GENERAL OUTLINE OF REPORT ON CDM/JI PROJECT STUDY OF FISCAL 2007

METHANE COLLECTION AND POWER GENERATION FROM WASTEWATER IN ALCOHOL FACTORY IN THAILAND

KANEMATSU CORPORATION

(1) Basic factors for project implementation

■Outline of proposed project and planning background

—Outline of proposed project

Thai Beverage PLC (hereinafter referred to as TB) owns 17 factories of beverage alcohol production from molasses as raw materials. Wastewater, after having been distilled, is treated in an anaerobic open-lagoon type wastewater treatment facility in the factory, one of these 17 factories, and this factory (hereinafter referred to as Nakhon Pathom Factory) is located in Don Tum District, Nakhon Pathom Province. The anaerobic wastewater treatment facilities have grown to an enormous size, and accordingly they at the factory are stranded because of difficulty in acquiring required land and also anxious about odor problem. It is the case that methane gas from the anaerobic open-lagoon is released in the atmosphere without being used. New anaerobic fermentation tank (ADI-BVF Reactor) are to be installed to remedy these situations and utilize methane gas so that methane gas can be collected by increasing innovatively its collection rate and be used as fuel for high-efficiency power generation for gas engine. At the same time, the project of installing flaring facilities for surplus methane gas and emergency operation shall be implemented to actualize energy saving and CO_2 reduction.

—Planning background

The starch factory (tapioca) in Thailand has 79 factories, and it is said for a CDM project if the business characteristics are high, but, as for the present conditions, Europe companies such as Denmark, the Netherlands are in condition to monopolize it. As a market of the Japanese company in future, Kanematsu must compete in future because prominent technology such as Japan transfers the wastewater that it is hard to handle such as small food factory, alcohol factory which COD concentration is high, and include many sulfur (for S) suspended solids (for SS) etc.

There were a great deal of alcohol (ethanol) factories, and the ingredient of the wastewater (waste fluid) was very bad, and, by a site survey in Thailand of last year, it became clear to be the almost anaerobic open lagoon of the wastewater treatment method.

In addition, to be the F/S investigation of last year was from the wastewater from starch factory (food factory), and the load to the environment was small in comparison with the alcohol (ethanol) factory (Refer to table 1).

Table 1 The quantity comparison of last year factory wastewater and this project factory wastewater

No.	Items	Unit	Starch factory wastewater	(This project) alcohol factory wastewater
1	Wastewater volume(Ave.)	m^3/d	2,800	450
2	pH	-	4-7	4.8
3	Temperature	℃	<38	49-55
4	SS	mg/l	**<500**	**20,840**
5	BOD	mg/l	5,059	35,600
6	COD	mg/l	**8,900**	**115,140**
7	T-N	mg/l	205.3	1,848
8	T-P	mg/l	90.7	172
9	T-Sul	mg/l	**32.2**	**4,865**

TB is past, and two factories (Buriram Factory and Ubon Ratchathani Factory) introduced a pilot plant in biogas technology of the own company, but there is little volume of methane gas generation, and there is the process that use did not succeed in. Therefore, TB performed comparison with the other companies technology, the inspection of the Pakistani operation plant of ADI Corporation on carrying out the project in the Nakhon Pathom Factory, but with that alone TB does not reach it by Feasibility Study which can decide investment. Therefore TB plans trust in Bionic Humus CO.,LTD (hereinafter referred to as BHC) which is the implementation subsidiary of the biogas plant about the implementation of the project.
According to BHC, a problem that COD concentration and S and SS were high chose the detailed investigation of the methane fermentation process to the wastewater that there was and, as a result, could collect methane effectively and took profit by the CER buying and selling into account for this factory, and, in TB, there was explanation of the effect to introduce if economy improved.

COD concentration was high, and there were much an S share and SS shares, and Kanematsu chose the most suitable process about the wastewater of the alcohol (ethanol) factory to include and investigated F/S and aimed for raising possibility of the realization today. Therefore, Kanematsu plans a Nakhon Pathom Factory project for TB and will draw it up.

By this investigation, Kanematsu performed detailed investigation, the choice of the methane fermentation process. As a result, this project could carry out an effective CDM model (brewing (beer, alcohol fermentation)) that could handle methane by the anaerobic fermentation tank (ADI-BVF Reactor) which made Feasibility Study and the PDD of the level that could decide investment of TB.
In addition, this project extracted a solution problem for realization and arranged it.

—Determination of project site

The project site in the territory of Nakhon Pathom Factory is located in the Don Tum District of Nakhon Pathom Province lying in the west of Bangkok.

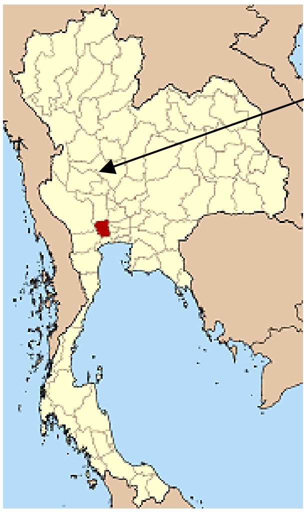

Figure 1 Map of project site

The wastewater from three factories concerned of TB is supplied to a Nakhon Pathom Factory by the tank lorry transportation. The wastewater is treated in anaerobic open-lagoons, and then treated in aerobic lagoons; transferred to the drying pond and afterwards discharged to the irrigation canal.

Anaerobic pond; one pond (10m deep): aerobic pond; one pond (6.5m deep): drying pond ; one pond (6.5m deep)

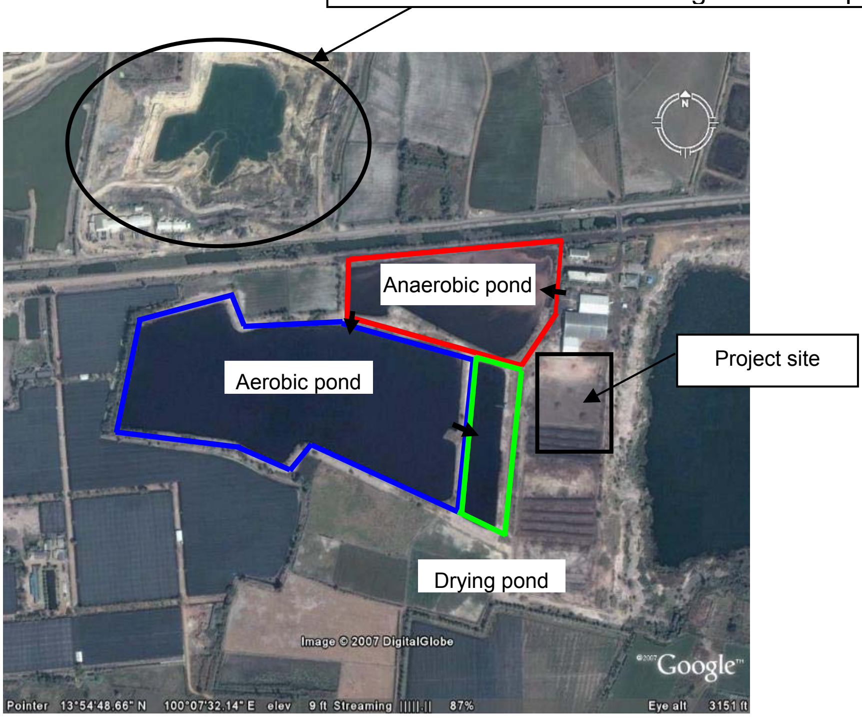

Figure 2 Factory overall view

■Outline of host country

Thaksin Administration who started in February, 2001 accused that I did the home demand with power of traction of the economy as well as conventional export leadership and proposed the promotion plan of a farm village and the medium and small-sized business. By activation of the individual consumption to be thought to be the fruition of these expansion of domestic demand policies, the economy was restored and achieved growth of 6.1% in 6.9%, 2004 in 2003. I slowed down by Sumatra offing big earthquake and the Indian Ocean tsunami damage slightly in 2005 and became the growth of 4.5%. In 2006, the influence of the political change was felt uneasy about, but achieved a growth rate of 5.0%.

■Policy and condition of CDM/JI such as criteria for receiving CDM/JI and DNA installation to the host country

－Policy and condition of CDM

On July 6, 2007, Thailand Greenhouse Gas Management Organization (hereinafter referred to as TGO Committee) was set up as a Thai national designated organization by Thai Royal Family Imperial ordinance. In addition, the TGO Committee secretariat is put in Office of Natural Resources & Environmental Policy and Planning (hereinafter referred to as ONEP). For CDM approval, the presentation of PDD and Initial Environmental Evaluation (hereinafter referred to as IEE) report are demanded from TGO Committee.

ONEP gives an approval letter in 15 projects in total in the case of DNA in seven projects in January, 2007 and eight projects August, 2007 before TGO Committee is established. Of these, five cases are already CDM board of directors Registered. In addition, seven biogas items hold (equivalent to 47%) when they examine 15 breakdowns.

This project is placed for a project related to energy generation of the energy section and the use (renewable energy), environment about energy such as the wastewater that ONEP establishes an important point. Therefore, efficient use of the energy and the utilization of the renewable energy are enabled.

In addition, the window having jurisdiction over a CDM project about the renewable energy is Department of Alternative Energy Development and Efficiency (hereinafter referred to as DEDE). The presentation of the IEE report is demanded here. This project is assessed by DEDE, but it is already said that it is submitted item degree similar project 40.

There is a connection in diverse projects, and Toyo-Thai Corporation planning local EPC of this project discusses it with DEDE.

－Current development

As new development of CDM reinforcement, around 20 projects a year subsidies of millions of Baht per 1 for a CDM project were founded in Thailand. We think as one of the finance methods of this project.

■Fields where the proposed project can contribute to sustainable development of the host country and where the project can transfer technology to the host country.

The administration of each factory is in a critically ill state by a heavy oil remarkable rise strictly in the Thai country. The biogas use that is renewable energy is strengthened by national energy policy and a development plan as one of the alternative energies of the fossil fuel such as the heavy oil, and this project is expected very much. But the barrier by a technical aspect, investment capital side, the local contribution is big. Therefore, this project can plan realization of Co-benefits of warming measures on the energy side and the antipollution measure on the environment side by matching it with a CDM scheme.

■Implementation structure for study (Japan, host country and others)

The implementation structure for this study is shown in Table 2.

Table 2　Study implementation structure

Participating countries	Responsible organization	Function
Japan	Kanematsu Corporation (KG)	－Overall control, Project evaluation －PDD preparation －Site survey
Japan	Kansai Design Co. (KDC) (Subcontractor)	－PDD preparation (technical part) －Technical consultant
Thailand (host country)	Bionic Humus Co.(BHC)	－Providing data on existing wastewater treatment facilities
Thailand (host country)	Toyo-Thai Corporation(TTCL)	－Water quality survey －Conceptual design －Detail estimation

(2) Project planning

■Principle particulars of the project

－Wastewater plan

The quality of wastewater supplied to Nakhon Pathom Factory is shown in Table 3. Those are the quality of aggregate wastewater discharged from three associated factories of TB. The characteristic of this wastewater is as follows:

①Chemical oxygen demand (COD) is quite high.

⇒There is a great deal of volume of methane generation.

②Sulfur content (S content) is quite high because of using sulfuric acid (H_2SO_4) in alcohol production process from molasses.

⇒The cost of the desulfurization equipment is added.

③Contents of suspended solid (SS) and calcium (Ca) are quite high.

⇒The treatment method becomes the problem so that sludge is deposited to a reactor.

Utilization of compost→It is with environment improvement

Table 3　Wastewater quality at project site

No.	Item	Unit	Value
1	Wastewater Volume (Ave.)	m^3/d	450
2	pH	-	4.8
3 ①	Chemical Oxygen Demand (COD)	mg/l	115,140
4	Biochemical Oxygen Demand (BOD)	mg/l	35,600
5	Volatile Fatty Acids (as acetic acid)	mg/l	1,937
6	Alkalinity (as $CaCo_3$)	mg/l	760
7	Total Solid (TS)	mg/l	109,260
8	Total Volatile Solid (TVS)	mg/l	85,140
9 ③	Suspended Solid (SS)	mg/l	20,840
10	Phosphate (PO^-_4)	mg/l	172
11 ②	Sulfur (SO^-_4)	mg/l	4,865
12	Total Nitrogen (N)	mg/l	1,848
13 ③	Calcium (Ca)	mg/l	3,129

—New wastewater treatment facilities

Methane fermentation tank and UASB method (EGSB method) are nominated for the anaerobic wastewater treatment method how it is thought that apply by this project.

As an anaerobic wastewater treatment unit maker, this project chose of the anaerobic fermentation tank (ADI-BVF Reactor) of ADI Systems Inc. (a product made in Canada) of the Canada country and high load type anaerobic wastewater treatment facilities (UASB (ESGB)) of Sumitomo heavy industries environment co., ltd.

The comparison of the treatment method is shown below.

Table 4　The comparison of the anaerobic treatment method

Items	ADI-BVF Reactor	UASB (EGSB)
Target wastewater	High concentration organic wastewater	Intermediate/High concentration organic wastewater
Treatment method	Anaerobic mixing agitated type	Upflow anaerobic sludge blanket
Microbial utilization	Floating floc type	Granular sludge
Microbial concentration	Intermediate concentration	High concentration
Volume load	0.3-3.0 $kgCODcr/m^3 \cdot d$	5-15 $kgCODcr/m^3 \cdot d$
Retention time	7-14 days	6-10 hours
COD removal rate	60-70%	80-90%
Methane gas generation	Medium	Large
Waste sludge	Small (Annually)	Small

Table 4　The comparison of the anaerobic treatment method (Cont.)

Items	ADI-BVF Reactor	UASB (EGSB)
Area	Large	Small
Running cost (Chemical)	Additive-free basically	Alkali of the pH adjustment is necessary
Odor measure	Closed type measures	Closed type measures
Management items	Small	Large
Gas fluctuation	Small	Medium
Diluting	Without	With

As a result of comparison, it was assumed that this project adopted anaerobic fermentation tank (ADI-BVF Reactor). Because maintenance is free by simple driving, and there is little running cost basically because chemical (additive) is not necessary, it is not necessary to dilute it can spend it as raw water.

Applicable process is shown in Figure 3.

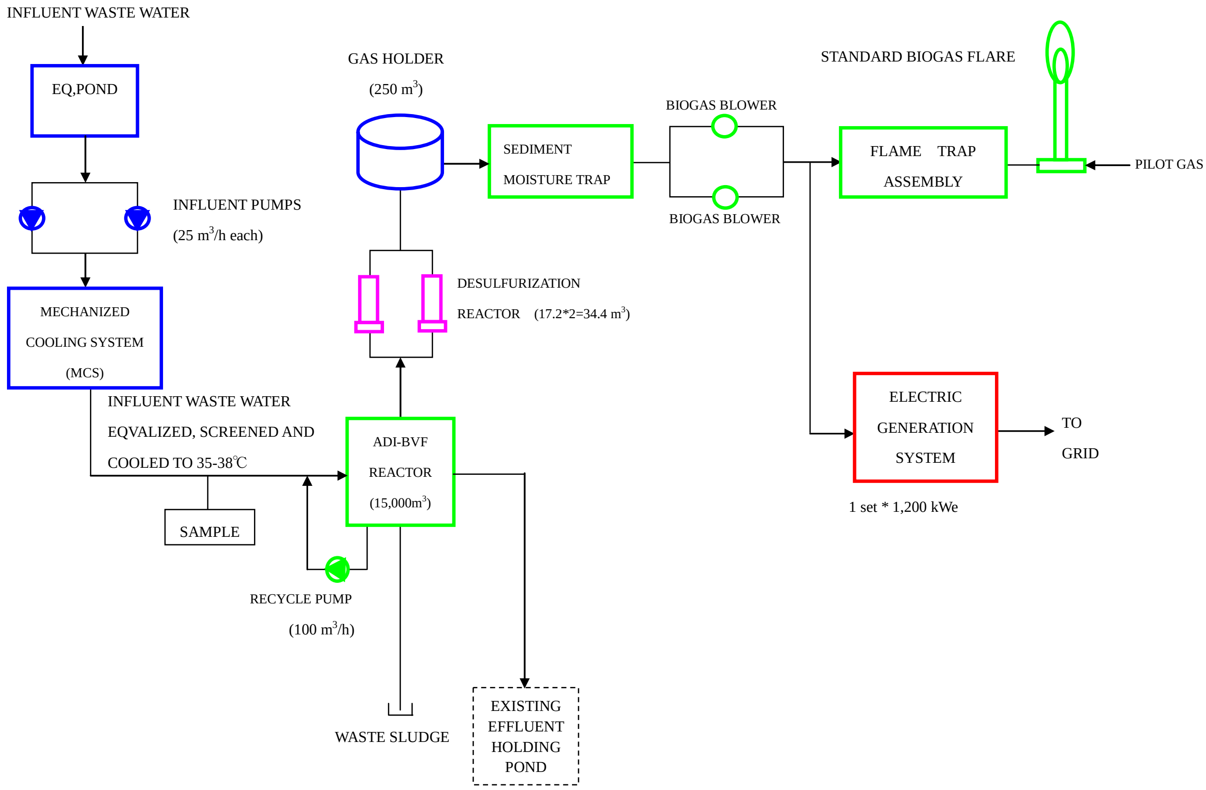

Figure 3　Applicable process

(2) Verification of additionality and configuration of project boundary and baseline

—Methodology

There are now two methods for recovering methane from wastewater approved by CDM executive board (EB):

AMS-III.H. (Ver.8)

Methane recovery in wastewater treatment

ACM0014 (Ver.1)

Avoided methane emissions from wastewater treatment

The comparison of the emission reduction is shown below.

Table 5 The comparison of the emission reduction by the methodology

Items	AMS-III.H.	ACM0014
Project Emissions		
Emissions from electricity or diesel consumption in the year	421	421
Emissions from degradable organic carbon in treated wastewater in the year	22,594	20,098
Emissions from anaerobic decay of the final sludge produced in the year	0	0
Emissions from methane release in capture and flare systems in the year	678	(Reactor)0 (Flaring)475
Emissions from dissolved methane in treated wastewater in the year	312	-
Total project emissions	24,005	20,994
Baseline emissions		
Baseline methane emission from an existing wastewater treatment in the year	60,249	50,223
Baseline electricity generation emissions in the year	4,582	4,582
Total baseline emissions	64,831	54,805
Leakage	0	0
Emission reduction	40,826	33,811

This project adopted AMS-III.H. (Ver.8) based on the following application.

・The actual results of the validation which Kanematsu with the same project makes effective.

・The amount of CER, what a small scale is more abundant in.

・As for the application as well, there is no problem.

・A simple procedure is to be available in comparison with usual CDM.

—Project boundary

The project boundary is shown in Figure 4.

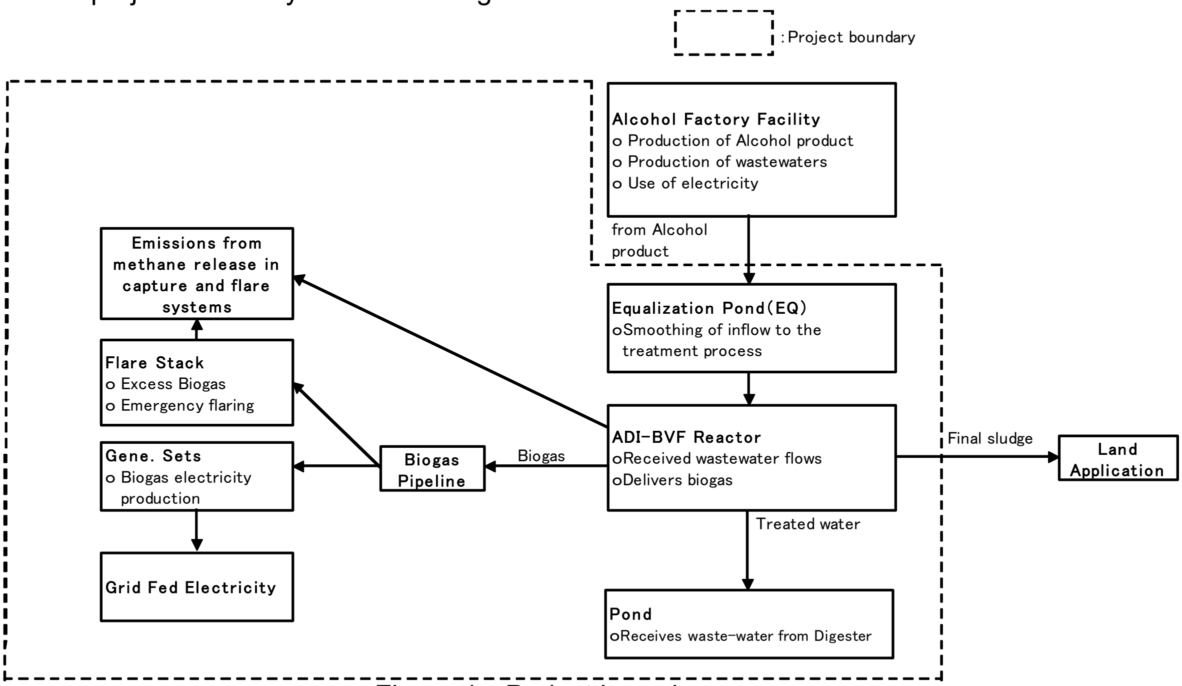

Figure 4 Project boundary

—Verification of additionality and configuration of baseline

More than one of the following barriers shall be verified as the reason why the project cannot be implemented:

Alternative baseline scenarios tested.

Scenario 1: Scenario of continuity of the current practice (Business-as-usual)

Scenario 2: Aerobic treatment of wastewaters
(activated sludge or filter bed type treatment)

Scenario 3: Proposed project

(1) Investment barrier

By the scenario 1, this technology is already installed and funding is not required any more. The scenario 2 is superior in a treatment function. However, aerobic treatment uses much electricity for an aeration device, and excess sludge occurring abundantly becomes a problem. In addition, this is higher cost compared to conventional systems, and there is no income source by introduction.

The scenario 3 of ADI-Digester has appropriate systems that can control, accelerate and capture the methane emissions arising in the process, but of course at a higher cost compared to conventional systems. IRR estimates indicate that the rate of return, -12.2 % is lower value the Expected Rate of Return if CERs revenue are not taken into account. These estimates do not take into account the risk associated with the operation of the plant to capture methane. Thus, it is clear that the project's IRR is not attractive for investment, particularly when considering the expected rate of return in Thailand, which is 5.14%.

(2) Technology barrier

Under the scenario 1, uses anaerobic lagoons to treat the wastewater. This is method of low technology. This type system is widely used in Thailand and other regions. It is considered low-risk technology. The present wastewater treatment facility, open-lagoon system, is able to treat the wastewater and meet the current environmental standards, with 120 mg or less COD per liter of wastewater released into the water bodies. The scenario 2 is new type installation in Thailand.

However, it is not almost used on a commercial scale.

It involves potentially lower risks than the ADI-Digester treatment, but it is not regarded as the optimum technology in Thailand.

All operating parameters for the pretreatment component need to be maintained at the right level for the reactor to receive quality feedstock. In any cases, inappropriate maintenance of operating conditions in pretreatment poses significant risks to the successful generation of methane. The ADI-Digester is critical equipment, which forces methane generation. The operating conditions need to be carefully maintained for efficient operation of the reactor.

(3) Barrier of general customary practice

(3)-1 Legal

The current practice (scenario 1) is a standard case where industrial wastewater involving high-organic load is treated on a basis of ponds in the area as well as Thailand. Direct discharge into water body (inclusive of rivers and lakes) is illegal.

Most of the plants use open lagoon system in Thailand. The possibility of making the existing wastewater discharge standards more stringent is very small and even if such an action is taken, the existing system can be extended by creating more retention ponds to meet stricter norms, for which additional land is readily available.

(3)-2 Social

The open lagoon systems (Scenario 1) are presently used and social barrier is almost not found. They are accepted as part of regional circumstances and standard operational practice by commercial entities. Aerobic (Scenario 2) and anaerobic (Scenario 3) installations could cause a small number of social barriers to be created through risks (explosion or smells). Although social barriers may be least, there is some possibility for barriers to implementation of new technology.

(4) Other barrier

It is considered that the current pond-based treatment (Scenario 1) is a standard operational baseline in Thailand and neighboring areas. They have no positive experience of utilizing aerobic (Scenario 2) or anaerobic (Scenario 3) technology in Thailand. It is not assumed that the ordering priority of management for the technology is high.

The high-priority issue for most of business people in this sector is the management of wastewater release for keeping easily with local regulations. More ample scale of management resources is required for the capital intensive energy production. Therefore, it is assumed that digesting process is not given their prior attention.

The above results are shown in Table 6.

Table 6 Summary Barrier Analysis

Alternative baseline / Barrier test	Scenario 1 : Continued present	Scenario 2 : Aerobic process	Scenario 3 : Proposed project
Investment barrier	N	Y	Y
Technology barrier	N	Y/N	Y
Barrier of general customary practice	N	Y/N	Y/N
Other barrier	N	Y	Y

Notes: Selection Y means no barrier, Selection N means there is barrier(s).

<u>Determination of additionalily - conclusion</u>

Although project activities using the ADI-BVF reactor technology are faced with investment, technology, general customary practice and other barriers, it is confirmed that continuing the existing lagoon system is the base line; since there is no ADI-BVF reactor technology in the existing lagoon system, the project will be additional.

■Project implementation period and credit period

It is said that durable years of methane fermentation tank and gas engine are 13 to 15 years. But durable years of the fermentation tank are dependent on the geo-membrane cover topping its upper part. Accordingly, the fermentation tank could be cracked due to aged deterioration even during operation. The project implementation period shall be 10 years in consideration of the past achievement and repairing frequency. The credit period as the fixed period of 10 years (2010-2019) shall be applied to acquire CER.

■GHG reduction and leakage by means of project implementation

－Project emissions

(1) Emissions from electricity or diesel consumption in the year ($PE_{y,power}$)

$PE_{y,power} = EP_{comsumed} * EF_{comsumed} = 825 * 0.51 = 421$ (tCO_2e)

(2) Emissions from degradable organic carbon in treated wastewater in the year ($PE_{y,ww,treated}$)

$PE_{y,ww,treated} = Q_{y,ww} * COD_{y,ww,treated} * B_{o,ww} * MCF_{ww,final} * GWP\_CH4$

$= 148{,}500 * 0.0345 * 0.21 * 1.0 * 21 = 22{,}594$ (tCO_2e)

(3) Emissions from anaerobic decay of the final sludge produced in the year ($PE_{y,s,final}$)

$PE_{y,s,final} = S_{y,final} * DOC_{y,s,final} * MCF_{s,final} * DOC_F * F * 16/12 * GWP\_CH4$

$= 0 * 0.09 * 0 * 0.5 * 0.5 * 16/12 * 21 = 0$ (tCO_2e)

(4) Emissions from methane release in capture and flare systems in the year ($PE_{y,fugitive}$)

$PE_{y,fugitive} = \underline{PE_{y,fugitive,ww}} + \underline{PE_{y,fugitive,s}} = 678 + 0 = 678$ (tCO_2e)

$PE_{y,fugitive,ww} = (1 - CFE_{ww}) * Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment} * GWP\_CH4$

$= (1 – 0.9) * 148,500 * 0.115 * 0.21 * 1.0 * 21 = 678$ (tCO_2e)

(5) Emissions from dissolved methane in treated wastewater in the year ($PE_{y,dissolved}$)

$PE_{y,dissolved} = Q_{y,ww} * [CH4]_{y,ww,treated} * GWP\_CH4$

$= 148,500 * 10^{-4} * 21 = 312$ (tCO_2e)

(6) Total project emissions

$PE_y = \underline{PE_{y, power}} + \underline{PE_{y,ww,treated}} + \underline{PE_{y,s,final}} + \underline{PE_{y,fugitive}} + \underline{PE_{y,dissolved}}$

$= 421 + 22,594 + 0 + 678 + 312 = 24,005$ (tCO_2e)

—Baseline emissions

(1) Baseline methane emission from an existing wastewater treatment in the year (BE_y)

$BE_y = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment} * GWP\_CH4$

$= 148,500 * 0.115 * 0.21 * 0.8 * 21 = 60,249$ (tCO_2e)

(2) Baseline electricity generation emissions in the year (BE_{grid})

$BE_{grid} = EP_{BIO} * EF_{grid} = 8,984 * 0.51 = 4,582$ (tCO_2e)

(3) Total baseline emissions = $\underline{BE_y} + \underline{BE_{grid}} = 60,249 + 4,582 = 64,831$ (tCO_2e)

—Emission reduction

ER_y = Total baseline emissions - (Total PE_y + Total $Leakage_y$)

$= 64,831 - (24,005 + 0) = 40,826$ (tCO_2e)

No leakage calculation is required since the equipment is not being transferred to or from another activity.

The amount of GHG reduction by the project implementation is shown in Table 7.

Table 7 GHG reduction by project implementation

Year	Base Line estimated emission ($t\text{-}CO_2$ e)	Project estimated active emission ($t\text{-}CO_2$ e)	Leakage estimation ($t\text{-}CO_2$ e)	Estimated reduction in emission ($t\text{-}CO_2$ e)
2010	64,831	24,005	0	40,826
2011	64,831	24,005	0	40,826
2012	64,831	24,005	0	40,826
2013	64,831	24,005	0	40,826
2014	64,831	24,005	0	40,826
2015	64,831	24,005	0	40,826
2016	64,831	24,005	0	40,826
2017	64,831	24,005	0	40,826
2018	64,831	24,005	0	40,826
2019	64,831	24,005	0	40,826
Total ($t\text{-}CO_2$ e)	648,310	240,050	0	408,260

■Monitoring plan

It is necessary to monitor an item of Table 8 that is necessary for the calculation of the discharge. In addition, this project considers the present conditions and lectures on it and copes about the heavy oil consumption reduction in the factory for local operator.

Table 8 Data and parameters monitored

Data/Parameter	Description	Value applied	Data unit
D	Operating days the alcohol plant	330	d
$\mathbf{Q}_{d,ww}$	Volume of wastewater treated per day	450	m^3/d
$\mathbf{Q}_{y,ww}$	Volume of wastewater treated in the year	148,500	m^3
$\mathbf{COD}_{y,ww,untreated}$	Chemical oxygen demand of the wastewater entering	0.115	t/m^3
$\mathbf{COD}_{y,ww,treated}$	Chemical oxygen demand of the treated wastewater leaving	0.0345	t/m^3
$\mathbf{EP}_{comsumed}$	Electricity consumed in the year	825	MWh
$\mathbf{EP}_{BIO}$	Electricity produced by the biogas generator unit in the year	8,984	MWh
$\mathbf{T}_{flare}$	Temperature of the exhaust gas from flare	More 500	°C
$\mathbf{T}_{flare\_time}$	Duration of sustenance of 500 °C in flare	Measured	min/h
$\mathbf{S}_{y,final}$	Quantity of sludge removed from the treatment system	Measured	t
$\mathbf{T}_{biogas}$	Temperature of biogas combusted	Measured	℃/K
$\mathbf{P}_{biogas}$	Pressure of biogas combusted	Measured	bar
$\mathbf{DOC}_{y,s,final}$	Degradable organic content of the final sludge generated by the wastewater treatment in the year	0.09	-
$\mathbf{MCF}_{s,final}$	Methane correction factor for soil application of the final sludge	0	-
$\mathbf{V}_{total}$	Biogas flow rate at digester outlet in the year	5,406,999	m^3 at normal conditions
$\mathbf{V}_{gene}$	Biogas flow rate at power generating unit inlet in the year	About 91 % of Biogas generated	m^3 at normal conditions

Table 8 Data and parameters monitored (Cont.)

Data/Parameter	Description	Value applied	Data unit
V_{flare}	Biogas flow rate into flare in the year	About 9 % of Biogas generated	m^3 at normal conditions
P_{CH4}	Biogas CH_4 content	65	%

■Environmental impact and other indirect impact

－Environmental impact

This project is designed to produce electricity with 1,200 kWe; EIA is not required of the project. IEE is requirements with PDD in the TGO committee which is Thai DNA.
IEE is described according to a guideline for prior IEE of ONEP; it is local contribution that is regarded as important most.
This has demands such as a road, the adoption of the local employer, the infrastructure of utility facilities and a cost impact is very big and gives big influence to project implementation. Therefore, conference, examination is separately necessary with doing a detailed explanation in the TB (owner) toward this project implementation.

－Other indirect impact

Refer to “Fields where the proposed project can contribute to sustainable development of the host country and where the project can transfer technology to the host country”.

■Comments of interested parties

Comments on the project are as follows (reception at interview):

(a) Thai Beverage PLC (TB)

－As for biogas technology, though our company research pilot plant was introduced in 2 factory in the past, the amount of methane occurrence was small, and employment didn't go well. Therefore, it is requested that the technology of the outside of the office is adopted this time.

－The technology of ADI is adopted, and our related company does purchase from the foreign countries, construction with methane fermentation system with the main machine (geo-membrane cover is contained.) with process engineering.

－The BHC of the subsidiary company manages employment with the wastewater that it is discharged from the factory of the TB, and sludge, and it becomes a compost, and it is used as for sludge.

－BHC will do an examination, and it will be advanced about biogas plant.

(b) Bionic Humus Co. (BHC)

－The environment countermeasure that it faces a labor environment, a circumference inhabitant, and so on in each TB factory is taken, and it aims at taking in biogas as one of the business.

－The implementation subject of this project is a TB persistently, and the power of decision is in the TB, too. Therefore, a TB has the power of decision to the CER purchase and sale as well.

－BHC will do operation and control of this project.

(c) DEDE

－The introduction of the energy project which can regenerate it is promoted.

－Methane collection project is promoted as an effect use with the energy from the wastewater of the industry which exists in the Thai country in many as a CDM project.

The meeting of stakeholder will be carried out in Thailand after the side of the TB is decided because relations with the neighboring inhabitant (NGO is contained.) influence project execution very greatly.

(3) Preparation for project implementation

■Project implementation structure (Japan, host country and others)

The split of works between Japanese and Thailand parties is shown in Table 9.

Table 9　Split of works between Japanese and Thailand parties

Participating countries	Participating private and public organizations	Split of works
Japan	Kanematsu Corporation（KG）	－PDD preparation －CDM project adviser －Point of contact for project －Arrangement of desulphurization equipment
Thailand (host)	Thai Beverage PLC（TB）	－Beverage alcohol production owner －Provision of project site －Project fund procurement
Thailand (host)	Bionic Humus Co.（BHC）	－Operation/control
Thailand (host)	Toyo-Thai Corporation　（TTCL）	－Local EPC (design/procurement/construction)

■Financial plan of project implementation

The amount of initial investment which is necessary for this project is 600000000 yen. A change in gas of the borrowing money is big about the project about the methane collection, and it is expressed whether a fund grant isn't done in the Thai local bank. Therefore, it is being adjusted in 3 fund-raising methods of the table 10.

Table 10 fund-raising method

No.	Fund plan	Conference conditions
①	Self-financed (100%)	Though TB is an owner and economically stable, IRR of this project doesn't reach a goal for an index. Cost reduction will be necessary from now on.
②	Self-financed (70%) Kanematsu (30%)	It invests as an advance payment of a CER purchase price to go through 30% to Kanematsu. The CER purchase price is the point conference.
③	Subsidy use	Several million Bahts per one use toward the CDM project. Maximum 5,000,000 Baht scale.

■Economical analysis

—Initial investment amount

Table 11　Initial investment breakdown

Items	Cost	Remarks
Desulfurization equipment	0.3M¥	Japanese supply
Methane fermentation tank (ADI-BVF Reactor)	1.72M¥	ADI Systems Inc scope
Construction cost	2.29M¥	TTCL scope
Gas engine generator set	1.44M¥	TTCL scope Jenbacher energiesisteme AG J420 GS equivalency
Others	0.25M¥	Construction, commissioning SV, water analysis, application procedure
Total	6.0M¥	

—Current CER price

CER price is as mentioned in the table 12 by Point Carbon. Danish enterprise has already faced a TB about this project, and it is approached with Euro13. The evaluation of this project was decided to be evaluated with 20US$/t-$CO_2$ based on this.

Table 12　CER price of Point Carbon

CER price	Dec.-12	US$ conversion
CER price before registration	Euro 7-15	10.85-23.25
Secondary CER price（08/Dec）	Euro 16.95	26.3
EUA price（08/Dec）	Euro 22.52	34.9
EUA/Secondary CER price difference	Euro 5.57	8.6

—The income, expenditure and precondition of this project

Table 13　The income and expenditure of this project

Items	Value	Unit
Generated electric power income		
Electric power selling price (By VSPP calculation)	2.67	Baht/kWh
Generated electric power	8,984	MWh/yr
Generated electric power income	78.2	M¥/yr
CER income		
CER price	20	US$/t CO_2e
Emission reduction	40,826	t CO_2e
CER income	89.82	M¥/yr
Expenditure		
Total maintenance cost	13.4	M¥/yr
Desulfurizer exchange cost	34.1	M¥/yr
Manpower cost	2.1	M¥/yr
Monitoring cost	1.2	M¥/yr
Total	50.8	M¥/yr

Table 14 Recondition of tax, depreciation etc.

Items	Value	Unit
Corporation tax	30	%
Depreciation taxable	60	M¥
Depreciation period	10	years
Depreciation method and rate	fixed installment method, 10%	
Salvage value	0	%
Price inflation rate	0	%
Exchange rate	3.26	¥/Baht
Exchange rate	110	¥/US$

—Internal rate of return (IRR)

The computed results of the internal rate of return of the project with or without credit are shown in Table 15.

Table 15 IRR of Project (After-tax)

	Without credit	With credit
IRR of Project	-12.2 %	10.6%
Payout year	Non-returnable	6 years

When this project makes a CER price 20US$/t-$CO_2$, IRR (After-tax) is 10.6%, and formation possibility as a business is poor. This is because the TB which is an owner is making that IRR is more than 15% as an index of the business promotion after-tax goal.

—Risk study

This project entails the following three risk. Risk evaluation was done about these.

① Rate of CODcr removal (70% (Design base) → 65% (Guarantee base))

② Wastewater (450 m^3/d (Ave.) → 400 m^3/d (Safety side))

③ Fluctuation on credit price(10,15 (price down) and 25 (price up) US$/t CO_2)

Table 16 Sensitivity of IRR with Risks (After-tax)

Risk Item	With credit	Reduction in emission t CO_2e	Total electricity generated MWh
①Rate of CODcr removal	9.4 %	37,588	8,984
②Wastewater	8.6 %	37,031	8,609

Table 17 Sensitivity of IRR with Credit Price (After-tax)

Credit price	IRR of Project
10 US$/t CO_2	2.5%
15 US$/t CO_2	6.7%
25 US$/t CO_2	14.2%

■Perspectives and tasks for project implementation

1) The approval of the TB (owner)

It can't get approval as a subject at present because a TB is making that IRRs are more than 15% as an index of the business promotion a goal.

The following is shown as the solution plan.

①Change to the heat use equipment (It is not generating electricity, but all the quantity heat should be used. Though only generating electricity scheme is being taken into consideration, a TB will submit it as an alternative plan from now on by the stabilization of selling income.)

②Cost reduction by the use of the machine of development of a BHC our company of the H_2S collection system (Because it has an actual plant, that system is used, and it copes with an engine exhaust gas requirement. (SOx：900ppm→60ppm))

③The material (geo-membrane cover system) of anaerobic fermentation tank, a cost reduction by the local supply

④The use of the used article of the gas engine generating electricity equipment (GE is height of a cost though it is planned with the one manufactured by Jenbacher energiesisteme AG. Therefore, a remodeling fee to GE of DE is being discussed with Hitachi engineering service at present the use of the used article included from now on is examined.)

⑤Use as a compost bin that it sludge (It aims at compost including the element and so on though it is planned as the farm, the soil material to plantation at present.)

⑥The differentiation of the CER purchase price is necessary because it is finally made to compete with each other by the owner (TB) in Thailand. Therefore, it is made a goal that a CER unit price is increased to EU base.

2) Wastewater fluctuation

Wastewater plan is an average, and an alcoholic production system will be assigned in each factory soon, and the plan change of that amount of production will be scheduled. A conference is done to reconsider a TB and a factory production plan for more displacement on the assumption that to increase as a solution plan.

3) The guarantee value of the COD removal rate

It tries to raise it as a solution plan to 70% of the guarantee value from now on though it is being discussed with ADI by 65% of the guarantee value, 70% of the design value.

4) The execution of the meeting of stakeholder which relates to IEE

It is area contribution that it is taken with IEE most seriously. There are roads, adoption of the area employer, a requirement such as the infrastructure of the utility equipment, and the cost impact of this is very big, and exerts a big influence on the project execution. Therefore, agreement with enough explanation (groundwork) and the inhabitant is necessary as a solution plan so that additional costs with the inhabitant countermeasure of the TB and so on may decrease though an inhabitant's requirement is very big.