CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

UTILIZATION OF BIOGAS AND POWER GENERATION ON WASTEWATER FROM FOOD FACTORY IN THE KINGDOM OF THAILAND

First Version

Date: January 19, 2007

A.2. Description of the project activity:

- The purpose of the project activity

At the moment, wastewater discharged from the Sitthinan Co., Ltd located on the project site 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.

- The view of the project participants on the contribution of the project activity to sustainable development

The following contribution to the sustainable development through the execution of the project is expected:

* The protection of the environmental pollution due to improvement of wastewater quality by the improvement of the anaerobic wastewater treatment facilities ability.
* Combat global warming by the effective utilization of methane gas as a renewable energy source.
* The protection of the environmental pollution by restraint on peripheral diffusion of emitted odour by means of the closed structure.
* Effective utilization of land by space – saving with a great help from of anaerobic treatment method.
* 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.
* The transfer of technology for the methane fermentation process and biogas power generating equipment.
* The project can disseminate around Southeast Asian countries including Thailand. It becomes clean technology demonstration project, and there is effect of that disseminate.
* The project may also serve as a project for establishing the CDM as an important capability so that the project can demonstrate that it provides funds as new financial machinery to the renewable energy and waste management sectors in the country and the provinces.

* The project will reduce energy import from abroad, thereby providing positive effects to the external payment balance of the country. Diversification of energy by its self-sufficiency and the security of energy supply will be also accelerated.
* The project will add value (production cost reduction and CER income) to starch industries of cassava, a valuable export commodity of Thailand.
* Effective utilization of organic material of waste effluents involving the risk of generation of flammable methane gas.
* The project management company will be established on a basis of revenues from CER.

A.3. Project participants:

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant(Yes/No)
Thailand (host)	Sitthinan Co., Ltd (STN)	No
Thailand(host)	Bio Natural Energy Company Limited (BNE)	No
Thailand (host)	Toyo-Thai Corporation Limited (TTCL)	No
Japan	Kanematsu Corporation (KG)	No
Japan	Sumitomo Heavy Industries., LTD (SHI)	No

Project concerned parties (Host and investing countries)

Investing countries: At the moment, investing countries can not be determined. The consultation among negotiable parties is in progress but an official agreement among them has not been achieved. It will be determined at a later stage.

All of the project concerned parties are private bodies.

(Host country)

* Sitthinan Co., Ltd (STN):
  Owner of a factory of bean-starch vermicelli, tapioca and green-bean starch, and donor of the project site
* Bio Natural Energy Company Limited (BNE):
  SPC (Special Purpose Company), CDM Project Management Company and the responsible organization for implementation of CDM project
* Toyo-Thai Corporation Limited (TTCL): On – site EPC (Engineering/Procurement /Construction)

(Japan)

* Kanematsu Corporation (KG):
  Preparation of PDD, CDM project adviser and contacting point of the project
* Sumitomo Heavy Industries, LTD (SHI):
  Design and engineering of anaerobic wastewater treatment unit

For detailed contact address, see Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Thailand (Host country)

A.4.1.2. Region/State/Province etc.:

Pathumthani Province

A.4.1.3. City/Town/Community etc:

Lardlumkaew District

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The aforesaid food factory is located in the Pathumthani Province about 50 km on the north of Bangkok and produces food items including starch and bean-starch vermicelli. The address is as follows:
Sitthinan Co., Ltd. :
38/1 Pathumthani-lardlumkaew Rd., Kubangluang, lardlumkaew, Pathumthani 12140, Thailand

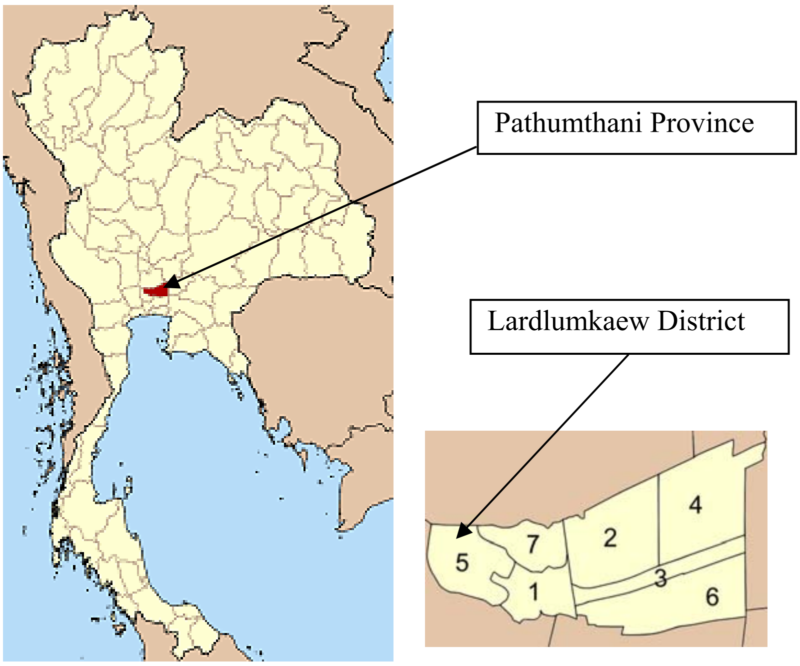

Figure 1 Location of Project Site

A.4.2. Category(ies) of project activity:

The sectoral scope of the project is 13 – Waste management and disposal defined in the UNFCCC.

A.4.3. Technology to be employed by the project activity:

At the moment, the wastewater of (Starch Process 1 Wastewater) after production of mung bean starch, of (Starch Process 2 Wastewater) after production of tapioca starch and of (Noodle Wastewater) after production of vermicelli in the food factory are discharged into the existing anaerobic lagoon pond (only the cover has been constructed) (Pond 1).
The noodle processing wastewater discharged into the anaerobic lagoon pond (Pond 1) is treated in the aerobic lagoon pond (Pond 6/7/8); then the treated wastewater is carried to the polishing pond (Pond 10) and is discharged into the Jaopraya River through the canal.
The starch processing wastewater discharged into the anaerobic lagoon pond (Pond 1) is treated in the aerobic lagoon pond (Pond 6/7); then the treated wastewater is carried to the aeration tank (Pond 10) where it is treated and is then discharged into the Jaopraya River after being treated in the sedimentation tank (SED).
The wastewater standard of the factory is less than 20mg/l in BOD and less than 120mg/l in COD.
The flow diagram of existing wastewater treatment facilities of the factory is shown in the Figure 2a, and the application process of anaerobic wastewater treatment facilities is shown in the Figure 2b

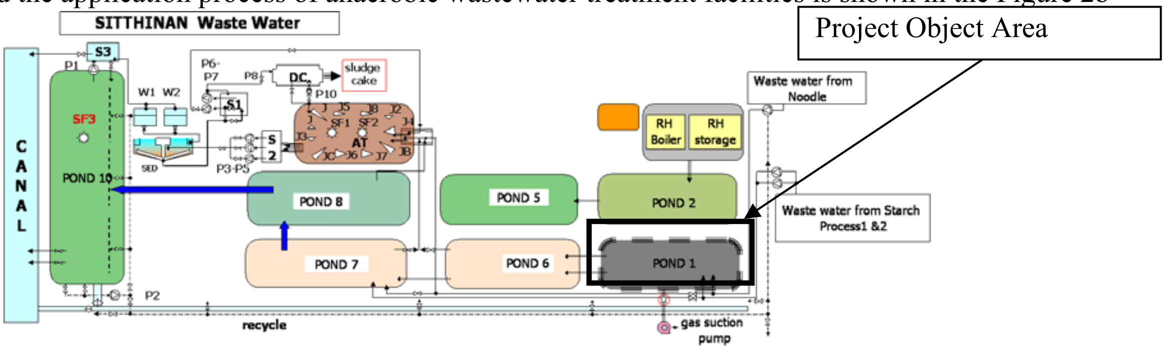

Figure 2a Flow Diagram of Existing Wastewater Treatment Facilities

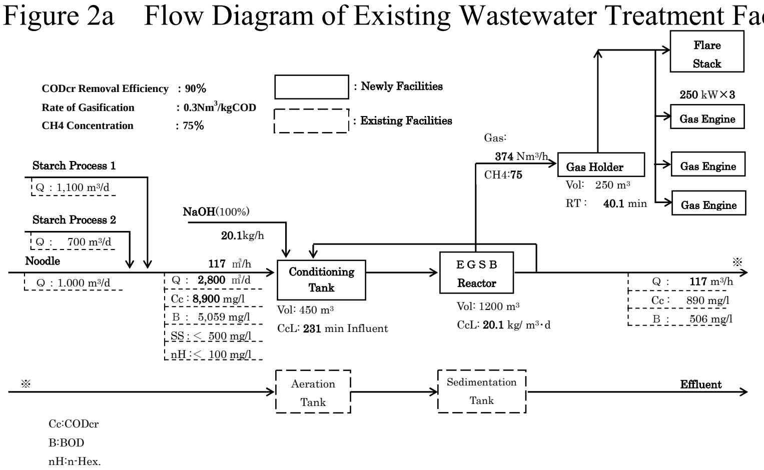

Figure 2b Application Process of Anaerobic Wastewater Treatment Facilities

The project is designed to apply the anaerobic wastewater treatment unit (EGSB) to the existing anaerobic lagoon pond (Pond 1) in order that the methane gas emitted in the atmosphere may be recovered and utilized for the gas engine power generator.
The project will introduce two important technologies of which transfer is required on different characteristics stages in the region and the world.

1. Alleviation of methane gas emission:
   The technology required for alleviation of methane gas emission is a new technology to be transferred. The project calls for the following technology transfer:
   * Knowledge – bio-engineering expertise mainly on a basis of Netherlands technology (Sumitomo Heavy Industries., LTD);
   * Technology – component part of super- load type anaerobic wastewater treatment unit (EGSB)[1] through the technology transfer. Advanced technological monitoring and management system are required so that the technology transfer will be promoted.

2. Biogas power generation:
   It has been characterized and deployed on a global basis; hence the technology may be obtained.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The crediting period of the project is 14 years and the total emission reduction amounts to 286,566 t-CO_2 e for the crediting period.

Table 1 Total Emission Reduction for Crediting Period

Year	Annual estimated of emission reductions (t-CO_2 e)
2009	20,469
2010	20,469
2011	20,469
2012	20,469
2013	20,469
2014	20,469
2015	20,469
2016	20,469
2017	20,469
2018	20,469
2019	20,469
2020	20,469
2021	20,469
2022	20,469
Total estimated reductions (t-CO_2 e)	286,566
Total number of crediting years	14
Annual average over the crediting period of estimated reductions (t-CO_2 e)	20,469

[1] Sumitomo Heavy Industries., LTD concluded technical cooperation on the UASB (Upflow Anaerobic Sludge Blanket) and EGSB(Expanded Granular Sludge Bed) methods for methane fermentation with Biothane-System – International of Netherlands and makes a sale of them as BIOTHANE and BIOBED respectively.

A.4.5. Public funding of the project activity:

Public funds will not be invested in this project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

The following methodology shall be applied to the project.
Revision to approved baseline and monitoring methodology AM0022.
AM0022 version 3 “Avoided wastewater and on-site energy emissions in the industrial sectors”

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The baseline methodology of AM0022 version 3 may meet the conditions of the Table 2; therefore it may be applied to the project activity.

Table 2 Applicable Condition of AM0022 version 3 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 facility.
* 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.

Applicable Condition of AM0022 version 3	Project Applicability
* 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).
* 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.
* Heat and electricity needs per unit input of the water treatment facility remain largely unchanged before and after the project;	Yes; The unit input of electric power is not altered before or after implementation of the project.
* Data requirements as laid out in the related Monitoring Methodology are fulfilled. In particular, organic materials flow into and out of the considered lagoon based treatment system and the contribution of different removal processes can be quantified (measured or estimated).	Yes; Data for related monitoring methodology can be fully equipped.

B.3. Description of the sources and gases included in the project boundary

The project boundary shall define the technical scope where the project benefits should be measured, monitored and verified.
The boundary should cover the GHG emission as results of the project and it should be monitored.
For an analytical aim, different boundaries are applied by means of the relation between the project and different elements contributing to the baseline emission.

*** Substitute power energy / emission level:**
The boundary is assumed to be a regional boundary in Thailand as far as the working scope of the grid system is concerned on grounds that the power transmission of hydraulic power generation in the grid system is considered as carbon neutral (Project & Baseline).

*** Wastewater methane emission/reduction:**
The boundary is assumed to be pond (Pond 1) where main methane is generated in existing treatment process (Project & Baseline).

*** Imperfect combustion methane emission:**
Power generating equipment and a flare stack facilities are included in the boundary (Project only).

*** Emission leaked from anaerobic reactor tank and pipelines:**
Biogas production in reactor tanks and emission during biogas supply of pipelines are included (Project only).

The scope of the project boundary is defined as the plant connecting with the project site and the project related grid system.

Wastewater methane emission and boundary

The pond 1 is the most effective anaerobic pond and it is observed that the pond eliminates a large amount of COD, thereby increasing a large quantity of release methane emission. It is assumed that a low level of (i.e. potential mantissa) release methane emission is continuously observed on the next pond in both cases of the project and the baseline. The analysis assesses the results of influence of the project introduction on the natural process in the following ponds. The prescribed boundaries work on limiting to analysis of what are measurable and attributable to the project.

Table 3 indicates the emission included in the system boundary for the project. Figure 3 shows the system boundary in the baseline and project scenario.

All of the direct emission on site and off site is included in the project boundary. And all of the indirect emission, if not any identifiable one, is excluded from the boundary.

Leakage of release from reactor tank

Leakage from the reactor tank is disregarded in the analysis. The pipe fittings connecting the reactor tank and the gas air blower (the entering point to the biogas supplying pipeline) are designed to be constantly under negative pressure for the safety function. Accordingly, any defect on the outer plate of the reactor tank makes it possible for air to be sucked in as opposed to actually releasing biogas.

Table 3 System Boundary

Emissions	Project scenario	Baseline scenario
On site Direct emission	* Methane emitted from ponds * Imperfect combustion biogas * Biogas leakage from pipeline * Biogas leakage from reactor tank(To be disregarded)	* Methane emitted from ponds
Off site Direct emission	* Use of electricity of the grid of Thailand - Emission of N_2O and CH_4 is disregarded * The remained methane in ponds and emitted methane from ponds (To be disregarded)	* Use of electricity of the grid of Thailand to be substituted by the project biogas energy - Emission of N_2O and CH_4 is disregarded * The remained methane in ponds and emitted methane from ponds (To be disregarded)
On site Indirect emission	* None identified	* None identified
Off site Indirect emission	* None identified	* None identified

The list of greenhouse effect gas associated with the project activities is shown in Table 4.

Table 4 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
		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.
		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 (EGSB)	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 reactor tank (EGSB).
		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.
		N_2O	Excluded	This is not a significant emission source.

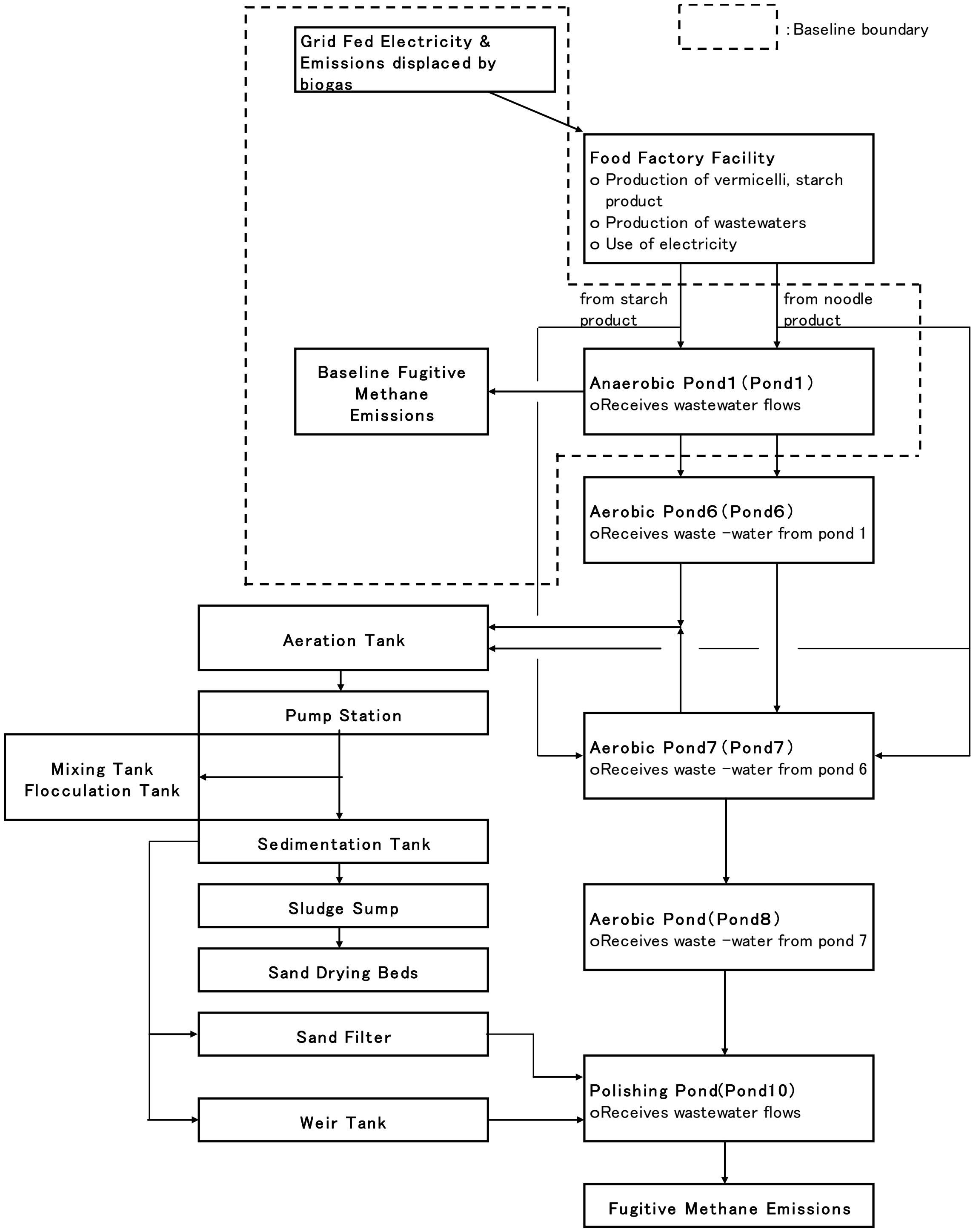

Figure 3a Baseline Boundary

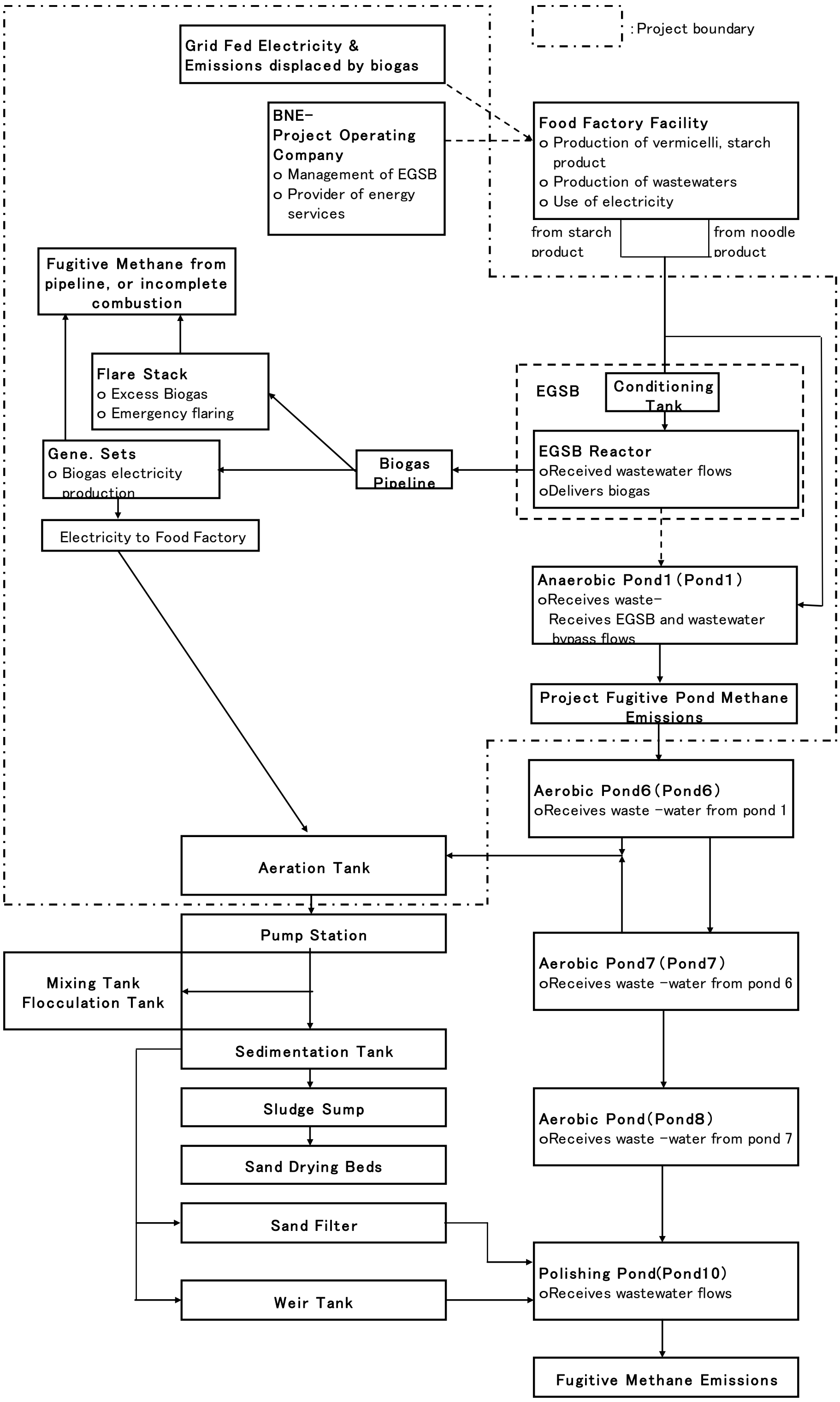

Figure 3b Project Boundary

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The baseline scenario shall be identified step by step like a tool for additional verification.

Baseline determination
Methodology of baseline determination consists of six steps for baseline definition, and demonstrates that the continuity of the current practice (the current wastewater treatment operation without biogas use or burning diffusion in the wastewater system through lagoons) is the baseline:

1. Enumeration of broader potential baseline choices;
   Utilizable choices are enumerated for those who are related with projects providing services for wastewater disposal equivalent to CDM project activities or for developers of similar projects. Conceivable choices include the following:
   * Direct discharge of the wastewater into nearby lakes and ponds;
   * Introduction of new anaerobic digester or aerobic digester (activated sludge or hearth type treatment).
   * Continuity of the current practice.
   * Not to be implemented as CDM project activity; proposed anaerobic treatment facilities.

2. A barrier is selected from the scope of potential barriers where importance can be clarified in the circumstances of specific projects which disturb the execution of any conceivable choice. Make judgments of a barrier in which those relative influences are expected to be the most important even if they have any difference. The most important barrier shall be put in writing and its influences on specific choice under consideration should be described. The barrier assumed to be certain shall be planned and clarified. The relevant choice will not be put into action any more in cases where there is a legal barrier to continuity of the baseline scenario;

3. Barrier assessment; extensive potential problems can be referred. The choice Y: there is a barrier, the choice N: there is no barrier and the choice NA: the subject is not applicable.
   In cases where barriers are clarified, project proponents should provide transparent and documented evidence and, concurrently, also remark a conservative explanation whether the documented evidence offers proof of its existence and the importance of clarified barriers.
   Anecdotal evidence may be included, but it by itself may not be ample demonstration of the relevant barrier. For barrier assessment, such factors to alleviate barriers by means of technical supports thanks to the host country or utilizable subsidies as the project should be considered;

4. They are plausible choices of baselines through assessments of the results of comparisons and barriers, and it is determined after taking everything into consideration that specific barriers can be shown to promote specific baselines;

5. Investment analysis:
   In cases where choices of plural baselines remain as a result of barrier analysis at the Step 2 - 4, those choices shall be classified in terms of financial realities and they shall also be calculated at the Step 2 (investment analysis) of the tool for additional-property verification (EB16 Annex 1) in order that the most likely baseline scenario may be determined;

6. Conclusion: The baseline shall be determined in the absence of CDM project activity, and it shall be clearly specified that in consideration of the project site, the current and historical practice (and emission) continue (i.e. baseline).

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality): >>

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

The supposed scenarios are enumerated.

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 EGSB for power generation. The electric power 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 scenario 1, 3 and 4 are tested.

Legal

** Is this practice regulated by Host Nation law or regulation and therefore legally allowed?*

The current practise 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. Although the authorities make efforts to eliminate such discharges, such illegal practices continue as specific cases. Illegal choices, however, are not practical and they can be regarded as an absolute barrier. There is no more controversy and the choice is carried out through the barrier analysis. Both of anaerobic and aerobic wastewater treatments are representative of legal practices, are not covered by additional rules and are managed to attain the same standards of wastewater discharge as applied to the current pond treatment system.

Is there any legal barrier to the alternative baseline practice?

Scenario 1: Scenario of continuity of the current practice

No, this activity is not regulated by the government laws; hence it is allowable.

Scenario 3: Scenario where the proposed project is not implemented as the CDM project

No, there is no law for promoting the practice of alternative wastewater management. This activity is not regulated by the government law; hence it is allowable.

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

No, there is no law for promoting the practice of alternative wastewater management. This activity is not regulated by the government law; hence it is allowable.

Consequently, legal questions are not assumed to be any barrier to all of those scenarios.

Step2: Investment analysis

The barriers of the above scenarios are analyzed from the perspective of technology, practice, investment and environments, and the baseline is set up.

Financial

* *Is this technology intervention financially attractive in comparison to other technologies?*
* *Is this the most financially viable option?*
* *Is equity participation easy to find internationally?*
* *Is equity participation easy to find locally?*
* *Are site owners/ project beneficiaries carrying any risk?*
* *Is technology currency (country) denomination a risk?*
* *Is the proposed project subject to commercial risks?*

Is there any financial barrier to the alternative baseline practice?

Scenario 1: Scenario of continuity of the current practice

No, this technology is already installed and funding is not required any more.

Scenario 3: Scenario where the proposed project is not implemented as the CDM project

Yes, it is recognized that this is a high risk and new project. There is no successful commercial EGSB plant without risks remained in Thailand, managers and foreign investors. As a result of calculation of IRR of the project, it is −5.9 % (After-tax) in this scenario (Refer to Annex 5). It is shown that the investment in the scenario with low IRR is not prospective if there is no gain on sale of the CER credit.

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

Yes, there are similar risks (probably rather lower) for aerobic treatment. This scenario does not produce any revenue source, and IRR can not be calculated.

Consequently, financial issues are assumed to be major barriers to the following two scenarios in terms of economical efficiency and there is no barrier to the current pond-based management system.

<u>*Step3: Barrier analysis*</u>
<u>*Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity*</u>

<u>*Technical*</u>
** Is this technology option currently available through local equipment suppliers?*
** Are there sufficient skills and labour to operationalise and maintain this technology in country?*
** Is this technology a regional or global standard, or technology of choice?*
** Can performance certainty be guaranteed within tolerance limits?*
** Can real, or perceived technology risk associated with this technology be discounted?*

The pond-based wastewater washing system is a solution by means of very low technology. This type system is widely used in Thailand and other regions. It is a choice of technology in tropical regions and other areas where lots of solvable technology is not required. It is considered low-risk technology. This low technology is used excessively to assure that final discharge of wastewater flow is within the permissible range. Anaerobic system is a new type facility in Thailand and over the wide areas in the world. Technology and skills required for construction and operation of the system are not available in general. 100% of the attribute and performance assurance of the EGSB system are based on ecosystem function and the system is relatively risky.
Ecosystem is in a certain risk of chemical crash which can completely annihilate anaerobic organism and biological activity (and both of the subsequent wastewater management and energy production system are a key factor of commercial operation). It is necessary that the EGSB holds a certain amount of various factors, water volume and pH, and that the process is controlled correctly. It is generally acknowledged that they are methods of solution of risks.
Before the development of this project, a commercial scale of EGSB activities have not been carried out in Thailand.
Aerobic management system is similarly a new type choice in Thailand.
The technology, however, is well characterized in Europe, the US and Japan. Aerobic technology has been widely used as alternative wastewater management in the Southeast Asia.
Lots of equipment and skilled operators can be available in Thailand and the surrounding areas.

Is there any technological barrier to the alternative baseline practice?

Scenario 1: Scenario of continuity of the current practice
No, it is the optimum technology in Thailand and the surrounding areas.

Scenario 3: Scenario where the proposed project is not implemented as the CDM project
Yes, it is acknowledged that the project involves taking risks and that the technology is new and not is utilized.
Before the implementation of this project, a commercial scale of EGSB activities have not been carried out in Thailand.

Scenario 4: Scenario of introduction of aerobic digester for wastewater (surplus sludge or hearth type treatment)
Yes / No, only few aerobic treatments are used on a commercial scale in local industrial sector. Actually aerobic digester is used in this factory and its technology is well characterized on a global scale. And it involves potentially lower risks than the EGSB treatment, but it is not regarded as the optimum technology in Thailand.

Consequently, in view of technical issues, the anaerobic scenario is a major barrier and the alternative aerobic scenario is the intermediate barrier. And there is no barrier to the current pond-based management system.

<u>Institutional</u>

** Are subsidies available?*
** Does the host nation have an active programme for technology support in the industry?*

Both of utilizable subsidies and program for aggressive technical relief work are not applicable for all three scenarios. It will not create barriers to the current installation to maintain the current installed pond system. Such barriers, however, are projected to be created to alternative practice and investment is required. Therefore, institutional barriers owing to lack of subsidies and promotion supports disturb the change of the current practice.

Is there any institutional barrier to the alternative baseline practice?

Scenario 1: Scenario of continuity of the current practice

No, the technology does not require any more assistance or promotion if it is currently installed.

Scenario 3: Scenario where the proposed project is not implemented as the CDM project

Yes, direct subsidies or promotion supports are not found in Thailand.

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

Yes, direct subsidies or promotion supports are not found in Thailand.

It is considered that institutional issues are intermediate barriers to the latter two scenarios, and there is no barrier to the current pond-based management system.

<u>Social</u>

** Is this considered a well understood and accepted technology in the Host Nation and among local constituencies?*

The ponds 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. Anaerobic and aerobic facilities 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.

Is there any social barrier to the alternative baseline practice?

Scenario 1: Scenario of continuity of the current practice

No, the technology has been locally accepted, and further operation of the existing facilities will not cause really any social barrier.

Scenario 3: Scenario where the proposed project is not implemented as the CDM project
Yes/No, the new technology will have risks attached with social cognition.

Scenario 4: Scenario of introduction of aerobic digester for wastewater (surplus sludge or hearth type treatment)
Yes /No,

Consequently, social issues seem to be small barriers in the latter two scenarios.
And there is no barrier to the current pond-based management system.

Business culture and others

* *Is there a willingness to change to alternative management practice in the absence of regulation?*
* *Is this technology considered 'standard practice' in the industry?*
* *Is there experience of applying the technologies?*
* *Is this technology considered a high management priority, as a result of its familiarity?*

It is considered that the current pond-based treatment is a standard operational baseline in Thailand and neighbouring areas. They have no positive experience of utilizing aerobic or anaerobic 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.

Is there any cultural or other barrier to the alternative baseline practice?

Scenario 1: Scenario of continuity of the current practice
No, the technology has been locally accepted, and further operation of the existing facilities will not cause really any social barrier.

Scenario 3: Scenario where the proposed project is not implemented as the CDM project
No, they have not enough experience of putting the technology into action in the circumstance of Thailand and there is enough operators experienced in energy self-sufficiency projects.

Scenario 4: Scenario of introduction of aerobic digester for wastewater (surplus sludge or hearth type treatment)
Yes, they have not enough experience of putting the technology into action in the circumstances of Thailand.

Consequently, business culture issues seem to be small barriers in the latter two scenarios. And there is no barrier to the current pond-based management system.

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 above, 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

The theory for verifying the project repeatability at the Step 1to3 is reinforced on a basis of analyzing whether projects similar to the proposed project are already in widespread use in related sectors or the area.
There is no similar project in that the relevant project of the scenario 3 does not involve the EGSB introduced in Thailand. Accordingly, results of analysis of the past or ongoing activities similar to the proposed project activities can not be provided.

Sub-step 4b. Discuss any similar options that are occurring

As per sub-step 4a, there are no similar options that are occurring.

Step5: Impact of CDM registration

It shall be described that the relevant project activities are approved and registered as CDM, and that benefits and incentives associated with the project activity will alleviate economic and financial barriers (Step 2) or other barriers (Step 3), thereby enabling the relevant project to be implemented.

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 to obtain CER based on risks of climate, water ingredient and construction circumstances. 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 11.56US$/t$CO_2$, the weighted average price, the reference book, "State and Trends of the Carbon Markets" of the World Bank (Refer to Annex 5).
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.
The analysis of the most likely baseline selection under the situation shows the continuity of the current treatment system and the historical emission. The methane emission from the pond system due to the absence of the project and the indirect emission from the continuous electric power transmission of the grid continue. The project reduces discharging methane emission in a dramatic way and utilizes carbon-neutral biogas for power generation, so that the sustainable wastewater treatment solution can be designed.
At the moment the food factory generates GHG emissions. Those emissions are estimated to be 22,877t-CO_2e per year and the two emission sources are shown in the following table. The project emission under the project scenario is 2,408t-CO_2e per year and the resulting emission reduction is estimated to be 20,469t-CO_2e.
The emission sources, the baseline and their contribution to the project scenario are described as Table 6:

Table 6 Emission Reduction

	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

The emission reduction is estimated to increase as a result of power generation on site for the baseline period.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Project emission

The following formulas are used for estimating the project emission on the basis of the formula set in AM0022.

Total project emission

The estimated total project emission represents a total of ① the discharged methane emission from the existing lagoons for the wastewater treatment system, ② the possible methane emission from the new anaerobic wastewater treatment facilities and ③ the imperfect combustion biogas and biogas leakage.

$E_{project} = E_{CH4\_lagoons} + E_{CH4\_NAWTF} + E_{CH4\_IC+leaks}$ $E_{CH4\_IC+leaks}$ ・・・(1)

$E_{project}$: Total project emission (tCO_2e)
$E_{CH4\_lagoons}$: Discharged methane emission from lagoons from the formula (2) (tCO_2e)
E_{CH4_NAWTF} : Discharged methane emission from new anaerobic wastewater treatment facilities (tCO_2e)
$E_{CH4\_IC+leaks}$: Methane emission from methane imperfect combustion and its leakage (tCO_2e)

Methane emission released from lagoons

The released methane emission:

$E_{CH\_4\ lagoons} = M_{lagoon\_anaerobic} * EF_{CH4} * GWP_{CH4} / 1,000$ ・・・(2)

$E_{CH\_4\ lagoons}$: Methane emission released from lagoons (tCO_2e)
$M_{lagoon\_anaerobic}$: Organic material eliminated by anaerobic treatment in lagoon system (kg COD[2])
EF_{CH4} : Methane emission factor (kg CH_4 / kg COD). For default COD of methane conversion factor, 0.21kg CH_4 / kg COD is used. [3] If the methodology uses the wastewater including non- monosaccharide elements like CH_4, different emission factors shall be estimated and applied. If a measurement standard for organic wastewater flow except COD, developers should set up cases of carbon emission coefficients.
GWP_{CH4} : Methane global warming potential ($GWP_{CH4} = 21$)

The total COD reduction from an individual lagoon is affected by the following:
* COD anaerobic surface oxidation;
* Chemical oxidation in lagoon (there are oxidizing species like sulfate salt) ;
* Deposition of indissoluble material before forming sediment; and
* COD decomposition as a result of micro-bacteria activities.

---

[2] The method of quantification of organic substance load is not specified here. It is entrusted to project developers for justifying that the optimum selection of wastewater concentration depends on local circumstances. Chemical Oxygen Demand (COD), however, is applied as a recommended standard of organic substance load for wastewater together with the IPCC quantification of industrial wastewater treatment.

[3] Source : IPCC, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, page 5.16.

The total reduction from an individual lagoon is affected in the unique way; hence their component elements should be characterized on a specific basis of the project.

The conceivable material balance in a lagoon system supplies the amount of organic material eliminated by the anaerobic system:

$$M_{lagoon\_anaerobic} = M_{lagoon\_total} - M_{lagoon\_aerobic} - M_{lagoon\_chemical\_ox} - M_{lagoon\_deposition} \quad \cdots (3)$$

M_{lagoon_total} : The amount of organic material (kg COD) eliminated in a lagoon system from the formula 5

$M_{lagoon\_aerobic}$: The amount of organic material decomposition aerobic bacteria(kg COD) in a lagoon system. The daily surface aerobic loss of organic material is 254kg COD/ ha of pond surface and it is assumed to be lost through the aerobic process. If other specific loss of the project can be determined, it should be applied.

$M_{lagoon\_chemical\_ox}$: The amount of organic material loss through chemical oxidation in a lagoon system (kg COD).

$M_{lagoon\_deposition}$: The amount of organic material loss through deposition (sedimentation) in a lagoon system from the formula 6 (kg COD).

The sensitivity analysis of surface aerobic loss of organic material shall be made for the assessment of its applicability under an individual situation of the project. The deposition and integrated extraction ratio are specific coefficients like the chemical oxygen demand should be quantified on a basis of the project understructures.

For assessment of the actual amount of COD flowed in the anaerobic system (lagoon), the amount of eliminated COD by the new wastewater treatment facilities shall be determined. It is set up by the formula 4.

<u>The project organic material flown into lagoon system from new anaerobic wastewater treatment system:</u>

$$M_{lagoon\_input} = M_{input\_total} * (1 - R_{NAWTF}) \quad \cdots (4)$$

M_{lagoon_input} : The amount of organic material input into the lagoon system from new anaerobic wastewater treatment facilities (kg COD).

M_{input_total} : The amount of total organic material input into wastewater treatment facilities of new project (kg COD).

R_{NAWTF} : The project specific coefficient in order to estimate COD removed from the total organic material removal factor (-) system of wastewater treatment facilities of new project. The most appropriate method for estimating the coefficient shall be assured on pilot-plant tests in a pilot scale of digester chamber. If the above is not possible, the equipment removal factor estimated by its manufacturer shall be applied. The coefficient is used for determining estimated flow of COD for the lagoon system of the project and the related monitoring methodology (AM0022 “Reduction of emission from factory wastewater and energy in the industries”) shall show that the actual amount of COD can be monitored in order to compute the actual emission from the project.

<u>Total material removed in lagoon system:</u>

$$M_{lagoon\_total} = M_{lagoon\_input} * R_{lagoon} \quad \cdots (5)$$

M_{lagoon_total} : Total amount of organic material removed in lagoon system through various routes. (kg COD)

R_{lagoon} : Total organic material removal factor (-) for the lagoon. It is the project specific coefficient and it is equivalent to the ratio of organic material removed in the boundary of lagoon system in consideration (through all of the routes). The coefficient shall be determined based on results of a series of biochemical tests before implementation of the project. These tests determine the amount of COD flow into and out of the system in the system boundary. The relative difference between COD flow at the inlet and the outlet of the system for a certain period shall enable the removal rate of the total organic material to be determined.

Deposition yield in lagoon system:

$$M_{lagoon\_deposition} = M_{lagoon\_input} * R_{deposition} \cdots (6)$$

$R_{deposition}$: Deposition efficiency of organic material in lagoons deposition; it is equivalent to the ratio of organic material deposited physically in a lagoon within the boundaries of the project. It is specific coefficients of the project obtained by means of appraisal of relative COD capacity by wastewater flow in the deposit through analysis of the preliminary project within its boundaries.

Methane emission from new anaerobic wastewater treatment facilities

The methane emission from the specific anaerobic wastewater treatment facilities to be constructed by the project should be appraised and estimated by measurements, data of the technology supplier and estimations of experts. Any verification provided is disregarded if it was verified by insignificant documents.

Methane emission from imperfect combustion emission

The biogas combustion will cause a significant increase in the methane emission as a result of imperfect or inefficient combustion. The routes of two major possibilities of methane breakdown are:
* Biogas flaring;
* Utilization of biogas for on-site power generation.

The methane shall be quantified through the formula 7.

$$E_{CH4\_IC+Leaks} = \Sigma V_r * C_{CH4\_r} * (1 - f_r) * GWP_{CH4} \cdots (7)$$

The sum total shall consist of two major routes for the methane breakup (flaring and power generation);

V_r : Biogas combustion processing volume in the route r (Nm^3)

C_{CH4} : Methane concentration (tCH_4/Nm^3)

f_r : Ratio of biogas broken by combustion (-)

Methane emission leaked from the biogas system

Leakage from the biogas system includes any leakage from the anaerobic digester chamber and the biogas pipeline supply system. The amount of biogas leaked from the biogas supply system (pipeline) should be computed.

The leakage in cases of short pipelines (e.c. less than 2km long and only supply to the on-site) is limited because high quality materials are used for their constructions. For the examination of this claim, the test shall be carried out to determine the leakage volume of biogas (and eventually methane) every year.

Baseline emission

The estimated total emission of the baseline comes to a grand total of methane emission released from the wastewater treatment system based on the existing lagoon, thermal production on site, if applicable and/or the amount of CO_2 emission from power generation on site/off site (Substitute for thermal production is not considered for the project).

Total baseline emission:

$E_{BL} = E_{CH4\_lagoons\_BL} + E_{CO2\_grid\_BL}$ ・・・(8)

E_{BL} : Total emission in the baseline case (tCO_2e)

$E_{CH4\_lagoons\_BL}$: Methane emission released from the lagoon in the baseline case (tCO_2e); it shall be calculated based on the formula 2 for the project emission.

$E_{CO2\_grid\_BL}$: The amount of CO_2 emission associated with the power supply to the grid in the baseline case to be substituted by power generation based on recovered biogas from the anaerobic treatment facilities.

Power generation on site and/or grid power supply on site to be substituted by the power generation based on biogas recovered from anaerobic treatment facilities

The substitute of electric power generated off site shall be applied to different quantification processes due to the carbon emission factor (CEF):

* Power generation of less than 15MW:

  If the power generation capacity of the project is less than 15 MW, procedures for small scale power generation of less than 15 MW are applied (ID, renewable power generation for power grids).

* Power generation of more than 15MW:

  If the power generation capacity of the project is more than 15 MW, the authorized methodology of integration of ACM0002 shall be applied.

The amount of CO_2 emission of the electric power to be substituted:

$E_{CO2\_power} = EL * CEF$ ・・・(10)

EL : The substitute electric energy for utilizing biogas recovered from the anaerobic treatment facilities; it is estimated by its production:

(1) Average specific power consumption for the factory production; it is estimated by use of the data of past three years.

(2) Annual production volume

CEF : The carbon emission factor for the substitute electric energy by power generation based on biogas.

If the electric power with its single source is used under the conditions of the baseline (consumption on site or grid), the quantified carbon emission factor is applied. If the electric power with its two sources is used under the conditions of the baseline, whichever is lower shall be applied between the following; (i) the carbon emission factor for the above-mentioned grid (tCO2e/MWh) and (ii) the carbon emission factor for the substituted power generation on site

The characteristics of fossil fuel, which had been used before start of the project activity and which to be substituted by biogas, shall be determined by the conservative method including (i) thermal production on site and (ii) the carbon emission factor used for the power generation on site:
A new anaerobic treatment facilities is not included in the baseline case; therefore, there is no degradable material from the wastewater before flowing to the lagoon system and all of the organic material flow and is treated in the lagoon system. The formula (4) for the project case should be changed to the baseline case:

The organic material for the baseline, which flows in the lagoon system from the new anaerobic wastewater treatment system, is:

$M_{lagoon\_input\_BL} = M_{input\_total}$ ・・・(11)

$M_{lagoon\_input\_BL}$: The value used for designating the organic material to be input in the lagoon system from the reactor tank in the way of project scenario (kg COD).

M_{input_total} : The total organic material supplied to the wastewater treatment facilities for the baseline (kg COD).
It is equivalent to the volume fed to the project wastewater treatment facilities in the project scenario.

All of emission factors, surface aerobic loss of the organic material, aerobic decomposition, deposition or removal of chemical oxidation are determined as the description of project scenario in the section of the above-mentioned project emission.

Leakage

The leakage is thought of as negligible.

Emission reduction

Emission reduction (ER) (t CO_2e) shall be computed as a difference between the emission of the base line (formula 8) and of the project (formula 1).

$ER = E_{BL} - E_{project}$ ・・・(12)

Furthermore, this formula should show that the emission reduction is a conservative estimation: i.e. the methane emission from the lagoon under the circumstance of the baseline is not large than the total emission of biogas from the digester chamber and lagoon under the circumstance of the project.

$E_{CH4\_lagoon\_BL} - (E_{CH4lagoon} + E_{CH4\_nawtf} + E_{CH4\_coll})$ ・・・(13)

$CH_{4\_coll\ E}$: The amount of methane included in the biogas recovery from the anaerobic treatment facilities (tCO_2e) (The total of biogas feeding to the power generating unit and the flare stack.)

If the difference is positive, it should be deducted from the result drawn from the formula (12) to obtain the final estimation of the emission reduction.

B.6.2. Data and parameters that are available at validation:

The data and parameters available at validation are shown.

Data / Parameter:	**CEF**
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor of the grid
Source of data used:	EGAT, DEDE, EPPO
Value applied:	0.54 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data choice and calculation method as per AMS I.D. Calculated based on the data for the year 2003, 2004 and 2005 which are the most recent data available at the time of the validation.
Any comment:	None

Data / Parameter:	**$CEF_{OM,Simple,2003-2005}$**
Data unit:	tCO_2/MWh
Description:	CO_2 Operating Margin emission factor of the grid
Source of data used:	EGAT's Annual Report 2001, 2003, 2005 "Key Statistical Data"
Value applied:	0.69 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data choice and calculation method as per AMS I.D.
Any comment:	None

Data / Parameter:	**CEF_{BM}**
Data unit:	tCO_2/MWh
Description:	CO_2 Build Margin emission factor of the grid
Source of data used:	EGAT, DEDE, EPPO
Value applied:	0.39 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data choice and calculation method as per AMS I.D.
Any comment:	None

The electric energy transmitted by the grid and the emission from fuel oil

There is only transmission electric energy on the grid by fossil fuels in the baseline scenario and the energy obtained by biogas is not used. Lots of different approaches dependent on the project specific characteristics are used to determine the emission from transmission electric energy on the grid. The emission factors of the Build Margin (BM) (Basic unit for the future power source to be constructed and CO2) and the Operating Margin (OM) (Basic unit of power source for power adjustments and CO2) are computed based on AMS I.D. Grid connected renewable electricity generation (version 10). In accordance with AMS I.D., the emission factor for the baseline is due to be computed by use of the Combined Margin (CM) emission factor consisting of the BM and OM emission factors.

Operational Margin (OM) indicates the regulated power supply to be substituted by the relevant project. The OM emission factor is described below.

(a) Dispatch Data Analysis OM,
(b) Simple OM,
(c) Simple Adjusted OM,
(d) Average OM

One of the above four computing methods shall be used for computation.

Including the above (a) Dispatch Data Analysis OM, computing the CM should be based on the published data of official information source. For this project, it was difficult to get data for the Dispatch Data Analysis OM; therefore the Simple OM method is applied. As shown in Table 7, if the regulated power supply on the grid system is covered by natural gas, lignite, heavy oil, diesel oil, hydraulic power generation can be regarded as regular servicing facilities with low cost. The share of the hydraulic power generation in the total power generation on the grid system is about 5.5 % for the most recent five years (2001-2005)[4]. If based on the long-term standard value of the hydraulic power generation, the hydraulic power generation in the total annual power generation on the grid is less than 50%; hence the Simple OM can be applied.

[4] PDD is prepared based on the data until 2006 and the project activity will commence in 2007 and start to operate in 2009.

Table 7 Electric Energy and Fuel Consumption by EGAT- 2001-2005[5]

Source		Gross Energy Generation and Purchase									
		Fiscal Year 2005		Fiscal Year 2004		Fiscal Year 2003		Fiscal Year 2002		Fiscal Year 2001	
		GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
EGAT's Power Plants	Natural Gas	33,065.96	24.52	30,901.08	24.24	31,969.63	27.38	35,607.91	32.85	34,871.18	33.80
	Lignite	18,334.45	13.60	17,993.57	14.12	17,133.53	14.68	16,890.30	15.58	17,306.58	16.78
	Hydroelectric	5,671.18	4.21	5,896.29	4.63	7,741.42	6.63	6,480.87	5.98	6,310.55	6.12
	Fuel Oil	7,640.01	5.67	5,467.67	4.29	2,112.69	1.81	2,024.49	1.87	3,110.61	3.02
	Diesel Oil	175.79	0.13	232.95	0.18	48.04	0.04	259.33	0.24	155.23	0.15
	Renewable Energy	2.26	0.00	2.13	0.00		0.00		0.00	1.74	0.00
	Subtotal	64,889.65	48.13	60,493.69	47.46	59,005.31	50.54	61,262.90	56.52	61,755.89	59.86
Purchase from	Domestic IPPs and SPPs	65,562.32	48.63	63,586.93	49.89	55,194.43	47.28	44,305.77	40.88	38,515.41	37.33
	Neighboring Countries	4,374.77	3.24	3,376.41	2.65	2,543.71	2.18	2,820.57	2.60	2,893.90	2.81
	Subtotal	69,937.09	51.87	66,963.34	52.54	57,738.14	49.46	47,126.34	43.48	41,409.31	40.14
Grand Total		134,826.74	100.00	127,457.03	100.00	116,743.45	100.00	108,389.24	100.00	103,165.20	100.00
Type of fuel		**Fuel Consumption**									
Natural Gas	(million cubic feet)	305,156.01		290,768.73		304,769		344,184		345,314.67	
Lignite	(million tons)	16.57		16.53		16		15		15.24	
Fuel Oil	(million liters)	1836.74		1292.81		529		514		781.56	
Diesel Oil	(million liters)	49.81		55.01		17		71		45.99	

In accordance with AMS I.D., reference years of the data used for computing the OM emission factor can be selected from the following two choices.

* The weighted average efficiency (ex-ante calculation) of the total power generation based on the most recent three year data available as of PDD submission, or
* The year when the power generation is carried out (ex-post calculation) if the data is updated based on the ex-post monitoring.

The ex-ante calculation is selected for the project; e.g. the calculation by use of the weighted average efficiency of the total power generation based on the most recent three year data (2003 to 2005). Accordingly, the Simple OM is the emission per unit generated energy taken a weighted average by the generated energy based on the power supply except regular servicing facilities with low cost (natural gas, lignite, heavy oil, diesel oil). It is calculated in Table 8.

[5] EGAT's Annual Report 2001, 2003, 2005 "Key Statistical Data"

Table 8 Simple OM Calculation Data[6]

Year	Fuel type	Electricity generated (GWh)	Fuel consumption (10^3ton)	CO_2 emission factor (tCO_2/MWh)	
				By fuel type	Simple OM
2003	Natural Gas	31,969.63	6,676	0.61	0.69
	Lignite	17,133.53	16,000	1.12	
	Heavy Oil	2,112.69	513	0.75	
	Diesel Oil	48.04	14	0.96	
	Imported Coal	30,901.08	6,369	0.60	
2004	Natural Gas	17,993.57	16,530	1.11	0.70
	Lignite	5,467.67	1,254	0.71	
	Heavy Oil	232.95	47	0.64	
	Diesel Oil	33,065.96	6,684	0.59	
	Imported Coal	18,334.45	16,570	1.09	
2005	Natural Gas	7,640.01	1,782	0.72	0.68
	Lignite	175.79	42	0.77	
	Heavy Oil	31,969.63	6,676	0.61	
	Diesel Oil	17,133.53	16,000	1.12	
	Imported Coal	2,112.69	513	0.75	

(1) Specific gravity of natural gas is typically around 0.6. The density of natural gas is calculated by multiplying density of air (1.29kg/m3) by 0.6. The result is 0.774kg/m3.
(2) Densities used for heavy oil and diesel oil are 0.97 kg/L and 0.85 kg/L respectively.
(3) Purchase electric power is excluding.

The Simple OM emission factor for a period of 2003 to 2005 is $EF_{OM,Simple,2003}$=0.69, $EF_{OM,Simple,2004}$=0.70, and $EF_{OM,Simple,2005}$=0.68 (ton-CO_2/MWh) respectively. And an average of 3 years is $EF_{OM,Simple,2003-2005}$=0.69 (ton-CO_2/MWh).

Calculation of BM emission factor

The Build Margin (BM) indicates the electric power to be substituted by this project in view of the future electric power development plan.
For calculating the BM emission factor, whichever larger of the following alternatives of the total annual power generation is to use

* The five power generation units constructed most recently, or
* The power generation plant recently constructed of which generation capacity may account for 20% of the total generation capacity (MWh) of the grid system.

[6] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3)

The calculation of the CM should be based on published data of official information sources.
Data on Build Margin (BM) were based on the Table 9 with this project.

Table 9 Generation and fuel consumption data for recently built plants[7]

Plant name	Commissioning Date	Fuel type	Capacity (MW)	Generation (GWh)	Efficiency (Btu/kWh)	Fuel Consumption (TJ)	CO2 emission (tCO2)
EPEC（IPP）	25-Mar-03	Natural Gas	350.0	2,627	7,083	19,630	1,095,761
Grow（IPP）	31-Jan-03	Natural Gas	713.0	4,646	6,850	33,575	1,874,167
Ratchaburi（IPP）	18-Apr-02, 1-Nov-02	Natural Gas	2175.0	14,796	7,262	113,358	6,327,599
Ratchaburi	22-Oct-00	Natural Gas	1512.0	6,902	10,110	36,810	2,065,041
Total				28,971[8]			11,362,568

BM emission factor with this result becomes CEF_{BM} = 11,362,568 (tCO2) / 28,971 (GWh) =0.39 (ton-CO2/MWh).
The CM emission factor is the weighted average of the OM and BM emission factors, where the default weightings are 50% each. As the emission factors were calculated as 0.69tCO2/MWh and 0.39tCO2/MWh, for the OM and BM respectively, the resultant combined margin CO2 emission factor is 0.53tCO2/MWh.
The CO_2 emission factor for a crediting period shall be 0.54 (ton-CO_2/MWh).

B.6.3 Ex-ante calculation of emission reductions:

Total emission of the project

$E_{project} = E_{CH4\_lagoons} + E_{CH4\_NAWTF} + E_{CH4\_IC+leakss}$ ・・・(1) (tCO_2e)
= 1,954 (tCO_2e) + 0 (tCO_2e) + 454 (tCO_2e) = 2,408 (tCO_2e)

E_{CH4_NAWTF} : 0 (tCO_2e)
(The leakage from the reactor tank seems to be disregarded in accordance with the data of the technology supplier. It is under the negative pressure but shall be monitored)

Emission of methane released from lagoon

$E_{CH\_4\ lagoons} = M_{lagoon\_anaerobic} * EF_{CH4} * GWP_{CH4} / 1,000$ ・・・(2) (tCO_2e)
= 434,245 (kg COD) * 0.2143 (kg CH_4/kgCOD) * 21/ 1,000
= 1,954 (tCO_2e)

EF_{CH4} : Sumitomo Heavy Industries, LTD, will be technology supplier, is an expert of starch effluent. In accordance with its introduction track records and empirical

[7] Department of Alternative Energy Development and Efficiency, http://www.dede.go.th/dede/ Electric Power in Thailand year 2005 and Energy Policy and Planning Office, http://www.eppo.go.th/
[8] The total generation was 134,827 GWh for 2005, the latest year for which data is publicly available. 20% of 134,827 GWh is 26,965 GWh.

values, the methane emission factor shall be 0.2143 kg CH_4/kg COD ($0.3Nm^3CH_4$/kg COD).

$M_{lagoon\_anaerobic}$ =
$M_{lagoon\_total} - M_{lagoon\_aerobic} - M_{lagoon\_chemical\_ox} - M_{lagoon\_deposition}$ ・・・(3) (kg COD)
= 476,595 (kg COD) − 42,350 (kg COD) −0 (kg COD) −0 (kg COD)
= 434,245 (kg COD)

$M_{lagoon\_aerobic}$: 121 (kg COD/day) * 350 (day/year) = 42,350 (kg COD)
(Same as baseline emission calculation)
$M_{lagoon\_chemical\_ox}$: 0 (kg COD)

(The project is designed to reduce the amount of CH_4 discharged from the existing anaerobic lagoon (Pond 1) by the introduction of a reactor tank (EGSB) in the project. The loss of aerobic surface due to the existing anaerobic lagoon (Pond 1) shall be considered. It is also considered that chemical oxidation (sulfate reduction) can be disregarded in the project in that the sulfate density is negligible 15mg/l as in the baseline according to the result of analysis of water - quality samples.)

Organic material of the project in lagoon flown from anaerobic treatment system to be newly constructed

$M_{lagoon\_input} = M_{input\_total} * (1- R_{NAWTF})$ ・・・(4) (kg COD)
= 5,607,000 (kg COD/ year) * (1− 0.9) = 560,700 (kg COD/year)

M_{input_total} : 1,800 (m^3/day) * 350 (day/year) * 8.9 (kg COD/m^3) = 5,607,000 (kg COD/year)
(See Annex 3, Table 6 & 9)
R_{NAWTF} : 0.9 (EGSB removal rate) (See Annex 3, Table 14)

Total organic material to be removed in lagoon

$M_{lagoon\_total} = M_{lagoon\_input} * R_{lagoon}$ ・・・(5) (kg COD)
= 560,700 (kg COD/year) * 0.85 = 476,595 (kg COD/year)

R_{lagoon} : 0.85 (Total organic material to be removed in existing anaerobic lagoon (Pond 1))
It is 85% as water sampling analysis result of GOSYU KOHSAN., LTD.
(See Annex 3, Table 1)

Organic material deposition within lagoon system

$M_{lagoon\_deposition} = M_{lagoon\_input} * R_{deposition}$ ・・・(6)
= 560,700 (kg COD/year) * 0 = 0(kg COD/year)

$R_{deposition}$: 0 (-)
(It is assumed to be zero. Most of all solid made up deposition is also assumed to be decomposed in the reactor tank of the project. The deposition is monitored and if its measurement is required, it is recorded.)

Methane emission from imperfect combustion

$E_{CH4\_IC+Leaks} = \Sigma V_r * C_{CH4\_r} * (1- f_r) * GWP_{CH4}$ ・・・(7) (tCO_2e)

= 2,018,520 (Nm^3/year) * 0.005357 (tCH_4/Nm^3) * (1− 0.98) * 21

= 454 (tCO_2e)

V_r : 240.3(Nm^3/h) * 24(h) * 350(day/year) = 2,018,520 (Nm^3/ year) (See Annex 3, Table 9 & 14)

C_{CH4} : 0.75*16/22.4/1000 = 0.005357 (tCH_4/Nm^3) (See Annex 3, Table 1)

f_r : 98%

(The share of being broken by combustion indicates the biogas generation volume on the grounds of operating days. Biogas surplus and generated on an emergency basis shall be flared. It is assumed that biogas methane emission can be disregarded without exception. It is gathered that the guaranteed combustion efficiency of a flare stack is 99.9999 %, next to 1.00. The flare stack (for decomposition of organic material) used on site, however, has a guaranteed combustion efficiency of 98%. And it is a standard efficiency in the flare stack market. It is anticipated that the methane emission due to the imperfect combustion can be disregarded. In the case of actual project, it is monitored by use of the formula (7) and it has an impact on the total emission reduction for the crediting period.)

Sensitivity analysis of surface oxidation factor

An assessment shall be made in order to determine the conformity of surface removal factor of 254 kg COD/ha/day.

Table 10 Sensitivity Analysis of Surface Oxidation Factor

Surface oxidation removal rate	Applied error factor	Emission from lagoon in baseline	Sensitivity	Emission from lagoon in project	Sensitivity	Estimated emission reduction	Sensitivity
kg/ha/day	%	tCO_2e	%	tCO_2e	%	tCO_2e	%
254	-	21,256	-	1,954	-	19,302	-
317.5	25%	21,209	0.22%	1,907	2.42%	19,302	0
381	50%	21,162	0.44%	1,860	4.84%	19,302	0
508	100%	21,067	0.89%	1,765	9.67%	19,302	0
1270	400%	20,497	3.57%	1,195	38.85%	19,302	0

This analysis shows clearly that the surface oxidation removal of COD is independent in the project in view of the calculated emission reduction. And the removal rate of 254kg COD/ha/day is appropriate for the project.

The emission scenarios of the baseline and project were calculated by use of 254 kg COD/ha/day in accordance with AM0022. The emission reduction, however, has not changed remarkably even though the constant of surface oxidation has increased. When higher constants of surface oxidation were applied, effected changes had an influence on both of the baseline and project emission. There are decreases in the emission reduction for the baseline and project. The difference between the baseline and the project is the same as when being calculated by use of 254kg COD/ha/day.

Total emission of the baseline

$E_{BL} = E_{CH4\_lagoons\_BL} + E_{CO2\_grid\_BL}$ ・・・(8)

$= 21,257\ (tCO_2e) + 1,620\ (tCO_2e) = 22,877\ (tCO_2e)$

Emission from power generation on grid for baseline

$E_{CO2\_power} = EL * CEF$ ・・・(10)

$= 3,000\ (MWh/yr) * 0.54\ (tCO_2e/MWh) = 1,620\ (tCO_2e)$

EL : 3,000 (MWh/yr) (See Annex 3, Table 12)

CEF : 0.54 (tCO_2e/MWh) (See the section B.6.2)

Organic material of baseline in lagoon system flown from food factory

$M_{lagoon\_input\_BL} = M_{input\_total}$ ・・・(11)

= 5,607,000 (kg COD/year)

M_{input_total} : 1,800 (m^3/day) * 350 (day/year) * 8.9 (kg COD/m^3) = 5,607,000 (kg COD/year) (See Annex 3, Table 6 & 9)

Emission from lagoon for the baseline

$E_{CH4\_lagoons\_BL} = M_{lagoon\_anaerobic} * EF_{CH4} * GWP_{CH4} / 1,000$ ・・・(2)' (tCO_2e)
= 4,723,600 (kg COD) * 0.2143 (kg CH_4/kgCOD) * 21/ 1,000
= 21,257 (tCO_2e)

EF_{CH4} : According to the IPCC guideline, 0.25 (kg CH_4/kgCOD) is described as the default value of Bo (the maximum methanation factor). In AM0022 ver.3, 0.21(kg CH_4/kgCOD) is used as the default COD of the methane conversion factor. If this methodology, however, is applied to the wastewater including non-monosaccharide, methane emission factors different from 0.21(kg CH_4/kgCOD) shall be estimated for use. Sumitomo Heavy Industries., LTD, will be technology supplier, is an expert of starch effluent. In accordance with its introduction track records and empirical values, the methane emission factor shall be 0.2143 kg CH_4/kg COD in this project.

$M_{lagoon\_anaerobic}$ =
$M_{lagoon\_total} - M_{lagoon\_aerobic} - M_{lagoon\_chemical\_ox} - M_{lagoon\_deposition}$ ・・・(3)' (kg COD)
= 4,765,950 (kg COD) −42,350 (kg COD) −0 (kg COD) −0 (kg COD)
= 4,723,600 (kg COD)

$M_{lagoon\_aerobic}$: 121 (kg COD/day) * 350 (day/year) = 42,350 (kg COD) (See Annex 3, Table 8)
$M_{lagoon\_chemical\_ox}$: 0 (kg COD)
(CH_4 is released from the existing anaerobic open lagoon (Pond 1) in the baseline. The loss of the aerobic surface of ponds shall be considered with inclusion of COD removal due to deposition of COD elements. It is considered that chemical oxidation (sulfate reduction) can be disregarded in that sulfate is not used in the manufacturing process of the food factory and that the sulfate density is negligible 15mg/l according to the result of analysis of water - quality samples.)

Organic material removed from lagoon system

$M_{lagoon\_total} = M_{lagoon\_input} * R_{lagoon}$ ・・・(5)' (kg COD)
= 5,607,000 (kg COD/year) * 0.85 = 4,765,950 (kg COD/year)

R_{lagoon} : 0.85 (Total organic material removed at anaerobic lagoon (Pond 1).
(See Annex 3, Table 1)

Deposition of organic material within lagoon system

$M_{lagoon\_deposition} = M_{lagoon\_input} * R_{deposition}$ ・・・(6)'
= 5,607,000 (kg COD/year) * 0 = 0 (kg COD/year)

$R_{deposition}$: 0 (-)
(The feasibility study of the first project concluded that anaerobic activity keeps efficiently solid COD material in soil suspension and that there is little or no disposition in anaerobic ponds. Accordingly, it was decided to be zero.)

Emission reduction

$ER = E_{BL} - E_{project}$ ・・・(12)

$= 22,877\ (tCO_2e) - 2,408\ (tCO_2e) = 20,469\ (tCO_2e)$

$E_{CH4\_lagoon\_BL} - (E_{CH4lagoon} + E_{CH4\_nawtf} + E_{CH4\_coll})$ ・・・(13)

$21,257\ (tCO_2e) - (1,954\ (tCO_2e) + 0\ (tCO_2e) + 19,303\ (tCO_2e)) = 0\ (tCO_2e)$

B.6.4 Summary of the ex-ante estimation of emission reductions:

Table 11 Results of Analysis of Emission Reduction in the Food Factory

Year	Estimation of project activity emissions ($t\text{-}CO_2$ e)	Estimation of baseline emissions ($t\text{-}CO_2$ e)	Estimation of leakage ($t\text{-}CO_2$ e)	Estimation of overall emission reductions ($t\text{-}CO_2$ e)
2009	2,408	22,877	0	20,469
2010	2,408	22,877	0	20,469
2011	2,408	22,877	0	20,469
2012	2,408	22,877	0	20,469
2013	2,408	22,877	0	20,469
2014	2,408	22,877	0	20,469
2015	2,408	22,877	0	20,469
2016	2,408	22,877	0	20,469
2017	2,408	22,877	0	20,469
2018	2,408	22,877	0	20,469
2019	2,408	22,877	0	20,469
2020	2,408	22,877	0	20,469
2021	2,408	22,877	0	20,469
2022	2,408	22,877	0	20,469
合計 ($t\text{-}CO_2$ e)	33,712	320,278	0	286,566

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data to be recovered to monitor the emission from the project

Data / Parameter:	**ID1**
Data unit:	m^3
Description:	Wastewater load at the inlet of EGSB(system boundary)
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,800 (m^3/day)/24=75 (m^3/h)

Description of measurement methods and procedures to be applied:	Measuring instrument: electromagnetic flow meter or vortex flow meter, Measuring frequency: continuous, Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): electronics
QA/QC procedures to be applied:	Flow instrument shall be regularly maintained and tested in an organized way to assure its accuracy.
Any comment:	

Data / Parameter:	**ID2**
Data unit:	m^3
Description:	Wastewater load at the outlet of EGSB (treatment facilities of the project)
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,800 (m^3/day)/24=75 (m^3/h)
Description of measurement methods and procedures to be applied:	Measuring instrument: electromagnetic flow meter or vortex flow meter, Measuring frequency: continuous, Ratio of data to be monitored : 100%, Storing method of data (paper/ electronics): electronics
QA/QC procedures to be applied:	Flow instrument shall be regularly maintained and tested in an organized way to assure its accuracy.
Any comment:	

Data / Parameter:	**ID3**
Data unit:	kg COD / m^3
Description:	Wastewater COD at the inlet of EGSB(system boundary)
Source of data to be used:	On-site sampling/Off-site analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8.9 kg COD / m^3(8,900 mg/l)
Description of measurement methods and procedures to be applied:	Measuring method: COD cr shall be measured by the method of potassium bichromate for checking COD. Measuring frequency: weekly, Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): paper and electronics
QA/QC procedures to be applied:	COD shall be sampled frequently and testing shall be done at an authorized laboratory every week.
Any comment:	An indicator for wastewater methane emission in the baseline. For organic material density, sampling shall be done on site and it shall be conducted at a recommended authorized laboratory off site.

Data / Parameter:	**ID4**
Data unit:	kg COD / m^3
Description:	Wastewater COD at the outlet of EGSB (treatment facilities)
Source of data to be used:	On-site sampling/Off-site analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.89 kg COD / m^3(890 mg/l)
Description of measurement methods and procedures to be applied:	Measuring method: COD cr shall be measured by the method of potassium bichromate for checking COD. Measuring frequency: weekly , Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): paper and electronics
QA/QC procedures to be applied:	COD shall be sampled frequently and testing shall be done at an authorized laboratory every week.
Any comment:	An indicator for wastewater methane emission in the baseline. For organic material density, sampling shall be done on site and it shall be conducted at a recommended authorized laboratory off site.

Data / Parameter:	**ID5**
Data unit:	MWh
Description:	The electric energy generated by biogas recovered in the anaerobic treatment facilities.
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.75 MWh
Description of measurement methods and procedures to be applied:	Measuring instrument: energy meter, Measuring frequency: continuous, Ratio of data to be monitored : 100%, Storing method of data (paper/ electronics): electronics
QA/QC procedures to be applied:	Regular maintenance assures the optimum operation of engine and generator. If the thermal efficiency used for the calculation of ER is significantly deviated from the standard or the previous value, it shall be checked every year or at fixed intervals. The electric energy transmitted from the grid is shown in billing statements to be received from the third party. The existing energy meters shall be maintained and checked at regular intervals to warrant their accuracy even after the implementation of the project. Reading values of meters are double-checked by power distribution body.
Any comment:	Indicator of substituted electric energy on the grid

Data / Parameter:	**ID6**
Data unit:	Nm^3
Description:	The amount of biogas flown to flaring
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 Nm^3
Description of measurement methods and procedures to be applied:	Measuring instrument: gas flow meter, Measuring frequency: continuous, Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): electronics
QA/QC procedures to be applied:	Biogas meter shall be regularly maintained and tested in an organized way to assure its accuracy.
Any comment:	The volume in terms of Nm^3 shall be standardized on the ground of pressure and temperature.

Data / Parameter:	**ID7**
Data unit:	Nm^3
Description:	The amount of biogas flown to the power generating unit
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	240 Nm^3
Description of measurement methods and procedures to be applied:	Measuring instrument: gas flow meter, Measuring frequency: continuous, Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): electronics
QA/QC procedures to be applied:	Biogas meter shall be regularly maintained and tested in an organized way to assure its accuracy.
Any comment:	The volume in terms of Nm^3 shall be standardized on the ground of pressure and temperature.

Data / Parameter:	**ID8**
Data unit:	%
Description:	Biogas methane concentration
Source of data to be used:	On-site measurements

Value of data applied for the purpose of calculating expected emission reductions in section B.5	75 %
Description of measurement methods and procedures to be applied:	Measuring instrument: Infrared methane gas concentration meter, Measuring frequency: continuous
QA/QC procedures to be applied:	Biogas methane concentration can be measured close to 100% by infrared analysis or quantitative process.
Any comment:	Measuring close to 100% by infrared analysis (immensely accurate)

Data / Parameter:	**ID9**
Data unit:	%
Description:	Flare thermal efficiency
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	98%
Description of measurement methods and procedures to be applied:	Measuring frequency: semi-annual, Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): electronics
QA/QC procedures to be applied:	Flare thermal efficiency shall be measure and determined every six months. Thermal efficiency shall be determined by the usual O&M stop time and part of the usual O&M schedule.
Any comment:	

Data / Parameter:	**ID10**
Data unit:	%
Description:	Thermal efficiency of power generating unit.
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	100%
Description of measurement methods and procedures to be applied:	Measuring frequency: usual O&M stop time, Ratio of data to be monitored: 100%, Storing method of data (paper/ electronics): electronics

QA/QC procedures to be applied:	Thermal efficiency of power generating unit shall be determined by the usual O&M stop time and part of the usual O&M schedule. This is the minimum requirements per year.
Any comment:	

Data / Parameter:	**ID11**
Data unit:	m^3
Description:	Wastewater flow rate to the pond system; direct to existing wastewater treatment facilities bypassing EGSB (new construction of wastewater treatment facilities).
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 m^3 (The EGSB outage days shall be assumed in view of operating days of the project and emergency time)
Description of measurement methods and procedures to be applied:	Measuring instrument: ultrasonic level sensor, Measuring frequency: continuous, Ratio of data to be monitored: 100%, Storing method of data (paper/electronics): electronics.
QA/QC procedures to be applied:	Usual correction of monitoring device
Any comment:	The bypassing flow rate shall be measured by ultrasonic level sensor.

Data / Parameter:	**ID12**
Data unit:	%
Description:	Loss of biogas from the pipeline
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 % (To be monitored actually during the project activity)
Description of measurement methods and procedures to be applied:	Measuring frequency: once a year, Ratio of data to be monitored: 100%, Storing method of data (paper/electronics): electronics.
QA/QC procedures to be applied:	Annual inspection shall be made by the international norm.

Any comment:	The loss of biogas methane puts pressure on the system and resulted leakage effects pressure drop; it shall be tested every year.

Data / Parameter:	**ID13**
Data unit:	t COD
Description:	Organic material removed from the wastewater facilities
Source of data to be used:	Calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	(75×8.9)－(75×0.89)=0.6 t COD
Description of measurement methods and procedures to be applied:	Measuring frequency: once a year, Ratio of data to be monitored: 100%, Storing method of data (paper/electronics): electronics.
QA/QC procedures to be applied:	
Any comment:	The COD removal from the treatment facilities shall be recorded so that it can be warranted that CH_4 emission is not overestimated: e.c. the substance sifted out after record of the wastewater density is recorded.

Data / Parameter:	**ID14**
Data unit:	J/Nm^3
Description:	Biogas heat value
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	26,848 J/Nm^3
Description of measurement methods and procedures to be applied:	Measuring frequency: once a year, Ratio of data to be monitored: 100%, Storing method of data (paper/electronics): electronics.
QA/QC procedures to be applied:	Annual inspection shall be made by the international norm.
Any comment:	

Data / Parameter:	**ID15**
Data unit:	$tonnes/m^3$
Description:	The amount of chemical oxidation flown into the system boundary

Source of data to be used:	On-site sampling/Off-site analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	15mg/l＝0.015×10^{-3}tonnes/ m^3 (There is no chemical oxidation<sulphate>)
Description of measurement methods and procedures to be applied:	Measuring frequency: continuous, Ratio of data to be monitored: 100％, Storing method of data (paper/electronics): electronics.
QA/QC procedures to be applied:	If usual samples are part of the process, oxidation consistency to show high likelihood of oxidation of the wastewater shall be tested (sulphuric acid).
Any comment:	

B.7.2 Description of the monitoring plan:

The measuring instrument used for various monitoring items is as follows:

(1) Sampling analysis
ID3: Wastewater COD at the inlet of EGSB (system boundary).
ID4: Wastewater COD at the outlet of EGSB (treatment facilities).
For water quality inspection, the method specified by the Environmental Protection Agency of the US (EPA) is applied, and for the chemical oxygen demand (COD), CODcr is measured by the potassium bichromate method.

(2) Wastewater flow meter
ID1: Wastewater load at the inlet of EGSB (system boundary).
ID2: Wastewater load at the outlet of EGSB (treatment facilities).
The measuring instrument shall be electromagnetic flow meters or vortex flow meters.

(3) Electric energy meter
ID5: The electric energy generated by biogas recovered from the anaerobic treatment facilities.
The measuring instrument shall be electric energy meters; continuous measuring and automatic integrating shall be available.

The electric energy generated by the project shall not be sold to the grid. All of the electric energy generated by biogas shall be used for the factory. But the power demand of the factory is far larger than its own generation, and the factory shall buy the electric energy from the grid even after the implementation of the project. At the moment, the power is supplied to the factory from the grid. The electric energy from the grid can be shown in billing statements to be received from the third party. As stated above, the electric energy to be reduced by the project and its consumption can be confirmed respectively by billing statements to be received from the third party.

(4) Biogas flow meter
ID6: The amount of biogas flown to flaring
ID7: The amount of biogas flown to the power generating unit
The measuring instrument shall be flow meters with integrating function: they shall measure simultaneously the pressure and temperature, and shall correct readings to flows in a standard state.

(5) Infrared methane gas concentration meter
ID8: Biogas methane concentration
ID9: Flare thermal efficiency
The measuring instrument shall be infrared methane gas concentration meters.

The following regulation was laid down at the 25th executive meeting of CDM.
EB approved the modification of flare efficiency monitoring and regulated the default methane destruction flare efficiency factor in cases where the flare efficiency is not measured.
In cases where enclosed flare is used: when a new construction is installed, the flare efficiency (the ratio of methane combusted perfectly in a flare) should be measured, and then it shall be done once per year; measured flare efficiency shall be valid until the next measurement; the default value of 90% shall be used if it is not measured after one year since the last; if the measured value is less than 90%, the measured value shall be applied.

As concerns open flare, if the flare efficiency is not measured, a conservative value of 50% is applied. For the project, enclosed flare is scheduled to be used. When a new construction is installed, the flare efficiency (the ratio of methane combusted perfectly in a flare) is measured by infrared methane gas concentration meters. Then it shall be done once per year; the measured flare efficiency shall be valid until the next measurement;

The monitoring plan is as follow:

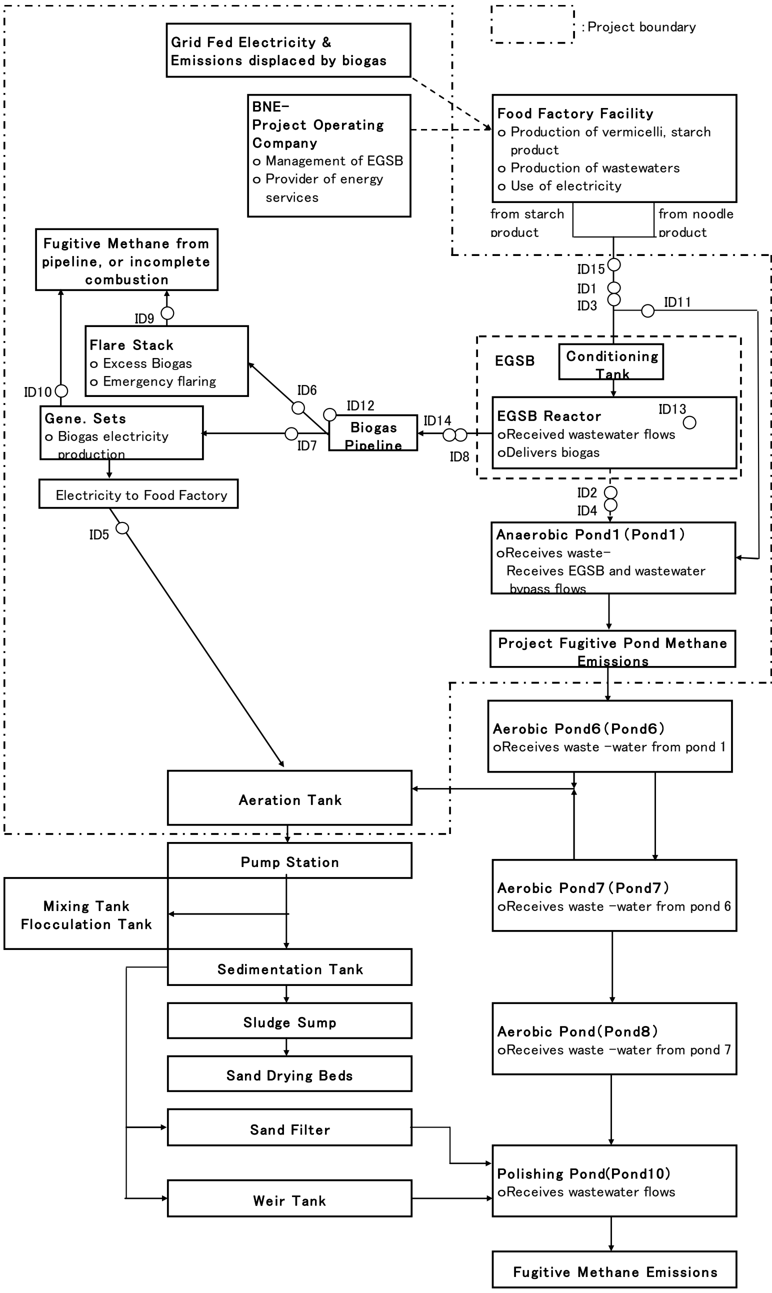

Figure 4 Monitoring Plan

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion: 24/01/2007
Kanematsu Corporation
SEAVANS NORTH, 2-1, Shibaura 1-chome, Minato-ku, Tokyo, Japan
Tel: +81-3-5440-8435
Fax: +81-3-5440-6518
E-mail：Shigeki_Yamane@kanematsu.co.jp

Kanematsu Corporation is the CDM advisor to the Project and is also a project participant listed in Annex 1.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

According to the UNFCCC guidance, the starting date of the CDM project activity is defined to be the date when the project implementation, construction and actual actions start.
The starting date of the CDM project activity shall be April 1, 2007 in consideration of validation, detailed design and construction period.

C.1.2. Expected operational lifetime of the project activity:

The operational lifetime shall be 14 years in consideration of durable years of equipment.

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

According to the UNFCCC guidance, the crediting period of CDM project is a period during which the reduction amount is verified by DOE and is certified for CER issue. A project implementing body can decide the time after the first day when emission reduction is made by the CDM project as the starting date of crediting. And the crediting period should not go beyond the operational period of the project. The GHG emission reduction has effect after the construction work is finished and the project is put into practice. Consequently, the date of the first emission reduction made by the project activity is April 1, 2009, the date of project starting.

C.2.1.2. Length of the first crediting period:

Seven years.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The environment impact analysis for this project is not required in view of the domestic system in Thailand.
The analysis, however, was carried out in accordance of EIA check list.

1. Will the construction, operation or termination have a risk of causing physical changes in the community (topographical changes, land use or changes of lakes and ponds)?
   Yes, less than one hectare of land which is located in the factory where production activity is under way.
   (Is the likelihood of being significantly influenced high?)
   No, the aforesaid land is an empty land in no use.
2. Will the construction or operation of the project use lands, water, substance or energy: among others, deficient natural resources like non-renewable energy?
   Yes, see the above for the land. And the plant construction includes materials for reactor tanks (EGSB), piping materials, power generating unit and other equipment.
   (Is the likelihood of being significantly influenced high?)
   No, only limited materials are utilized.
3. Will the project have a risk of use, storage, transport, disposal or production of substance or materials, which are or may be harmful to human health or environments?
   Yes, there is flammable biogas but a large amount of gas is not stored in the site.
   (Is the likelihood of being significantly influenced high?)
   No, the biogas is used for production activity, while its surplus is broken by means of the flare system technology. The biogas is not stored in the site, while its delivery is supported by the system technology of the short pipeline.
4. Will the project generate solid wastes during the construction, operation or termination of the project?

No, it will not generate significant solid wastes except those related to usual construction and operation activities. Those wastes will be safely taken off from the site and they will be cleared out.

5. Will the project release contaminations or dangerous and harmful materials?
   No, there is mainly carbon dioxide except combustion gas. A large amount of methane gas (greenhouse gas with harmfulness 21 times as much as carbon dioxide) is emitted through a series of ponds, and therefore emission of carbon dioxide will be greatly improved if compared with the current state.
   (Is the likelihood of being significantly influenced high?)
   This will provide major favourable impacts to the environment and it is one of aims to commence the project.
6. Will the project generate noise, vibration, light diffusion, thermal energy or electro magnetic radiation?
   No, the power generating unit and the blower generate a little noise.
   (Is the likelihood of being significantly influenced high?)
   The flare system is operated only when the system requires an emergent backup due to the gas explosion or the power generating unit stops. The power generating unit is designed in consideration of atmospheric noise; therefore the noise is negligible. This is the case if in view of the fact that there is no residence in the neighbourhood.
7. Will the project have risks of causing land or water contamination by releasing contaminant from ground surfaces, surface moisture, groundwater, coasts or the sea?
   No, the wastewater in the reactor tank will not be penetrated into the soil by means of tests by the factory.
8. Will the project have a risk of causing an accident during the construction or operation of the project having exerted an influence on human health or environments?
   No, there is likely a fire although it is rare.
   (Is the likelihood of being significantly influenced high?)
   The pond system is now opened directly to the atmosphere and it generates biogas which is a significant risk for fires; hence the EGSB construction will place restrictions on those fire risks.
9. Is there any nearby place or area of which pollution level exceeds the existing legal environmental standards and which has been contaminated or environmentally damaged under the influence of the project?
   No, the proposed plant will be constructed on site in the existing factory; therefore, it will be subject to all of the related regulations.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

The project makes limited environmental impacts and positive environmental impacts (alleviation of greenhouse gas emission and fuel reduction by the grid electric energy) are more important than negative environmental impacts. Negative environmental impacts from the reactor tank and combustion system are negligible and their influences are not significant. Consequently, the environmental impact analysis is not required.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

Comments of each of stakeholders about the project were received by project implementing persons of the Japanese party at hearings held in August and December, 2006 when they visited Bangkok.

E.2. Summary of the comments received:

The specific comments about the project are as follows:

* 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 labour 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 material.
* 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.

Further hearings hereafter shall be held 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

E.3. Report on how due account was taken of any comments received:

There is now no contrary view or claim to the project.
Instead the project seems to be welcomed in expectation of improvement of the environmental issues in the surrounding area and district. The proposed power generating unit shall be designed to be given to the attention to its combustion gas including compliance with the related regulations.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Kanematsu Corporation
Street/P.O.Box:	Shibaura1-2-1
Building:	SEVANS NORTH
City:	Minato-ku
State/Region:	Tokyo
Postfix/ZIP:	105-8005
Country:	Japan
Telephone:	-
FAX:	-
E-Mail:	-
URL:	http://www.kanematsu.co.jp/
Represented by:	President Yoshihiro Miwa
Title:	Manager in charge
Salutation:	Mr.
Last Name:	Yamane
Middle Name:	-
First Name:	Shigeki
Department:	Cable & Electric Power Project Department
Mobile:	-
Direct FAX:	+81-3-5440-6518
Direct tel:	+81-3-5440-8435
Personal E-Mail:	Shigeki_Yamane@kanematsu.co.jp

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Public funds are not invested in the project.

Annex 3

BASELINE INFORMATION

Baseline data

Table 1 List of Parameters

No	Item	Value	Unit	Source
1	Wastewater volume	1,800	m^3/day	*1 Reference
2	COD concentration of wastewater	8.9	kg COD/m^3	*1 Reference
3	Organic material removed in anaerobic lagoon (Pond 1)	85[9]	%	Gosyu Kohsan Co., Ltd. Based on water quality analysis report.
4	Biogas methane concentration	75[10]	%	It presumed from the introduction performance of Sumitomo Heavy Industries, Ltd.
5	Biogas heat value	6,413(26.85)	kcal/Nm^3 (MJ/Nm^3)	It presumed from the introduction performance of Sumitomo Heavy Industries, Ltd.
6	Methane heat value	8,550(35.8)	kcal/Nm^3 (MJ/Nm^3)	Methane lower heating value
7	Greenhouse warming factor of methane	21	-	Intergovernmental panel of climate change (IPCC) (1996) ”Science of Climate Change” (Climate Change 1995: Page 22), Table 4, ”GWP for 100 years”
8	Methane emission factor	0.2143 0.3	kg CH_4/kg COD $Nm^3 CH_4$/kg COD	It presumed from the introduction performance of Sumitomo Heavy Industries, Ltd. 0.3$Nm^3 CH_4$/kg COD /(22.4(Nm^3/mol)/ CH_4 ： 16 kg/mol=0.2143 kg CH_4/kg COD

[9] COD removal factor of anaerobic ponds is generally 50 - 70%. The baseline data is based on the results of water quality sampling analysis by Gosyu Kohsan Co., Ltd.

[10] The normal biogas composition consists of 60 -70% of methane, 30 – 40% of carbon dioxide and a small quantity of nitrogen, hydrogen and hydrogen sulphide. (Source：Japanese Sewage Works Association)

*1: In this food factory, the wastewater of (Starch Process 1 Wastewater) after production of mung bean starch, of (Starch Process 2 Wastewater) after production of tapioca starch and of (Noodle Wastewater) after production of vermicelli are discharged into the existing anaerobic lagoon pond (only the cover has been constructed) (Pond 1). Wastewater after production is unsteady. Data on the wastewater quality by system is shown in Table 2 – 4. (For the period of September – December, 2006, estimated data is used)

Table 2 Wastewater Quality of Starch Process 1

Item \ Month	1	2	3	4	5	6
Operating days	24	—	28	—	24	—
Wastewater volume (m^3/d)	785	—	955	—	1,008	—
COD concentration (mg/l)	4,031	—	4,031	—	2,500	—
Item \ Month	7	8	9	10	11	12
Operating days	19	—	—	13	26	24
Wastewater volume (m^3/d)	1,009	—	—	1,100	1,100	1,100
COD concentration (mg/l)	3,631	—	—	3,110	3,110	3,110

Table 3 Wastewater Quality of Starch Process 2

Item \ Month	1	2	3	4	5	6
Operating days	18	—	17	—	24	—
Wastewater volume (m^3/d)	692	—	643	—	490	—
COD concentration (mg/l)	18,048	—	18,048	—	19,641	—
Item \ Month	7	8	9	10	11	12
Operating days	19	—	—	13	26	24
Wastewater volume (m^3/d)	495	—	—	636	636	636
COD concentration (mg/l)	26,459	—	—	10,848	10,848	10,848

Table 4 Wastewater Quality of Noodle Production

Item \ Month	1	2	3	4	5	6
Operating days	25	23	27	20	25	26
Wastewater volume (m^3/d)	815	890	846	942	847	872
COD concentration (mg/l)	4,942	3,519	2,787	3,954	3,125	3,817
Item \ Month	7	8	9	10	11	12
Operating days	19	26	26	25	26	24
Wastewater volume (m^3/d)	999	912	800	900	900	900
COD concentration (mg/l)	3,216	2,109	3,500	3,500	3,500	3,500

The setting of the base line was implementing based on wastewater quality data of the Table 2 - 4. The baseline wastewater is shown in Table 5. 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 5 Baseline Wastewater

Item \ Month	Unit	1	2	3	4	5	6		
Wastewater volume	m^3/d	2,292	890	2,444	942	2,345	872		
Item \ Month	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 6a. Therefore, the parameter of baseline to use for emission reduction calculation is shown in the Table 6b.

Table 6a Client Wastewater Quality Analysis Report of Project Site

No.	Item	Unit	Starch Process 1 line	Starch Process 2 line	Noodle line	Facility inflow mixed wastewater
1	Wastewater (Max.) (Operation 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	Temp.	℃	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

Table 6b Baseline Parameters

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

The design bases of the gas engine generating facilities are methane gas and biogas generation volume which generated anaerobic wastewater treatment facilities (EGSB).

Table 7 Design Base of Gas Engine Generator

Item	Unit	Value
Wastewater volume	m^3/d	2,800
COD concentration	mg/l	8,900
COD load	kg COD/d	24,920

Table 8 shows all of surface areas and its pond surface losses in the current lagoon ponds.

Table 8 Surface Area and Pond Surface Loss of Organic Material Source

Item	Value	Unit	Remarks
Pond 1 surface area (Existing anaerobic lagoon)	84.7*56.09= 4,750	m^2	Baseline, project coverage area
Pond 6 surface area (Anaerobic lagoon)	84.7*56.09= 4,750	m^2	Out of the boundary
Pond 7 surface area (Anaerobic lagoon)	84.7*45.7= 3,870	m^2	Out of the boundary
Pond 8 surface area (Anaerobic lagoon)	84.7*45.7= 3,870	m^2	Out of the boundary
Pond 10 surface lagoon (Sand basin)	140*48.7= 6,818	m^2	Out of the boundary
Pond 2 surface area (Anaerobic lagoon)	84.7*45.7= 3,870	m^2	Out of the boundary
Pond 5 surface area (Anaerobic lagoon)	84.7*45.7= 3,870	m^2	Out of the boundary
Surface COD loss factor	254	kg COD/ha/day	
Surface oxidation of organic material	121	kg COD/day	4,750/10,000*254

<u>Project data</u>

Operating days of this project are shown in Table 9.

Table 9 Project Operating Days

No.	Item	Value	Unit	Remarks
1	Days of releasing wastewater of food factory	292	day/year	Refer to the data of noodle line.
2	Hours of releasing wastewater of food factory	24	hour/day	Based on hearing from the food factory
3	Project operating days	350	day/year	The maintenance period for the reactor tank (EGSB) is assumed to be 15 days/year. Biogas is not recovered during the maintenance period for the reactor tank (EGSB) (Releasing to the existing Pond 1 through by passing).
4	Operating hours of power generating unit	335*24= 8,040	hour/year	The operation shall be continuous. For the months of February, April, June, August and September without releasing from the starch process line, the power generation shall be one unit should be driven.
5	Surplus and emergent time flaring operating hours	Surplus and emergent time	hour/year	The biogas and surplus gas generated in February, April, June, August and September shall be flared as burning waste.

The technical specifications of the GE power generating unit for the project are shown in Table 10.

Table 10 Technical Specifications of Power Generating Unit

No	Item	Value	Unit	Remarks
1	Power generation output	250×3	kW	Based on the project design
2	Power generation voltage	380	V	
3	Frequency	50	Hz	
4	Generating efficiency	35	%	Based on the project design

The operation conditions of power generating unit for the project are shown in Table 11.

Table 11 Operation Conditions of Power Generating Unit

No	Item	Value	Unit	Remarks
1	Operating load factor	-	%	Change subject to collected gas volume (See Table 12)
2	Accident(failure)factor	5	%	5% of annual operating hours
3	Operation margin	0	%	
4	Loss of auxiliary machine of power generating unit	5	%	Supplementary equipment (pump and cooling facilities) to the power generating unit and measuring instrument. 40kW for power supply for EGSB shall be supplied from the factory in consideration of the outage of power generating unit (the power consumption is assumed to be about 50 kW).
5	Transmission loss	0	%	Not applicable due to non-sales of electric power.
6	Regular maintenance	30	day/ year	The gas shall be flared during outage time of power generating unit.

Monthly & yearly electric power generation of the project is shown in Table 12.

Table 12 Monthly & Yearly Electric Power Generation

Item \ Month	Unit	1	2	3	4	5	6
Possible production of electricity	kW	739	123	697	146	579	130
Operating load	%	0.99	0.49	0.93	0.58	0.77	0.52
Operating days of flaring	day/ month	0	0	0	0	0	0
Operating days of power generating unit	day/ month	16	28	31	30	31	15
Electric power generation	MWh /month	256	74	468	95	389	42

Item \ Month	Unit	7	8	9	10	11	12	Total
Possible production of electricity	kW	750	75	110	527	527	527	-
Operating load	%	1.0	0.3	0.44	0.70	0.70	0.70	-
Operating days of flaring	day/ month	0	0	0	0	0	0	0
Operating days of power generating unit	day/ month	31	31	30	31	30	31	335
Electric power generation	MWh /month	504	51	71	354	343	354	3,000

The electric power generation during the project is shown in Table 13.

Table 13 Electric Power Generation during the Project

Year	2009	2010	2011	2012	2013	2014	2015
Electric energy (MWh/yr)	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Year	2016	2017	2018	2019	2020	2021	2022
Electric energy (MWh/yr)	3,000	3,000	3,000	3,000	3,000	3,000	3,000

The technical specifications of reactor tank (EGSB) are shown in Table 14.

Table 14 Technical Specifications of Reactor Tank (EGSB)－Source: SHI

Item	Value	Unit
Expected COD removal efficiency by reactor tank (EGSB)	90	%
Biogas generation by reactor tank (EGSB)	415	m^3GAS/h
Methane gas generation by reactor tank (EGSB)	311	m^3CH_4/h
Biogas generation per m^3 of wastewater	415/(2,800/24)=3.56	m^3 GAS/m^3 of wastewater
Biogas generation per kg of COD	415/(2,800/24*8.9)=0.4	m^3 GAS/kg COD

・*Maximum methane gas generation(Nm^3CH_4/d) =*
*Wastewater volume (m^3/day) * COD concentration (mg/l) * COD removal efficiency (-) * Maximum methane emission factor (Nm^3CH_4/kg COD)*
= 2,800(m^3/day) * 8,900(mg/l) *10^{-3}* 0.9(-) * 0.3(Nm^3CH_4/kg COD) = 6,728(Nm^3 CH_4/d)
= 280(Nm^3 CH_4/h)
= 311(m^3 CH_4/h)

・*Maximum methane gas generation (Nm^3GAS/d) =*
Methane gas generation (Nm^3CH_4/d)/ Methane concentration (-)
= 6,728(Nm^3CH_4/d)/0.75(-) = 8,971(Nm^3 GAS/d)
= 374(Nm^3 GAS/h)
= 415(m^3 GAS/h)

・*Baseline methane gas generation (Nm^3CH_4/d) =*
*Wastewater volume (m^3/day) * COD concentration (mg/l) * COD removal efficiency (-) * Maximum methane emission factor (Nm^3CH_4/kg COD)*
= 1,800(m^3/day) * 8,900(mg/l) *10^{-3}* 0.9(-) * 0.3(Nm^3CH_4/kg COD) = 4,325(Nm^3 CH_4/d)
= 180(Nm^3 CH_4/h)
= 200(m^3 CH_4/h)

・*Baseline methane gas generation (Nm^3GAS/d) =*
Methane gas generation (Nm^3CH_4/d)/ Methane concentration (-)
= 4,325(Nm^3CH_4/d)/0.75(-) = 5,767(Nm^3 GAS/d)
= 240(Nm^3 GAS/h)
= 266(m^3 GAS/h)

Annex 4

MONITORING INFORMATION

Measuring instrument used for each of monitoring items is as follows:

(1) Sampling analysis

ID3: Wastewater COD at the inlet of EGSB (system boundary).

ID4: Wastewater COD at the outlet of EGSB (treatment facilities).

For water quality inspection, the method specified by the Environmental Protection Agency of the US (EPA) is applied, and for the chemical oxygen demand (COD), CODcr is measured by the potassium bichromate method.

(2) Wastewater flow meter

ID1: Wastewater load at the inlet of EGSB (system boundary).

ID2: Wastewater load at the outlet of EGSB (treatment facilities).

The measuring instrument shall be electromagnetic flow meters or vortex flow meters.

(3) Electric energy meter

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

The measuring instrument shall be electric energy meters; continuous measuring and automatic integrating shall be available.

The electric energy generated by the project shall not be sold to the grid. All of the electric energy generated by biogas shall be used for the factory. But the power demand of the factory is far larger than its own generation, and the factory shall buy the electric energy from the grid even after the implementation of the project. At the moment, the power is supplied to the factory from the grid. The electric energy from the grid can be shown in billing statements to be received from the third party. As stated above, the electric energy to be reduced by the project and its consumption can be confirmed respectively by billing statements to be received from the third party.

(4) Biogas flow meter

ID6: The amount of biogas flown to flaring

ID7: The amount of biogas flown to the power generating unit.

The measuring instrument shall be flow meters with integrating function: they shall measure simultaneously the pressure and temperature, and shall correct readings to flows in a standard state.

(5) Infrared methane gas concentration meter

ID8: Biogas methane concentration

ID9: Flare thermal efficiency

The measuring instrument shall be infrared methane gas concentration meters.

The following regulation was laid down at the 25th executive meeting of CDM.
EB approved the modification of flare efficiency monitoring and regulated the default methane destruction flare efficiency factor in cases where the flare efficiency is not measured.
In cases where enclosed flare is used: when a new construction is installed, the flare efficiency (the ratio of methane combusted perfectly in a flare) should be measured, and then it shall be done once per year; measured flare efficiency shall be valid until the next measurement; the default value of 90%

shall be used if it is not measured after one year since the last; if the measured value is less than 90%, the measured value shall be applied.
As concerns open flare, if the flare efficiency is not measured, a conservative value of 50% is applied.

For the project, enclosed flare is scheduled to be used. When a new construction is installed, the flare efficiency (the ratio of methane combusted perfectly in a flare) is measured by infrared methane gas concentration meters. Then it shall be done once per year; the measured flare efficiency shall be valid until the next measurement;

- - - - -

Annex 5

Internal rate of return (IRR) of this project is calculated on the condition of the Table 1 and the Table 2.

Table 1-1 Recondition of Internal Rate of Return (IRR) calculation

Items	Value	Unit	Remarks
Initial investment	315	Million Yen	
Maintenance cost and utility costs in year	7.56	Million Yen /yr	
Labor cost	0	Million Yen /yr	Existing factory worker, will double as the plant worker.
Purchased power price	2.58	Baht/kWh	
Generated electric power	250×3	kW	Refer to Table 10
Total power generation	3,000	MWh/yr	Refer to Table 12
GHG emission reduction	20,469	t CO_2e	Refer to Section B.6.4
CERs price	11.56	US$/t CO_2e	
Project operational lifetime and crediting period	14	years	Refer to Section C

Table 1-2 Recondition of tax, depreciation etc.

Items	Value	Unit	Remarks
Corporation tax	30	%	Tax rate of Thailand
Interest, Borrowing period	-	-	Because it will be implemented in the fund on hand completely, it isn't considered for the IRR calculation.
Payment start time	2009	year	
Depreciation taxable	283.5	Million Yen	Equipment cost and design expense
Depreciation period	10	years	Least 5 years
Depreciation method and rate	fixed installment method, 10%	-	Fixed installment method is general in Thailand.
Salvage value	10	%	
Price inflation rate	0	%	It isn't considered for the IRR calculation.
Exchange rate (Yen ⇔Baht)	3	Yen/Baht	
Exchange rate (Yen ⇔USD)	110	Yen/US$	

The calculation results of the Internal Rate of Return (IRR) of this project in case of without CERs and with CERs are shown in the Table 1-3.

Table 1-3 Project IRR (After-tax)

	without CERs	with CERs
Project IRR	−5.9 %	7.0 %

《Cash flow statement》 (Initial investment : 315 Million Yen, without CERs)

(Unit: Million Yen)

Profit-and-loss statement		Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sales	Electric generation income		23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	
	CERs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	＜Total＞		23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	
Cost																	
	Nutrient		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
	Lubricating oil		0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	
	NaOH		2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	
	Gas engine maintenance cost		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
	Other maintenance cost		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
	＜Total＞		7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	

Depreciation			28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	–	–	–	–	
Operating income			−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	15.7	15.7	15.7	15.7	
Nonoperating expense	Interest cost	0.0%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Current profits			−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	15.7	15.7	15.7	15.7	
Corporation tax	Corporation tax etc.	30%	–	–	–	–	–	–	–	–	–	–	4.7	4.7	4.7	4.7	
Current income			−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	11.0	11.0	11.0	11.0	
Cumulative profits			−12.7	−25.4	−38.1	−50.8	−63.5	−76.1	−88.8	−101.5	−114.2	−126.9	−115.9	−105.0	−94.0	−83.1	

Cash flow statement	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Current profits		−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	−12.7	15.7	15.7	15.7	15.7	
Depreciation		28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	–	–	–	–	
Total cash inflows		15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	
Corporation tax etc. payment		–	–	–	–	–	–	–	–	–	–	4.7	4.7	4.7	4.7	
Repayment of borrowed money		–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Total cash-out flow		–	–	–	–	–	–	–	–	–	–	4.7	4.7	4.7	4.7	
Cash flow		15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	11.0	11.0	11.0	11.0	

Balance sheet	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Available assets (Excess funds)		15.7	31.3	47.0	62.6	78.3	94.0	109.6	125.3	140.9	156.6	167.6	178.5	189.5	200.4	
Fixed assets(Depreciation assets)	315.0	283.5	255.2	229.6	206.7	186.0	167.4	150.7	135.6	122.0	109.8	98.9	89.0	80.1	72.1	
Total assets (Assets section)		299.2	286.5	276.6	269.3	264.3	261.4	260.3	260.9	263.0	266.4	266.4	267.5	269.6	272.5	
Borrowed money		–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Total liabilities		–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Capital	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	
Surplus		−15.8	−28.5	−38.4	−45.7	−50.7	−53.6	−54.7	−54.1	−52.0	−48.6	−48.6	−47.5	−45.4	−42.5	
Total shareholders' equity		299.2	286.5	276.6	269.3	264.3	261.4	260.3	260.9	263.0	266.4	266.4	267.5	269.6	272.5	
Total liabilities, shareholders' equity		299.2	286.5	276.6	269.3	264.3	261.4	260.3	260.9	263.0	266.4	266.4	267.5	269.6	272.5	

Break-even calculation	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
After-tax cash flow		15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	11.0	11.0	11.0	11.0	
Accumulated after-tax cash flow		15.7	31.3	47.0	62.6	78.3	94.0	109.6	125.3	140.9	156.6	167.6	178.5	189.5	200.4	
Accumulated after-tax cash flow- Investment capital		−299.3	−283.7	−268.0	−252.4	−236.7	−221.0	−205.4	−189.7	−174.1	−158.4	−147.4	−136.5	−125.5	−114.6	
Internal rate of return [IRR] Excepted interest, after-tax)						#NUM!					−11.0%				−5.9%	
(IRR calculation data)	−315.0	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	11.0	11.0	11.0	11.0	
Internal rate of return [IRR] (Excepted interest, before-tax)						#NUM!					−11.0%				−4.5%	
(IRR calculation data)	−315.0	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	

Setting item		Setting item				
Salvage value	10%	Purchased power price	2.58 Baht/kWh	=	7.74	Yen/kWh
Initial investment(Million Yen)	315	CERs price	0 US$/t CO2	=	0	Yen/t CO_2
Depreciation(Million Yen)	28.35	Exchange rate	110 Yen/US$			
Depreciation rate	10%		3 Yen/Baht			

Payout period	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
	−315.0	−299.3	−283.7	−268.0	−252.4	−236.7	−221.0	−205.4	−189.7	−174.1	−158.4	−147.4	−136.5	−125.5	−114.6	
		1	1	1	1	1	1	1	1	1	1	1	1	1	1	
		0	0	0	0	0	0	0	0.0	0	0	0	0	0	1	15.0 year
Project income	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Total power generation	MWh	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
GHG emission reduction	t CO2															

Figure 1 Cash flow statement(without CERs)

《Cash flow statement》 (Initial investment : 315 Million Yen, Crediting period : 14 years, Credit price: 11.56US$)

(Unit: Million Yen)

Profit-and-loss statement		Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sales	Electric generation income		23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	23.22	
	CERs		26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	26.03	
	＜Total＞		49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	49.25	
Cost																	
	Nutrient		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
	Lubricating oil		0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	
	NaOH		2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	
	Gas engine maintenance cost		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
	Other maintenance cost		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
	＜Total＞		7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	7.56	

Depreciation			28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	–	–	–	–	
Operating income			13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	41.7	41.7	41.7	41.7	
Nonoperating expense	Interest cost	0.0%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Current profits			13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	41.7	41.7	41.7	41.7	
Corporation tax	Corporation tax etc.	30%	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	12.5	12.5	12.5	12.5	
Current income			9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	29.2	29.2	29.2	29.2	
Cumulative profits			9.3	18.7	28.0	37.3	46.7	56.0	65.4	74.7	84.0	93.4	122.6	151.7	180.9	210.1	

Cash flow statement	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Current profits		13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	41.7	41.7	41.7	41.7	
Depreciation		28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	–	–	–	–	
Total cash inflows		41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	
Corporation tax etc. payment		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	12.5	12.5	12.5	12.5	
Repayment of borrowed money		–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Total cash-out flow		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	12.5	12.5	12.5	12.5	
Cash flow		37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	29.2	29.2	29.2	29.2	

Balance sheet	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Available assets (Excess funds)		37.7	75.4	113.1	150.7	188.4	226.1	263.8	301.5	339.2	376.9	406.1	435.2	464.4	493.6	
Fixed assets(Depreciation assets)	315.0	283.5	255.2	229.6	206.7	186.0	167.4	150.7	135.6	122.0	109.8	98.9	89.0	80.1	72.1	
Total assets (Assets section)		321.2	330.5	342.7	357.4	374.4	393.5	414.5	437.1	461.2	486.7	504.9	524.2	544.5	565.7	
Borrowed money		–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Total liabilities		–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Capital	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	315.0	
Surplus		6.2	15.5	27.7	42.4	59.4	78.5	99.5	122.1	146.2	171.7	189.9	209.2	229.5	250.7	
Total shareholders' equity		321.2	330.5	342.7	357.4	374.4	393.5	414.5	437.1	461.2	486.7	504.9	524.2	544.5	565.7	
Total liabilities, shareholders' equity		321.2	330.5	342.7	357.4	374.4	393.5	414.5	437.1	461.2	486.7	504.9	524.2	544.5	565.7	

Break-even calculation	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
After-tax cash flow		37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	29.2	29.2	29.2	29.2	
Accumulated after-tax cash flow		37.7	75.4	113.1	150.7	188.4	226.1	263.8	301.5	339.2	376.9	406.1	435.2	464.4	493.6	
Accumulated after-tax cash flow- Investment capital		−277.3	−239.6	−201.9	−164.3	−126.6	−88.9	−51.2	−13.5	24.2	61.9	91.1	120.2	149.4	178.6	
Internal rate of return [IRR] Excepted interest, after-tax)						−15.0%					3.4%				7.0%	
(IRR calculation data)	−315.0	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	29.2	29.2	29.2	29.2	
Internal rate of return [IRR] (Excepted interest, before-tax)						−12.4%					5.4%				9.5%	
(IRR calculation data)	−315.0	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	

Setting item		Setting item				
Salvage value	10%	Purchased power price	2.58 Baht/kWh	=	7.74	Yen/kWh
Initial investment(Million Yen)	315	CERs price	11.56 US$/t CO2	=	1,272	Yen/t CO_2
Depreciation(Million Yen)	28.35	Exchange rate	110 Yen/US$			
Depreciation rate	10%		3 Yen/Baht			

Payout period	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
	−315.0	−277.3	−239.6	−201.9	−164.3	−126.6	−88.9	−51.2	−13.5	24.2	61.9	91.1	120.2	149.4	178.6	
		1	1	1	1	1	1	1	1	0	0	0	0	0	0	
		0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	8.4 year
Project income	Fiscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Total power generation	MWh	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
GHG emission reduction	t CO2	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	20,469	

Figure 2 Cash flow statement(with CERs)