Feasibility Studies on Climate Change Mitigation Projects for Clean Development Mechanism (CDM) and Joint Implementation (JI)

"Feasibility Study on Power Generation Utilizing Biogas from Sewage Sludge and Organic Wastes in Kazakhstan"

Digest Version of the Report

(1)Basic factors for implementation of the project

■Outline of the proposed project and background of the planning

Astana City is the capital of the Republic of Kazakhstan, the largest country in Central Asia. The population of the city has increased from 270,000 in 1997 when the capital was transferred from Almaty to 517,000 as of June 1, 2004 and is forecasted to reach a million in 2030 according to some sources.

Along with the rapid population growth, emergence of environmental problems in Astana City due to lack of waste disposal sites and degrading and decrease in function of sewage plants has been reported to the Study on Master Plan for Comprehensive Development of the New Capital City, Astana, Kazakhstan (the Feasibility Study on Water Supply and Sewerage) by Japan International Cooperation Agency (JICA) and, against this backdrop, "Astana Water Supply and Sewerage Project" is currently underway by Japan Bank for International Cooperation.

This is a project to introduce an anaerobic cofermentation system into a swage plant in Astana City and install generating facilities which utilize biogas to be produced, aiming to alleviate the above environmental problems and realize a JI project.

Initially, it was planned to create the anaerobic cofermentation system by utilizing an anaerobic digester chamber for sewage sludge treatment at the sewage plant in Astana and putting organic wastes from nearby food factories and livestock processing business into the chamber. However, as we proceeded with the study, we found out that ①there are not so many food factories nor livestock processing firms in and around Astana City since the capital was transferred there quite recently and that ②a new waste disposal site is currently under construction with help from Spain and LFG flaring is planned there. Consequently, we had to reexamine the plan.

Fig.-1 The Republic of Kazakhstan

In this report, on the assumption that sorted collection of wastes which is presently under discussion in Astana City is started, we have planned to use the anaerobic cofermentation system by organic wastes to be collected through the sorted collection and sewage sludge.

■General description of the host country

General description of Kazakhstan is indicated below.

Country Name : the Republic of Kazakhstan

Capital : Astana

Total area of the country :2,717,300km² (Land:2,669,800km², Lake/River:47,500km²)

Climate :Continental climate, severe winter and hot summer, arid or semiarid

Population :14,862,500 (as of December 2002)

Ethnic composition :Kazak 53.4%, Russian 30.0%, Ukrainian 3.7%, Uzbek 2.5%, German 2.4%, Tatar 1.7%, Uigur 1.4%, Belarusian 0.7%, Korean 0.5% (as of March 1999)

Population growth rate:0.17% (2003)

Language :Kazak (National language), Russian (Official language)

Religion :Islam (Sunni is predominant) 47%, Russian orthodox church 44%, Protestant 2%, Others 7%

Natural resources :Oil, Natural gas, Coal, Iron ore, Manganese, Chrome nickel, Cobalt, Copper, Molybdenum, Lead, Zinc, Bauxite, Gold, Uranium

Currency :Tenge (131Tenge/a dollar (November 2004))

■CDM/JI-related policies and conditions of the host country including the criteria for acceptance of CDM/JI and establishment of DNA

Kazakhstan signed the UN Framework Convention on Climate Change in 1992 and President Nazarbayev formally ratified the Convention in 1995. At the Fourth Conference of the Parties (COP4) held in 1998, the nation expressed its intention to undertake voluntary emission reduction commitments and submitted the Initial National Communication under UNFCCC in the same year.

In March 1999, the nation signed the Kyoto Protocol as a non-Party to Annex I of the UNFCCC and as a non-Party to Annex B of the Kyoto Protocol. Then, in April of that year, Kazakhstan stated its intent to accede to Annex I to the UNFCCC.

Kazakhstan is aiming to set a quantitative target of GHG reductions in 2006 and accede to Annex I in time for First Commitment Period. Prior to that, the nation has decided to engage in GHG reduction project from 2002.

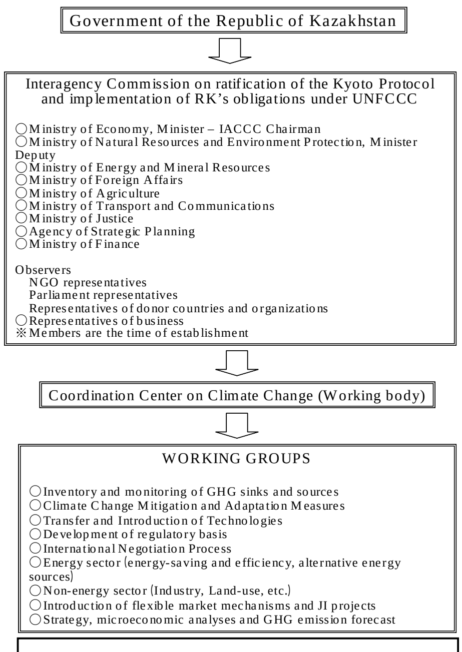
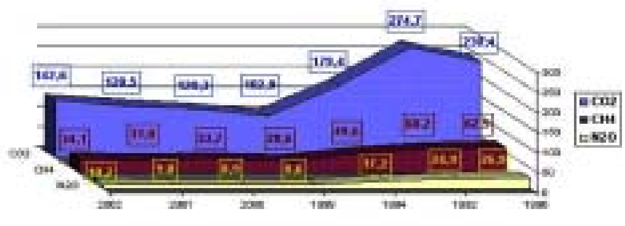


Fig.-2 Structure on GHG

Since the signing of the Kyoto Protocol, the Interagency Commission and working groups have been established in the nation and discussion has been made on issues toward ratification of the Protocol.

The objective of the Interagency Commission(set up in April 2004) is to make coordination among agencies on decision making with regard to ratification of the Kyoto Protocol to the UNFCCC, implementation of obligations of Kazakhstan under the UNFCCC, international climate change negotiations and implementation of activities toward GHG emission reductions in the nation under joint projects. So far, the Commission has discussed such issues as challenges for the accession to Annex I and mechanism for GHG emission reductions. Under the Interagency Commission, the Climate Change Coordination Center has been placed as its working body and has also served as the secretariat of the abovementioned working groups.

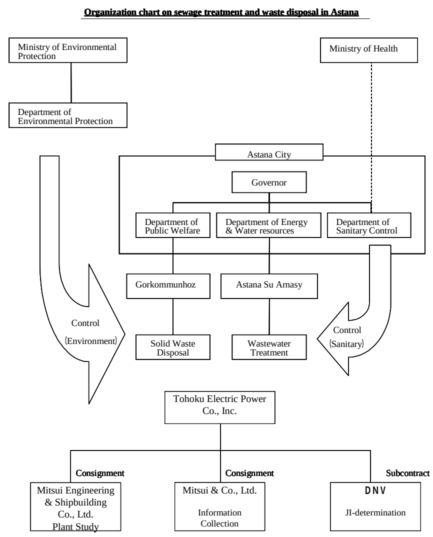
Fig.－3 Changes in GHG emissions from 1992 to



In “the Strategy of industrial and innovational developments of the Republic of Kazakhstan in 2003-2015” dated May 2003, the nation’s commitments to improvement of GDP and diversification of industries have been stated. While there has been a debate in discussions among agencies over a balance between achieving economic goals and setting an obligation of emission reductions with the accession to Annex I, the nation has set the target of doubling Energy Intensity, which unquestionably means improving energy efficiency, intending to simultaneously pursue economic development and GHG reductions. To that end, Kazakhstan is hoping to introduce foreign investments and new technologies and has cited development of renewable energy including the use of biogas as one of the promising options.

■Implementation structure for the study(in Japan/the host country/others)

Implementation structure for this study on Japan’s side is as follows. We recommissioned a survey and examination on biogas power plants to Mitsui Engineering & Shipbuilding Co., Ltd., and collection of some of on-site information to Mitsui & Co., Ltd. We went through validation of a draft PDD(JI determination) by outsourcing it to DNV (Det Norske Veritas AS) .



In Kazakhstan, we carried out the study under the cooperation of Representative of Mitsui and Co., Ltd. in Almaty and with the help of the Climate Change Coordination Center.

Meanwhile, municipal departments of Astana City and its affiliate public corporations, which will be direct counterparts in this project, were cooperative for the study as a whole.

(2)Planning of the project

■Specific description of the project

This is a project to put organic wastes collected separately and sewage sludge produced at the sewage plant into the same fermenters to coferment, collect methane gas produced from the cofermentation and generate electricity using the gas in Astana City.

The following are GHG reductions to be achieved in this project.

・ LFG reductions at the landfill site by putting organic wastes, which would otherwise anaerobically ferment and release methane into the atmosphere at the site, into the anaerobic fermenters
・ CO2 reductions by decreasing a part of the grid electricity through power generation utilizing methane gas produced from sewage sludge and organic wastes at the methane fermenters

Meanwhile, the yen-loan-financed project which includes the sewage plant in Astana City, “Astana Water Supply and Sewerage Project” (hereinafter referred to as JBIC project) was provided in July 2003. Our project has adopted a grid and facilities which do not exert any huge impacts on the existing system on the premise of implementation of the JBIC project.

The amount of gas to be produced in this project has been calculated on the assumption that the project system has the capacity to take in 60,130 /year of organic wastes(food wastes) which are acceptable to the cofermenters among all the general wastes transported to the landfill site and the amount of sewage water treated at the sewage plant is 136,000m3/day. As a result of the calculation, the amounts of gas to be produced from organic wastes and sewage sludge are 7,235Nm^3/day and 11,125m^3/day respectively.

Based on the above, daily average electricity production calculated with the above gas generation is 30.07MWh and average output is 1.25MW. The flow of this project is from Receiving and feeding equipment → Methane fermentation equipment →Energy recovery equipment → Sludge treatment equipment.

Arrangement plan for the equipment is shown in the following page.

■Project boundary・Determination of baseline・Verification of additionality

・Project boundary

In this project, the project boundary is considered to be as indicated in Figure 5 since the project equipment is to be installed in the sewage plant.

・Receiving and feeding equipment (Raw garbage) : Receipt → Grind/Separation → Storage (solubilization) → Methane fermentation equipmet
・Methane fermentation equipment (Raw garbage solibilizer) : Input and adjustment → mesophilic methane fermentation → retention → sludge treatment equipment (Biogas) : Gas collection → desulfurization → storage → Energy recovery equipment
・Sludge treatment equipment (Digested sludge) : Adjustment → dehydration → Disposal ※Separated water goes to inlet of wastewater treatment plant
・Energy recovery equipment (Biogas) : Electricity generation → heat waste → hot water

In this regard, separation of wastes and transportation of the wastes to the anaerobic fermenters at the sewage plant are the tasks the administration is responsible for and thus they are excluded from the project boundary.

・Determination of baseline/Verification of additionality

In Astana City, all wastes are being collected together, both organic and inorganic wastes are being transported to the landfill site and, after sanitary landfill, LFG flaring is being carried out at present. Sewage sludge at the sewage plant is being anaerobically fermented at a digester chamber and biogas produced from the fermentation is being used to fuel boiler during the winter season. Based on this situation, the following 12 scenarios are conceivable.

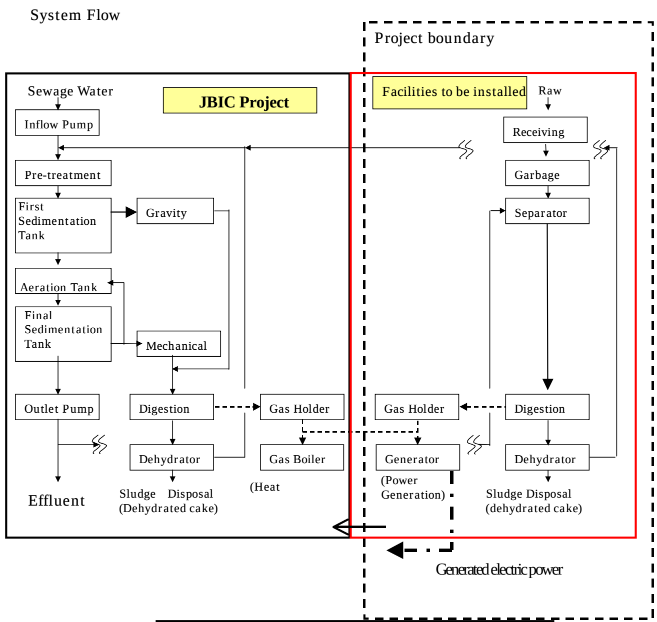


Fig. —6 Project boundary

Table —1 Conceivable scenarios

Idea	Collected Wastes		Sewage Plant	
1	After collected all together, landfilled	Wastes are landfilled and produced LFG is flared	Methane fermentation by sewage sludge	Combusted by boiler
2				Used for power generation by generator
3		Wastes are landfilled and produced LFG is utilized for power generation at the landfill site	Methane fermentation by sewage sludge	Combusted by boiler
4				Used for power generation by generator
5		Wastes are landfilled and produced LFG is supplied to other facilities than the landfill site	Methane fermentation by sewage sludge	Combusted by boiler
6				Used for power generation by generator
7	Disposed by other methods than landfill	Organic wastes gathered through sorted collection or from factories are used to produce compost	Methane fermentation by sewage sludge	Combusted by boiler
8				Used for power generation by generator
9		Flammable wastes are incinerated.	Methane fermentation by sewage sludge	Combusted by boiler
10				Used for power generation by generator
11		Organic wastes gathered through sorted collection or from factories are transported to the sewage plant	Methane fermentation by sewage sludge and organic wastes	Combusted by boiler
12				Used for power generation by generator

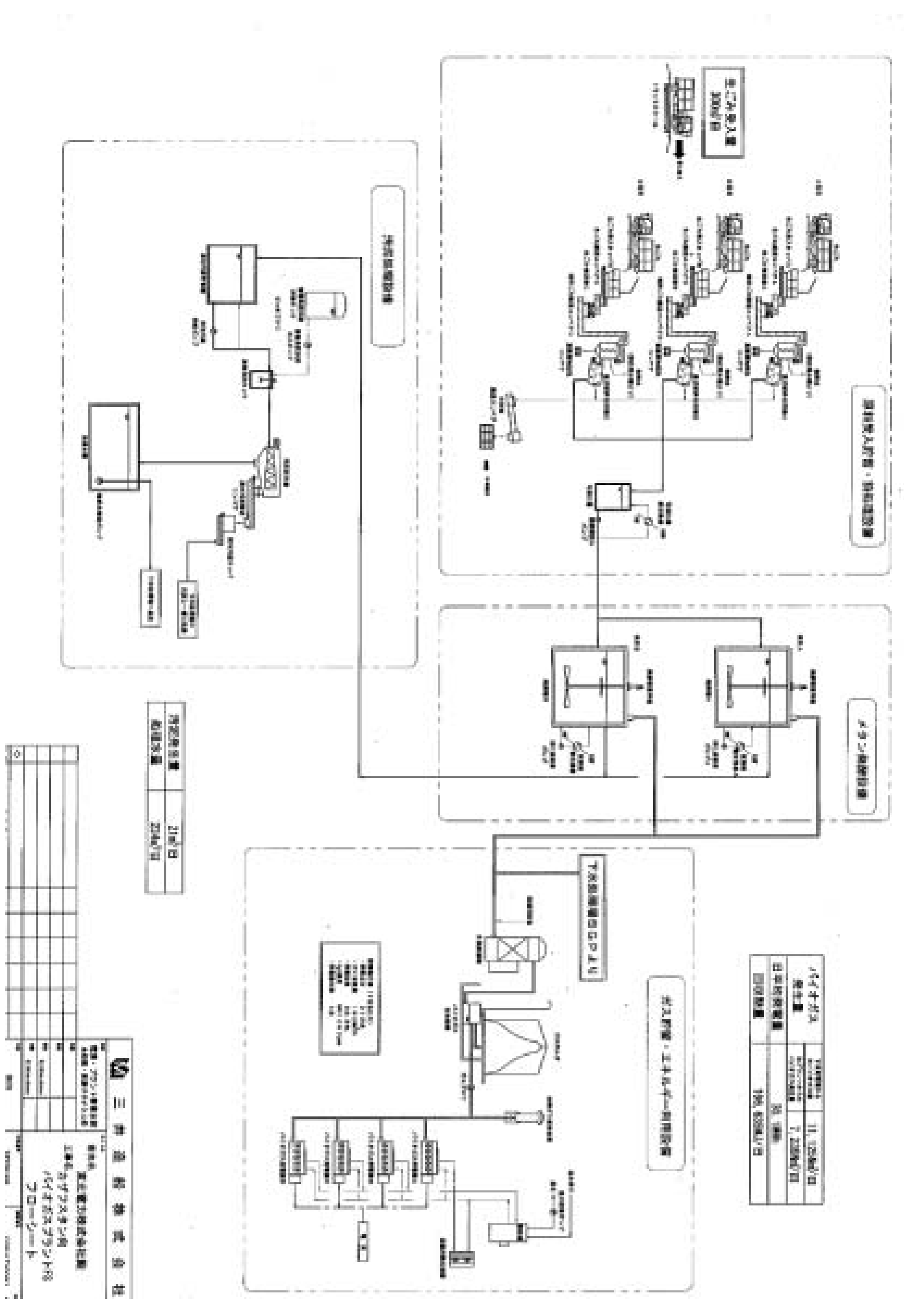
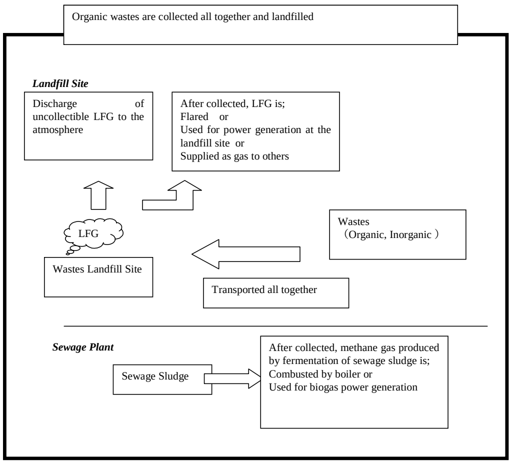


Figure —7 Arrangement plan for equipment

Schematic overviews of the conceivable scenarios are shown below.
The baseline is chosen from the 12 scenarios.



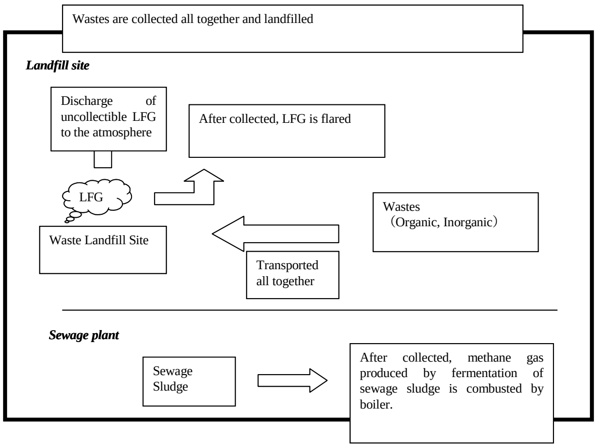
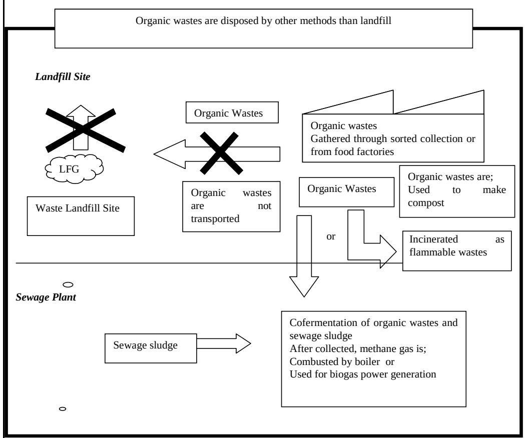


Fig.-8 Conceivable scenarios(left & lower left)&Baseline scenario(above)



As a result of examination with legislation/ Institution, technical barriers, investment barriers, environmental impacts, regional trend and market barriers taken into account, Scenario 1 has been defined as the baseline scenario.

Scenario 1 is; all wastes are collected together, then landfilled, with produced methane gas (hereinafter referred to as LFG) flared. Sewage sludge is anaerobically fermented with produced methane gas combusted at a boiler.

・Verification of additionality

Scenario 12 has been defined as the project scenario. The scenario is; among all wastes, organic wastes collected through sorted collection or from factories are transported to the sewage plant, the organic wastes are put into anaerobic fermenters at the sewage plant with sewage sludge, and produced methane gas is utilized for power generation.

This project scenario is inferior to the baseline scenario in technical barriers and investment barriers. However, by carrying out the project as a JI project, we can overcome the technical barriers with technical guidance and lower the investment barriers through CO_2 credits trading. Therefore, the project scenario has additionality.

■GHG reductions(CO_2 sinks) and leakage by implementation of the project

The project scenario is to coferment sewage sludge and organic wastes at anaerobic fermenters and introduce the power generation system utilizing methane gas produced.

The following are GHG reductions to be achieved in this project.

- LFG reductions by putting organic wastes, which would otherwise produce methane that would leak from a recovery system at the landfill site and be released into the atmosphere instead of being flared, into anaerobic fermenters
- CO2 reductions by decreasing a part of the grid electricity through power generation utilizing methane gas produced from sewage sludge and organic wastes at the methane fermenters.

GHG emissions in the case that the project is carried out are determined by the following formula. (Please refer to the main report for the detail of the calculation.)

GHG reductions ＝Baseline GHG emissions－(Project GHG emissions＋Leakage)

＝73,923[t- CO_2/year]

Baseline GHG emissions＝67,200；Project GHG emissions＝-6,798

Leakage＝75 (due to transportation)

Initially, we had calculated GHG reductions at about 160,000t/year based on the condition of solid waste disposal in Astana City. However, in the process of the study, we had found out that the construction of a new landfill site is underway with help from Spain, which led to changes in the expected conditions and decrease in GHG reductions. As a result, we had to revise GHG emission reductions considerably downward, which had significantly decreased positive factors expected from CO2 credits toward implementation of the project.

■Monitoring Plan

With regard to monitoring, data measurement is critical for precise calculation of GHG emissions. Outline of the monitoring plan is as follows.

■ Environmental impact/Other indirect impact(In the case of afforestation, result of a risk analysis should be included.)

Problems of noise or vibration are

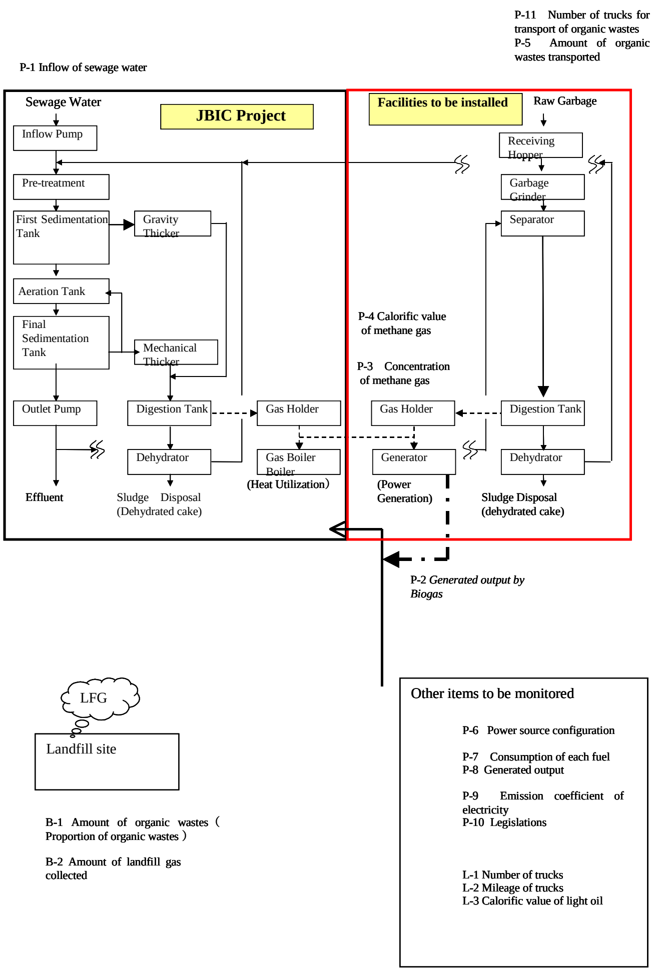


Fig. — 9 Outline of

conceivable as specific environmental impacts in this project since gas engines using biogas are installed and operated. Odor issues from organic wastes are also possible as the wastes are brought to the sewage plant.

However, the environmental impacts can be fully diminished by taking countermeasures. The following table sums up the countermeasures.

Table－2 Environmental impacts and countermeasures

Possible environmental impact	Problem and countermeasures
Noise and vibration by installation of gas engines	Noise and vibration will be small as several small engines are installed inside the plant.
Exhaust gas from gas engine	Identification and assessment of environmental impacts should be made. However, as gas engines are small with little amount of emissions, additional countermeasures are considered unnecessary.
Odor at the time of organic waste transport	It can be solved by such devices as deodorizing equipment

■Stakeholders' comment

・Residents living in the vicinity of the project site

No interview is currently held, however basically the residents are considered to be positive for realization of the project as the ambient environment is expected to improve.

・Local distribution company

Astanaenergo is highly in favor of the project. We have received a reply from the company that they would like us to consult with them in case that electricity is sold.

・Sewage treatment management company and Solid waste disposal company

In Astana City, there are Astana Su Arnasy which has managed sewage treatment and Gorkommunhoz which has managed solid wastes. Both companies have expressed their interest in the project, however further approaches are needed to deepen their understanding about the project toward its materialization.

・Local government

Astana City has been working to raise the quality of collection method of solid wastes produced from households and factories to the international level in accordance with Master Plan for Comprehensive Development of Astana and has shown a positive attitude to this project.

(3)Toward implementation

■Implementation structure for the project(in Japan/the host country/others)

The following is an example of conceivable scheme for this biogas power generation project.

In this example, the project is envisaged to be carried out in the form of IPP through project financing. Participation of ASA and Gorkommunhoz, crucial partners to the project, is the key to the realization of the project.

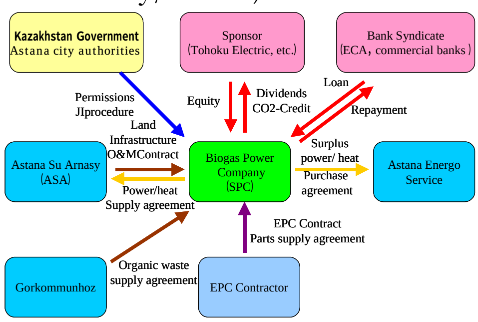


Fig.-10 an example of conceivable schemes for the biogas power generation project

■Financial scheme for implementation of the project

We have planned to finance project expenses through project financing.

In this plan, the ratio of capital to liabilities in project financing is set as 3 to 7. The capital (investments) will be raised by companies in Kazakhstan as well as ones in Japan. In terms of money borrowed, we will consider to raise the full amount from Japanese financial institutions given the ability of financial institutions in Kazakhstan for foreign currency-denominated loan.

Table－３ Finance structure (unit：1,000US$)

Necessary funds		Fund raising	
EPC expenses	12,970	Capital(Investments)	4,234
Development expenses	130	Money borrowed (ECA)	5,928
Start-up costs	200	Money borrowed (commercial banks)	3,952
Other expenses	6		
Initial working capital	230		
Interest during construction	380		
Financial outlay	198		
Total project expenses	14,114	Total funds raised	14,114

We have decided to use the investment credit system of Japan Bank for International Cooperation to the utmost extent to obtain loans and, for the remaining amount uncovered with the system, to get finance from Japanese commercial banks.

With regard to capital funds, in addition to funds from Tohoku Electric Power Co., we will call on such entities as Japanese trading companies which are knowledgeable about various matters in Kazakhstan to raise funds when we advance the development of the project from now on.

Meanwhile we will encourage Astana Su Arnasy(ASA) and Gorkommunhoz to participate in the project in some ways including provision of financial contribution for the success of the project.

■ Cost-effectiveness

Cost-benefit analysis of this project has been made through (1)financial analysis(①without credit value taken into account ②with credit value taken into account ③the initially expected baseline), (2) CO2 credit cost(①the current baseline ②the initially expected baseline).

The analysis has proven that the there is a low possibility for this project to be realized as a JI project in the current baseline, however on the other hand there exists sufficient feasibility for cases in which different baseline can be adopted.

（1） Financial analysis

This is on the condition that CO2 reductions per unit generated energy is 8.15t- CO_2／MWh in the project case, 53.86t- CO_2／MWh in the initially expected baseline case which does not include flaring at the landfill site, CO2 credit value is 5 US$／t- CO_2 and the period of CO2 credits

Table-4 Result of financial analysis

Items	Without Credit	With Credit	Initially Expexted Baseline
Project IRR	Impossible to calculate	Impossible to calculate	12.10%
Equity IRR	Impossible to calculate	-1.00%	17.90%
Payback period	N.A.	N.A.	7 years
NPV※ (×1000USD)	-12,609	-10,167	109

※Discount rate was set as 12% in reference to Philippine 10-year government bond which has the same S&P rating.

acquisition for this financial analysis is 20 years.

（2） CO2 credit cost

In calculation of CO2 credit cost, Net Present Value such as necessary funds for GHG reduction activities and repayment of loans has been divided by CO2 generation. Then it has been examined in two ways; i.e., with and without project cash flow (profits from commercial operation) by the power generation operation taken into account. In this regard, all the credits to be generated have been assumed to belong to sponsors, following the example of ongoing NEDO model projects.

The calculation has resulted in 11.96～11.97 US$/t- CO_2 in the current baseline and 1.81 US$/t-$CO_2$ in the initially expected baseline.

■ Prospect and challenge for concretization of the project

This project is based on the premise that sorted collection of wastes is put in place in Astana City. Thus, materialization of the project is subject to the progress of the examination on sorted collection. However, efforts has been made currently in Astana City to raise the quality of collection method of solid wastes produced from households and factories to the international level based on Master Plan for Comprehensive Development of Astana and sorted collection is considered likely to be put into practice in the near future.

It has been found out that there exists a problem on the baseline in Astana City by the construction project of a new waste disposal site and it will become a major obstacle to implementation of this project. It is regrettable that these conditions have become obvious after the launch of the study. We are planning to further improve a preliminary survey on local conditions going forward.

In the meantime, this project scheme is applicable to other cities which have the same challenges as Astana City if no baseline-related issue exists. We have found out situations in Almaty City and Karaganda City in this study as new potential sites for the project.

As a result, it has been proven that Karaganda City has a possibility for the use of biogas at a sewage plant and LFG at a waste disposal site and this scheme is applicable to the city. Meanwhile, Almaty City has also turned out to have an availability of biogas at a sewage plant, have sorted collection of wastes in place and have a possibility that this project scheme can be applied.

We will examine whether this project scheme shall be applied to projects in these regions or they shall be carried out as an independent project, taking economical efficiency of the projects into consideration.

Apart from the above, Kazakhstan also has rich potential for the use of biomass such as wheat husks obtained from wheat, which is a staple of the nation's production, paltry manure and livestock manure in the livestock industry. We have planned to conduct studies on these options.

(4) Validation/Determination(if this process is carried out)
■Outline of Validation(Determination) or Desk Review The host country, the Republic of Kazakhstan, is scheduled to ratify the Kyoto Protocol as a JI country and is currently undertaking adjustments at home. A system is gradually set up in the nation to accurately grasp its green house gas emissions. However, it cannot be denied that there is a possibility that the nation may ratify the Kyoto Protocol without the system firmly put in place. Therefore, this time we created PDD and asked Designated Operational Entity to verify it to go through the verification process called "Second Track" by third-party institutions similar to CDM Executive Board and Designated Operational Entity in the case of CDM ■Progress of communications with DOE We carried out determination by DOE(DNV) by submitting PDD to them early in January and having an interview on the 26th of January.