Feasibility study of wastewater treatment with anaerobic digester at starch processing plant in Tay Ninh, Vietnam

Report

Toshiba Corporation

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1. Fundamental subjects of the project

1.1 Background, overview and survey objectives of the project

The objects of this survey are to study the business feasibility and clarify the assignment for implementation of the CDM project, which contains the reduction of methane gases emitted from the existing lagoon of the tapioca starch processing plant and the reduction of green house gas emission followed by cutting of energy consumption of the plant.

1.2 Overview of Vietnam and the site

1.2.1 Overview of Vietnam

(1) Population[1]

According to the latest published information in 2006, the Vietnamese population is about 84.16 million and population density is 254 (no. of people/km^2). The ratio of Vietnamese (Kinh tribes) is 86% together with 53 minority races according to the government.

(2) Labor affairs

Labor population of Vietnam shows tendency of increasing, and it reaches 43 million in 2006. Although the ratio of the farm population is still high (the primary industry 56%, the service industry 25% and the manufacturing industry 19%), farm population is decreasing every year (23.2 million in 2002, 23 million in 2004 and 22.6 million in 2006). The unemployment rate keeps decreasing after a peak of 6.9% in 1998, and becomes 4.8% in 2006. [2]

(3) National economy

Table 1-1 Economic conditions of Vietnam in 2006

Main industry	**Agriculture forestry, fisheries and mining**
Per capita GDP	**US$835 (2007)**
Rate of economic growth	**8.5% (2007)**
Price rise index	**6.6%**
International trade amounts	**(1) Export US$39.82 billion** **(2) Import US$44.89 billion**
Major international trade articles	**(1) Export Crude oil, clothing, footwear, marine products** **(2) Import Machinery, facilities parts, oil products, textile goods**
Trading partners	**(1) Export U.S.A., Japan, Australia** **(2) Import China, Singapore, Taiwan**

[1] Cited from "General Statistics Office of Vietnam" HP, 2008
[2] Cited from "General Statistics Office of Vietnam" HP, 2008

Vietnam joined WTO as the 150th signatory in January 2007. As a result, the access to the market of the foreign capital becomes possible and the import duty is reduced, so an economic activity has been activated.

The minimum wage of the domestic and foreign capital enterprise in Vietnam was improved in January, 2008. In the highest region (Hanoi and Ho Chi Minh), the minimum monthly wage of the domestic enterprise became 620,000 VND of 38% rise and the foreign capital enterprises became one million VND of 15% rise.[3]

1.2.2 Electric enterprise in Vietnam

(1) Overview

In Vietnam, stabilized supply of electric energy is ranked as one of the most important task to support the sustainable growth of the social economy. The action plan concerning the electric power business in "Japan-Vietnam joint initiative" started up between two governments in 2003 mainly contains following topics; [4]

- Usual "Foreign capital entry ratio restriction" (20%) shall not be applied to the electric power field (Shall not provide even to the electric power method).
- "Industrial electricity cost" shall be improved to the level of not inferior to the surrounding country, and internal amends from industrial use to other usages (customer) shall be decreased.
- The continuous effort shall be made to achieve stable and high-quality (small voltage fluctuation) power supply.
- The development of the main power plant along "Electric power development master plan" shall be advanced on schedule.

(2) System of power supply[5]

Electricity is supplied by Electricity of Vietnam (EVN), including retailing enterprises. EVN is an integrated enterprise which has some subsidiary companies and makes the plan of electric power development and the electric rate revision, etc. The subsidiary companies are divided into the direct control enterprise that EVN own 100% and the independent profit enterprise of a joint method, and the direct control enterprise includes a central power control station, a power plant, a power transmission company and an energy laboratory. The independent profit enterprises are an electric power distribution company, an electric power facilities investigation/designing company and an electric power facilities manufacturer etc. The electric power systems include 500 kV transmission lines between north and south was constructed in 1994, to connect north, central and south region. The Tay Ninh Province in charge of this project is controlled by Power Company No. 2 (PC2).

3 Cited from “JETRO HP”, 2008
4 Cited from “Electric enterprise in overseas nations, Volume 1, Supplement version 2006” JEPIC, Dec 2006
5 Cited from “Electric enterprise in overseas nations, Volume 1, Supplement version 2006” JEPIC, Dec 2006

(3) Resources of electricity supply

Fig. 1-1 shows electricity supply resources. [6] Hydropower and gas turbines are used mainly for electricity supply, occupying about 60% of total electric power generated. The balance resources of about 30% include coal-fired thermal power and power generation systems by independent power producers.

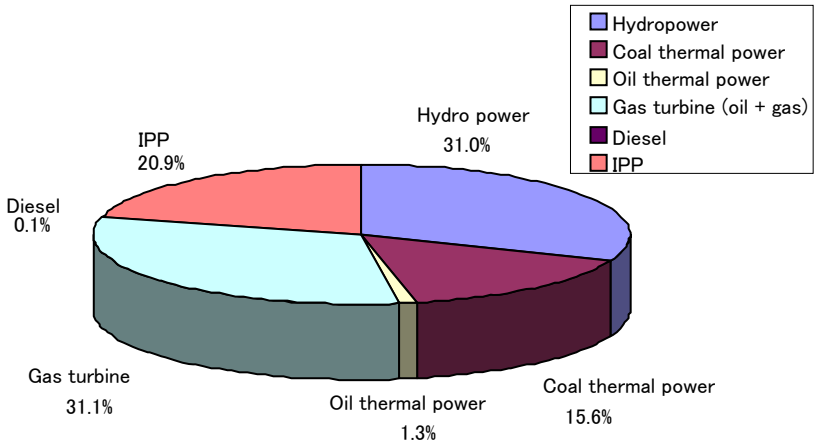

Fig. 1.1 Electricity supply resources in Vietnam

New energy technologies such as wind power, solar energy and geothermal energy are researched and developed in energy laboratory of EVN subsidiary. In many cases, the technologies are not profitable enough to attract the investor's attention at the present stage.

(4) Calculation of Carbon emission factor

Necessary information for operating margin and build margin that are used to calculate carbon emission factor (CEF) was collected by doing the hearing to EVN and the energy laboratory, and each CEF was calculated.

The standard value of the efficiency written in the CDM methodology tool was used for the calculation of CEF.

- CEF for the baseline calculation is estimated: $CEF_{grid\ BL}$ = 0.496 (kg-CO_2/kWh)
- CEF for the project calculation is estimated: $CEF_{grid\ PJ}$ = 0.412 (kg-CO_2/kWh)
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1.2.3 Present status of CDM in Vietnam[7,8]

(1) Background of CDM

The CDM operating organization of the Vietnamese government is composed as shown in Figure 1-2. The CDM National Executive and Consultative Board are held bimonthly (July, September, November and February) and the approval of CDM project is processed in there. In Vietnam, it takes about 50 days to receive LOA after applying

6Cited from "EVN Report 2004-2005"
7Cited from "Vietnam CDM project pipeline" ministry of natural resources and environment (international cooperation department) HA NOI, 2007
8Cited from "Information platform of Kyoto mechanism", 2008

PDD.

Cogeneration is added to the list of expected themes of developing and achieving the CDM project, shown in the last year.

There are 33 PDD approved by Vietnam DNA, and 27 of that is a hydro-power project according to the latest announcement of MONRE (2008). [9]

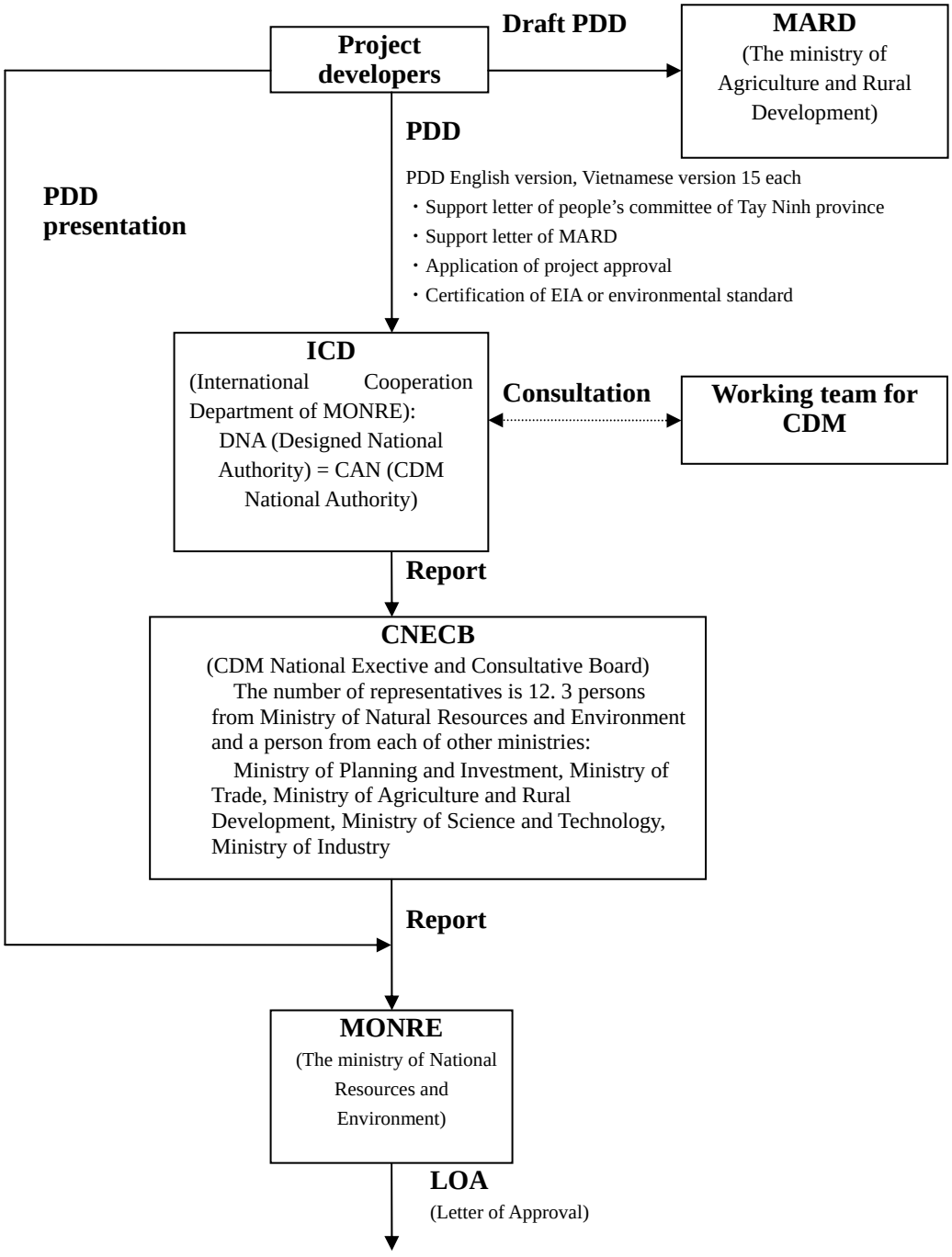

Fig. 1-2 CDM project approval procedures

9Cited from The latest CDM activities in Vietnam and opportunities for investment, MONRE, 19 Mar 2008

1.2.4 Present status of agriculture and cassava root production in Vietnam

(1) Present status of agriculture in Vietnam[10]

The proportion of the primary industry site including agriculture and forestry, etc. reaches as much as 25 million hectares among 33 million hectares of Vietnam country area, and the farmland is more than the half of the primary industry site. Tay Ninh province where the project is executed has proportion of farmland by 69% and it is eighth in 64 provinces.

(2) Information on the production of cassava root in Vietnam

The total production amount of cassava root in Vietnam has been steadily increasing up to now from 2000. In 2006, the production amount is 290% and planted acreage is twice of 2000. The production amount of Tay Ninh province is 1,119 thousand tons and planted acreage is 45 thousand hector, which is ranked top among other provinces. Tay Ninh province is sharing about 14.5% of the Vietnamese domestic production.

The amount of world production in 2006 is 226 million tons. Top three production countries are Nigeria (20.0%), Brazil (11.8%) and Thailand (10.0%). Vietnam is producing 3.4% of cassava root which is ranked seventh in the world.

(3) Present status of starch manufacturing[11]

The amount of the cassava starch export in a high-ranking country of the cassava production is 10,000 tons in Brazil, 1.29 million tons in Thailand, 3,000 tons in Indonesia, and 310,000 tons in Vietnam. Comparing to Brazil, Thailand exports a huge amount of cassava starch, though the production amount of the cassava root is higher in Brazil. The fact that Indonesia exports very little amount of the starch in spite of its production amount of the cassava root shows the first consumption of the cassava root is the main current of Indonesia and no effort is made for the production of starch. Vietnam exports comparatively large amount of the starch and most of the 310,000 tons are exported to China.

1.3 Survey operating organization

(1) Corporation responsible for the survey Toshiba Corporation

(2) Locale counterpart TRUONG THINH Co., Ltd. (TRUONG THINH)

The project operating site is a tapioca starch processing plant. In this survey project, the corporation and the counterpart administrate meetings with governmental authorities and other organizations, site surveys, facility planning work, and surveys operated by participating parties.

[10] Cited from "General Statistics Office of Vietnam" HP, 2008
[11] Cited from "World Trade Atlas", 2008

2 Details of project

2.1 Project overview

This project is aimed at reducing CO2 emissions out of fossil fuels and is performed at TRUONG THINH, a tapioca starch processing plant in the Tay Ninh province; the existing wastewater treatment facilities consisting of open lagoons is improved, and methane gas is recovered preliminarily, thereby reducing the gas emitted from the lagoon while utilizing collected methane gas as a resource of energy consumed in the plant.

2.2 Operating site

Outline of operating site

Name of operating site:
TRUONG THINH company

Address: Tay Ninh province,

Socialist Republic of Vietnam

Established: 2003

Production article: Tapioca starch

Production capacity: 150 t/day

Production amount: (Mean)1700 t/month

Fig. 2-1 Outlook of TRUONG THINH company

2.2.1 Existing wastewater treatment facilities

At present state, all wastewater from processing plant is treated by 4 open lagoons in TRUNG THINH. The lagoons directly receive wastewater in a very high pollution concentration, discharged from production processes, therefore, the interior of a lagoon is considered to be in an anaerobic environment; on the surface of a lagoon, a large amount of bubbles is observed, that may be created by methane gas.

Fig. 2-3 Lagoon of TRUONG THINH company

2.2.2 Types of produced wastewater

Two types of wastewater are produced from the plant; root cleaning wastewater and process drainage. The amount and quality of process wastewater, which is the object of this project is shown below.

Table 2-1 Amount and quality of wastewater (mean values)

Amount		438,358 m^3/yr
Quality	COD	16,807 mg/L
	BOD	10,863 mg/L

2.3 Facilities for project

This project is implemented by installing methane fermentation facilities, gas refining facilities and energy utilization facilities to the existing wastewater treatment system which consists of open lagoons.

Methane gas, collected in the methane fermentation facilities, is purified by removing impurities such as hydrogen sulfide by the gas refining facilities, and is used as a fuel of the boiler for the digester. The remaining biogas is used as a fuel of the gas engine generator which covers a part of the power consumption of the factory, and also is used as a fuel of the gas furnace which is used for starch production process, so the coal consumption of the existing coal heating furnace decreases. When these gas use equipments are not driven though the excess biogas is generated, the combustion processing is done by the flare.

Process flow of project facilities is shown in Fig.2-3.

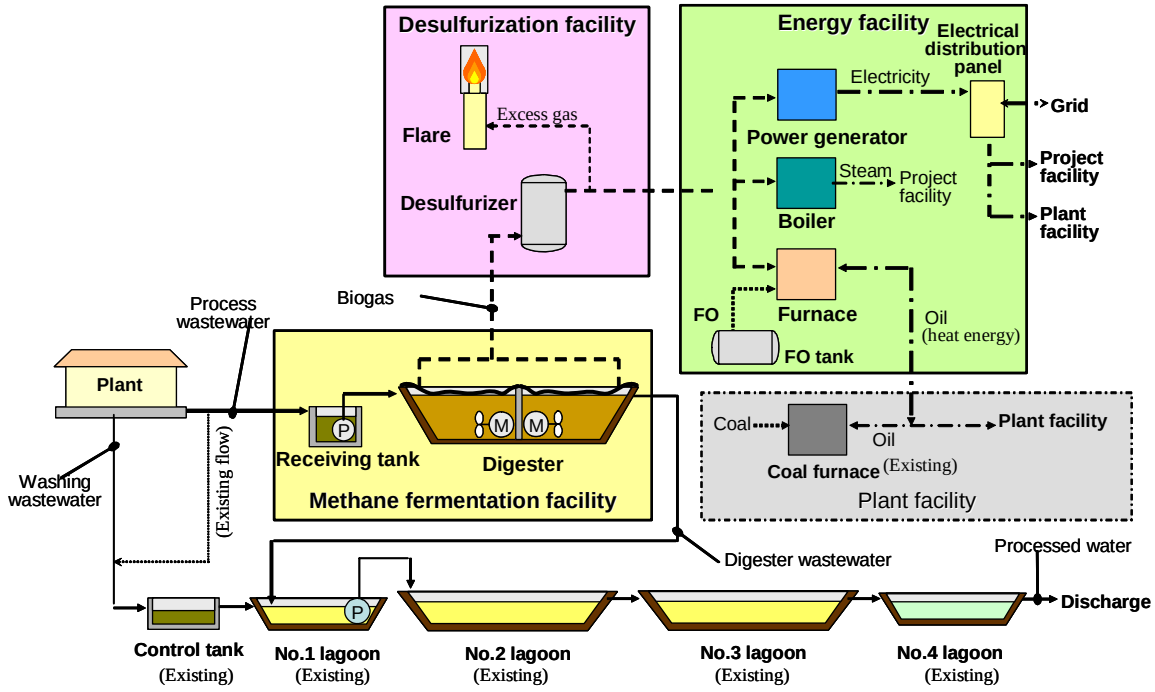

Fig. 2-3 Process flow of project facilities

2.4 Setting of baseline

2.4.1 Application of methodology

The following 3 approval methodologies are applied to this project from category III and I.

● Category III

・ AMS III.H. / Version 09 (Revised：EB38) (Methane recovery in wastewater treatment)

● Category I

・AMS I.C. / Version 13 (Revised：EB38) (Thermal energy for the user with or without electricity)

・AMS I.D. / Version 13 (Revised：EB36) (Grid connected renewable electricity generation)

This project is thought to be comparatively small scale project, so examined the approval methodology application of small-scale CDM. The change in the definition of small-scale CDM was agreed at the 26th conference in September 2006, and the latest coverage of small-scale CDM is shown in Table 2-2. As a result, it is confirmed that this project is in the following ranges, thus it is applicable to small-scale CDM.

Table 2-2 Coverage of small-scale CDM

Type	Category	Coverage
I	Renewable energy project	At most 15MW of electric generation
II	Energy efficiency improvement project	At most 60GWh/yr of reduction of energy consumption at supplier / consumer
III	Other project	Less than 60ktCO_2/yr of emission reduction

2.4.2 Identification of baseline

(1) Category III

A baseline scenario is ascertained based on AMS III.H.

Baseline scenario of this case is that the methane gas emission to the atmosphere from existing open lagoons which treat organic wastewater from the plant would have been continued in the absence of the project activity.

For this project, (iv) “the existing anaerobic wastewater treatment system without methane recovery and combustion” is chosen out of 6 baseline scenarios

(2) Category I

A baseline scenario is ascertained based on AMS I.C. and AMS I.D.

In this case, the baseline scenario is that coal consumption for the starch production process of Truong Thinh factory and electricity consumption from grid would have been continued in the absence of the project activity.

2.5 GHG emissions

Based on Category III and Category I, GHG emissions are calculated on trial before the project starts.

Table 2-3 Emission reduction amount of the project

	Category III (AMS III.H.)	Category I (AMS I.C., AMS I.D.)
Baseline emission	25,956 (tCO_2/y)	2,366 (tCO_2/y)
Project emission	4,028 (tCO_2/y)	0 (tCO_2/y)
Leakage	0 (tCO_2/y)	0 (tCO_2/y)
Emission reduction	21,928 (tCO_2/y)	2,366 (tCO_2/y)
(Total)	24,294 (tCO_2/y)	

2.6 Monitoring plan

To understand the accurate GHG emission of the project, the monitor plan was made by referring the approval methodology.

The monitor plan in this project is shown in Figure 2-4.

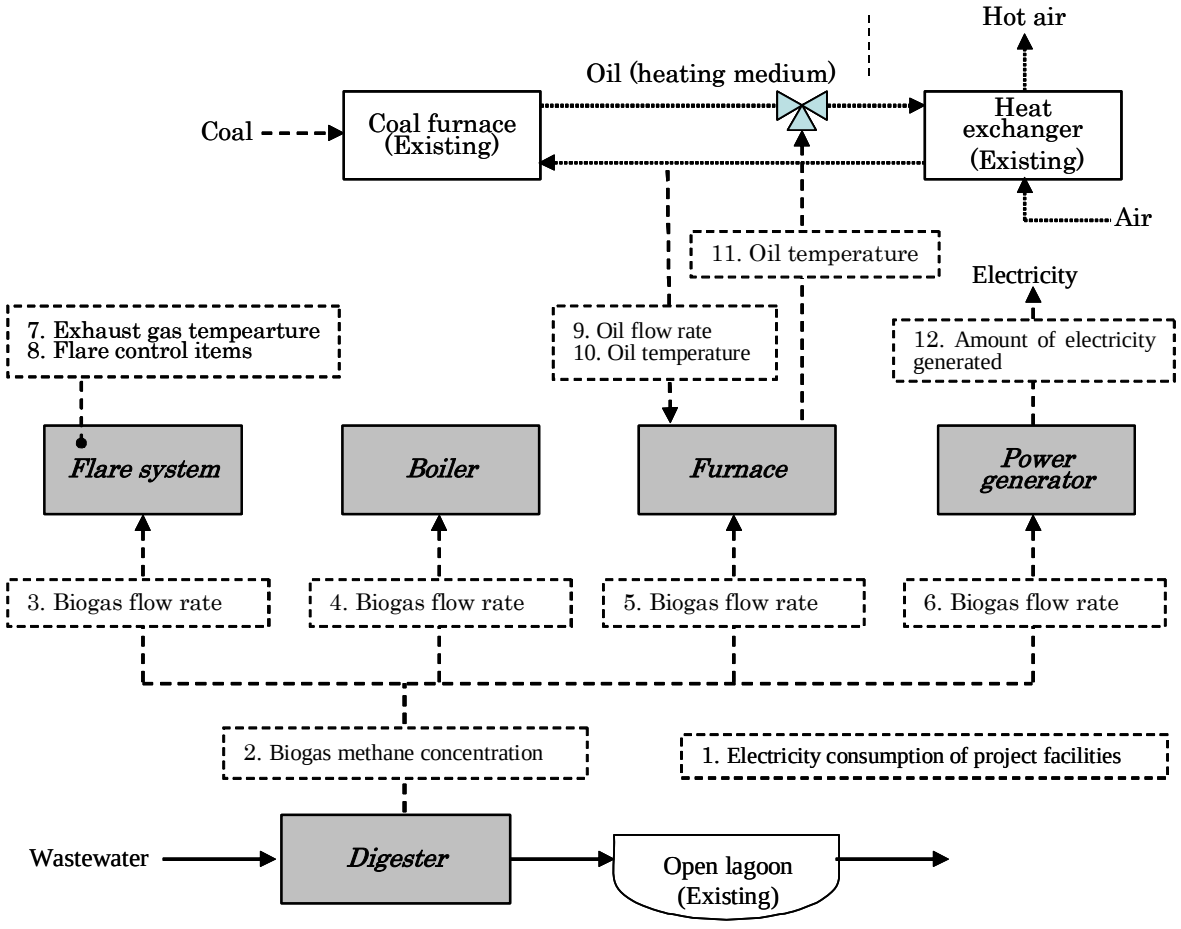

Fig. 2-4 Monitoring plan

2.7 Environmental impacts and other indirect effects

2.7.1 Environmental impacts

(1) Environmental impacts

Obnoxious odors evolved from open lagoons are reduced because wastewater from the plant is preliminarily purified by removing pollutants from wastewater, at the digester installed in this project, and the water is discharged to open lagoons. In addition, another expected effect is that groundwater pollution due to permeation of liquids stored in open lagoons is reduced.

Furthermore, work environment at the project site is improved as a result of reduced obnoxious odor, and the improvement of groundwater quality contributes to the betterment of surroundings.

(2) Other indirect impacts

The quality of groundwater used as agricultural and life waters is ameliorated, so sanitary conditions for nearby inhabitants are expected to improve.

Moreover, once the project is completed, tapioca starch processing plants in Vietnam can be operated with a small amount of energy, so that the operation efficiency of tapioca starch plants is improved, resulting possibly in the economical growth of Vietnamese agricultural areas and correcting economical handicap to urban districts.

2.8 Stakeholders' comments

The following organizations were interviewed to acquire stakeholders' comments.

- Ministry of Agriculture and Rural Development (MARD)
- People's Committee, Tay Ninh province
- Truong Thinh Co.
- People's Committee
- Fatherland front

3. Establishing an enterprise

3.1 Project operating systems and organization

This project is executed as a corporate enterprise of Toshiba and Vietnam/TRUONG THINH Co. The role of each company and the operating chart of this corporate business are as follows.

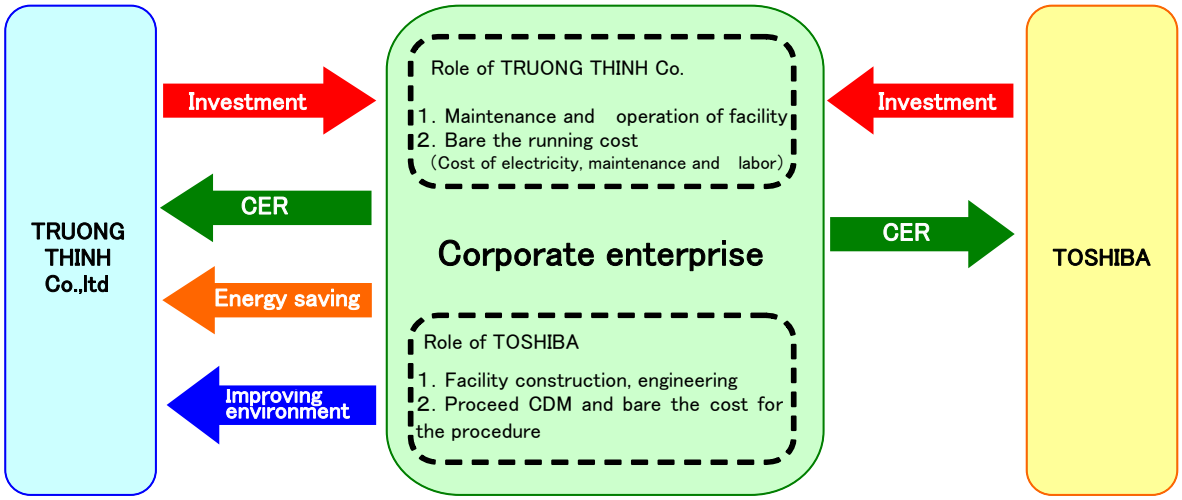

Fig. 3-1 CDM corporate business operating system diagram

3.2 Calculation of project IRR

Three schemes about utilization of available methane gas generated after subtracting the facility use are assumed for this project, and their IRR is calculated.

(Scheme A): The case of using almost all of available gas for energy generation, by installing gas furnace to substitute coal consumption of existing coal furnace, and setting up power generator to generate electricity from remaining gas.

(Scheme B): The case of using methane gas for electric power generation to cover electricity consumption of plant and project facilities. (No gas furnace)

(Scheme C): The case of consuming methane gas as the alternative energy of coal by installing gas furnace. (No power generator)

The CER price was assumed as 0, 10, 12.5, and 15 USD/CO_2.

Table 3-1 Conditions of calculation of IRR

Item	Unit	Scheme A	Scheme B	Scheme C
		Power generation + substitution of coal	Power generation only	substitution of coal only
Initial investment	USD	2,567,000	2,587,000	2,067,000
Expenditure	USD/year	399,809	421,809	299,809
Income (Excl. CER)	USD/year	215,646	227,113	66,146
Expected amount of CER	tCO_2/year	33,702	32,851	31,200
Unit price of CER	USD/tCO_2	0, 10, 12.5, 15		

Table 3-2 Results of IRR trial calculation

Unit price of CER	Scheme A	Scheme B	Scheme C
	Power generation + substitution of coal	Power generation only	substitution of coal only
0 USD/tCO_2	Not feasible	Not feasible	Not feasible
10 USD/tCO_2	9 %	8 %	6 %
12.5 USD/tCO_2	13 %	12 %	11 %
15 USD/tCO_2	18 %	16 %	16 %

3.3 Analysis of economic performance and tasks toward business success

Here, the results of above examination are follows:

- For this project, some business profit is expected by the business execution as CDM. However, the business profit is dominated by the CER price.
- The profitability shows the tendency to rise as both coal substitution and power generation are adopted to maximize the effective use of biogas generated in the project activity.

Some factors with the possibility of influencing the business condition can be considered.

(1) Price of CER after the first commitment period (After 2013) (negative factor)

(2) Influence by factory repair of Truong Thinh company (positive factor)

(3) Steep rise in fuel expense (positive factor)

(4) Deterioration of electric power condition (positive factor)

As considering these factors, The business profit is thought to have high possibility of improving from present trial calculation. Therefore we start a conference for the business execution with the Truong Thinh company, and aim at beginning of the business (contract and equipment construction) in the autumn of 2008 and the CER acquisition in October 2009.