**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)**
**Version 03 - in effect as of: 22 December 2006**

**CONTENTS**



**Revision history of this document**

| Version Number | Date | Description and reason of revision |
|---|---|---|
| 01 | 21/01/ 2003 | Initial adoption |
| 02 | 08 /07/2005 | • The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document.<br>• As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>. |
| 03 | 22/12/ 2006 | • The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM. |

## SECTION A. General description of small-scale project activity

### A.1 Title of the small-scale project activity:

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Utilization of Biogas and Power Generation on Wastewater from alcohol Factory in the Kingdom of Thailand

First Version

Date: 25/1/2008

### A.2. Description of the small-scale project activity:

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***- The purpose of the project activity***

At the moment, 450 $m^3$/day wastewater discharged from the Nakhon Pathom alcohol factory is treated in open lagoon ponds. The project is designed to treat the wastewater in an anaerobic processing system (Digester) 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 with gross output 1*1,200 kW by gas engine. The electricity generated is sold to PEA (Provincial Electricity Authority)'s grid under VSPP (Very Small Power Producer) scheme through the step up transformer. By limiting fossil fuel consumption for grid power supply equivalency and through the combustion of surplus methane gas by means of a flare stack, this project makes it possible for reduction of greenhouse gas. A flare stack is to be installed in cases of emergency, and possible equipment is installed. In total, 40,826 tonnes greenhouse gas emission (GHGs) can be reduced through the execution of the project.

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

Through the execution of the project, the following contribution to the sustainable development is expected:

* The protection from the environmental pollution led by improvement of wastewater quality through upgrading the ability of the anaerobic wastewater treatment facilities.
* Combat global warming by the effective utilization of biogas as a renewable energy source.
* The protection from 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 anaerobic processing method.
* Against skyrocketing energy cost such as heavy oil, the energy saving effect by fossil fuel consumption reduction for grid power supply equivalency by selling electric power is provided.
* The transfer of technology for the methane fermentation process and biogas power generating equipment.
* The project can spread around Southeast Asian countries including Thailand, and the transmitting effect of the project as clean technology demonstration project is expected.
* The project may also serve as a project which establishes the CDM and demonstrate an important role that 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 alcohol industries and a valuable export commodity of Thailand.
* Effective utilization of organic material of waste effluents involving the risk of generation of flammable methane gas.

## A.3. Project participants:

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| 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) | Bionic Humus Co., Ltd. (BHC) | No |
| Thailand (host) | Bio Natural Energy Company Limited (BNE) | No |
| Japan | Kanematsu Corporation (KG) | No |

Project concerned parties (Host and investing countries)

(Host country)

* Bionic Humus Co., Ltd. (BHC):
  BHC is operation management company of the waste treatment by Nakhon Pathom alcohol factory for producing beverage alcohol from molasses (treacle), and the supplier of the project site and waste water from the alcohol factory under long term agreement with BNE

* Bio Natural Energy Company Limited (BNE):
  SPC (Special Purpose Company) and an organization responsible for the project execution

(Investing country, Japan)

* Kanematsu Corporation (KG):
  Preparation of PDD, CDM project management and a contacting entity of the project

For detailed contact address, see Annex 1.

The following entities are noted for the implementation of the project;

* Toyo-Thai Corporation Ltd. (TTCL):
  EPC (Engineering, Procurement, and Construction) Contractor (Acquisition of ISO 9001) for the Plant, and Operation and Maintenance for the Project, using anaerobic fermentation reactor (ADI's BVF Reactor) under long term agreement with BNE

**A.4. Technical description of the small-scale project activity:**

**A.4.1. Location of the small-scale project activity:**

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**A.4.1.1. Host Party(ies):**

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Thailand (Host country)

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

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Nakhon Pathom Province

**A.4.1.3. City/Town/Community etc:**

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Don Tum District

**A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :**

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The aforesaid alcohol factory is located in Don Tum District, Nakhon Pathom Province about 60 km on the west of Bangkok and produces beverage alcohol from molasses (treacle).

Nakhon Pathom Alcohol Factory

Address : 139 Moo.4 ,Tambon Banlhuang ,Dontoom District,Nakhon Pathom Province

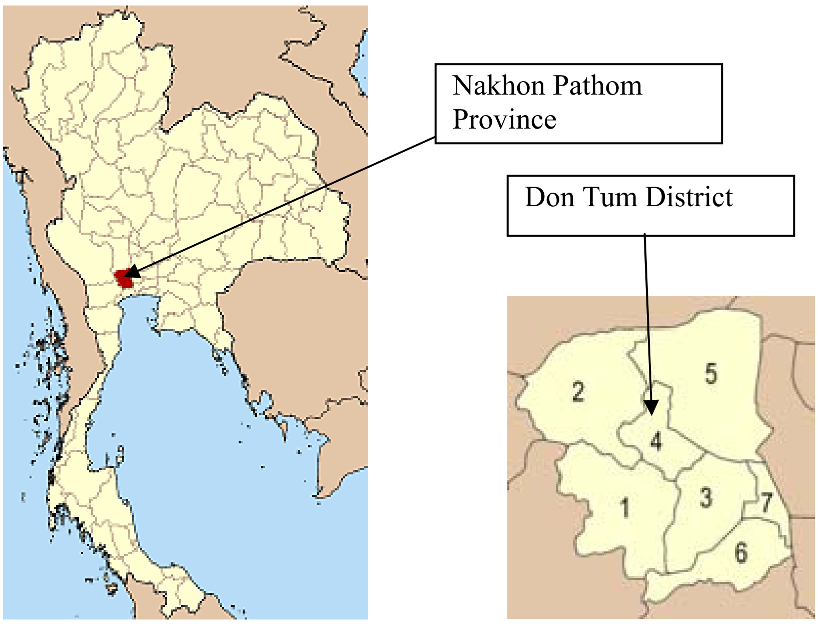


Figure 1 Location of Project Site

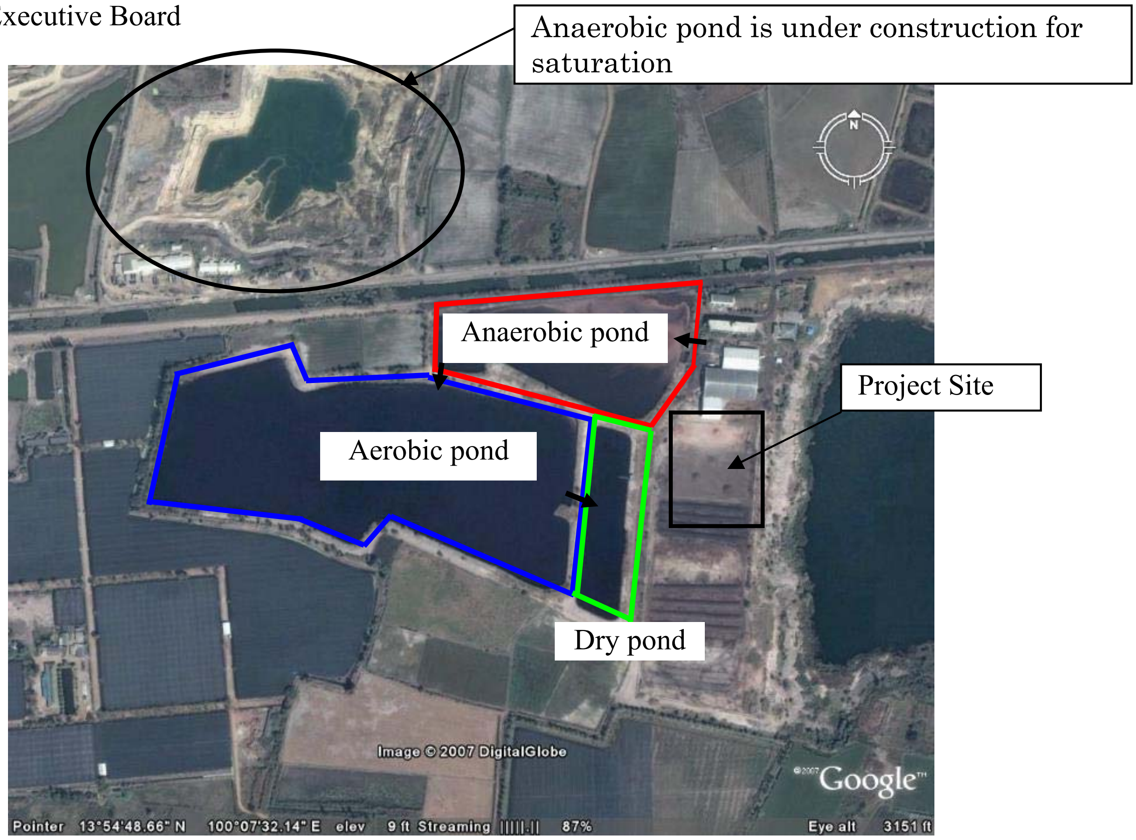


Figure 2 Factory Layout

### A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

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At the moment, the wastewater after the production process of alcohol from molasses is discharged into the existing anaerobic lagoon pond (without the constructed cover).
It is treated after anaerobic processing in aerobic lagoon, and seen to the dry pond, and it is discharged into the irrigation canal afterwards

The gas engine made by Jenbacher energiesisteme AG will be used and the model is J420 GS equivalency. The output is assumed to 1,413 kWm at engine output, 1,200 kWe at generator output. The project will introduce two important technologies of which transfer is required on different characteristics stages in the region and worldwide.

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 Canadian technology (ADI Systems Inc.);

   * Technology – component part of Digester[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:

[1] ADI System Inc. has the technology of methane fermentation process under the name of ADI-BVF Digester.

It has been characterized and deployed on a global basis; hence the technology may be obtained.

The project activity falls under the following types and categories.
Type (iii): Other project activities
AMS- III.H. Methane Recovery in Wastewater Treatment
This category covers the methane recovery component of the project by '(vi) introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery'. Measures are limited to those that result in emission reductions less than or equal to 60,000 $tCO_2e$ annually.

Type (i): Renewable energy projects
AMS- I.D. Grid Connected Renewable Electricity Generation
This category comprises renewable energy generation units, such as photovoltaics, hydro, tidal/wave, wind, geothermal and renewable biomass, that supply electricity to and/or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit. The added capacity shall be not exceed 15MW.

Newly anaerobic wastewater treatment facilities

Application process is shown in Figure 3. This process is composed by anaerobic fermentation reactor (ADI-BVF REACTOR), and it liquefies, and acid formation, acetic acid formation, methane formation progress on it. And, it gets the alkaline collection of the treatment water, effect on planting seed of acid formation fungus by a part of the reactor treatment water being returned. Methane fermentation reactor of lagoon type in the base, the concrete wall is installed in the circumference, and lagoon wall, lagoon slope, the bottom part, and so on are covered and lining with PVC. The top of lagoon is covered with geomembrane cover, and a PVC pipe is installed in the bottom part, and wastewater is made to circulate in it by the pump. The pump and blower are controlled in the gas control room. As for wastewater process and the generated gas, DCS is controlled.

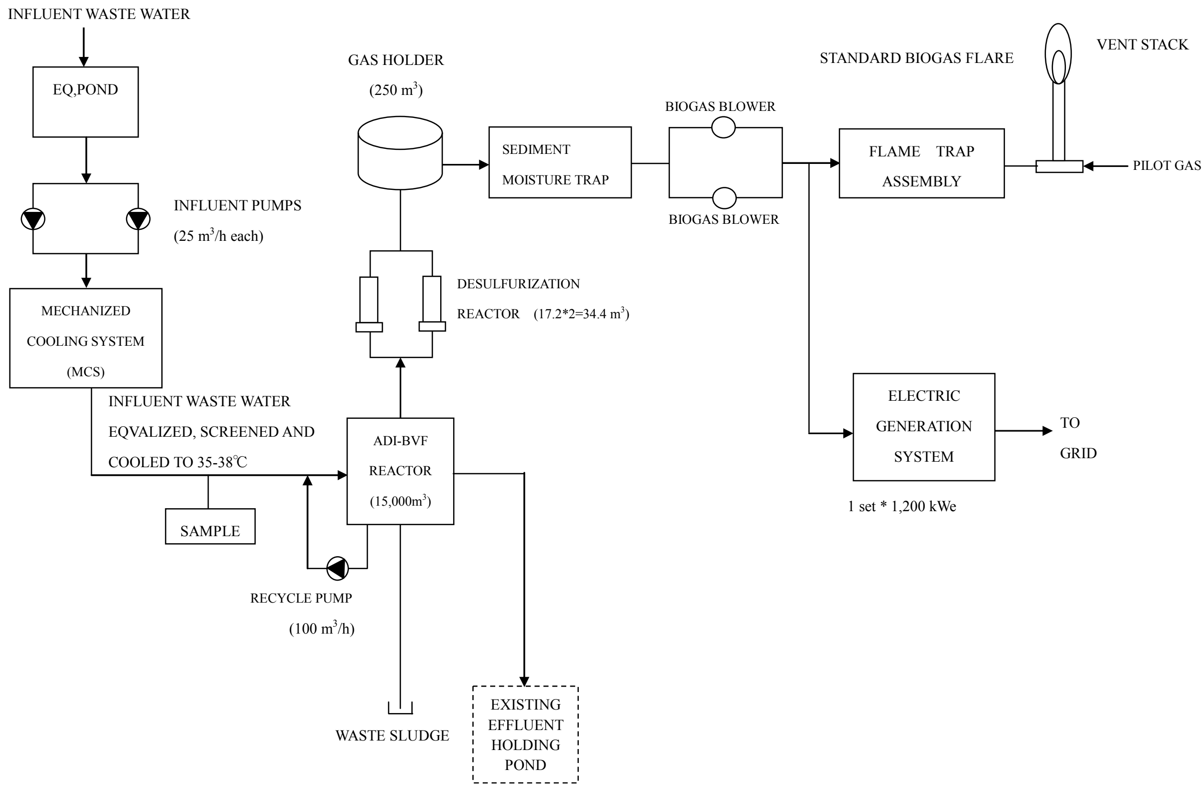


Figure 3 Application Process

Main equipment
* Equalization Pond
* Influent Pumps
* Mechanized Cooling System (MCS)
* ADI-BVF Unit (Included Circulation pump)
* Biogas Electric Generation Unit
* Biogas Unit (Sediment Moisture Trap, Biogas Blower, Flame Trap, Flare Stack etc.)

**A.4.3 Estimated amount of emission reductions over the chosen crediting period:**

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The crediting period of the project is 10 years and the total emission reduction amounts to 408,260 $tCO_2e$ for the crediting period.

Table 1 Total Emission Reduction for Crediting Period

| Years | Estimation of annual emission reductions in tonnes of $CO_2e$ |
|---|---|
| Year 2010 | 40,826 |
| Year 2011 | 40,826 |
| Year 2012 | 40,826 |
| Year 2013 | 40,826 |
| Year 2014 | 40,826 |
| Year 2015 | 40,826 |
| Year 2016 | 40,826 |
| Year 2017 | 40,826 |
| Year 2018 | 40,826 |
| Year 2019 | 40,826 |
| Total estimated reductions (tonnes of $CO_2e$) | 408,260 |
| Total number of crediting years | 10 |
| Annual average of the estimated reductions over the crediting period ($tCO_2e$) | 40,826 |

**A.4.4. Public funding of the small-scale project activity:**

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Public funds will not be invested in this project.

**A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:**

As defined in paragraph 2 of Appendix C of the SSC M&P, proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

* With the same project participants;
* In the same project category and technology/measure; and
* Registered within the previous 2 years; and
* Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

From there not being other CDM project activity within 1 km from boundary of this project activity, this project is not debundling.

## SECTION B. Application of a baseline and monitoring methodology

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

>>

AMS- III.H. Methane Recovery in Wastewater Treatment
(Version 8, Scope 13, dated 14/12/2007)

AMS- I.D. Grid Connected Renewable Electricity Generation
(Version 12, Scope 1, dated 10/8/2007)

### B.2 Justification of the choice of the project category:

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AMS- III.H. Methane Recovery in Wastewater Treatment
The applicability criteria for the methodology are as below.

1. This project category comprises measures that recover methane from biogenic organic matter in wastewaters by means of one of the following options:
   (i) Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with methane recovery and combustion.
   (ii) Introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater treatment plant without sludge treatment.
   (iii) Introduction of methane recovery and combustion to an existing sludge treatment system.
   (iv) Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant.
   (v) Introduction of anaerobic wastewater treatment with methane recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream.
   (vi) Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).
2. If the recovered methane is used for heat and/or electricity generation that component of the project activity, the project can use a corresponding category under type I.
6. Measures are limited to those that result in emission reductions of less than or equal to 60 kt $CO_2$ equivalent annually.

The proposed CDM project activity deals with the implementation of digester at an existing alcohol manufacturing plant to treat the organic wastewater generated in the production process.
Methane produced during the process in the digester is captured by using appropriate systems, and the captured methane is used for electric power selling.
Thus, the project satisfies Criteria (vi) above.

The recovered methane is combusted in gas engines for electricity generation for the factory, which displaces bought-in grid electricity. Thus, component of the project activity can use a category under type I.D..

Section A.4.3. demonstrates that the estimated annual emission reduction of the project activity during the crediting period is 40,826 $tCO_2e$ only, which is not exceeding the maximum proposed value of 60 kt $CO_2e$ in any year of the crediting period, as proposed by the Type III category of project activity guidelines.

AMS- I.D. Grid Connected Renewable Electricity Generation
For the renewable electricity generation component of the project activities, the added generation capacity is less than 15 MW.
The power generation capacity added to this project is 1,200 kWe, and it is not exceed 15MW.

## B.3. Description of the project boundary:

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The project boundary for type III.H. (AMS-III.H.) projects is the physical, geographical site of the methane recovery facility.
The project boundary for type I.D. (AMS-I.D.) is the physical, geographical site of the renewable generation source.

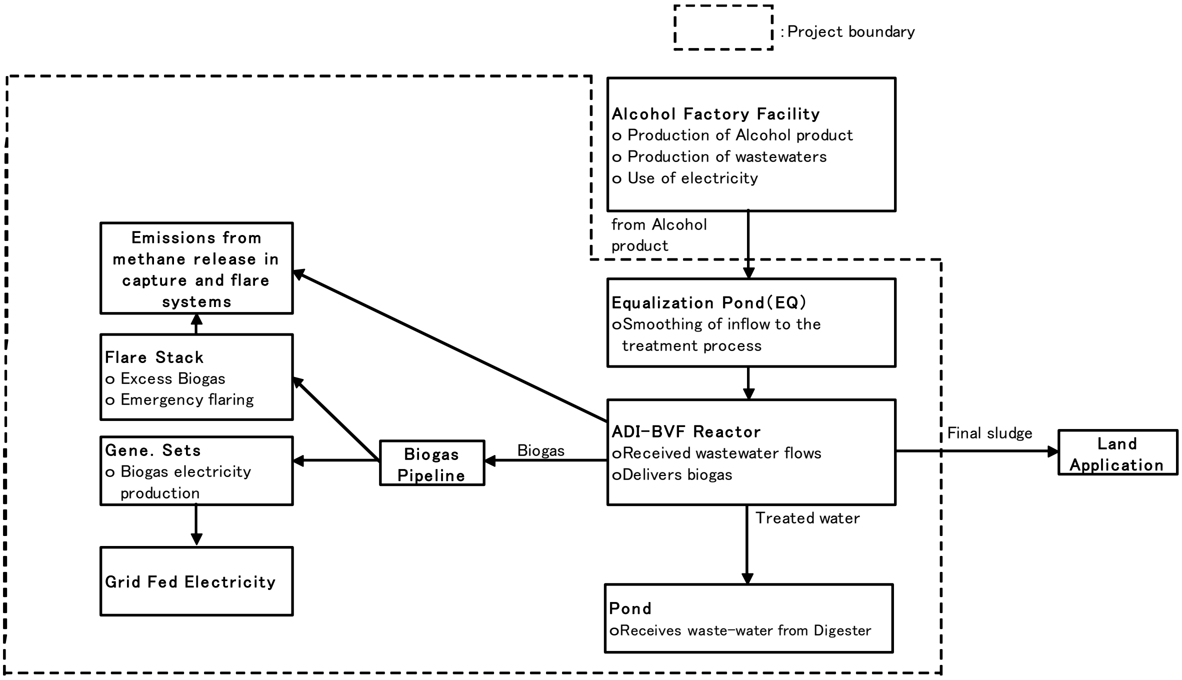


Figure 4 Project Boundary

**B.4. Description of baseline and its development:**

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The baseline study was concluded using relevant methodology AMS-I.D. and AMS-III.H.
*The appropriate baseline for project category Type I.D. (AMS-I.D.) is found in paragraphs 7 to 11.
*The appropriate baseline for project category Type III.H. (AMS-III.H.) is found in paragraphs 6 and 7.

Total baseline emission (BE):
The total baseline emission is the sum of the two discussed below.

$BE = BE_y + BE_{grid}$ = 60,249 ($tCO_2e$) + 4,528 ($tCO_2e$) = 64,831 ($tCO_2e$)

For AMS-III.H.:
In this case, the baseline scenario is continuation of the present open lagoon based treatment of organic wastewater and release of methane into the atmosphere.
The above stated condition fits well with paragraph 6 baseline scenario (vi) of the AMS-III.H. methodology, "The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery" as suggested in indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories, III.H., Version 8, Scope 13 dated 14/12/2007.

$BE_y$ = Baseline methane emission from an existing wastewater treatment in the year ($tCO_2e$)

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

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Volume of wastewater per day | $Q_{d,ww}$ | 450 | $m^3$/day | Estimated plant data alcohol plant design value<br><br>Actually this item will be monitored. |
| Operating days | D | 330 | Days | The annual average value of the factory results of 2006 |
| Volume of wastewater treated in the year | $Q_{y,ww}$ | 148,500 | $m^3$ | Calculated as $Q_{y,ww} = Q_{d,ww} * D$ |
| Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture in the year | $COD_{y,ww,untreated}$ | 0.115 | tonnes/$m^3$ | Measured plant data |
| Methane producing capacity of the wastewater | $B_{o,ww}$ | 0.21 | kg $CH_4$/kg COD | IPCC default value, as per AMS-III.H. |

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Methane correction factor for the existing wastewater treatment system to which the sequential anaerobic treatment step is being introduced | $MCF_{ww,treatment}$ | 0.8 | - | IPCC default value MCF lower value for anaerobic deep lagoon (depth more than 2 metres) in AMS-III.H. table III.H.1. |
| Global warming potential for methane | GWP_CH4 | 21 | - | AMS-III.H. |

For AMS-I.D.:
The emission coefficient is calculated as per paragraph 9.(a), as a combined margin (CM) consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM0002 as suggested in indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories, I.D., Version 12, Scope 1 dated 10/8/2007.

$BE_{grid}$ = Baseline electricity generation emissions in the year ($tCO_2e$)

$BE_{grid} = EP_{BIO} * EF_{grid}$

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Electricity produced by the biogas generator unit for grid electricity replacement in the year | $EP_{BIO}$ | 8,984 | MWh | Calculated estimation plant data<br>1 (set) * 1,200 (kWe) * 24 (h) * 330 (Days)* 0.95 *0.995 = 8,984 (MWh)<br><br>Operation condition<br>* No. of set : 1 set<br>* Generator output : 1,200 kWe<br>* Operation hour : 24 h<br>* Operation day : 330 Days<br>* Accident factor : 5 %<br>* Transmission loss : 0.5 %<br><br>Actually this item will be monitored. |
| Emission factor of grid electricity | $EF_{grid}$ | 0.51 | kg $CO_2e$/kWh | As per AMS-I.D./ACM0002 |

**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 small-scale CDM project activity:**

The project activity would not have occurred due to at least any one of the following.
Consistent with Attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the Project's additionality can be established if it faces at least one of the following barriers:
(1) Investment barrier
(2) Technological barrier
(3) Barrier due to prevailing practice
(4) Other barriers

Alternative baseline scenarios tested.
Scenario 1: Scenario of continuity of the current practice (Business-as-usual)
Scenario 2: Aerobic treatment of wastewaters (activated sludge or filter bed type treatment)
Scenario 3: Proposed project
(The proposed project is designed to recover methane gas through anaerobic processing digester for power generation. The electric power generated is used for grid connection, while surplus gas will be burned for diffusion.)

Investment barrier
By the scenario 1, this technology is already installed and funding is not required any more.

A simple alternative to the proposed project activity is a simple aerated lagoon (Perform oxygen supply in a lagoon) operated by mechanical aerators which infuse the oxygen required for the decomposition of the organic matter in the wastewater. This technology is relatively simpler and low-cost compared to the proposed activity. However, aerated lagoons also consume electricity for the aerators.

The scenario 2 of aerobic treatment (activated sludge or filter bed type treatment) is superior in a processing function.
However, aerobic treatment uses much electricity for an aeration device, and excess sludge occurring abundantly becomes a problem. In addition, this is higher cost compared to conventional systems, and there is no income source by introduction.

The scenario 3 of ADI-Digester has appropriate systems that can control, accelerate and capture the methane emissions arising in the process, but of course at a higher cost compared to conventional systems.
Internal rate of return (IRR) of this project is calculated on the condition of the Table 2 and the Table 3.

Table 2 Precondition of Internal Rate of Return (IRR) calculation

| Items | Value | Unit | Remarks |
|---|---|---|---|
| Initial investment | 5.45 | Million USD | Estimated plant data |
| Total maintenance cost | 0.08 | Million USD | Estimated plant data |
| Desulfurizer exchange cost | 0.31 | Million USD | Estimated plant data |
| Manpower cost | 0.02 | Million USD | Estimated plant data |
| Monitoring cost | 0.01 | Million USD | Estimated plant data |
| Electric power selling price | 2.67 | Baht/kWh | VSPP Tariff Calculation |
| Generated electric power at generator output | 1,200 | kWe | Jenbacher energiesisteme AG will be used and the model is J420 GS-B.L equivalency |
| Total power generation in the year | 8,984 | MWh/yr | Estimated plant data |
| GHG emission reduction | 40,826 | t $CO_2$e | Refer to Section B.6.4 |
| CERs price | 20 | US$/t $CO_2$e | - |
| Project operational lifetime and crediting period | 10 | Years | Refer to Section C |

Table 3 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 | 2010 | year | - |
| Depreciation taxable | 0.545 | Million USD | Equipment cost and design expense |
| Depreciation period | 10 | years | Min. 5 years |
| Depreciation method and rate | fixed installment method, 10% | - | Fixed installment method is general in Thailand. |
| Salvage value | 0 | % | Salvage value is zero. |
| Price inflation rate | 0 | % | It isn't considered for the IRR calculation. |
| Exchange rate (Baht□USD) | 33.74 | Baht/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 4.

Table 4 Project IRR (After-tax)

| | without CERs | with CERs | Expected Rate of Return |
|---|---|---|---|
| Project IRR | -12.1 % | 10.6 % | 5.14 %[2] |

IRR estimates indicate that the rate of return, -12.1 % is lower value the Expected Rate of Return if CERs revenue are not taken into account. These estimates do not take into account the risk associated with the operation of the plant to capture methane. Thus, it is clear that the project's IRR is not attractive for investment, particularly when considering the expected rate of return in Thailand, which is 5.14%. This adequately demonstrates that the project cannot proceed on a business-as-usual basis.

Technology barrier

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

The scenario 2 of aerobic treatment (activated sludge or filter bed type treatment) is new type installation in Thailand.
However, it is not almost used on a commercial scale.
It involves potentially lower risks than the ADI-Digester treatment, but it is not regarded as the optimum technology in Thailand.

The scenario 3 of the proposed project activity can be divided into three components.
* Pretreatment of the wastewater,
* Methane extraction using a digester,
* Biogas Utilization for gas engine

All operating parameters for the pretreatment component need to be maintained at the right level for the reactor to receive quality feedstock. In any cases, inappropriate maintenance of operating conditions in pretreatment poses significant risks to the successful generation of methane. The ADI-Digester is critical equipment, which forces methane generation. The operating conditions need to be carefully maintained for efficient operation of the reactor. Owing to such inherent risks and non-availability of appropriate technologies adequately addressing all operation and maintenance issues, ADI-Digester has not been the most preferred choice for wastewater treatment in the country. Commonly available, simple, cost-effective technologies using either anaerobic or aerated lagoons have been the adopted ones in several places.
Therefore, it could be concluded that the ADI-Digester technology reasonably poses significant risks in operation and maintenance in relation to its simple counterparts.

Barrier due to prevailing practice

[2] Bank of Thailand (2007): Economic data, Table 29 : Interest Rates in Financial Market, http://www.bot.or.th/bothomepage/databank/EconData/EconFinance/tab29e.asp

Legal
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. Aerobic and anaerobic liquid waste treatment observe it on a current law (Industrial Effluent Standards) together and do not take an application of an additional rule.
Industrial Effluent Standards
* Notification of the Ministry of Industry No.2 B.E. 2539(1996) issue under the Factory Act B.E. 2535(1992).

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

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

Other barriers
It is considered that the current pond-based treatment (Scenario 1) is a standard operational baseline in Thailand and neighbouring areas. They have no positive experience of utilizing aerobic (Scenario 2) or anaerobic (Scenario 3) technology in Thailand. It is not assumed that the ordering priority of management for the technology is high.
The high-priority issue for most of business people in this sector is the management of wastewater release for keeping easily with local regulations. More ample scale of management resources is required for the capital intensive energy production. Therefore, it is assumed that digesting process is not given their prior attention.

Table 5 Summarized Results of Barrier Analysis

| Baseline Alternative / Barrier Tested | Scenario 1: Continuity of the current practice | Scenario 2: Aerobic treatment | Scenario 3: Proposed project |
|---|---|---|---|
| Investment barrier | N | Y | Y |
| Technology barrier | N | Y/N | Y |
| Barrier due to prevailing practice | N | Y/N | Y/N |
| Other barriers | N | Y | Y |

The choice Y means that there are barriers; the choice N means that there is no barrier.

.

Addtionality Determination – Conclusion
Since the project activity that will use the ADI-Digester technology confronts investment, technical, barrier due to prevailing practice and other barriers while the current lagoon system does not, the baseline is confirmed as the continuation of current lagoon system practice and the Project is additional. And this adequately demonstrates that the project activity cannot proceed on a business-as-usual basis.

**B.6. Emission reductions:**

**B.6.1. Explanation of methodological choices:**

>>

The project follows the AMS-III.H. small scale methodology for Methane Recovery in Wastewater Treatment, Version 8, Scope 13 dated 14/12/2007.
In addition, the project follows the AMS-I.D. small scale methodology for Grid Connected Renewable Electricity Generation, Version 12, Scope 1 dated 10/8/2007.

Estimating the Baseline emissions:
The baseline emission is calculated as follows:

1) Total Baseline Emission = $\underset{2)}{\underline{BE_y}} + \underset{3)}{\underline{BE_{grid}}}$

Where,
$BE_y$ = Baseline methane emission from an existing wastewater treatment in the year ($tCO_2e$)
$BE_{grid}$ = Baseline electricity generation emissions in the year ($tCO_2e$)

2) Baseline methane emission from an existing wastewater treatment in the year ($BE_y$)
The baseline emissions from the lagoons are estimated based on the Chemical Oxygen Demand (COD) of the effluent that would enter the lagoon in the absence of the project activity, the maximum methane producing capacity (Bo) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons.

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

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Volume of wastewater per day | $Q_{d,ww}$ | 450 | $m^3$/day | Estimated plant data alcohol plant design value<br>Actually this item will be monitored. |
| Operating days | D | 330 | Days | The annual average value of the factory results of 2006 |
| Volume of wastewater treated in the year | $Q_{y,ww}$ | 148,500 | $m^3$ | Calculated as<br>$Q_{y,ww} = Q_{d,ww} * D$ |

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture in the year | $COD_{y,ww,untreated}$ | 0.115 | tonnes/$m^3$ | Measured plant data |
| Methane producing capacity of the wastewater | $B_{o,ww}$ | 0.21 | kg $CH_4$/kg COD | IPCC default value, as per AMS-III.H. |
| Methane correction factor for the existing wastewater treatment system to which the sequential anaerobic treatment step is being introduced | $MCF_{ww,treatment}$ | 0.8 | - | IPCC default value MCF lower value for anaerobic deep lagoon (depth more than 2 metres) in AMS-III.H. table III.H.1. |
| Global warming potential for methane | GWP_CH4 | 21 | - | AMS-III.H. |

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

$BE_{grid} = EP_{BIO} * EF_{grid}$

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Electricity produced by the biogas generator unit for grid electricity replacement in the year | $EP_{BIO}$ | 8,984 | MWh | Calculated estimation plant data<br>1 (set) * 1,200 (kWe) * 24 (h) * 330 (Days)* 0.95 *0.995 = 8,984 (MWh)<br><br>Operation condition<br>* No. of set : 1 set<br>* Generator output : 1,200 kWe<br>* Operation hour : 24 h<br>* Operation day : 330 Days<br>* Accident factor : 5 %<br>* Transmission loss : 0.5 %<br><br>Actually this item will be monitored. |
| Emission factor of grid electricity | $EF_{grid}$ | 0.51 | kg $CO_2$e/kWh | As per AMS-I.D./ACM0002 |

**Power generation component**

1. Baseline electricity generation emissions
   The baseline for power generation is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg $CO_2e$/kWh) calculated in a transparent and conservative manner as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM0002. This is consistent with paragraph 9.(a) of AMS-I.D.

   In the project, the baseline emissions are calculated using the following formulae based on AMS-I.D.

   $$BE_{grid} = EP_{BIO} * EF_{grid} \quad (1)$$

   where:
   $BE_{grid}$ = Baseline electricity generation emissions in the year (t $CO_2e$)
   $EP_{BIO}$ = Electricity produced by the biogas generator unit for grid electricity replacement in the year (MWh)
   $EF_{grid}$ = Emission factor of grid electricity (kg $CO_2e$/kWh)

2. Baseline emission factor

   The OM and BM emissions factors shall be calculated and the baseline emission factor is to be identified by 50% weighted of both emission factors.

   $$EF_{grid} = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y} \quad (2)$$

   where:
   $w_{OM}$ = Weight of Operating Margin in the Combined Margin (fraction), 0.5 by default;
   $w_{BM}$ = Weight of Build Margin in the Combined Margin (fraction), 0.5 by default;
   $EF_{OM,y}$ = Emission factor of set of plants in the Operating Margin in the year ($tCO_2$/MWh);
   $EF_{BM,y}$ = Emission factor of set of plants in the Build Margin in the year ($tCO_2$/MWh).

3. Operating margin emission factor

   For the Operating Margin, ACM0002 allows four methods: (a) Simple OM, (b) Simple Adjusted OM, (c) Dispatch Data Analysis OM, or (d) Average OM. The first methodological choice, Dispatch Data Analysis OM, was not carried out due to data constraints. Therefore, the second methodological choice, the Simple OM is applied.

   The low-cost/must-run (LC/MR) resources include hydro and other sources.
   According to data reported by DEDE, Table 6 shows that the LC/MR resources constitute approximately 6.3 % of total national grid generation.

The Simple OM method (a) can only be used where low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term normals for hydroelectricity production.
Hence the Simple OM can be applied.

Table 6 National grid generation by energy source, 2002-2006 ($10^3$ MWh)[1,2]

| Year | Hydro | Fuel Oil | Diesel Oil | Coal & Lignite | Natural Gas | Others[3] | Total | LC/MR | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | $10^3$ MWh | % |
| 2002 | 7,471 | 2,616 | 168 | 16,652 | 69,538 | 2 | 96,447 | 7,473 | 7.7 |
| 2003 | 7,299 | 2,941 | 180 | 16,807 | 76,332 | 2 | 103,561 | 7,301 | 7.0 |
| 2004 | 6,040 | 7,138 | 551 | 17,993 | 80,489 | 2 | 112,213 | 6,042 | 5.4 |
| 2005 | 5,798 | 8,244 | 414 | 18,334 | 85,703 | 2 | 118,495 | 5,800 | 4.9 |
| 2006 | 8,125 | 8,350 | 143 | 22,051 | 86,339 | 3 | 125,011 | 8,128 | 6.5 |
| Average | | | | | | | | | 6.3 |

Source: Electricity Power in Thailand 2006, p. 21.
Notes:
1 Excluding generation from SPP and VSPP generated from renewable and conventional energy amounting to 13,731 GWh.
2 Excluding private generation for own use.
3 Including geothermal, solar cell, wind turbine, etc.

The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated as the generation-weighted average emissions per electricity unit ($tCO_2/MWh$) of all generating sources serving the system, not including low-operating cost and must-run power plants. The calculation is a 3-year average based on most recent statistics available at the time. The formula used is shown below.

$$EF_{OM,y} = EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y}.COEF_{i,j}}{\sum_{j} GEN_{j,y}} \quad (3)$$

where:
$F_{i,j,y}$ = Amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y*, *j* refers to the power sources delivering electricity to the grid, not including low-operating cost and mustrun power plants, and including imports to the grid;
$COEF_{i,j}$ = $CO_2$ emission coefficient of fuel *i*, taking into account the carbon content of the fuels used by relevant power sources *j* and the percent oxidation of the fuel in year(s) *y* ($tCO_2$/mass or volume unit);
$GEN_{j,y}$ = Electricity delivered to the grid by source *j* (MWh).

The $CO_2$ emission coefficient ($COEF_i$) is obtained as

$$COEF_i = NCV_i * EF_{CO2,i} * OXID_i \quad (4)$$

where:
$NCV_i$ = Net calorific value (energy content) per mass or volume unit of a fuel *i*,
$EF_{CO2,i}$ = $CO_2$ emission factor per unit of energy of the fuel *i*.
$OXID_i$ = Oxidation factor of the fuel,

The list of default values and it sources is shown in Table 7.

Table 7 Other input parameters for the grid emission factor calculation

| Fuel Type | Net calorific value (NCV)[1] | | Carbon Emission Factor[2] tC/TJ | Oxidation Factor[3] % |
|---|---|---|---|---|
| | TJ/unit | $10^3$ Btu/unit | | |
| Natural Gas (dry) | 1.02 | 970,000 | 15.3 | 1 |
| Fuel Oil | 39.77 | 37,700,000 | 21.1 | 1 |
| Lignite | 10.47 | 9,920,000 | 27.6 | 1 |
| Diesel Oil | 36.42 | 34,520,000 | 20.2 | 1 |
| Mass Conversion Factor C to $CO_2$ | | | | 44/12 |

Notes:
1 Adopted from Electric Power in Thailand 2006, p. 44. Also note that the value of Lignite is based on Mae Moh site.
2 Adopted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 2, Table 1-4, p. 1.23.
3 Adopted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 2, Table 1-4, p. 1.23.

Table 8 demonstrates the $CO_2$ emission coefficient (Equation (4)) of each fuel type computed from the default values shown in Table 7.

Table 8 $CO_2$ emission coefficient of each fuel type

| Fuel Type | $CO_2$ emission coefficient COEF | Unit |
|---|---|---|
| Natural Gas (dry) | 57.22 | $tCO_2$/m $ft^3$ |
| Fuel Oil | 3076.87 | $tCO_2$/m litres |
| Lignite | 1059.56 | $tCO_2$/k tonnes |
| Diesel Oil | 2697.51 | $tCO_2$/m litres |

Table 9 shows the Grid generation, fuel usage and $CO_2$ emission from the system, 2004-2006. According to the methodology, electricity imports from other countries should be included in the calculation with 0 $tCO_2$/MWh, whereas electricity exports should not be subtracted.

Table 9 Grid generation, fuel usage and $CO_2$ emission from the system (excl. SPPs), 2004-2006

| Fuel Type | Fuel Usage[1] | | Generation[1] GEN | $CO_2$ emissions[2] F * COEF | $CO_2$ emission per unit[3] (F * COEF)/GEN |
|---|---|---|---|---|---|
| | F | Unit | MWh | $tCO_2$ | $tCO_2$ / MWh |
| 2004 | | | | | |
| Natural Gas | 724,560 | m ft$^3$ | 80,489,000 | 41,460,772 | 0.52 |
| Fuel Oil | 1,697 | m litres | 7,138,000 | 5,218,448 | 0.73 |
| Lignite | 16,537 | k tonnes | 17,993,000 | 17,521,944 | 0.97 |
| Diesel Oil | 120 | m litres | 551,000 | 323,701 | 0.59 |
| Import | - | | 3,388,000 | 0 | 0 |
| Total | | | 109,559,000 | 64,527,866 | **0.59** |
| 2005 | | | | | |
| Natural Gas | 764,118 | m ft$^3$ | 85,703,000 | 43,724,360 | 0.51 |
| Fuel Oil | 1,996 | m litres | 8,244,000 | 6,141,433 | 0.74 |
| Lignite | 16,571 | k tonnes | 18,334,000 | 17,557,969 | 0.96 |
| Diesel Oil | 83 | m litres | 414,000 | 223,893 | 0.54 |
| Import | - | | 4,419,000 | 0 | 0 |
| Total | | | 117,114,000 | 67,647,655 | **0.58** |
| 2006 | | | | | |
| Natural Gas | 857,103 | m ft$^3$ | 86,339,000 | 49,045,148 | 0.57 |
| Fuel Oil | 2,030 | m litres | 8,350,000 | 6,246,046 | 0.75 |
| Lignite | 17,166 | k tonnes | 22,051,000 | 18,188,407 | 0.82 |
| Diesel Oil | 41 | m litres | 143,000 | 110,598 | 0.77 |
| Import | - | | 5,159,000 | 0 | 0 |
| Total | | | 122,042,000 | 73,550,199 | **0.60** |

Notes:
1 Adopted from Electric Power in Thailand 2006, p. 21, 23, 25.
2 Emissions from coal and lignite usage are calculated based on $CO_2$ emission coefficient of lignite for conservative.
3 The emission factor of electricity imported from other countries is 0 $tCO_2$/MWh, as stated in ACM0002.

From the Table 9, the 3-year average OM emission factor of the years 2004-2006 is 0.59 as shown in Table 10.

Table 10 OM emission factors, 2004-2006

| Year y | Total Supply MWh | $CO_2$ Emissions $tCO_2$ | OM Emission Factor $tCO_2$ / MWh |
|---|---|---|---|
| 2004 | 109,559,000 | 64,527,866 | 0.59 |
| 2005 | 117,114,000 | 67,647,655 | 0.58 |
| 2006 | 122,042,000 | 73,590,199 | 0.60 |
| **Average** | | | **0.59** |

4. Build margin emission factor

The Build Margin is calculated as the generation-weighted average emission factor of a sample of power plants *m*, as follows.

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y.} COEF_{i,m}}{\sum_{m} GEN_{m,y}} \qquad (5)$$

Where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the simple OM method above for plants *m*.

where:

$F_{i,m,y}$ = Amount of fuel consumed by sample group *m* in year *y*, where sample group *m* consists of either the five power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently;

$COEF_{m,j}$ = $CO_2$ emission coefficient of fuel *i*, used in sample group *m* ($tCO_2$/mass or volume unit);

$GEN_{m,y}$ = Electricity delivered to the grid by sample group *m* (MWh).

This PDD chose option 1 among option 1 and 2.

*Option 1*. Calculate the Build Margin emission factor $EF_{BM,y}$ *ex-ante* based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. The sample group *m* consists of either the five power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently. Project participants should use from these two options that sample group that comprises the larger annual generation.

Table 11 show the list of Data for Build Margin, sourced from DEDE and EPPO.

According to "Electricity Power in Thailand 2005", total generation was 118,495 GWh for 2005, the latest year for which data is publicly available, 20 % of 118,495 GWh is 23,699 GWh. 24,574 GWh of the sample group is larger than 20%.

Table 11 Data for Build Margin, sourced from DEDE and EPPO

| Plant name | Commissioning Date | Fuel type | Generation (GWh) | Efficiency | Fuel Consumption (TJ) |
|---|---|---|---|---|---|
| EPEC | 25-Mar-03 | Natural Gas | 1,922 | 7,083 | 14,363 |
| Grow | 31-Jan-03 | Natural Gas | 4,298 | 6,850 | 31,062 |
| Ratchaburi | 18-Apr-02, 1-Nov-02 | Natural Gas | 12,315 | 7,262 | 94,355 |
| SPP-collective | post 28-Oct-00 | Renewable | 1,236 | - | 0 |
| SPP-collective | post 28-Oct-00 | Natural Gas | 1,352 | - | 9,386 |
| Ratchaburi | 22-Oct-00 | Natural Gas | 3,451 | 10,110 | 36,810 |
| Total | | | 24,574 | | 185,976 |

Therefore, the BM emission factor equals to 0.42 as shown in Table 12.

Table 12 BM emission factor in 2003

| Fuel Type | Generation GEN | Fuel Used | | $CO_2$ Emission Coefficient COEF | $CO_2$ Emissions |
|---|---|---|---|---|---|
| | MWh | F | Unit | $tCO_2$/kt | $tCO_2$ |
| Natural Gas | 23,338,000 | 3874.3 | kt | 2692.80 | 10,432,754 |
| Renewable Energy | 1,236,000 | - | - | - | - |
| Total | 24,574,000 | 3874.3 | kt | - | 10,432,754 |
| **BM** | | | | | **0.42** |

Estimating the Project emissions:

The project activity emission is calculated using the following:

Due to the project activity, the emission will be from the electricity used for the project, emission through treated wastewater, emission through the final sludge produced, emission through capture and flare system and emission through dissolved methane in treated wastewater.

$$PE_y = \underset{4)}{\underline{PE_{y,power}}} + \underset{5)}{\underline{PE_{y,ww,treated}}} + \underset{6)}{\underline{PE_{y,s,final}}} + \underset{7)}{\underline{PE_{y,fugitive}}} + \underset{8)}{\underline{PE_{y,dissolved}}}$$

Where,

$PE_y$ : Project activity emissions in the year ($tCO_2e$)

$PE_{y,power}$ : Emissions from electricity or diesel consumption in the year ($tCO_2e$)

$PE_{y,ww,treated}$ : Emissions from degradable organic carbon in treated wastewater in the year ($tCO_2e$)

$PE_{y,s,final}$ : Emissions from anaerobic decay of the final sludge produced in the year ($tCO_2e$)

$PE_{y,fugitive}$ : Emissions from methane release in capture and flare systems in the year ($tCO_2e$)

$PE_{y,dissolved}$ : Emissions from dissolved methane in treated wastewater in the year ($tCO_2e$)

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

$$PE_{y,power} = EP_{comsumed} * EF_{comsumed}$$

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Electricity consumed by project activity facilities in the year | $EP_{comsumed}$ | 825 | MWh | Estimation plant data<br><br>Actually this item will be monitored. |
| Emission factor of electricity consumed | $EF_{comsumed}$ | 0.51 | kg $CO_2e$/kWh | As per AMS-I.D./ACM0002 |

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

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

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Volume of wastewater treated in the year | $Q_{y,ww}$ | 148,500 | $m^3$ | |
| Chemical oxygen demand of the treated wastewater in the year | $COD_{y,ww,treated}$ | 0.0345 | tonnes/$m^3$ | Estimated plant data<br><br>Actually this item will be monitored. |
| Methane producing capacity of the wastewater | $B_{o,ww}$ | 0.21 | kg $CH_4$/kg COD | |
| Methane correction factor based on type of treatment and discharge pathway of the wastewater (fraction) | $MCF_{ww,final}$ | 1.0 | - | IPCC default value MCF high value for anaerobic deep lagoon (depth more than 2 metres) in AMS-III.H. table III.H.1 |
| Global warming potential for methane | GWP_CH4 | 21 | - | |

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

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

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Amount of final sludge generated by the wastewater treatment in the year | $S_{y,final}$ | 0 | tonnes | N/A (not envisaged)<br><br>Actually this item will be monitored. |
| Degradable organic content of the final sludge generated by the wastewater treatment in the year (fraction) | $DOC_{y,s,final}$ | 0.09 | - | IPCC default value for industrial sludge as per AMS-III.H. |
| Methane correction factor of the landfill that receives the final sludge | $MCF_{s,final}$ | 0 | - | The sludge will be given to farmers for land application. |
| Fraction of DOC dissimilated to biogas | $DOC_F$ | 0.5 | - | IPCC default value, as per AMS-III.H. |
| Fraction of $CH_4$ in landfill gas | F | 0.5 | - | IPCC default value, as per AMS-III.H. |
| Global warming potential for methane | GWP_CH4 | 21 | - | |

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

$PE_{y,fugitive} = \underset{7)-1}{\underline{PE_{y,fugitive,ww}}} + \underset{7)-2}{\underline{PE_{y,fugitive,s}}}$

Where,

$PE_{y,fugitive,ww}$ : Fugitive emissions through capture and flare inefficiencies in the anaerobic wastewater treatment in the year ($tCO_2e$)

$PE_{y,fugitive,s}$ : Fugitive emissions through capture and flare inefficiencies in the anaerobic sludge treatment in the year ($tCO_2e$)

7)-1

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

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment | $CFE_{ww}$ | 0.9 | - | As per AMS-III.H. for enclosed flares |
| Volume of wastewater treated in the year | $Q_{y,ww}$ | 148,500 | $m^3$ | |
| Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture in the year | $COD_{y,ww,untreated}$ | 0.115 | tonnes/$m^3$ | |
| Methane producing capacity of the wastewater | $B_{o,ww}$ | 0.21 | kg $CH_4$/kg COD | |
| Methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion | $MCF_{ww,treatment}$ | 1.0 | - | IPCC default value MCF high value for anaerobic deep lagoon (depth more than 2 metres) in AMS-III.H. table III.H.1 |
| Global warming potential for methane | GWP_CH4 | 21 | - | |

7)-2

$PE_{y,fugitive,s} = (1 - CFE_s) * S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * 16/12 * MCF_{s,treatment} * GWP\_CH4$

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Capture and flare efficiency of the methane recovery and combustion equipment in the sludge treatment | $CFE_s$ | 0.9 | - | IPCC default value, as per AMS-III.H. |
| Amount of untreated sludge generated in the year | $S_{y,untreated}$ | 0 | tonnes | Project design<br>No sludge treatment occurs. |

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Degradable organic content of the untreated sludge generated in the year (fraction) | $DOC_{y,s,untreated}$ | 0.09 | - | |
| Fraction of DOC dissimilated to biogas | $DOC_F$ | 0.5 | - | |
| Fraction of $CH_4$ in landfill gas | F | 0.5 | - | |
| Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion | $MCF_{s,treatment}$ | 1.0 | - | IPCC default value MCF high value for anaerobic deep lagoon (depth more than 2 metres) in AMS-III.H. table III.H.1 |
| Global warming potential for methane | GWP_CH4 | 21 | - | |

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

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

| Description | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Volume of wastewater treated in the year | $Q_{y,ww}$ | 148,500 | $m^3$ | |
| Dissolved methane content in the treated wastewater | $[CH4]_{y,ww,treated}$ | 10e-4 | $tonnes/m^3$ | AMS-III.H. default value for anaerobic treatment |
| Global warming potential for methane | GWP_CH4 | 21 | - | |

<u>Leakage:</u>
As per AMS-I.D., paragraph 12 and AMS-III.H., paragraph 8:
No leakage calculation is required since the equipment is not being transferred to or from another activity.

<u>Emission Reduction:</u>
$ER_y$ = Total Baseline emission - (Total $PE_y$ + Total $Leakage_y$)
$ER_y$ = Emission Reduction in the year ($tCO_2e$)

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

*(Copy this table for each data and parameter)*

| **Data / Parameter:** | **$EF_{grid}/EF_{consumed}$** |
|---|---|
| Data unit: | t $CO_2e/MWh$ |
| Description: | Emission factor of grid electricity/electricity consumed |
| Source of data used: | EGAT, DEDE, EPPO, IPCC |
| Value applied: | 0.51 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | As per AMS-I.D./ACM0002 |
| Any comment: | See Sections B.6.1. and B.6.3. for details. |

| **Data / Parameter:** | **$S_{y,untreated}$** |
|---|---|
| Data unit: | t |
| Description: | Amount of untreated sludge generated annually |
| Source of data used: | Project design |
| Value applied: | 0 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Visual confirmation by DOE.<br>$PE_{y,fugitive,s}$ is not relevant, as no sludge treatment occurs. |
| Any comment: | N/A |

| **Data / Parameter:** | **$MCF_{ww,final}$** |
|---|---|
| Data unit: | - |
| Description: | Methane correction factor based on type of treatment and discharge pathway of the wastewater |
| Source of data used: | IPCC default value for anaerobic decay of the untreated wastewater |
| Value applied: | 1.0 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | MCF higher value for anaerobic deep lagoon (depth more than 2 metres) in table III.H.1 is used. |
| Any comment: | The data is essential to determine the methane emission potential of the wastewater entering the treatment system during baseline and project emission estimations. |

| **Data / Parameter:** | **$MCF_{ww,treatment}$** |
|---|---|
| Data unit: | - |
| Description: | Methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion |
| Source of data used: | IPCC default value for anaerobic decay of the untreated wastewater |
| Value applied: | 0.8 for Baseline emission calculation<br>1.0 for Project emission calculation |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | If the depth of the open lagoons is more than 2 m, then the MCF lower value/higher value in table III.H.1 is used. |
| Any comment: | The data is essential to determine the methane emission potential of the wastewater entering the treatment system during baseline and project emission estimations. |

| **Data / Parameter:** | **$D_{lagoon}$** |
|---|---|
| Data unit: | m |
| Description: | Depth of ponding water (from the water surface to the bottom of the pond) |
| Source of data used: | Plant condition |
| Value applied: | > 7.0 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Based on plant condition |
| Any comment: | Essential to determine if the lagoons capable of anaerobic digestion in baseline. |

| **Data / Parameter:** | **$CFE_{ww}$** |
|---|---|
| Data unit: | % |
| Description: | Capture and Flare efficiency of the methane recovery and combustion equipment in the wastewater treatment |
| Source of data used: | Default value from UNFCCC methodological tool to determine project emissions from flaring gases containing methane |
| Value applied: | 90 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Essential to calculate fugitive emissions through capture & flare inefficiencies in the anaerobic wastewater treatment. |
| Any comment: | Flame is detected on minute basis and flow rate of biogas is monitored continuously to use this default value. Enclosed flare is used. |

| **Data / Parameter:** | **$B_{o,ww}$** |
|---|---|

| | |
|---|---|
| Data unit: | kg $CH_4$/kg .COD |
| Description: | Methane producing capacity of the wastewater |
| Source of data used: | IPCC default value for domestic wastewater |
| Value applied: | 0.21 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The earlier default value of IPCC was 0.25. Taking in to account the uncertainty of this estimate and considering the fact that the above furnished value (0.21) has been established as the result of comprehensive discussions among the methodology panel as well as the CDM Executive Board, it is a conservative and transparent approach for the project participant to adopt this value for the methane producing capacity of the wastewater. |
| Any comment: | N/A |

**B.6.3 Ex-ante calculation of emission reductions:**

>>

Estimating the Baseline emissions:

The baseline emission is calculated as follows:

1) Total Baseline Emission = $\underline{BE_y}$ + $\underline{BE_{grid}}$

2) 3)

= 60,249 + 4,582 = 64,831 ($tCO_2e$)

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

The baseline emissions from the lagoons are estimated based on the Chemical Oxygen Demand (COD) of the effluent that would enter the lagoon in the absence of the project activity, the maximum methane producing capacity (Bo) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons.

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

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

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

$BE_{grid} = EP_{BIO} * EF_{grid}$

= 8,984 * 0.51 = 4,582 ($tCO_2e$)

**Power generation component**

Equation (2) where the weights $w_{OM}$ and $w_{BM}$, by default, are 50% as stated in ACM0002.

The baseline emission factor of Thailand's national electricity system is 0.51 as shown in Table 13.

Table 13 Baseline emission factor of Thailand's national electricity system in 2006

| | Weight | Emission Factor |
|---|---|---|
| OM | 0.5 | 0.59 |
| BM | 0.5 | 0.42 |
| **Baseline** | | **0.51** |

Estimating the Project emissions:

The project activity emission will be calculated using the following:

Due to the project activity, the emission will be from the electricity used for the project, emission through treated wastewater, emission through the final sludge produced, emission through capture and flare system and emission through dissolved methane in treated wastewater.

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

4) 5) 6) 7) 8)

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

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

$PE_{y,power} = EP_{comsumed} * EF_{comsumed}$

= 825 * 0.51= 421 ($tCO_2e$)

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

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

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

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

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

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

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

$PE_{y,fugitive} = \underline{PE_{y,fugitive,ww}} + \underline{PE_{y,fugitive,s}}$

7)-1 7)-2

= 678 ＋ 0 = 678 ($tCO_2e$)

7)-1

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

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

7)-2

$PE_{y,fugitive,s} = (1 - CFE_s) * S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * 16/12 * MCF_{s,treatment} * GWP\_CH4$

= (1 – 0.9) * 0 * 0.09 * 0.5 * 0.5 * 16/12 * 1.0 * 21 = 0 ($tCO_2e$)

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

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

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

<u>Leakage:</u>

As per AMS-I.D., paragraph 12 and AMS-III.H., paragraph 8:
No leakage calculation is required since the equipment is not being transferred to or from another activity.

<u>Emission Reduction:</u>

$ER_y$ = Total Baseline emission - (Total $PE_y$ + Total $Leakage_y$)

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

= 40,826 ($tCO_2e$)

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

>>

| Year | Estimation of project activity emissions ($tCO_2$ e) | Estimation baseline emissions ($tCO_2$ e) | Estimation of leakage ($tCO_2$ e) | Estimation of overall emission reductions ($tCO_2$ e) |
|---|---|---|---|---|
| Year 2010 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2011 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2012 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2013 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2014 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2015 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2016 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2017 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2018 | 64,831 | 24,005 | 0 | 40,826 |
| Year 2019 | 64,831 | 24,005 | 0 | 40,826 |
| Total (tonnes of $CO_2$ e) | 648,310 | 240,050 | 0 | 408,260 |

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

### B.7.1 Data and parameters monitored:

| **Data / Parameter:** | **D** |
|---|---|
| Data unit: | d |
| Description: | The number of days the alcohol plant is operating in a year. |
| Source of data to be used: | The date sheet of operation |
| Value of data | 330 |
| Description of measurement methods and procedures to be applied: | The data is based on the historical recorded data in the plant. |
| QA/QC procedures to be applied: | N/A |
| Any comment: | N/A |

| **Data / Parameter:** | $\mathbf{Q_{d,ww}}$ |
|---|---|
| Data unit: | $m^3/d$ |
| Description: | Volume of wastewater treated per day |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | 450 |
| Description of measurement methods and procedures to be applied: | The data is measured continuously and the measurements are taken using flow meters electronically. |
| QA/QC procedures to be applied: | The flow meter undergoes maintenance / calibration subject to appropriate industry standards. |
| Any comment: | Used for the project emission and baseline emissions calculation. |

| **Data / Parameter:** | $\mathbf{Q_{y,ww}}$ |
|---|---|
| Data unit: | $m^3$ |
| Description: | Volume of wastewater treated in the year |
| Source of data to be used: | Calculated |
| Value of data | 148,500 |
| Description of measurement methods and procedures to be applied: | Calculated as $Q_{y,ww} = Q_{d,ww} * D$ |
| QA/QC procedures to be applied: | The flow meter undergoes maintenance / calibration subject to appropriate industry standards. |
| Any comment: | Used for the project emission and baseline emissions calculation. |

| **Data / Parameter:** | **$COD_{y,ww,untreated}$** |
|---|---|
| Data unit: | $t/m^3$ |
| Description: | Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture |
| Source of data to be used: | On-site sampling/off-site analysis (Onsite Technicians/Workers) |
| Value of data | 0.115 |
| Description of measurement methods and procedures to be applied: | Sampling shall be done on-site and analysis is carried out the off -site lab adhering to internationally accepted standards and archived electronically. Monthly average values are used for the estimation of emissions. |
| QA/QC procedures to be applied: | The data are cross-checked with samples analyzed by a external accredited laboratories once in 3 months. |
| Any comment: | N/A |

| **Data / Parameter:** | **$COD_{y,ww,treated}$** |
|---|---|
| Data unit: | $t/m^3$ |
| Description: | Chemical oxygen demand of the treated wastewater leaving the new anaerobic digester system |
| Source of data to be used: | On-site sampling/off-site analysis (Onsite Technicians/Workers) |
| Value of data | 0.0345 |
| Description of measurement methods and procedures to be applied: | Sampling shall be done on-site and analysis is carried out the off -site lab adhering to internationally accepted standards and archived electronically. Monthly average values are used for the estimation of emissions. |
| QA/QC procedures to be applied: | The data are cross-checked with samples analyzed by a external accredited laboratories once in 3 months. |
| Any comment: | N/A |

| **Data / Parameter:** | **$EP_{comsumed}$** |
|---|---|
| Data unit: | MWh |
| Description: | Electricity consumed by project activity facilities in the year |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | 825 |
| Description of measurement methods and procedures to be applied: | Electricity is to be continuously metered through the use of an electricity meter. The meter is maintained regularly, and measurement precision is secured. The reading of the meter is double-checked. |
| QA/QC procedures to be applied: | Electricity meters undergo maintenance/calibration according to domestic or International Standards (IEC521 or equivalent). |
| Any comment: | The data is used to determine the emissions arising from electricity consumption. |

| **Data / Parameter:** | **$EP_{BIO}$** |
|---|---|
| Data unit: | MWh |
| Description: | Electricity produced by the biogas generator unit for grid electricity replacement in the year |
| Source of data to be used: | Onsite Technicians/Workers/PEA |
| Value of data | 8,984 |
| Description of measurement methods and procedures to be applied: | Electricity is to be continuously metered through the use of an electricity meter. The meter is maintained regularly, and measurement precision is secured. The reading of the meter is double-checked.<br>The wattmeter is proofreaded for the precision security of the purchase electric energy every year by an electricity supply of electric power supplier. |
| QA/QC procedures to be applied: | Electricity meters undergo maintenance/calibration according to domestic or International Standards (IEC521 or equivalent). |
| Any comment: | The data is used to determine the emissions by electricity connected to the grid. |

| **Data / Parameter:** | **$T_{flare}$** |
|---|---|
| Data unit: | °C |
| Description: | Temperature of the exhaust gas from flare |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | - |
| Description of measurement methods and procedures to be applied: | Measurement of temperature of the exhaust gas stream in the flare electronically. A temperature of above 500 °C indicates that a significant amount of gases are still being burnt and that the flare is operating. |
| QA/QC procedures to be applied: | The flame detectors are kept serviced as per manufacturer's recommendation as and when required. |
| Any comment: | N/A |

| **Data / Parameter:** | **$T_{flare\_time}$** |
|---|---|
| Data unit: | min/h |
| Description: | Duration of sustenance of 500 °C in flare |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | - |
| Description of measurement methods and procedures to be applied: | An electronic flame detector will be used to determine the minutes in each hours for which the temperature of 500 °C occurs in a closed flare. |
| QA/QC procedures to be applied: | The temperature duration monitors are kept serviced as per manufacturer's recommendation as and when required. |
| Any comment: | Only applicable in the case of use of a default value. |

| Data / Parameter: | $S_{y,final}$ |
|---|---|
| Data unit: | t |
| Description: | Quantity of sludge removed from the treatment system and its application such as in farms, plantations, etc. in the year |
| Source of data to be used: | Measurement of truck weight and application of the sludge<br>(Onsite Technicians/Workers) |
| Value of data | - |
| Description of measurement methods and procedures to be applied: | Sludge removal and its application will be measured whenever the sludge is removed from the biogas reactor and open lagoon system, and a record will be maintained in the plant. |
| QA/QC procedures to be applied: | Measurement is carried out adhering to internationally recognized procedures. |
| Any comment: | N/A |

| Data / Parameter: | $T_{biogas}$ |
|---|---|
| Data unit: | ℃/K |
| Description: | Temperature of biogas combusted |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | N/A – this parameter is not relevant for the purpose of the *ex ante* estimation |
| Description of measurement methods and procedures to be applied: | The fraction of methane in the biogas will be measured either with a continuous analyzer, or with periodical measurements at a 95% confidence level. |
| QA/QC procedures to be applied: | The temperature meter will undergo maintenance / calibration subject to appropriate industry standards. |
| Any comment: | N/A |

| Data / Parameter: | $P_{biogas}$ |
|---|---|
| Data unit: | bar |
| Description: | Pressure of biogas combusted |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | N/A – this parameter is not relevant for the purpose of the *ex ante* estimation |
| Description of measurement methods and procedures to be applied: | The fraction of methane in the biogas will be measured either with a continuous analyzer, or with periodical measurements at a 95% confidence level. |
| QA/QC procedures to be applied: | The pressure gauge will undergo maintenance / calibration subject to appropriate industry standards. |
| Any comment: | N/A |

| **Data / Parameter:** | **$DOC_{y,s,final}$** |
|---|---|
| Data unit: | - |
| Description: | Degradable organic content of the final sludge generated by the wastewater treatment in the year |
| Source of data to be used: | AMS-III.H.<br>IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent |
| Value of data | 0.09 |
| Description of measurement methods and procedures to be applied: | This parameter will be monitored in the case that the sludge is not given to the farmers and disposed on-site, or if the end use cannot be monitored. |
| QA/QC procedures to be applied: | N/A |
| Any comment: | N/A |

| **Data / Parameter:** | **$MCF_{s,final}$** |
|---|---|
| Data unit: | - |
| Description: | Methane correction factor for soil application of the final sludge |
| Source of data to be used: | AMS-III.G. |
| Value of data | 0 |
| Description of measurement methods and procedures to be applied: | The farmers, the amounts and the dates of sludge delivery are verified through the statements of delivery or delivery records, so that the application to agricultural land under aerobic conditions is confirmed. |
| QA/QC procedures to be applied: | N/A |
| Any comment: | N/A |

| **Data / Parameter:** | **$V_{total}$** |
|---|---|
| Data unit: | $m^3$ at normal conditions |
| Description: | Biogas flow rate at digester outlet in the year |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | 5,406,999 |
| Description of measurement methods and procedures to be applied: | On-site metering using electronic continuous flow meters. The fraction of methane in the gas should be measured with a continuous analyzer or, alternatively, with periodical measurements at a 95% confidence level. |
| QA/QC procedures to be applied: | Flow meters undergo maintenance / calibration subject to appropriate industry standards. |
| Any comment: | N/A |

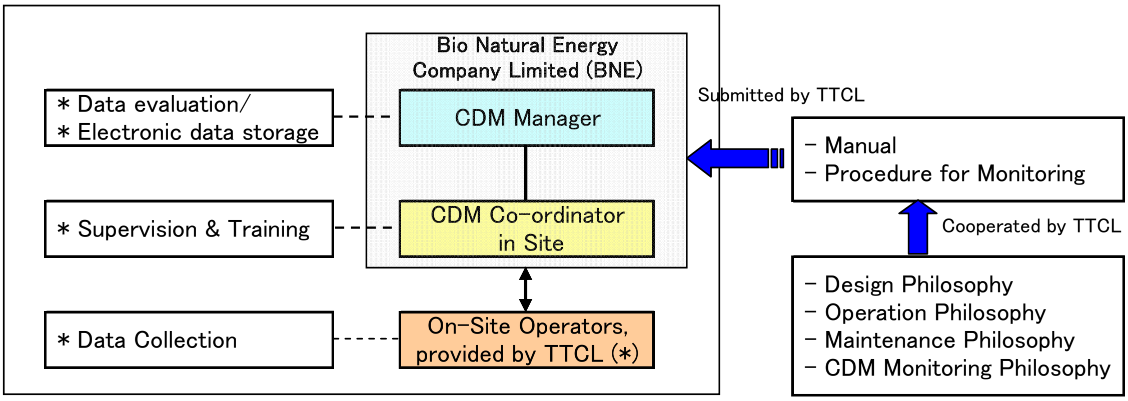
| Data / Parameter: | $V_{gene}$ |
|---|---|
| Data unit: | $m^3$ at normal conditions |
| Description: | Biogas flow rate at power generating unit inlet in the year |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | About 91 % of Biogas generated from the reactor |
| Description of measurement methods and procedures to be applied: | On-site metering using electronic continuous flow meters. The fraction of methane in the gas should be measured with a continuous analyzer or, alternatively, with periodical measurements at a 95% confidence level. |
| QA/QC procedures to be applied: | Flow meters undergo maintenance/calibration according to appropriate industry standards. |
| Any comment: | Used for project emissions and emissions reduction calculation. |

| Data / Parameter: | $V_{flare}$ |
|---|---|
| Data unit: | $m^3$ at normal conditions |
| Description: | Biogas flow rate into flare in the year |
| Source of data to be used: | Onsite Technicians/Workers |
| Value of data | About 9 % of Biogas generated from the reactor |
| Description of measurement methods and procedures to be applied: | On-site metering using electronic continuous flow meters. The fraction of methane in the gas should be measured with a continuous analyzer or, alternatively, with periodical measurements at a 95% confidence level. |
| QA/QC procedures to be applied: | Flow meters undergo maintenance/calibration according to appropriate industry standards. |
| Any comment: | Used for project emissions and emissions reduction calculation. |

| Data / Parameter: | $P_{CH4}$ |
|---|---|
| Data unit: | % |
| Description: | Biogas $CH_4$ content |
| Source of data to be used: | Actual measurement |
| Value of data | 65 |
| Description of measurement methods and procedures to be applied: | Electronic on-site sample analysis. At least quarterly Interval to satisfy statistical 95% confidence level. |
| QA/QC procedures to be applied: | Sampling is carried out, adhering to internationally recognized procedures. This is being carried out at least quarterly. |
| Any comment: | Used for project emissions and emissions reduction calculation. |

**B.7.2 Description of the monitoring plan:**

>>
All monitoring equipment will be installed and regularly calibrated for quality control by a reliable constructor (TTCL) with the appropriate industry standards.
Execution will be carried out by TTCL under the management of BNE (SPC), who will monitor, record and store relevant data. Such data will be made available to the DOE for verification in a transparent manner.
The operational and management structure for monitoring plan is summarized in the below diagram.




(*) In future, BHC's Existing Staffs will perform as an operator under management of BNE.

On-site staffs with appropriate knowledge and skills will be assigned by TTCL. Monitoring Manual and Procedure are provided by TTCL, respecting Design, Operational and Maintenance (O&M) Philosophy with CDM Monitoring Philosophy, and based on these philosophies, Data collection will be conducted by on-site operators under CDM Manager's Supervision. Data will be electrically transferred to BNE office, and Data evaluation will be conducted by CDM Manager and kept in BNE storage.

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

>>
Date of completion: 28/12/2007

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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:

>>
01/07/2008

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

>>
10 years and 0 month

### 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:

>>
Not applicable

##### C.2.1.2. Length of the first crediting period:

>>
Not applicable

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

>>
01/07/2010

##### C.2.2.2. Length:

>>
10 years and 0 month

## SECTION D. Environmental impacts

>>

### D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>

The environment impact analysis (EIA) for this project shall not be required under the National Environmental Quanlity Act (NEQA). EIA will be required only for more than 10MW electricity power producing project. The project produces only 1,200 kWe electricity power.
However, Initial Environmental Evaluation (IEE) was carried out due to the requirement of Thailand's DNA Office of National Resources and Environmental Policy and Planning (ONEP). IEE consists of the application to DNA Thailand.
In IEE, the following points were described in Thai language in accordance with Guideline for Preparing IEE by ONEP under Ministry of Natural Resources and Environmental (MONRE).

1. Social Aspect
    - Public participation
    - Support for local community development
    - Public health
2. Technology Aspect
    - Technology development
    - End of the project life
    - Training
3. Economic Aspect
    - Stakeholders' income
    - Energy (Renewable energy utilization)
    - Local content

The industrial effluent standard of this factory in Environmental Laws is BOD < 20 mg/l and COD < 120 mg/l. These lagoons are dredged once or twice a year, and final sludge is supplied as soil improvement for agriculture.
The project is designed to apply the anaerobic wastewater treatment unit (Digester) to the existing anaerobic lagoon pond in order that the methane gas emitted in the atmosphere may be recovered and utilized for the gas engine power generator.
Power generation system will consist of one (1) gas engine (1,200 kW net in Total) and produce electricity sold to the grid of PEA (Provincial Electricity Authority) in Thailand under very small power producer (VSPP) scheme. Power generation system fits the emission standard from New Power Plants. It will be subject to all of the related regulations.

Power plant using biomass (all sizes)

| Pollutants | Unit | Emission Standard Value |
|---|---|---|
| SOx as $SO_2$ at 7% $O_2$ | ppm | 60 |
| NOx as $NO_2$ at 7% $O_2$ | ppm | 200 |
| Particulate | $mg/m^3$ | 120 |

Source : Notification of the Ministry of Industry, Subject: Stack Emission Standard of Power Plant, B.E. 2547 (2004), published in the Royal Government Gazette, vol. 121, special part 113D, dated October 7, B.E. 2547 (2004).

This project observes the law by installing the denitrification device in the exhaust gas system.

**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 environment impact analysis (EIA) for this project shall not be required under Thailand's environmental laws.

In addition to the above, the project 's limiting environmental impacts and adding positive environmental impacts (alleviation of greenhouse gas emission and fuel reduction by the grid electric energy) are far more important than concerning negative environmental impacts. Negative environmental impacts from the digester and combustion system are negligible and their influences are not significant. Under Thailand's laws, no EIA or similar application is required for the project activity under normal circumstances. Application scales of EIA of a power station are more than generation capacity 10MW. However, the Thai DNA requires that an Initial Environmental Examination (IEE) is required for CDM projects.

## 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 investing country party (Japan) at the meeting held in August and September, 2007 when they visited in Thailand.

**E.2. Summary of the comments received:**

>>

The specific comments about the project are as follows:

* Thai Beverage PLC (TB)
  - ―As for biogas technology, though our company research pilot plant was introduced in 2 factory in the past, the amount of methane occurrence was small, and employment didn't go well. Therefore, it is requested that the technology of the outside of the office is adopted this time.
  - ―The technology of ADI is adopted, and our related company does purchase from the foreign countries, construction with methane fermentation system with the main machine (geo-membrane cover is contained.) with process engineering.
  - ―The BHC of the subsidiary company manages employment with the wastewater that it is discharged from the factory of the TB, and sludge, and it becomes a compost, and it is used as for sludge.
  - ―BHC will do an examination, and it will be advanced about biogas plant.

* Bionic Humus Co. (BHC)
  - The environment countermeasure that it faces a labor environment, a circumference inhabitant, and so on in each TB factory is taken, and it aims at taking in biogas as one of the business.
  - The implementation subject of this project is a TB persistently, and the power of decision is in the TB, too. Therefore, a TB has the power of decision to the CER purchase and sale as well.
  - BHC will do operation and control of this project.

* DEDE (Department of Alternative Energy Development and Efficiency)
  - The introduction of the energy project which can regenerate it is promoted.
  - Methane collection project is promoted as an effect use with the energy from the wastewater of the industry which exists in the Thai country in many as a CDM project.

**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 |
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| URL: | http://www.kanematsu.co.jp/ |
| Represented by: | President Yoshihiro Miwa |
| Title: | General Manager |
| Salutation: | Mr. |
| Last Name: | Gondaira |
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## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
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| E-Mail: | - |
| URL: | - |
| Represented by: | President Mr. Iriya Hironobu |
| Title: | President |
| Salutation: | Mr. |
| Last Name: | Iriya |
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**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

| | |
|---|---|
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| State/Region: | Bangkok |
| Postfix/ZIP: | 10900 |
| Country: | Thailand |
| Telephone: | - |
| FAX: | - |
| E-Mail: | - |
| URL: | - |
| Represented by: | Managing Director |
| Title: | - |
| Salutation: | Mr. |
| Last Name: | Phoopatana |
| Middle Name: | - |
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| Direct Tel: | +66-2-617-9500 |
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## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

Public funds are not invested in the project.

# Annex 3

## BASELINE INFORMATION

### Internal rate of return (IRR)

1) Without CERs

《Cash flow statement》 (Initial investment : 5.45 Million USD, Crediting period : 10 years, CERs price: 0 US$)

(Unit:Million USD)

| Profit-and-loss statement | | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sales | Electric generation income | | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 |
| | CERs | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | ＜Total＞ | | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 |
| Cost | Gas engine maintenance cost | | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| | ADI Systems maintenance cost | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Desulfurization Reactor maintenance cost | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Desulfurizer exchange cost | | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| | Manpower cost | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Monitoring cost | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | ＜Total＞ | | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |

| | | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depreciation | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Operating income | | | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 |
| Nonoperating expense | Interest cost | 0.0% | − | − | − | − | − | − | − | − | − | − |
| Current profits | | | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 |
| Corporation tax | Corporation tax etc. | 30% | − | − | − | − | − | − | − | − | − | − |
| Current income | | | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 |
| Cumulative profits | | | −0.3 | −0.6 | −0.9 | −1.2 | −1.5 | −1.8 | −2.1 | −2.4 | −2.7 | −2.9 |

| Cash flow statement | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Current profits | | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 | −0.3 |
| Depreciation | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total cash inflows | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Corporation tax etc. payment | | − | − | − | − | − | − | − | − | − | − |
| Repayment of borrowed money | | − | − | − | − | − | − | − | − | − | − |
| Total cash-out flow | | − | − | − | − | − | − | − | − | − | − |
| Cash flow | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

| Balance sheet | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Available assets(Excess funds) | | 0.3 | 0.5 | 0.8 | 1.0 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 |
| Fixed assets(Depreciation assets) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 |
| Total assets(Assets section) | | 5.7 | 6.0 | 6.2 | 6.5 | 6.7 | 7.0 | 7.2 | 7.5 | 7.7 | 8.0 |
| Borrowed money | | − | − | − | − | − | − | − | − | − | − |
| Total liabilities | | − | − | − | − | − | − | − | − | − | − |
| Capital | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 |
| Surplus | | 0.3 | 0.5 | 0.8 | 1.0 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 |
| Total shareholders' equity | | 5.7 | 6.0 | 6.2 | 6.5 | 6.7 | 7.0 | 7.2 | 7.5 | 7.7 | 8.0 |
| Total liabilities, shareholders' equity | | 5.7 | 6.0 | 6.2 | 6.5 | 6.7 | 7.0 | 7.2 | 7.5 | 7.7 | 8.0 |

| Break-even calculation | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| After-tax cash flow | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Accumulated after-tax cash flow | | 0.3 | 0.5 | 0.8 | 1.0 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 |
| Accumulated after-tax cash flow- Investment capital | | −5.2 | −4.9 | −4.7 | −4.4 | −4.2 | −3.9 | −3.7 | −3.4 | −3.2 | −2.9 |
| Internal rate of return [IRR] Excepted interest, after-tax ) | | | | | | #NUM! | | | | | −12.1% |
| (IRR calculation data) | −5.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Internal rate of return [IRR] (Excepted interest, before-tax) | | | | | | #NUM! | | | | | −12.1% |
| (IRR calculation data) | −5.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

| Setting item | | Setting item | | | |
|---|---|---|---|---|---|
| Salvage value | 0% | Electricity Cost | 2.67 Baht/kWh | = | 0.08 US$/kWh |
| Initial investment(Million USD) | 5.45 | CERs price | 0 US$/t CO2 | | |
| Depreciation(Million USD) | 0.545 | Exchange rate | 0.030 US$/Baht | | |
| Depreciation rate | 10% | | | | |

| Payout period | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | −5.5 | −5.2 | −4.9 | −4.7 | −4.4 | −4.2 | −3.9 | −3.7 | −3.4 | −3.2 | −2.9 | |
| | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0 | 1 | 11.0 year |
| Project income | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| Total power generation | MWh | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | |
| GHG emission reduction | t CO2 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | |

2) With CERs

《Cash flow statement》 (Initial investment : 5.45 Million USD, Crediting period : 10 years, CERs price: 20 US$)

(Unit:Million USD)

| Profit-and-loss statement | | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sales | Electric generation income | | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 | 0.71 |
| | CERs | | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| | ＜Total＞ | | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 | 1.53 |
| Cost | Gas engine maintenance cost | | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| | ADI Systems maintenance cost | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Desulfurization Reactor maintenance cost | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Desulfurizer exchange cost | | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| | Manpower cost | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Monitoring cost | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | ＜Total＞ | | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depreciation | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Operating income | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Nonoperating expense | Interest cost | 0.0% | – | – | – | – | – | – | – | – | – | – |
| Current profits | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Corporation tax | Corporation tax etc. | 30% | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Current income | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Cumulative profits | | | 0.4 | 0.7 | 1.1 | 1.5 | 1.8 | 2.2 | 2.6 | 2.9 | 3.3 | 3.6 |

| Cash flow statement | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Current profits | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Depreciation | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total cash inflows | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Corporation tax etc. payment | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Repayment of borrowed money | | – | – | – | – | – | – | – | – | – | – |
| Total cash-out flow | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Cash flow | | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |

| Balance sheet | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Available assets(Excess funds) | | 0.9 | 1.8 | 2.7 | 3.6 | 4.5 | 5.5 | 6.4 | 7.3 | 8.2 | 9.1 |
| Fixed assets(Depreciation assets) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 |
| Total assets(Assets section) | | 6.4 | 7.3 | 8.2 | 9.1 | 10.0 | 10.9 | 11.8 | 12.7 | 13.6 | 14.5 |
| Borrowed money | | – | – | – | – | – | – | – | – | – | – |
| Total liabilities | | – | – | – | – | – | – | – | – | – | – |
| Capital | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 |
| Surplus | | 0.9 | 1.8 | 2.7 | 3.6 | 4.5 | 5.5 | 6.4 | 7.3 | 8.2 | 9.1 |
| Total shareholders' equity | | 6.4 | 7.3 | 8.2 | 9.1 | 10.0 | 10.9 | 11.8 | 12.7 | 13.6 | 14.5 |
| Total liabilities, shareholders' equity | | 6.4 | 7.3 | 8.2 | 9.1 | 10.0 | 10.9 | 11.8 | 12.7 | 13.6 | 14.5 |

| Break-even calculation | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| After-tax cash flow | | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Accumulated after-tax cash flow | | 0.9 | 1.8 | 2.7 | 3.6 | 4.5 | 5.5 | 6.4 | 7.3 | 8.2 | 9.1 |
| Accumulated after-tax cash flow- Investment capital | | -4.5 | -3.6 | -2.7 | -1.8 | -0.9 | 0.0 | 0.9 | 1.8 | 2.7 | 3.6 |
| Internal rate of return [IRR] Excepted interest, after-tax ) | | | | | | -5.7% | | | | | 10.6% |
| (IRR calculation data) | -5.5 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Internal rate of return [IRR] (Excepted interest, before-tax) | | | | | | -0.7% | | | | | 14.5% |
| (IRR calculation data) | -5.5 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |

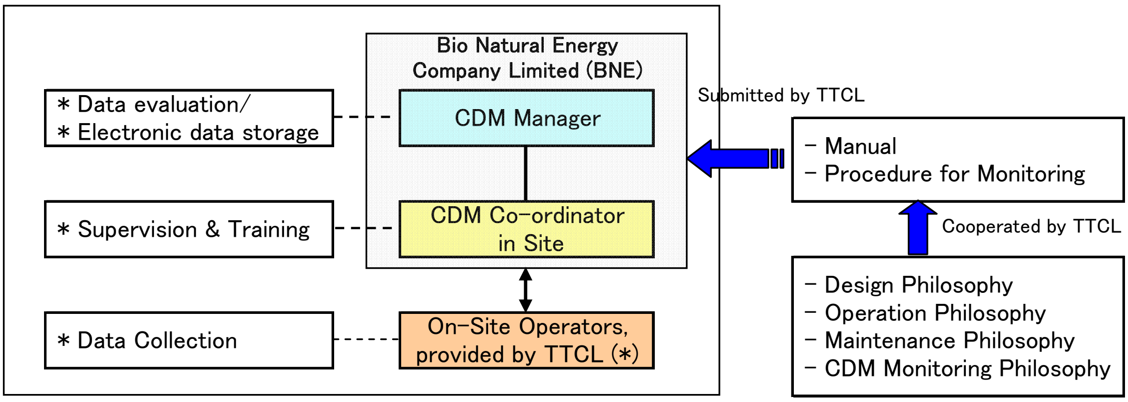
| Setting item | | Setting item | |
|---|---|---|---|
| Salvage value | 0% | Electricity Cost | 2.67 Baht/kWh = 0.08 US$/kWh |
| Initial investment(Million USD) | 5.45 | CERs price | 20 US$/t CO2 |
| Depreciation(Million USD) | 0.545 | Exchange rate | 0.030 US$/Baht |
| Depreciation rate | 10% | | |

| Payout period | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -5.5 | -4.5 | -3.6 | -2.7 | -1.8 | -0.9 | 0.0 | 0.9 | 1.8 | 2.7 | 3.6 | |
| | | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | |
| | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0.0 | 0 | 0 | 6.0 year |
| Project income | Fiscal year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| Total power generation | MWh | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | 8,984 | |
| GHG emission reduction | t CO2 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | 40,826 | |

## Annex 4

### MONITORING INFORMATION

All monitoring equipment will be installed and regularly calibrated for quality control by a reliable constructor (TTCL) with the appropriate industry standards.
Execution will be carried out by TTCL under the management of BNE (SPC), who will monitor, record and store relevant data. Such data will be made available to the DOE for verification in a transparent manner.
The operational and management structure for monitoring plan is summarized in the below diagram.




(*) In future, BHC's Existing Staffs will perform as an operator under management of BNE.

On-site staffs with appropriate knowledge and skills will be assigned by TTCL. Monitoring Manual and Procedure are provided by TTCL, respecting Design, Operational and Maintenance (O&M) Philosophy with CDM Monitoring Philosophy, and based on these philosophies, Data collection will be conducted by on-site operators under CDM Manager's Supervision. Data will be electrically transferred to BNE office, and Data evaluation will be conducted by CDM Manager and kept in BNE storage.

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