Fiscal 2006 CDM/JI Project Study : Report Summary

"Feasibility Study on Utilization of Biogas from Wastewater at Noodle-Making Factory in the Kingdom of Thailand"

Kanematsu Corporation

1. Basic Elements Concerning Project Implementation

(1) General Outline of Proposed Project and Background for the Project Planning

- General Outline of Proposed Project

At the moment, wastewater discharged from the food factory of Sitthinan Co, Ltd, where the site for the proposed project is located, is treated in lagoon ponds. The project is designed to treat the wastewater in an anaerobic treatment system (EGSB) so as to restrict the atmospheric emission of methane gas. At the same time, the methane gas is recovered without leak in the atmosphere by means of anaerobic wastewater treatment to utilize for high- efficiency power generation by gas engine. The electricity generated in this way is used to power the factory (this being regularly fed to a functional agitator serving the aeration tank). The electric power obtained from the Provincial Electricity Authority (PEA) can accordingly be reduced, thus cutting greenhouse gas fossil-fuel emission by an equivalent amount. Additionally, this project makes it possible for greenhouse gases to be reduced through the combustion of surplus methane gas and in cases of emergency by means of a flare stack.

- Background for the Project Planning

The existing anaerobic open-lagoon type in the Sitthinan noodle- making factory is equipped with covers alone as measures against foul smells in the neighboring factories, methane gas can not be recovered in the existing treatment system, and gases are only discharged at regular intervals by vacuuming up with an air blower from these lagoon ponds. In this respect, it is desired on the factory's part that the factory power consumption can be saved by means of installation of facilities to recover efficiently methane gas. In the background this study was conducted. The expansion program of the factory is now under contemplation and it is anticipated that the downsizing of lagoon ponds with installation of the proposed anaerobic wastewater treatment facilities will have beneficial effects to the factory's part.

It is requested that if methane gas will be recovered efficiently in the proposed project, thereby contributing to the betterment of financial capability of the factory in view of profits to be gained by the CER trading, the implementation of the project might be worthy of serious consideration. Therefore, the study was conducted with an eye on the efficient recovery of methane gas, thereby advancing the economical efficiency of the project.

- Determination of the Project Site

At an early stage of the study, the utilization of wastewater from Siam Modified Starch Co.,Ltd located near the project was also considered as a similar project so that this similar project and the proposed project could be bundled up. The study of bundling these projects into one project, however, was not conducted owing to the following reasons; the volume of wastewater (m^3/d) from this factory was extremely small due to its qualitative reason, the wastewater had low concentrations of organic materials (BOD and COD) and the size of the resulted power generation would be small, thereby earning only small amount of the CER trading. In this

regard, similar schemes with Pornvilai International Group Trading Co., Ltd (PVL) (Ayuttaya Province) and Thai Beverage Co., Ltd (TB) (Nakhon Pathom Province) are now under contemplation as intended parties for bundling and under discussion among relevant parties. Figure 1 shows the location of proposed sites for the study.

The reasons for having selected the Sitthinan noodle-making factory as a viable site for the CDM project are described below.

① The existing open-lagoon ponds are equipped with covers alone and methane gas is not recovered in the existing treatment system.

② Measures against foul smells in the neighboring factories are painstakingly taken.

③ Much further efficient treatment and utilization of a large amount of wastewater discharged after cleansing/refining processes by tightening environmental regulations can be expected with the result that some of existing site will be diverted to the proposed expansion program.

④ Electric energy equivalent to the power consumption by existing wastewater treatment facility (aeration tank) is expected to be alternated by biogas energy.

⑤ The factory is located about one hour by car from Bangkok with high accessibility.

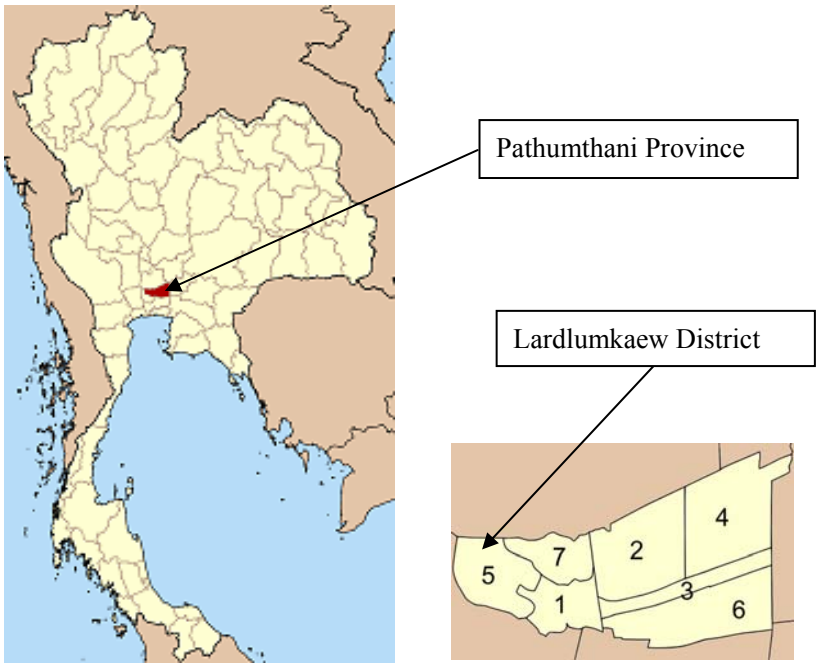

Figure 1 Proposed Project Sites

(2) Outline of the Host Country

The Thaksin Government inaugurated in February, 2001 hammered out measures for the economic promotion of agricultural communities and medium/ small companies on the ground that the domestic demand along with existing export-oriented demand could be traction forces for the national economy. The economy has recovered and attained the economic growth of 6.9 % for 2003 and 6.1 % for 2004 respectively owing to activated personal consumption as a result of a likely response of the domestic demand expansion policy.

On the night of September 19, 2006 in Bangkok, the army blocked off the central part where the prime minister office and other government offices are located with tanks and soldiers mobilized. A military coup intended to deprive the authority of Thaksin of former prime minister, and General Sonthi Boonyaratglin, Army Commanding Officer led the coup. In the predawn hours of

the next day, the junta declared through TV a message to the effect that “Democratic reformation council” consisting of the military and police seized the control of the authority. And it was also purported that General Sonthi acceded to the interim prime minister. Afterwards, in the morning of September 21, public offices, banks and schools resumed and civil life almost returned to normal.
The country is the largest producer of cassava; its recent production is 16 to 18 million tons, about 10 % share of the world production of 160 million tons. The country is also the largest producer of cassava starch and a large producer of the starch related food. Therefore, the country can be called as “Cassava starch industrial nation.” The annual production of cassava starch is more than 2 million tons. The project objective factory is one of leading companies of “Cassava starch industry” and there are lots of similar factories in the country. And these companies of “Cassava starch industry” have similar open lagoon ponds for treatment of their wastewater in their factories like the project objective factory, and therefore, it is considered that operation of projects with similar schemes can be anticipated.
Consequently, it is possible to disseminate the proposed project and start getting similar schemes into operation with a certain intention based on the feasibility study of CDM/JI.

(3) Policy and Current State Relating CDM/JI, Including the Host Country’s Criteria to Accept CDM/JI and Current State of DNA Installation

- Policy and State Related to CDM

Biogas utilization-related projects account 47 % of the total CDM projects expected in the country, the suitability of efficient utilization of biogas as CDM projects is acknowledged and its implementation is highly expected.
The six projects are ready and waiting for the authorization of the Cabinet as CDM projects for prosecution treatment, four projects of biogas power generation and two projects of biogas utilization of wastewater. Among the two projects of biogas utilization of wastewater, one project is “Korat waste to energy project (KWTE) in Thailand” and if they will be approved by the Cabinet, by means of the use of similar method (Approved Methodology UNFCCC, AM0022 Version 3) the project can go a long way to south-eastern Asia countries including Thailand. Because it is the same utilization project, this project pays attention to the current.

- Recent Trends

According to DEDE (Department of Alternative Energy Development and Efficiency) of the Ministry of Energy in charge of CDM projects related to renewable energy, ONEP (Office of Natural Resources & Environmental Policy and Planning) (within MONRE) of the Ministry of Natural Resources and Environment, DNA, was reorganized and BGEMO(Board of Greenhouse Effect Management Organization) and Greenhouse Effect Management Organization were newly established under the Cabinet on August 15, 2006. BGEMO is broken down into five sectional committees in accordance with the characteristics of CDM projects. As of this study it was gathered that they would commence their actual works after office preparations and determination of member staff and that the minister of MONRE (Ministry of Natural Resources and Environment) would be chairman of BGEMO and the selection of actual working staff would be completed at the end of 2006. It is anticipated that they will start their actual works at the beginning of 2007.

(4) Project Contribution to Sustainable Development and Technology Transfer in the Host Country

- Contribution to Sustainable Development

① The protection of the environmental pollution due to improvement of wastewater quality by the improvement of the anaerobic wastewater treatment facilities ability.

② Combat global warming by the effective utilization of methane gas as a renewable energy source.

③ The protection of the environmental pollution by restraint on peripheral diffusion of emitted odour by means of the closed structure.

④ Effective utilization of land by space – saving with a great help from of anaerobic treatment method.

⑤ Against skyrocketing energy cost such as heavy oil, fossil-fuel consumption required for the power supply to the grid can energy-saving effect be reduced to the extent that the power generation by the project is supplied to the factory.

⑥The project can disseminate around Southeast Asian countries including Thailand. It becomes clean technology demonstration project, and there is effect of that disseminate.

⑦ The project will add value (production cost reduction and CER income) to starch industries of cassava, a valuable export commodity of Thailand.

- Transfer of Technology

① Methane fermentation technology

② Methane gas power generation technology

③ Technological monitoring and management system

(5) Study Implementation Structure (Domestic, Host Country and Others)

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

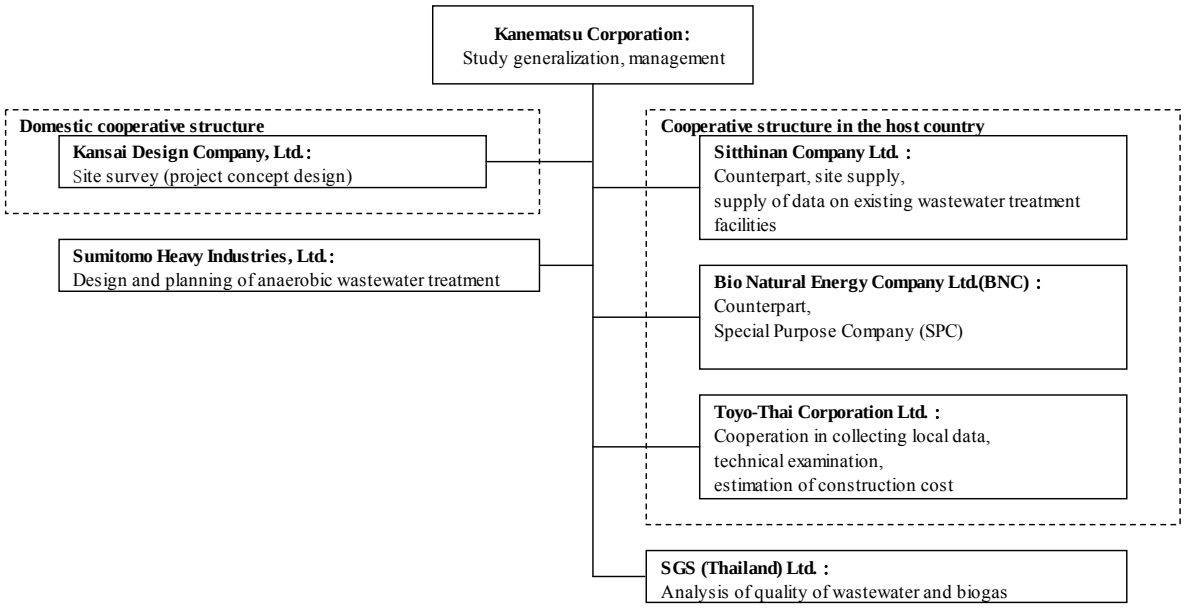

Figure 2 Study Implementation Structure

2. Project Planning

(1) Project Particulars

- Project Site

At the moment, the wastewater (Starch Process 1 Wastewater) after production of mung bean starch, the wastewater (Starch Process 2 Wastewater) after production of tapioca starch and the wastewater (Noodle Wastewater) after production of vermicelli in the food factory which made starch are discharged into the existing anaerobic lagoon pond (only the cover has been constructed) (Pond 1).

- Wastewater Planning

The water properties of each wastewater from process lines are shown in Table 1. The mixed wastewater flowed in from each of process lines shall be the database for preparation of PDD and design of anaerobic wastewater treatment system (EGSB).

Table 1 Quality of Wastewater at the Project Site

No.	Item	Unit	Starch Process 1 Line	Starch Process 2 Line	Noodle Line	Mixed wastewater flowed from facilities
1	Wastewater volume(Max.) (operating month)	m^3/d	1,100 (1,3,5,7,10,11,12)	700 (1,3,5,7,10,11,12)	1,000 (every month)	2,800
2	pH	-	4～5	4～5	6～7	4～7
3	Temperature	℃	30～50	50	30～50	<38
4	SS	mg/l	-	-	630	<500
5	BOD	mg/l				5,059
6	COD(Max.)	mg/l	4,000	28,000	4,000	8,900
7	T-N	mg/l	270	850	0	205.3
8	T-P	mg/l				90.7
9	T-Sul	mg/l				32.2
10	n-Hex.	mg/l				<100

- Wastewater Volume and Component

Because the average wastewater volume on around one day of every month changes, the baseline wastewater volume from this factory shall be1,800 m^3/d to annual average wastewater volume.

Table 2 Wastewater Baseline Volume

Month / Item	Unit	1	2	3	4	5	6		
Wastewater volume	m^3/d	2,292	890	2,444	942	2,345	872		
Month / Item	Unit	7	8	9	10	11	12	Total	Average
Wastewater volume	m^3/d	2,503	912	800	2,636	2,636	2,636	21,908	1,826

For COD concentration, the COD concentration value of 8,900 (8.9 kg/m^3) from this factory shall be applied as the steady one based on the design from the client wastewater quality analysis report of Table 1. Therefore, the parameter of baseline to use for emission reduction calculation is shown in the Table 3.

Table 3 Parameters for Baseline

Item	Unit	Value
Wastewater volume	m^3/d	1,800
COD concentration	mg/l	8,900
COD load	kg COD/d	16,020

- New Wastewater Treatment Facilities

For the selection of new wastewater treatment facilities, comparative studies of the proposals from three companies; Sumitomo Heavy Industries, Ltd (Japan), Goshu Kohsan Co., Ltd (Thailand) and ADI Systems Inc. (Canada) were conducted. The process of Sumitomo Heavy Industries, Ltd was selected for the adoption in the project from the aspect of capacity for methane recovery and capital cost.

The process of Sumitomo Heavy Industries, Ltd to be adopted in the project is shown in Figure 3. It consists of an acid formation tank and a reactor tank; liquefaction and acid formation will grow in the acid formation tank, while acetic acid formation and methanation also will grow in the reactor tank. Acid formation, detoxification of inhibitory substances, temperature regulation, pH adjustments, and nitrification are performed in the acid formation tank. Some of the treated water in the reactor tank returns to the acid formation tank, thereby enabling alkali recovery from the treated water and propagation effects of acid producing bacteria. Despite changes of the raw water volume (suspension) and water quality, the operation will continue so as to improve the operational stability and streamline the operation management.

The reactor tank will advance efficiently reactions, react in response to high load and gasify low-molecular weight organic matters. The wastewater distribution, upward-moving stream within the tank and three-phase separation of gas and granule produced by the settler and the treated water will be also efficiently performed in the reactor tank.

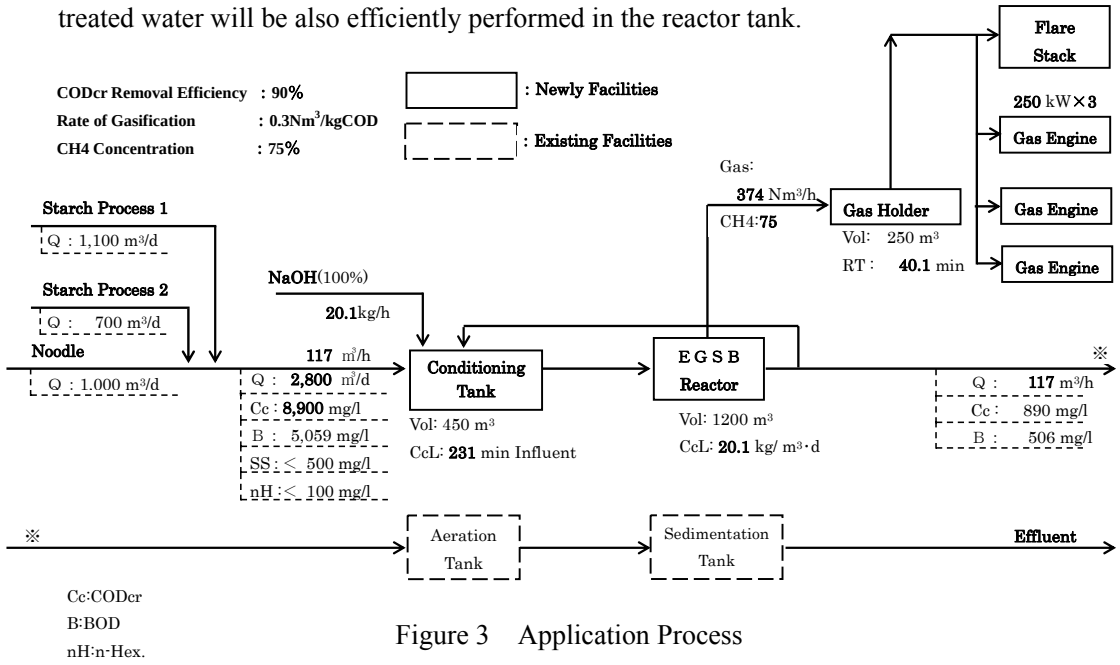

Figure 3 Application Process

(2) Setting of the Project Boundary and Baseline and Demonstration of Additionality

- Methodology

This project was to be examined in the AM0013 but the AM0013 was revised to the AM0013 version3 owing to the methodology revision made in public in May 2006; the methane conversion factor was revised and the initial objective amount of CER was not able to be expected. In this background the project reached to the stage where some methodology through which the project can earn bigger CER than through the AM0013 version3 should be picked out and prepared for implementation of the project. Three methodologies (AM0013 version3, AM0022 version3 and AMS-III.H. version3) were selected and the simulation checkout was carried out for the project; the AM0022 version3 was selected among them. In this respect, the project belongs to the open lagoon category of the AM0013 version3, but it can not be applicable to the project due to its restriction of the retention time of less than 10 days in anaerobic lagoons. The AMS-III.H. version3 can be applicable to small-scale schemes but its factors are conservative with rather small CER to be earned. The AM0022 version3 was determined as the baseline methodology to be applied to the project activities on the ground that it can meet the following conditions.

Table 4 Applicable Conditions of AM0022 vervion3 and Project Applicability

Applicable Condition of AM0022 version 3	Project Applicability
This methodology is applicable to projects that introduce anaerobic treatment systems in existing industrial lagoon-based water treatment facilities under the following conditions:	(Yes;) It is a project where the anaerobic treatment system is applied to the existing industrial lagoon-pond type water treatment facilities.
* Project is implemented in existing lagoon-based industrial waste water treatment facilities for wastewater with high organic loading;	(Yes;) The project is implemented to an industrial wastewater (food wastewater) treatment facilities.
* The organic wastewater contains simple organic compounds (mono-saccharides). If the methodology is used for waste water containing materials not akin to simple sugars a CH_4 emissions factor different from 0.21 $kgCH_4/kgCOD$ has to be estimated and applied;	(Yes;) The project target food wastewater includes non-monosaccharide. Sumitomo Heavy Industries., LTD, will be technology supplier, however, specializes in food wastewater and uses the methane release factor of 0.2143 kg CH_4/kg COD from the perspective of results of the related introduction and empirical values.
* The methodology is applicable only to the improvement of existing wastewater treatment facilities. It is not applicable for new facilities to be built or new build to extend current site capacity;	(Yes;) It is improvement of existing wastewater treatment facilities. There is no new construction on the project site. There is also no plan for expansion of existing facilities.
* It can be shown that the baseline is the continuation of a current lagoon system for managing waste water. In particular, the current lagoon based system is in full compliance with existing rules and regulations;	(Yes;) It shown that the baseline is the continuation of a current lagoon system for managing waste water. And, the current lagoon based system is in full compliance with existing rules and regulations.
* The depth of the anaerobic lagoons should be at least 1m;	(Yes;) The anaerobic lagoon pond is 3.5 m.
* The temperature of the wastewater in the anaerobic lagoons is always at least 15 °C;	(Yes;) The anaerobic lagoon pond shall have a temperature of more than 30 °C (at a drain).

Applicable Condition of AM0022 version 3	Project Applicability
* In the project, the biogas recovered from the anaerobic treatment system is flared and/or used onsite for heat and/or power generation, surplus biogas is flared;	Yes; Recovered biogas is burned up with a flare stack for power generation on site and the surplus is burned and diffused.

- Project Boundary

The project boundary is shown in Figure 4. The existing anaerobic lagoon, Pond 1 shall be the boundary for the project.

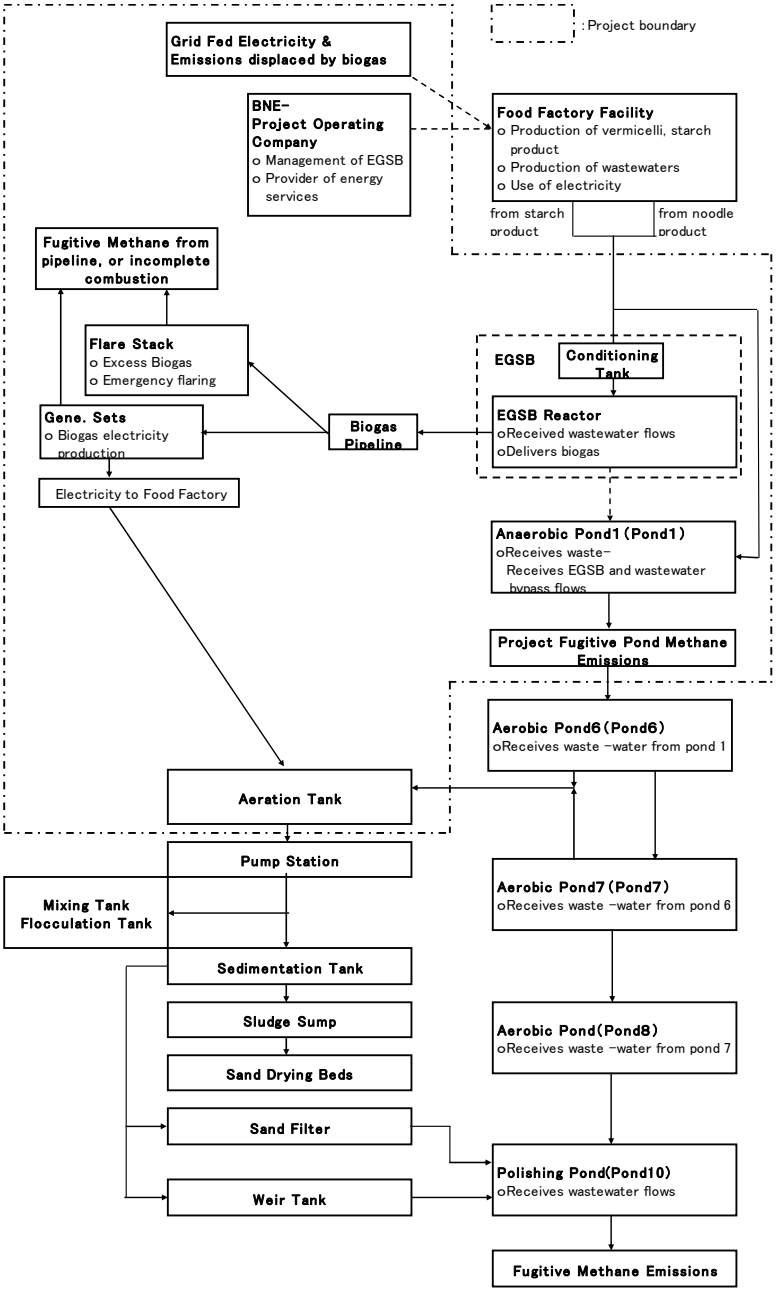

Figure 4 Project Boundary

- Setting of Baseline and Demonstration of Additionality

Step1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity

Scenario 1: Scenario of continuity of the current practice
(The project activity or other alternative scenarios are not implemented)

Scenario 2: Direct discharge of wastewater into nearby lakes and ponds,

Scenario 3: The proposed project is not implemented as the CDM project.
(The proposed project is designed to recover methane gas through anaerobic treatment facilities (EGSB) for power generation. The electric power generated is used for own purpose and surplus gas is burned for diffusion.)

Scenario 4: Introduction of aerobic digester for wastewater (surplus sludge or hearth type treatment)

Sub-step 1b. Enforcement of applicable laws and regulations

The scenario 2 is disregarded as against the law of Thailand; hence the scenario 1, 3 and 4 are tested.

Step2 : Investment analysis

Step3 : Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity

The results of analysis of legal, financial, technical, institutional, social, business cultural and other barriers are shown in Table 5.

Table 5 Summarized Results of Barrier Analysis

Alternative baseline / Barrier tested	**Scenario 1: Scenario of continuity of the current practice**	**Scenario 3: Scenario where the proposed project is not implemented as the CDM project**	**Scenario 4: Aerobic digester**
Legal	N	N	N
Financial	N	Y	NA
Technical	N	Y	Y/N
Institutional	N	Y	Y
Social	N	Y/N	Y/N
Business culture and others	N	Y	Y

The choice Y means that there are barriers, the choice N means that there is no barrier, the choice NA means that the relevant subject is not applicable.

Therefore

(a) **Scenario 3: Scenario where the proposed project is not implemented as the CDM project** covering the project activity similar to the proposed project is discouraged from being implemented.

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The scenario 3 & 4 are not implemented due to barriers as identified in Table 5, but the scenario 1, the current practice, is not disturbed by the above barriers.

Therefore,

(b) It was shown that at least one alternative scenario, **Scenario 1: Scenario of continuity of the current practice** is not discouraged from being implemented by means of the prescribed barriers.

Step4: Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity

There is no similar project in that the relevant project of the scenario 3 does not involve the EGSB technology introduced in Thailand. Accordingly, results of analysis of the past or ongoing activities similar to the proposed project activities can not be provided.

Step5: Impact of CDM registration

The relevant project of the scenario 3 is not the baseline scenario as stated in Step 2 & 3. It is additional for the implementation organization to execute the project by means of utilizing anaerobic treatment facilities (EGSB) to obtain CER based on risks of climate, water ingredient and construction circumstances.

The IRR of the project scenario 3, if taking account of profits on sales of CER to be gained by CO_2 reduction, is 7.0% (After-tax) on the assumption that the credit price is 11.56 US$/t$CO_2$, the weighted average price, the reference book, "State and Trends of the Carbon Markets" of the World Bank. As a result, the project will be registered as CDM and result in CER generation; hence, economic and financial hurdles for the project implementation will be lowered, thereby enabling the project to be implemented. Therefore, the project can be recognized as its supplement.

Addtionality Determination – Conclusion

The project described in the project scenario, utilizes high-technology of methane fermentation (EGSB) unfamiliar in Thailand; its additional property is demonstrated and **Scenario 1: Scenario of continuity of the current practice** is selected as the baseline scenario.

(3) The Operational Period of the Project Activity/Crediting Period

The project operational period shall be 14 years in consideration of durable years of the equipment, and 7 years shall be initially applied as the crediting period with renewable, it is assumed that CER will be earned for the project operational period of 14 years (years of 2009-2015and 2016-2022).

(4) GHG Reduction and Leakage by the Project Implementation

- Target Greenhouse Effect Gas

The list of greenhouse effect gas is shown in Table 6.

Table 6 List of Greenhouse Effect Gas

	Source	Gas	Included/ excluded	Justification/ Explanation
Baseline	Wastewater treatment (Anaerobic lagoon)	CO_2	Excluded	The emission of CO_2 from resolving of organic material is not counted. (Excluded from the status of carbon neutral)
		CH_4	Included	Main source of the baseline emission : ①
		N_2O	Excluded	To be excluded for simplicity. This is conservative.
	Electric power of the grid	CO_2	Included	Electric power is consumed from the grid in the baseline scenario. : ②
		CH_4	Excluded	To be excluded for simplicity. This is conservative.
		N_2O	Excluded	To be excluded for simplicity. This is conservative.
Project activity	Wastewater treatment facilities (ESGB)	CO_2	Excluded	The emission of CO_2 from resolving of organic material is not counted. (Excluded from the status of carbon neutral)
		CH_4	Included	Imperfect combustion methane or leakage from the EGSB. : ④
		N_2O	Excluded	This is not a significant emission source.
	Wastewater treatment facilities (existing anaerobic lagoon)	CO_2	Excluded	The emission of CO_2 from resolving of organic material is not counted. (Excluded from the status of carbon neutral)
		CH_4	Included	This is a major source of the project emission. : ③
		N_2O	Excluded	This is not a significant emission source.

- GHG Emission by the Project Implementation

③：Discharged methane emission from lagoon

$E_{CH\_4\ lagoons} = M_{lagoon\_anaerobic} * EF_{CH4} * GWP_{CH4} / 1{,}000$

$= 434{,}245\ (kg\ COD) * 0.2143\ (kg\ CH_4/kgCOD) * 21/\ 1{,}000 = 1{,}954\ (tCO_2e)$

④：Methane emission from imperfect combustion (flaring efficiency set at 98 %)

$E_{CH4\_IC+Leaks} = \sum V_r * C_{CH\ 4\ \_\ r} * (1- f_r) * GWP_{CH\ 4}$

$= 2{,}018{,}520\ (Nm^3/年) * 0.0005357(tCH_4/Nm^3) * (1-0.98) * 21 = 454\ (tCO_2e)$

③＋④：Total project emission

$E_{project} = E_{CH4\_lagoons} + E_{CH4\_NAWTF} + E_{CH4\_IC+leaks}$ (E_{CH4_NAWTF} ：0 (tCO_2e))

$= 1{,}954\ (tCO_2e) + 0\ (tCO_2e) + 454\ (tCO_2e) = 2{,}408\ (tCO_2e)$

- GHG Emission by the Baseline

①：Discharged Methane Emission from Baseline Lagoon

$E_{CH4\_lagoons\_BL} = M_{lagoon\_anaerobic} * EF_{CH4} * GWP_{CH4} / 1{,}000$

$= 4{,}723{,}600\ (kg\ COD) * 0.2143\ (kg\ CH_4/kgCOD) * 21/\ 1{,}000 = 21{,}257\ (tCO_2e)$

②：CO2 emission from power generation of the baseline grid

$E_{CO2\_power} = EL * CEF = 3{,}000\ (MWh/yr) * 0.54\ (tCO_2e/MWh) = 1{,}620\ (tCO_2e)$

①＋②：Total baseline emission

$E_{BL} = E_{CH4\_lagoons\_BL} + E_{CO2\_grid\_BL} = 21{,}257\ (tCO_2e) + 1{,}620\ (tCO_2e) = 22{,}877\ (tCO_2e)$

- Leakage

There shall be no leakage from the project in accordance with the methodology of AM0022 version 3.

- GHG Emission Reduction

GHG emission reduction by the project is shown in Table 7. The project period and the crediting period are assumed to be 14 years respectively.

Table 7　GHG Emission Reduction by the Project

	Baseline emission (t-CO_2e)	Project emission (t-CO_2e)	Emission reduction (t-CO_2e)
Power transmission on the grid (Indirect)	1,620		1,620
Emission from discharged pond (Direct)	21,257	1,954(Discharged methane) 454 (Imperfect combustion)	18,849
Total	22,877	2,408	20,469

(5) Monitoring Plan

The monitoring plan is shown in Figure 5.

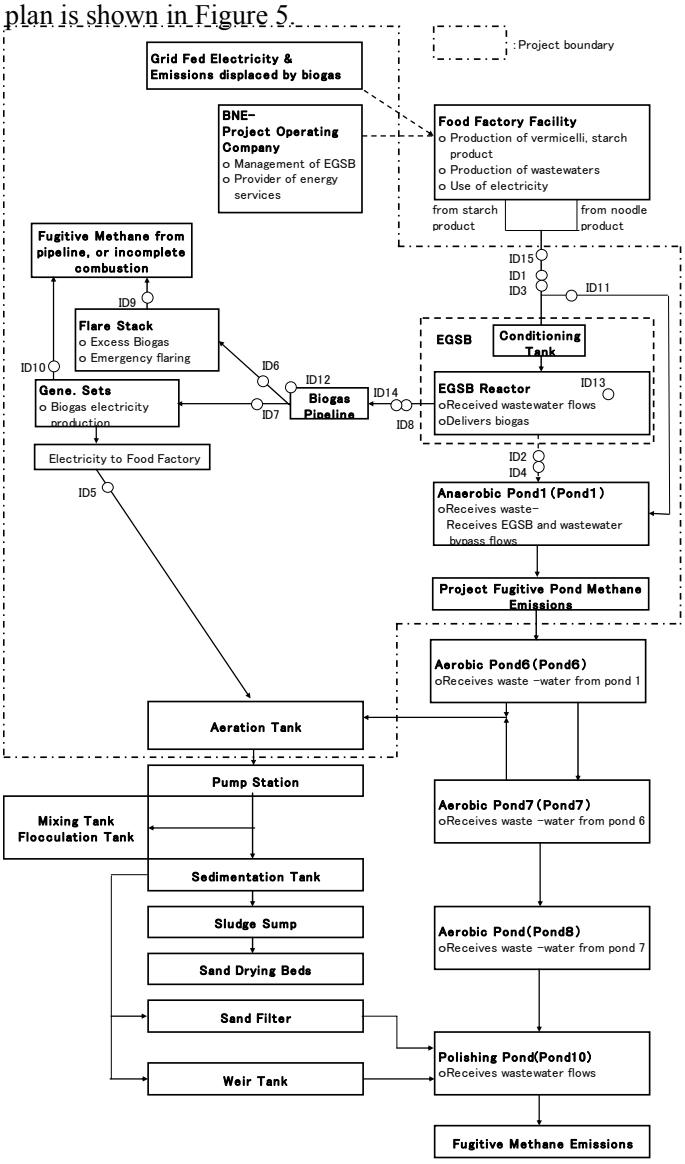

Figure 5 Monitoring Plan

ID1 : Wastewater load at the inlet of EGSB (system boundary) : m^3

ID2 : Wastewater load at the outlet of EGSB (treatment facilities of the project) : m^3

ID3 : Wastewater COD at the inlet of EGSB (system boundary) : kg COD / m^3

ID4 : Wastewater COD at the outlet of EGSB (treatment facilities) : kg COD / m^3

ID5 : The electric energy generated by biogas recovered in the anaerobic treatment facilities. : MWh

ID6 : The amount of biogas flown to flaring : Nm^3

ID7 : The amount of biogas flown to power generating unit : Nm^3

ID8 : Biogas methane concentration : %

ID9 : Flare thermal efficiency : %

ID10 : Thermal efficiency of power generating unit **:** %

ID11 : Wastewater flow rate to the pond system: direct to the existing wastewater treatment

facilities bypassing EGSB (new construction of wastewater treatment facilities)：m^3

ID12： Loss of biogas methane from the pipeline：%

ID13： Organic materials removed from the wastewater facilities **:** t COD

ID14： Biogas heat value：J/Nm^3

ID15： The amount of chemical oxidation flown into the system boundary：$tonnes/m^3$

(6) Environmental Impacts/ Other Indirect Impacts

- Environmental Impacts

The project and particulars relevant to the environmental impact assessment system in Thailand had been discussed and conferred with Sitthinan Co., Ltd and related government ministries and agencies with the result that the project is not incompatible with the system; it was confirmed that the project does not fall under the coverage of the environment impact assessment system.

- Other Indirect Impacts

① Local environmental conditions will be improved by means of methane gas recovery and reduced foul odor.

② Efficient utilization of renewable energy will do a service to the power demand in Thailand.

③ Local economic effects are expected as below: positive economic effects such as local construction and regular maintenance service together with macroscopic effects such as saving of foreign currencies by power generation with indigenous resources.

④ Specialized knowledge and experience are required for the maintenance and management of the reactor tank, thereby encouraging improvement of technical capabilities of operators and technical staff for facility management and maintenance; therefore, the improvement of technological capabilities in the entire local communities can be expected.

(7) Stakeholders' Comments

・Sitthinan Co., Ltd (STN) (the project participant)

- Residents living in the vicinity; they give endorsement to the project because it can be an odor control to their labor environments.
- They open their arms to the project because they can make efficient use of renewable biogas energy.
- They bid welcome to the project because the wastewater treatment is now a major matter.

・DEDE (Department of Alternative Energy Development and Efficiency)

- They welcome introduction of renewable energy project.
- They welcome implementation of the project as CDM project.
- They estimate the worth of efficient use of energy by the project so that the project can set a good example for the wastewater treatments improvement of lots of food factories located in Thailand.

・Surrounding factories (industrial area)

- The project achieved their understanding of its odor reduction.
- The present situation of releasing directly from generating a large quantity of biogas may pose them significant fire risks (hazard) and thus a new construction of the project gained

a better comprehension of its restriction of these fire risks (hazard).

Further hearings shall be held hereafter to receive comments from the following organizations:

・ONEP (Office of Natural Resources and Environment Policy and Planning)

・Lardlumkaew District (local governmental unit)

・PEA (Provincial Electricity Authority) Local power distribution public corporation

3. Toward Project Implementation

(1) Project Implementation Structure (Domestic, Host Country and Others)

The project implementation structure is shown in Figure 6.

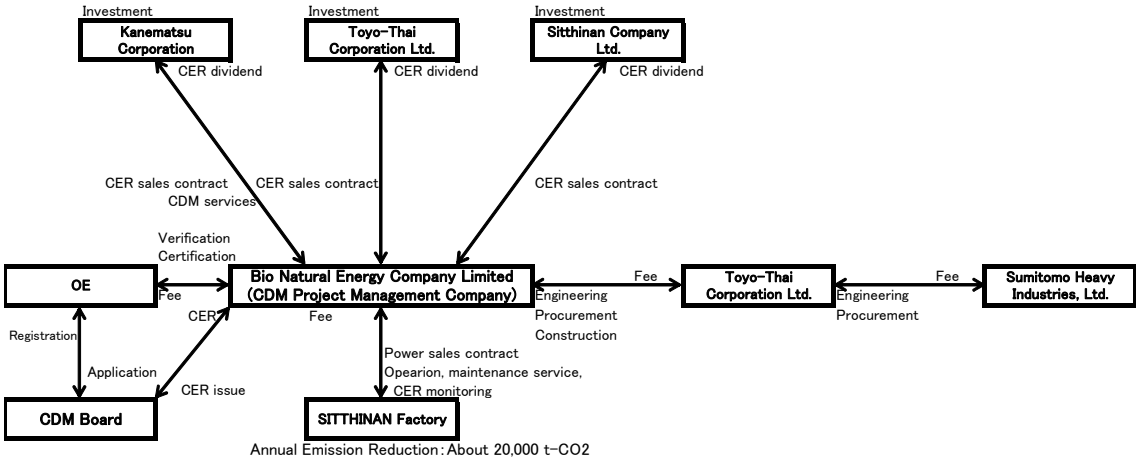

Figure 6　Project Implementation Structure

(2) Financial Plan for Project Implementation

The results of the study is that the project shall be implemented with 100 % own funds owing to its qualitatively lower economic efficiency (IRR) and its requirement for non-massive amount of investment. Hereafter, final version of the financial plan will be discussed among three parties based on the study results. It is under study that part of the investment will be asked of Sumitomo Heavy Industries, Ltd. It is also under study that part of funds will be raised from financial facilities on the condition that the prescribed economic efficiency of the project can be secured. However, there was a remark if fixed economy was secured by Sitthinan Co., Ltd to examine a supply from a financial institution to the maximum, the bank of the Japanese and local bank are being asked for the examination of the loan at present.

(3) Analysis of Economic Efficiency

- Initial investment amount: ¥315,000,000.

- Internal Rate of Return IRR

The results of computing the internal rate of return (IRR) of the project with the credit and without the credit are shown in Table 8.

Table 8 IRR of the Project (after tax)

	without CERs	with CERs
IRR of the project	−5.9 %	7.0 %
Emission reduction	20,469 t CO_2e	
Total generated electrical energy	3,000 MWh	

(4) Prospects and Issues for Project Implementation

1) Assessment of risks relevant to the internal rate of return (IRR) of the project

The project is assumed to be accompanied by the following seven risks including related methodology: The assessment of these risks is made for the discussion of the project with the use of IRR shown in Table 9, and its results are shown in Table 9.

① Project operating days ($M_{lagoon\_input\_BL} = M_{input\_total}$) (350→292 days /year)
② Methane recovery ratio (rate of removal of organic materials of new aerobic wastewater treatment system) (R_{NAWTF}) (90→80 %)
③ COD concentration ($M_{lagoon\_input\_BL} = M_{input\_total}$) (8,900→8,600 mg/l)
④ Wastewater volume ($M_{lagoon\_input\_BL} = M_{input\_total}$) (1,800→1,620 m^3/d)
⑤ Organic materials removed from lagoon system (R_{lagoon}) (85→75 %)
⑥ Revising risk to AM0022version 3 by UNFCCC
⑦ Credit-taking risk; solvency of interest payable (6 %) against 50 % of the total investment.

Table 9 Sensitivity of IRR (after tax) to Risks

Particulars of risks	With credit	Emission reduction t CO_2e	Total generated electrical energy MWh
① Project operating days	4.6 %	17,158	2,655
② Methane recovery efficiency	5.5 %	18,266	2,800
③ COD concentration	6.8 %	19,833	3,000
④ Wastewater volume	5.3 %	18,421	2,700
⑤ Organic materials removed from lagoon system	6.0 %	18,197	3,000
⑥ Revising risk to AM0013 version 3	1.5%	9,094	3,000
⑥ Revising risk to AMS- III.H. version 3	2.8%	11,276	3,000
⑦ Risk of interest payable (6 %)	5.5%	20,469	3,000

The assignments ahead are that the aforesaid risks should be deliberated in details so as to avoid these risks and that economical efficiency of the project will be further improved.

2) Improvement of economical efficiency

The project aims to secure 15 % of IRR as the reference index for making investment decisions (at least 10 % as the target). The IRR of the project is 7.0 % insofar as the credit price is 11.56US$/t CO_2 without measuring up to the reference index. It is, however, gathered that the credit price will be 15US$/t CO_2 and if this is the case, the IRR of the project comes up to 9.6%. Considering the aforesaid risks, further thorough examination of the investment should be made.

Despite the above circumstances, the project will be able to accomplish main physical objectives (odor control, power demand and saving the factory space) if viewed from the standpoint of Sitthinan noodle making factory' part. In that context, it was discussed with them whether they will implement the project, even if the project will not secure the reference index. As a result, more examination such as risk, economy, water quality, gas analysis will be carried out hereafter, it was confirmed that this project is promoted.

3) Periodical and long-term analysis of methane gas and wastewater quality

Sampling analyses of wastewater quality and methane gas component were made on October 21, 2006 as one sphere of the study. And the thorough analysis of methane gas component was also made. Periodical and long-term methane gas generation in existing open lagoon ponds should be confirmed. Sampling analysis of methane gas component is necessary due to its unstable composition. And sampling analysis of wastewater quality on regular and long-term basis is also indispensable due to its big load variation.

4) Determination of methane emission factor (EF_{CH4})

In point of the methane emission factor (EF_{CH4}) to be used for the quantities of emission of the project, Sumitomo Heavy Industries, Ltd, specialized in food wastewater, which is to provide the relevant technology to the project, uses the value of 0.2143 $kgCH_4/kgCOD$ ($0.3Nm^3$ CH_4/kg COD) as the methane emission factor determined from actual performances based on their introductions and their experience.

The investigation works for determining the methane emissions factor such as the measurement of the quantities of methane generation including actual application into the methodology will be necessary.