totals	—	437.7km^2	2,770,000	—	830,000m^3/day	Approx. 502,000 m^3/day

Note: OA method: anaerobic – aerobic method,
A2O method: anaerobic – anoxic –aerobic
OD method: oxidation ditch method
Document: Xiamen Water Group Co., Ltd.

(2) Planned quantity of wastewater to be treated

Table 3-3-5 shows the planned quantity of wastewater to be treated at the wastewater treatment plants.

Table 3-3-5 Planned Quantity of Wastewater to be Treated

(unit: 10,000t/year)

Facility name	2010	2011	2012	2013	2014
Yundang Wastewater Treatment Plant	8,979	8,395	8,567	8,760	9,125
Shiweitou Wastewater Treatment Plant	3,654	5,110	6,570	7,300	7,300
Haicang Wastewater Treatment Plant	1,894	2,008	2,190	2,373	2,446
Tongan Wastewater Treatment Plant	2,026	2,190	2,482	2,738	2,920
Xiangan Wastewater Treatment Plant	234	347	529	657	730
Xinglin Wastewater Treatment Plant	1,734	1,825	1,898	2,008	2,190
Jimei Wastewater Treatment Plant	1,402	1,643	1,643	1,643	1,643
Totals	19,922	21,517	23,878	25,477	26,353

Document: Xiamen Water Group Co., Ltd.

(3) Present treated sludge

Table 3-3-6 shows the present quantities of treated sludge produced by the wastewater treatment plants (2009).

Table 3-3-6 Present State of Sludge Treatment (2009)

Facility name	Dewatering method	Sludge production		Treatment methods
		Annual (t/year)	Daily (t/day)	
Yundang Wastewater Treatment Plant	Deep dewatering, centrifugal dewatering	49,897	136.7	Composting, incineration, fill, construction materials
Shiweitou Wastewater Treatment Plant	Deep dewatering, centrifugal dewatering	31,786	87.1	Fill, construction materials
Haicang Wastewater Treatment Plant	Belt press dewatering	19,170	52.5	Incineration, fill
Tongan Wastewater Treatment Plant	Centrifugal dewatering	12,041	33.0	Incineration, fill, construction materials
Xiangan Wastewater Treatment Plant	Centrifugal dewatering	342	0.9	Fill
Xinglin Wastewater Treatment Plant	Deep dewatering	11,640	31.9	Incineration, fill
Jimei Wastewater Treatment Plant	Deep dewatering	9,384	25.7	Fill
Totals	-	134,260	367.8	-

Document: Xiamen Water Group Co., Ltd.

(4) Predicted quantity of sludge produced

Table 3-3-7 shows the results of a prediction of the increase in the quantity of sludge produced as a result of the increase of the quantity of wastewater treated.

Table 3-3-7 Predicted Quantity of Sludge Produced

(Unit: t/day)

Plant name	2010	2011	2012	2013	2014
Yundang Wastewater Treatment Plant	145.9	136.4	139.2	142.4	148.3
Shiweitou Wastewater Treatment Plant	91.0	127.3	163.7	181.9	181.9
Haicang Wastewater Treatment Plant	59.4	62.9	68.7	74.4	76.7
Tongan Wastewater Treatment Plant	40.1	43.4	49.2	54.2	57.9
Xiangan Wastewater Treatment Plant	1.5	2.2	3.4	4.2	4.7
Xinglin Wastewater Treatment Plant	33.1	34.9	36.3	38.4	41.9
Jimei Wastewater Treatment Plant	29.0	34.0	34.0	34.0	34.0
Totals	400.0	441.1	494.5	529.5	545.4

(5) Sludge treatment cost

Table 3-3-8 shows the cost of treating sludge produced by the wastewater treatment plants (2009).

Table 3-3-8 Sludge Treatment Cost

Treatment method	Treatment Cost
Composting	At the Yundang Wastewater Treatment Plant, greening use compost (water content: 40% or less) and agricultural use compost (water content: 30% or less) are manufactured and sold for a price of 450 yuan/ton.
Construction materials	Sewage sludge (water content: 80%) is sold to a brick works at a price of 80 yuan/ton.
Incineration	Sewage sludge (water content: 80%) is sold to a private sector incineration plant at a price of 320 yuan/ton. But 140 yuan is paid by the city government while the remaining 180 yan is paid by the Xiamen Water Group Co.,Ltd.
Fill	The cost of treatment of sewage sludge disposed of as fill at the Tohbu Landfill Site is not paid. On the other hand, water drained from the Tohbu Landfill Site is treated by treatment plants operated by the Xiamen Water Group Co.,Ltd., but treatment costs are not paid.

Document: Xiamen Water Group Co.,Ltd.

Table 3-3-9 shows cost of transporting sludge produced by the final treatment plants (2009).

Table 3-3-9 Transportation Cost

Water content	Within 10km	Per km at 10km and more
60% (DRY)	7 yuan/ton	1.28 yuan/ton
80% (WET)	10 yuan/ton	1.80 yuan/ton

Document: Xiamen Water Group Co., Ltd.

(6) Study of properties of sludge

At the time of the first field study, one sample of dewatered sludge was obtained and analyzed at wastewater treatment plants at four locations. Table 3-3-10 shows the results of the analysis of the dewatered sludge.

Table 3-3-10 Results of Analysis of Dewatered Sludge

Item		Unit	Shiweitou (deep dewatering)	Yundang (dewatered sludge)	Haicang (dewatered sludge)	Xiangan (dewatered sludge)	Analysis method
Three constituents	Water	%	60.0	78.1	79.8	67.9	1977 kansei No. 95, Attachment 2
	Ash	%	21.8	8.8	11.2	19.0	1977 kansei No. 95, Attachment 2
	Combustible contents	%	18.2	13.1	9.0	13.1	1977 kansei No. 95, Attachment 2
High calorific value		J/g	8,410	15,300	8,660	8,130	JIS M 8814
Low calorific value		J/g	1,530	1,140	-410	648	JIS M 8814
Unit volume weight		g/L	940	1,000	1,000	1,000	1977 kansei No. 95, Attachment 2
Evaporation residue		%	39	21	21	32	Sewage Testing Method, Volume 2, Chapter 2
Ignition loss		%	43	58	43	38	1988 kansuikan No. 127
Nitrogen content		%	3.4	4.1	3.5	2.8	Method using a C.H.N. recorder
Phosphorus content		%	1.9	1.7	1.6	2.0	1988 kansuikan No. 127
BOD		g/kg	160	430	110	39	JIS K 0102.21 and 32.3
COD_{Cr}		g/kg	510	920	580	460	JIS K 0102 20.

3.4 Study of the electric power generation system

3.4.1 Study of the quantity of the biomass produced

This project will permit the collection of 250 tons/day of sewage sludge produced from the wastewater treatment plants shown in 3.3.2 State of wastewater treatment. And 1,663tons/day (average over 10 years of the project period) of waste will disposed as landfill in the final disposal site.

3.4.2 The electric power generation system adopted for the project

The result of analysis of its properties show that the sewage sludge has high water content and low calorific value, making it unsuitable for direct combustion, so gas engine electric power generation based on methane fermentation has been adopted as the electric power generation system. Methane fermentation is the decomposition of organic material by a variety of anaerobic microorganisms, producing methane gas and carbon dioxide. The following is a description of the actual electric power generation system.

- Sewage sludge produced by the wastewater treatment plants is received and mixed in receiving and feeding equipment, then placed in sludge digestion tanks.
- The sewage sludge undergoes methane fermentation in the sludge digestion tanks.
- LFG generated by a final treatment plant is recovered by LFG recovery equipment.
- Biogas obtained from the sludge digestion tanks and LFG from the final treatment plant are first pretreated, including dehumidification and desulfurization, then stored temporarily in a gas holder, and finally they are recovered as electric power and heat by electrical generation and heat utilization equipment etc.
- The electric power which is generated is used as a internal plant power source and is sold to the grid. And the heat produced is used to heat the sludge digestion tank.
- Residue produced by the methane fermentation tank undergoes deep dewatering, and is then sent to the final disposal site for disposal as fill.
- The supernatant liquor produced by deep dewatering is treated in drainage treatment equipment then discharged into the sewer system.
- The quantity of biogas obtained from methane fermentation of the sewage sludge and the quantity of LFG produced by the final treatment plant will generate 6MW of electric power.

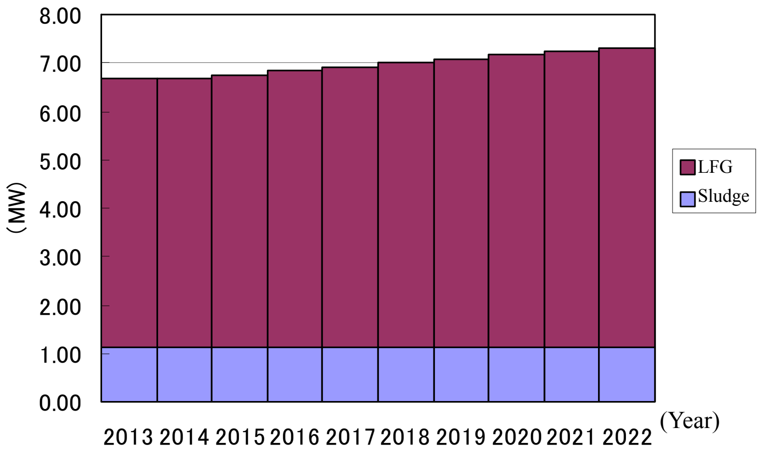


Figure 3-4-1. Electric Power Generation Capacity

Figure 3-4-2 shows the electric power generation system adopted for this project.

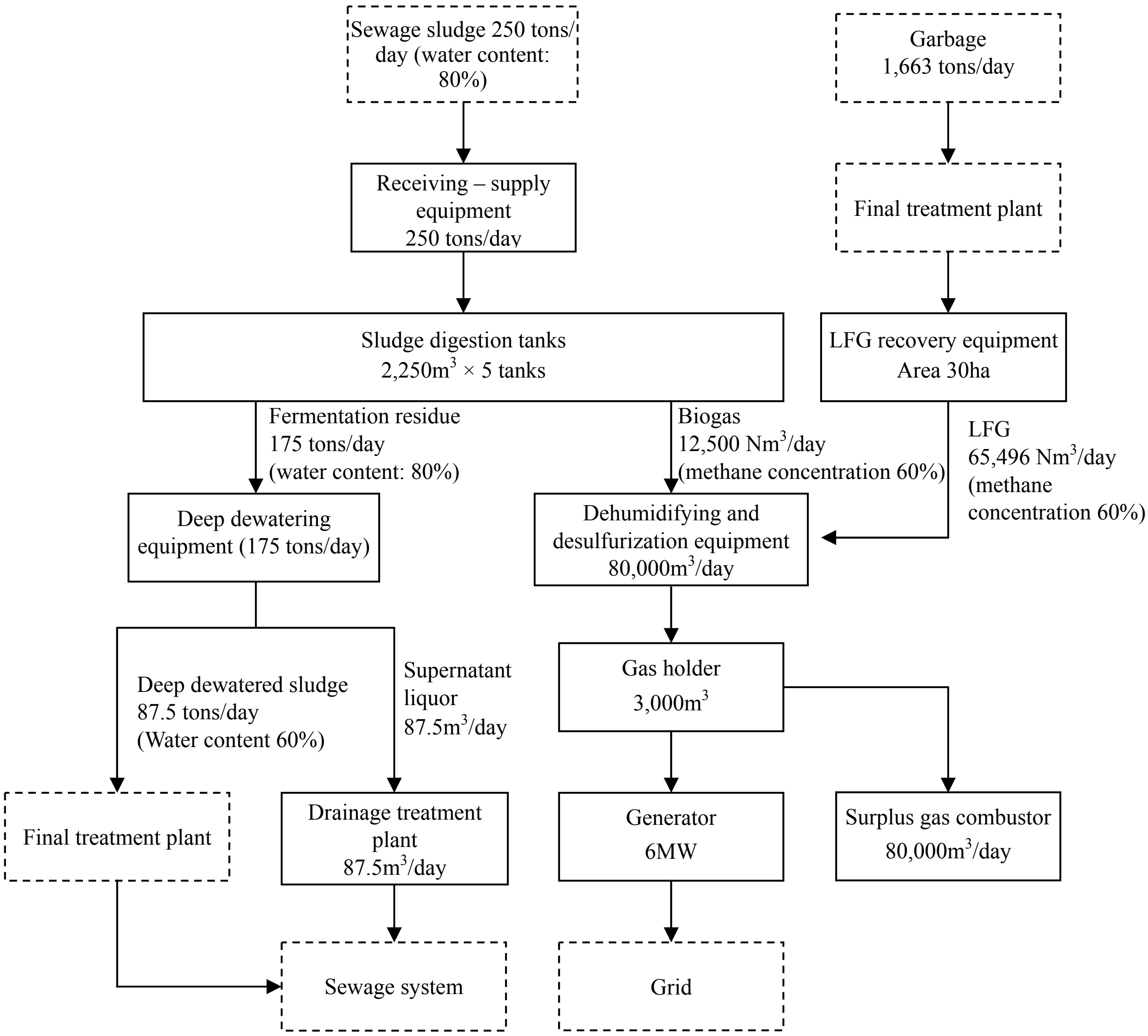


Figure 3-4-2 Biomass Electric Power Generation System

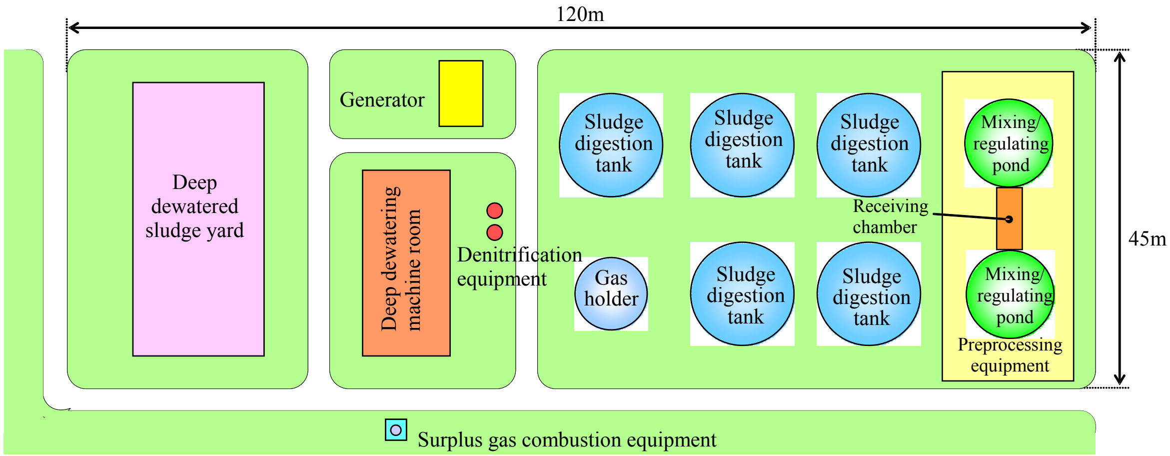


Figure 3-4-3 Layout Plan (proposed)

Table 3-4-1 Approximate Project Costs

Equipment name	Details	Specifications	Unit (10,000 yuan)	Quantity (units)	Amount (10,000 yuan)
LFG recovery equipment	LFG recovery equipment	Fill area: 30ha	550	1	550
Sludge digestion equipment	Receiving and feeding equipment	Receiving capacity: 250tons/day (w80%)	160	1	160
	Anaerobic digestion tank	Treatment capacity: 250tons/day (w80%)	400	5	2,000
Gas regulating equipment	Dehumidification equipment	Treatment capacity: 80,000m^3/day (CH4:60%)	200	1	200
	Desulfurization equipment	Treatment capacity: 80,000m^3/day (CH4:60%)	400	1	400
	Gas holder	Storage capacity: 3,000m^3 (CH4:60%)	380	1	380
Dewatering equipment	Dewaterer	Filter press (w80%→w60%) Treatment capacity: 250tons/day (w80%)	300	2	600
Surplus gas combustion equipment	Flare equipment	Treatment capacity: 80,000m^3/day (CH4:60%)	120	1	120
Electric power generator	Electric power generation system	Gas engine, power generation capacity: 6MW	1,100	3	3,300
	Transformer	0.4kV→13.2kV	500	1	500
	Power transmission equipment	Transmission distance: 2km	200	1	200
Civil engineering/ construction equipment	Control building	Floor area: 300m^2	300	1	300
Water treatment equipment		Treatment capacity: 125m^3/day Treatment capacity; BOD (2,000mg/L→300mg/L)	1,800	1	1,800
Other costs		Transportation cost, personnel cost, crane, tools, insurance etc.			2,200
Total	-	-	-	-	12,710

4. Results of study in preparation for implementation of the CDM Project

4.1 Setting the base line scenario and project boundary:

This project will produce methane from gas recovered from anaerobic fermentation of sewage sludge discharged in Amoy in China, and which until now has not been recoverable and usable as a resource, and gas recovered from a final landfill site, use the methane to power a gas engine to generate electric power, and use waste heat from the gas engine to heat the sludge digestion tanks.

Existing approved methodologies are applied as the base line methodologies.
[ACM0001]: Integrated Methodology for Landfill Gas Project Activities
[AMS-I.D]: Grid Connected Renewable Electricity Generation
[AMS-III.H]: Methane Recovery in Wastewater Treatment

4.2 Quantity of emissions by the project

(1) Project emissions resulting from methane recovery and electric power generation at the final disposal site.

$PE_{MSW,y} = PE_{EC,y} = EC_{PJ,y} * CEF_{elec,BL,y} * (1+TDL_y)$

$PE_{EC,y}$	Quantity of project emissions from electric power consumption by the project (tCO2e/yr)
$EC_{PJ,y}$	Electric power consumption by the project (MWh)
TDL_y	Average transmission to the grid and distribution loss

(2) Production of methane by disposing of digested dewatered sludge in landfill and seepage of methane from the system (AMS-III. H)

$PE_{sluge,y} = PE_{power,y} + PE_{s,treatment,y} + PE_{s,final,y} + PE_{fugitive,y}$

$PE_{power,y}$	Quantity emitted by consumption of electric power or fuel (tCO_2e);
$PE_{s,treatment,y}$	Quantity of methane emitted from the sludge treatment system impacted by use of the project (tCO_2e);
$PE_{s,final,y}$	Quantity of methane emitted from anaerobic decay of final sludge (tCO_2e);
$PE_{fugitive,y}$	Quantity of methane emitted as a result of gas leakage from the gas recovery system. (tCO_2e).

The project will introduce sludge anaerobic digestion tanks and biogas recovery equipment. Residual sludge will be transported to the Tohbu Final Disposal Site for disposal as fill.
In cases where there is no sludge treatment system impacted by project activities and residual sludge of the project is disposed of at a disposal site with a biogas recovery facility, there ought to be no emissions from anaerobic decay of the sludge.
Consequently, $\mathbf{PE_{s,treatment,y}}$ and $\mathbf{PE_{s,final,y}}$ are zero.

$$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y}$$
$$PE_{fugitive,s,y} = (1 - CEF_s) * MEP_{s,treatment,y} * GWP_{CH4}$$

$$MEP_{s,treatment,y} = \sum_l \left(S_{l,PJ,y} * MCF_{s,treatment,PJ,l} \right) * DOC_s * UF_{PJ} * DOC_F * DOC_F * F * \frac{16}{12}$$

$PE_{fugitive,ww,y}$	Quantity of emissions from seepage caused by inefficient gas recovery by the anaerobic drainage treatment system. (tCO_2e)
$PE_{fugitive,s,y}$	Quantity of emissions from seepage caused by inefficient gas recovery by the anaerobic sludge treatment system. (tCO_2e)
CEF_s	Recovery efficiency of biogas recovery equipment in the sludge treatment system (default value is 0.9)
$MEP_{s,treatment,y}$	Potential methane emission of the sludge treatment system including a biogas recovery system
$S_{l,PJ,y}$	Quantity of sludge treated by the project's sludge treatment system, which includes a biogas recovery system (t);
$MCF_{s,treatment,PJ,l}$	Methane correction coefficient of a sludge treatment system with a biogas recovery system.
UF_{PJ}	Model uncertainty compensation coefficient (1.12).

4.3 Monitoring Plan

4.3.1 Monitoring method

This project will monitor parameters considered necessary to confirm the quantity of reduction of emissions in line with ACM0001, AMS-I.D. and AMS-III.H. The monitoring, which is based on direct measuring of gas consumption and electric power production at each location and electric power generator in the power plant, measures these values using measuring instruments.

4.3.2 Items monitored

The following are the items which should be monitored during this project.

Table 4-3-1 Monitoring plan

No.	Items	Frequency
1	Quantity of LFG recovered (LFG-total)	Daily
2	Methane concentration of LFG (LFG-WCH4.y)	Daily
3	Temperature of LFG (LFG-T)	Daily
4	Pressure of LFG (LFG-P)	Daily
5	Total quantity of biogas recovered (BG-total)	Daily
6	Methane concentration in biogas	Daily
7	Temperature of biogas (BG-T)	Daily
8	Pressure of biogas (BG-P)	Daily
9	Total gas used to generate electricity (Gas-electricity.y)	Daily
10	Methane concentration of gas used to generate electricity (Gas-WCH4.y)	Daily
11	Temperature of gas used to generate electricity (Gas-T)	Daily
12	Pressure of gas used to generate electricity (Gas-P)	Daily
13	Quantity of electricity generated (EG)	Daily
14	Operating hours (H)	Daily
15	Quantity of electric power consumed (ECy)	Monthly
16	Quantity of fossil fuels consumed (Qfuel.y)	Monthly
17	Grid discharge coefficient (CEFelectricity)	Once/year
18	Quantity of waste in land fill (Qwaste.prod.y)	Daily
19	Quantity of sludge treated (Qsludge.prod.y)	Daily

In addition, laws and regulations concerning the project activities must be studied and equipment specifications must be compared with actual equipment as necessary.

4.4 Greenhouse effect gas reduction (or absorption)

Table 4-4-1 shows estimates of greenhouse gas (GHG) emission reduction which the project is counted on to achieve.

Table 4-4-1 Greenhouse Effect Gas Reduction

(unit: t-CO_2)

Years of operation	Reduction of emissions by avoiding production of methane from sewage sludge	Methane recovered from the final disposal site	Reduction of emissions by replacing grid power	Base line emissions	Electric power consumed inside the power plant	Electric power consumed by sludge digestion equipment	Quantity of methane produced by disposing of digested sludge as fill	Emissions by the project	Greenhouse gas emission reduction
2013	56,849	205,259	33,808	295,916	1,690	563	5,723	7,977	287,939
2014	56,849	205,558	33,808	296,215	1,690	563	5,723	7,977	288,238
2015	56,849	208,207	33,808	298,864	1,690	563	5,723	7,977	290,887
2016	56,849	211,053	33,808	301,710	1,690	563	5,723	7,977	293,733
2017	56,849	214,024	33,808	304,681	1,690	563	5,723	7,977	296,704
2018	56,849	217,045	33,808	307,702	1,690	563	5,723	7,977	299,725
2019	56,849	220,073	33,808	310,730	1,690	563	5,723	7,977	302,753
2020	56,849	223,071	33,808	313,728	1,690	563	5,723	7,977	305,751
2021	56,849	226,038	33,808	316,695	1,690	563	5,723	7,977	308,718
2022	56,849	228,968	33,808	319,625	1,690	563	5,723	7,977	311,648
Totals	568,488	2,159,296	338,083	3,065,866	16,904	5,635	57,232	79,771	2,986,095

4.5 Project period/credit acquisition period

The project will begin in 2011, with its schedule predicting validation after 4 months, UN approval including both governments after 8 months, and the work itself taking 12 months. It is aiming to start electric power production in January 2013. The planned credit acquisition period is 10 years from January 2013 until December 2022.

4.6 Environmental impact and other indirect impacts

The environmental impact of implementing the project includes atmospheric pollution by fine particles caused by operation of the gas engine, plant noise, and dust during construction, but an environmental impact assessment will be done, and in response, high level exhaust control, monitoring, and maintenance will be carried out.

Construction period

① Construction period

Noise: Under GB12523-90 Restrictions on Noise at Construction Site Boundary, low-noise construction machinery will be used and work periods restricted.

② Operating period

Atmospheric pollution: Under DB35/323-1999 Amoy Atmospheric Pollutant Exhaust Control Standards and GB16297-1996: Atmospheric Pollution Exhaust Standards, SOx and NOx etc. will be managed by controlling combustion through the gas engine and flare.

Drainage: Under DB35/322-1999: Amoy Water Pollutant Drainage Control Standards and GB8978-1996: Drainage Standards, treatment will be performed at the seepage water treatment facility at the Tohbu Final Disposal Site so that the standard values are satisfied.

4.7 Comments by Interested Parties

During interviews with people who are presumed to have an interest in this project, they made the following comments.

(1) General Water of Xiamen Sewage Co., Ltd.

Date: September 13 (Mon.) 2010, December 8 (Wed.), 2010

Place: Conference room at the Shiweitou Wastewater Treatment Plant

Interviewee: Xie General Manager

Method: Face-to-face interview

Specific comments: Regarding our present sludge treatment, we are implementing and studying composting, incineration, fill and other disposal methods, but we have not made a clear decision on the disposal method. As the population has increased in Amoy City, the quantity of sludge has also continually risen, so we are eagerly looking forward to the results of the study. Producing electricity from sludge as we dry it is a model project of the Government of China, so we definitely want to make it a reality.

We want to effectively use sewage sludge in the future in order to return it to the soil without incineration whenever possible. And even inside China, reducing gases that cause global warming is an important challenge.

(2) Eastern Landfill Site

Date: September 16 (Thurs.) 2010

Place: Director's office at the Eastern Landfill site

Interviewee: Plant Director

Method: Face-to-face interview

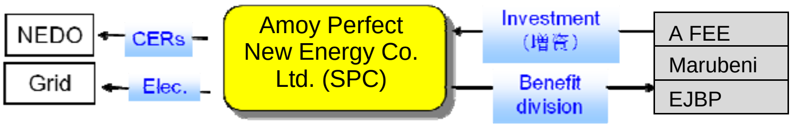
Specific comments: We must study the use of methane gas produced by garbage, including electric power production. I am extremely interested in the effective use of sludge, so if you have a good idea, please propose it to me.

4.8 Project implementation organization

The following is the project implementation organization.

It is assumed that this CDM project will be implemented by increasing funding of the Xiamen Perfect New Energy Co., Ltd., which has already been established as a joint venture company to implement the gas recovery and electric power production CDM project at the Donfu Disposal Site in Amoy City.

The investing companies, Xiamen Associated Flourish Environmental S&T Co., Ltd. (AFEE), Marubeni Corporation (Marubeni), and EJ Business Partners Co., Ltd. (EJBP) are shareholders in Xiamen Perfect New Energy Co., Ltd. (SPC).



AFEE: Xiamen Associated Flourish Environmental S&T Co., Ltd.

Figure 4-8-1 Project Implementation Organization

4.9 Funding plan

4.9.1 First phase project cost

The initial investment is estimated to be about 1.652 million yen (converted to yuan at a rate of 1 yuan = 13 yen)

(1) Recovery, digestion, and pre-processing equipment: 558 million yen

LFG recovery equipment, sludge digestion equipment, gas regulating equipment, dewatering equipment etc.

(2) Gas electric power generation/heat utilization equipment: 536 million yen

Flare equipment, electric power generation equipment, transformer equipment, power transmission equipment, etc.

(3) Civil engineering and construction equipment: 39 million yen

Control building etc.

(4) Water treatment equipment: 234 million yen

(5) Other costs: 286 million yen

Transport cost, personnel cost, tools, cranes, insurance, etc.

4.9.2 Funding plan (loans and interest)

Approximately 30% (500 million yen) of the initial project investment (1,652 million yen) will be capitalized. The remaining 70% (1,152 million yen) will be borrowed from banks etc.

Through specific consultations with lenders, fund procurement in the form of project financing and corporate financing from lenders with past loan experience, local banks, or the main bank of funding companies will be studied.

4.10 Analysis of economic efficiency

4.10.1 Project income

Table 4-10-1 shows the income earned by this project

Based on the estimate that the price of credit is US$10.—/t-$CO_2$, the internal rate of return (IRR) of the project for the 10 year period when credit will be obtained is 19.5%.

Table 4-10-1 Project Income Table (unit: millions of yen)

Item	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Sales	606	606	609	611	614	616	619	622	624	627	6,155
Sale of electricity	352	352	352	352	352	352	352	352	352	352	3,521
CERs sales ($10/t-$CO_2$)	254	254	257	259	262	264	267	270	272	275	2,634
Costs (maintenance cost, personnel cost, etc.)	190	190	190	190	190	190	190	190	190	190	1900
Depreciation (residual 10%)	123	123	123	123	123	123	123	123	123	123	1230
Operating earnings	293	293	296	298	301	304	306	309	311	314	3,026
Interests paid	92	92	74	55	37	18	-	-	-	-	369
Pre-tax profit	201	201	222	243	264	285	306	309	311	314	2,657
Corporate tax etc.	50	50	56	61	66	71	77	77	78	79	664
After-tax profit	151	151	167	182	198	214	230	232	234	236	1,993

4.10.2 Sensitivity analysis of credit

A sensitivity analysis of the economic efficiency of the project was performed within the range from no credit (CER_S) price to credit (CER_S) price of $10/t-$CO_2$. (Table 4-10-2).

As a result, it was determined that in a case where the CERs price is more than US$4/ton, the project IRR will exceed the bench mark discussed below (6.14%).

Table 4-10-2 Sensitivity Analysis of Credit

CER price (USD/tCO2)	0	1	2	3	4	5	8	10
Project IRR (%)	-0.9%	1.8%	4.0%	6.1%	8.1%	10.1%	15.8%	19.5%

4.11 Proving additionality

This project is categorized as a large-scale CDM project, so if possible, it should be verified that the project cannot be implemented without measures to deal with existing barriers such as investment barriers, technological barriers, barriers due to prevailing practice, and other barriers. The following story can prove additionality.

There are technological barriers because at this time, energy is not recovered by sewage sludge digestion at wastewater treatment plants, making this project the first case where this is done.

The following investment analysis of the investment barrier is performed.

The economic efficiency of this project was determined to be potentially high as a CDM project, because a comparison of a case without profits from CERs sale with a case of profits from CERs sale at US$10/t-$CO_2$, showed a sharp increase in the IRR.

Without CERs credit: IRR = -0.9% (recovery impossible)

With CERs credit: IRR = 19.5% (recovered in 6 years)

The bench mark for investment in this project is set at long term interest of 6.0% by the People's Bank of

China. Without profits from the sale of CERs, it would be impossible to recover the investment, so this project is judged impossible without CDM.
The above proves that there are technological barriers and investment barriers, and also verifies the additionality of this project.

4.12. Prospects for commercialization

4.12.1 Technical aspects

The sludge digestion technology and methane gas electrical power generation technology to be adopted for this project are technically highly feasible, because many proven technologies will be introduced from overseas (from Europe in particular). Our company group has past experience operating a landfill gas recovery and electric power generation project in Amoy City in China, the region where this project will be implemented, almost ensuring it will face no technical or operating problems.

4.12.2 Economic aspects

The economic efficiency of the project exceeds the benchmark if CER income is earned. So carefully watching international negotiation trends between post-Kyoto Japan and China, we put top priority on treating the emission reduction effects of this project as the economic value of credit etc. In the future, it will be necessary to further lower costs and improve its economic efficiency as an electric power sales project.

4.12.3 System aspects

The project feasibility may change greatly according to the feed-in tariff based on the credit price of the Second Commitment Period under the Kyoto Protocol and the Chinese Government's reusable energy policy. Granting incentives to promote reusable energy is a trend not only in China, but around the world, so although it is predicted that the system will be maintained or improved, it is necessary to pay attention to these risks.

4.12.4 Period

Although there is a trend to simplify the inspection procedures of the CDM Executive Board, there continues to be concern with the increasingly long time to complete registration. It is necessary to smoothly carry out CDM registration procedures while observing the past performance of the validator.
Regardless of the several causes for anxiety mentioned above, it has been decided that the project is feasible, and we plan to begin implementing the project as soon as possible.

5. Activation screening

5.1 Outline of activation screening

The Designated Operational Entity (DOE) presented the PDD prepared for this study (implementation period: January 14 to January 27, 2011). The presentation was limited to the desk review of the PDD, and the following are the major items studied.

・Overall entered items from the project activities
・Applicability of base line methodology
・Additionality
・Applicability of monitoring methodology
・Stake holders' comments

5.2 Background to exchanges with the DOE

The following are the major items pointed out by the DOE.

◆Conclusions

As a result of the first review of the PDD, no items clearly fatal for the applicability and interpretation of the project as a CDM project were discovered.

◆Overall entered items from the project activities

Entries regarding detailed information about drainage treatment facilities at 7 locations, about equipment newly introduced through project activities, and clear specification of existing equipment are mentioned as improvements.

And references to the compositions of LFG gas and sludge digestion gas and preprocessing methods necessary before mixing these two gases are also cited as improvements.

◆Applicability of the base line methodology

There are no problems regarding the applicability of ACM0001 and AMS I.D. Entries concerning the impact of project facilities on existing treatment facilities should be included in AMS III.H. And because multiple methodologies are used, the methodology which is the major one for this project should be clearly indicated.

◆ Additionality

The bench mark was used with reference to a bench mark for electric power production projects, but the applicability to a waste material electric power generation project must be confirmed, including the application of the latest version.

◆ Applicability of monitoring methodology

It is necessary to study the monitoring plan along with the three methodologies.

◆Stake holders' comments

It is necessary to a hold stake holders meeting before validation.

In response to the items pointed out above, corrections such as supplementing PDD entries concerning locations which can be corrected at this time were not done.

6. Results of the study of co-benefits

6.1 Study results

6.1.1 Items evaluated

The quantification of environmental pollutant effects of this project are "reduction of waste disposed of as landfill" and "reduction of COD load".

6.1.2 Base line/project scenario

This project will effectively use methane obtained by anaerobic fermentation of sewage sludge, which has not been recycled and used effectively as a resource in the past, and by recovery of gas from a final disposal site.

Therefore, the base line scenario is (1) power from the grid is consumed, (2) methane is produced from city garbage disposed of at the disposal site, and (3) methane is produced from sewage sludge also disposed of at the disposal site.

The project scenario is reduction of waste disposed of as fill and reduction of the COD load by obtaining methane by anaerobic fermentation of sewage sludge and recovery of gas from a disposal site, and use of the gas as fuel.

6.1.3 Method of evaluating the base line and monitoring plan

(1) Method of evaluating the base line.

The base line is evaluated by, in principle, using measurement data.

6.1.4 Calculation process and results of the trial calculation (quantification) preceding implementation of the project

The base line and the quantity of COD treated by the project are trial calculated and the annual reduction of waste and reduction of COD load achieved by the project are calculated.

(1) Reduction of waste disposed of as landfill

Sludge which has undergone anaerobic digestion is disposed of as landfill a second time, so the quantity of sludge reduced by anaerobic digestion equals the reduction of waste as landfill.

The TS (total solids) of sludge is approximately 20% according to the analysis results, and because the TS reduction rate by anaerobic digestion is 30% according to the Rules for Planning and Design for Provision of Facilities at Excess Sludge Resource Recycling Centers (Japan Waste Management Association):

Reduction of waste disposed of as landfill = quantity of sewage sludge which is the object of anaerobic digestion

= 250t/day×TS20% × reduction rate 30%

= 15t-dry/day＝4,500t-dry/year

(2) COD load reduction

Because COD in sludge is decomposed to methane gas by anaerobic digestion, the difference between the quantity of COD in sludge before digestion and the quantity of COD remaining in the sludge after digestion is the COD load reduction.

The CODcr of sludge is approximately 600mg/kg according to analysis results, and because the CODcr decomposition rate of sludge is 35% according to the Rules for Planning and Design for Provision of Facilities at Excess Sludge Resource Recycling Centers (Japan Waste Management Association):

COD load reduction = sewage sludge which is the object of anaerobic digestion

= 250t/day×300 days×600mg/kg×decomposition rate 35%

= 15,750kg-CODcr/year

7. Results of study of contribution to sustainable development

Implementing the project can contribute to sustainable development in the host country as outlined below.

- Reducing waste disposed of as fill
- Avoiding creating odors
- Potential for improvement by obtaining the ability to restrict pollution such as atmospheric pollution indirectly produced by, for example, the atmospheric pollution prevention effects etc. of reducing the fossil fuel share by generating electric power using biomass energy (reduction of use of fossil fuels)
- Creating new employment: staff to install and maintain electric power generation equipment
- Ending energy shortages facing development in China

In China, national development is accompanied by increasing energy consumption. Because this is also increasing the consumption of fossil fuels, producing energy from waste and sludge, which have not been used effectively in the past, will make a big contribution to the environment and the economy, and can also contribute to sustainable development by transferring technology from advanced countries.