CDM/JI Feasibility Study Programme

(the Ministry of the Environment/GEC Sponsoring CDM Project FY2005)

Feasibility Study on Efficient Methane Recovery and Heat Generation in Palm Oil Mill in Malaysia

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Summary Report

March 2006

Sanwa Engineering Co. Ltd.

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1. Outline of the Study

The Malaysian palm oil industry, whose production is currently the highest in the world, is very important for Malaysian economy not only as a mean of earning foreign currencies but also as a source of renewable energy. The palm oil industry is currently growing at a rapid rate in reflection of the growing domestic and international demand for palm oil.
There is over 380 Palm Oil Mills in Malaysia and the possible recovered alternative energy from the wastes of Palm Oil Mills such as POME, EFB, Fiber and Shell is assumed to 5 % of the Power Generation in Malaysia

The study targeted Bell Palm Industry owned by the Bell Group Company in Johor, Malaysia is a crude palm oil mill plant with capacity of 40t-FFB/h. The BPI obtains energy from steam boilers and back pressure steam generator utilized fiber and shell disposed of CPO production process. Meanwhile, palm oil mill effluent (POME) discharged from the CPO production process currently undergoes anaerobic and aerobic lagoon treatment to comply with the effluent standard in Malaysia, however, this treatment releases a large quantity of methane gas into the atmosphere, which has 21 times of effects compared with CO_2 as GHGs.
This project aims to collect methane gas generated in the POME treatment process, and to utilize it as a boiler fuel. The fuel of the surplus (part of the shell), which was substituted with recovered methane, is planned to sell to a Cement Company located nearby the BPI.

2. Development Surrounding the CDM in Malaysia

Malaysia, the host country of this project ratified the Kyoto Protocol on Sep. 4th 2002, and is promoting CDM actively. The social system is stable in Malaysia.

3. Technologies applied in the project

Bio gas facilities introduced from the European manufacturer and so on are widely used in Japan, but the main treatment objects have been the waste from stock farming, the organic waste processing and etc, excepting the POME.
The technologies and system to be introduced in the project were determined in terms of the efficiency and stability in methane-based biogas generation and its cost performance. Taking into account the nature of POME and methane recovery efficiency, the high temperature anaerobic

digesting technology (the reaction temperature is nearly at 55℃) is adopted. Four digester tanks with a capacity of 3,000m^3 each are to be installed to meet the estimated maximum discharge of POME from the factory.

Recovered biogas (methane concentration is around 60%) will be used in the steam boilers for heat generation, partly replacing current biomass fuel, mesocarpfiber and palm shell separated from the waste of palm oil mill. The partly replaced fuel of palm shell will be sold to a big cement factory located neighboring to the BPI. Selling palm shell as a fuel should be the alternative fuel for the fossil fuel indirectly, because most part of the fuel used in the cement factory is the fossil fuel and coal.

Chart 1 shows the overall schematic of the system.

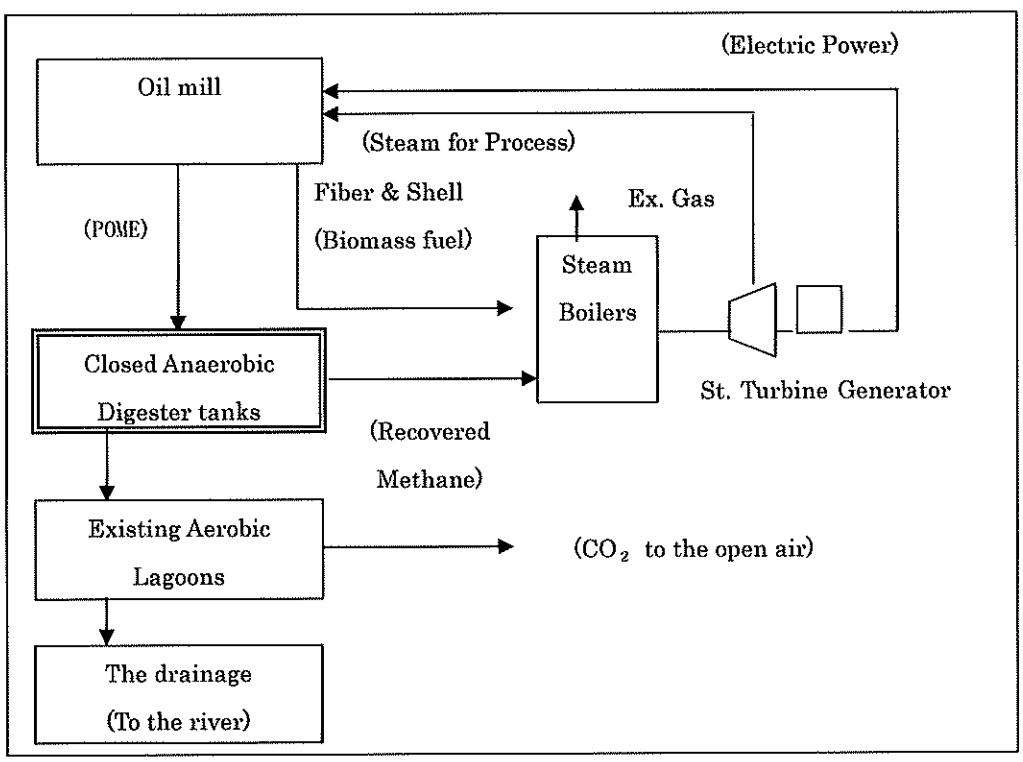

Chart 1. Overall schematic of the project system

4. Outline of the Counterpart and Scheme of the FS

4.1 The Counterpart (BPI)

The counterpart company name of this project is Bell Palm Industries (Bell Palm Industries Sdn.Bhd. hereinafter write with BPI), which is a company of the Bell Group Company (the holding company). BPI is situated in the 20km north from the

downtown in Johor Batu Pahat in Peninsular Malaysia, and is situated in the 250km south from Kuala Lumpur, the capital of Malaysia. The BPI mill is surrounded by the plantation.

BPI was established in the end of the 1970's to produce natural palm oil, and was acquired by the Bell Group Company in 1986, and the company name was changed to BPI in 2005 .(The company name was formerly Bell Prisawit Sdn. Bhd.)

The capacity of production was reinforced from 20t/h FFB to 40t/h FFB in 2002. The Bell Group Company possesses eight palm oil mills in Malaysia and the mils are dispersed to the Malaysia.

4.2 The factory overview

The lot area	145,692m^2 (36 acre)
The factory area	24,282m^2 (6 acre)
The lagoon area	101,175m^2 (25 acre)
The CPO production	48,000t/year
The FFB throughput	240,000t/year
The operation hour	6,000h/year
The employee	About 200
Address	Bell Palm Industries Sdn. Bhd. 4910 ,Parit Ju, Simpang Kiri,83000 Batu Pahat, Takzim Johor Darul. Malaysia
President	Bell Group Company Chairman Dato' Low Boon Eng

Chart 2 shows the location of BPI.

4.3 Outline of the BPI and process

BPI discharges the waste water (Palm Oil Mill Effluent ; POME) 24m^3/h by processing the FFB 40t/h. POME is treated in the open anaerobic lagoons(lagoon ;the reservoir) at first and then treated in the open aerobic lagoons to satisfy the waste water quality standards, and is discharged to the river. It is regarded as the big problem because the quantity of POME from mills in Malaysia is very large, POME includes organic ingredients so much and the treatment is difficult.


THAILAND
Phuket
Phatthalung
Trang
PENINSULAR
MALAYSIA
Hat Yai
Kangar
Kota Baharu
Alor
Setar
Kuala
Terengganu
Kuala Kerai
George Town
KELANTAN
Kuala Dungun
Taiping
Ipoh
Kuala
Lipis
Cukai
Strait of Malacca
PERAK
Raub
Medan
Kuantan
Mentekab
PAHANG
Letur
Kuala
Lumpur
Seremban
Labuhanbilik
NORTH SUMATRA
Melaka
Segamat
JOHOR
Sibolga
Rantauprapat
Padangsidempuan
Duri
Tanjungbalai
Singapore
S U M A T R A


JOHOR
Sagil
Bukit Kepong
Bekok
Tangkak
Lenga
Chaah
Panchor
Pagoh
Paloh
Kahang
Kangkar
Lenggor
Kg. Gajah
Pagoh
Bukit Pasir
Yong Peng
Kg. Paya Baharu
Yong Peng
Utara
Yong Peng
Selatan
Kluang
Parit Sulong
Ayer Hitam
Tongkang
Pechah
Parit Yaani
Renggam
Kangkar Dohol
Semerah
Batu Pahat
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Seri Gading
Simpang
Renggam
Senggarang
Simpang
Renggam
Bukit Batu
Layang Layang
Sedenak
Kulai
Ulu Tiram
50
1
3
5

Project Site:
Bell Palm Industries Sdn Bhd
4910 Parit Ju, Simpang Kiri
83000 Batu Pahat, Johor Darul Takzim
MALAYSIA

Chart 2 The Location of BPI

In Malaysia, open lagoon treatment is the popular processing system used for the palm oil mill and the other category of factories dealing with organic materials, because the mechanism is simple, the operating expenses is cheap and requires no special skills of the operators.

The methane generated with the anaerobic treatment in the open lagoons is diffused to the atmospheric and isn't used at all. It is an urgent problem to refrain from methane gas diffusion, because the strength of methane gas among the greenhouse gas (GHG) effect is 21 times of carbon dioxide (CO2).

5. Applied Methodology

5.1 Methodology

The methodology applied to the project is AM0013/Version 02 "Forced methane extraction from organic waste-water treatment plants for grid-connected electricity supply and/or heat production" (May 13th,2005) . It is justified to apply the methodology AM0013/version 02 in utilizing the recovered methane for the heat production (the boiler fuel). This methodology is based on the baseline approach by the paragraph 48 in the Form and the Procedure of CDM, "Existing actual or historical emissions as applicable".

At first, the mill which uses fossil fuel for the boilers and electricity from the grid (the Power company) is proposed for this project ,but afterward changed to the BPI which does not use fossil fuel and electricity from the grid,

BPI has already used the shell and fiber which is the residual from the palm oil mill as steam boilers fuel, and electric power was generated by the back pressure steam turbine generator, and supplied utility which is necessary for the factory process. Recovered methane is utilized for the steam boilers fuel replacing a part of the biomass fuel (shell). Left shell will be sold to the nearby cement factory as a fuel ,so it means that the sold shell substitutes the fossil fuel used in the cement factory.

Selling left electricity generated in BPI to the grid is not planned in this project, because the condition that the sale period is fixed for 20 years, the rate of selling price is very cheap and the connecting point of grid cable is very far from BPI.

5.2 The applicable-condition of the project

The proposed project activity satisfies the applicability standard defined in AM0013/Version 2 as follows ;

- Methane recovery project activities involving an industrial organic wastewater treatment plant.
- Existing waste water treatment system is an open lagoon system, with:
  - depth of the open lagoon system is at least 1 m.
  - residence time of the sludge in the open lagoons should be at least one year.
  - temperature at the sludge in the open lagoons is always higher than 15°C.
- The project activity includes a forced CH_4 extraction.
- There is a process change from open lagoon to accelerated CH4 generation in a closed tank digester or similar system.
- Captured methane is used for electricity generation and/or for the production of heat.
- The renewable power generation capacity is lower than 15 MW.

5.3 Host country eligibility criteria

The following table shows that the project activity conforms to the national eligibility criteria set by the Designated National Authority of Malaysia.

Eligibility Criteria	Conformity by Project Activity
1. Sustainable Development	i. The methane recovered can be used for heat generation, thus promoting the

Describe how the project addresses **one or more** of the following: i. Ensuring adequacy and security of fuel supply as well as promoting the utilisation of gas and renewable energy ii. Ensuring adequacy of electricity supply as well as improving productivity and efficiency iii. Developing the energy-related industries and services as well as increasing local content iv. Promoting Malaysia as a regional centre for energy-related engineering services v. Encouraging efficient utilisation of energy, particularly in the industrial and commercial sectors vi. Giving due importance to environmental considerations	utilisation of renewable energy. ii. The project activity contributes to steam generation. iii. The project contributes to the development of energy-related industries and services as well as increasing local content. iv. The project will promote Malaysia as a regional centre for methane recovery from POME treatment as a new energy source. v. The project encourages the utilisation of POME as energy resource in the palm oil industrial sector. vi. The project contributes to GHG emission reductions and enhances the efficiency of POME treatment and thus improves the quality of the treated effluent discharge.
2. Environmental regulations i. Has the project conformed to the environmental regulations of the country? ii. List the approvals (or exemptions) obtained	i. The project activity conforms to the Environmental Quality Act 1974 and the relevant regulations therein. ii. The palm oil mill has been operating under a licence from the Department of Environment Malaysia as a Prescribed Premises in accordance with the requirements of the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977.
3. Technology to be employed and source of technology Show that the technology selected is "best available" for the project and indicate local content. It would be useful to provide a few examples of where the proposed technology	The closed tank anaerobic digester system for methane recovery selected is the "best available" technology considering the following factors: i. The closed tank anaerobic digester is proven to be a successful system for POME anaerobic digestion treatment

has been employed and how it would facilitate technology transfer	and methane recovery; ii. There is no known and proven anaerobic digester technology for POME treatment available from outside Malaysia which is better than the technology selected; and iii. There have been a few attempts reported locally where a few other anaerobic digestion technologies have been applied for POME treatment, but none have been reported in successful commercial operations to-date.

Chart 3. Eligibility Criteria

6. The emission reduction

The emission reduction of GHGs (ER) is due to the formulae as follows:

ER [t·CO_2eq/yr] = Baseline emissions [t·CO_2eq/yr] − Project emissions [t CO_2eq/yr]

6.1 Baseline emission

Baseline emission is showed as follows;

Baseline Emissions ($t\text{-}CO_2$ eq/yr)	=	Baseline Emissions from Open Lagoons ($t\text{-}CO_2$ eq/yr)	+	Baseline Emissions from Grid Electricity Generation ($t\text{-}CO_2$ eq/yr)	+	Baseline Emissions portion of Fossil Fuel displaced by Biogas in Heating Equipment ($t\text{-}CO_2$ eq/yr)

Because there is not fossil fuel substitution in this project and the electric-power selling,so the baseline emission is shown as follows;

Baseline Emissions ($t\text{-}CO_2$ eq/yr)	=	Baseline Emissions from Open lagoons ($t\text{-}CO_2$ eq/yr)

6.2 Project emission

Project emission is showed as follows;

Project Emissions ($t-CO_2eq/yr$)	=	Emissions from Open Lagoons ($t-CO_2eq/tr$)	+	Physical Leakage from Biodigester ($t-CO_2eq/yr$)	+	Emissions from electric consumption by auxiliary Heating Equipment ($t-CO_2eq/yr$)

Project emission in this project is shown as follows, because there is no physical leakage and the auxiliary consumes electricity, which is generated by biomass fuel, can be ignored ;

Project Emissions ($t-CO_2eq/yr$)	=	Emissions from Open Lagoons ($t-CO_2eq/yr$)

Therefore the project emission reduction (ER)is shown as following;

ER ($t-CO_2eq/yr$)	=	Baseline Emissions from Open Lagoons ($t-CO_2eq/yr$)	-	Project Emissions from Open Lagoons ($t-CO_2eq/yr$)

7. Project Boundary and Baseline Methodology

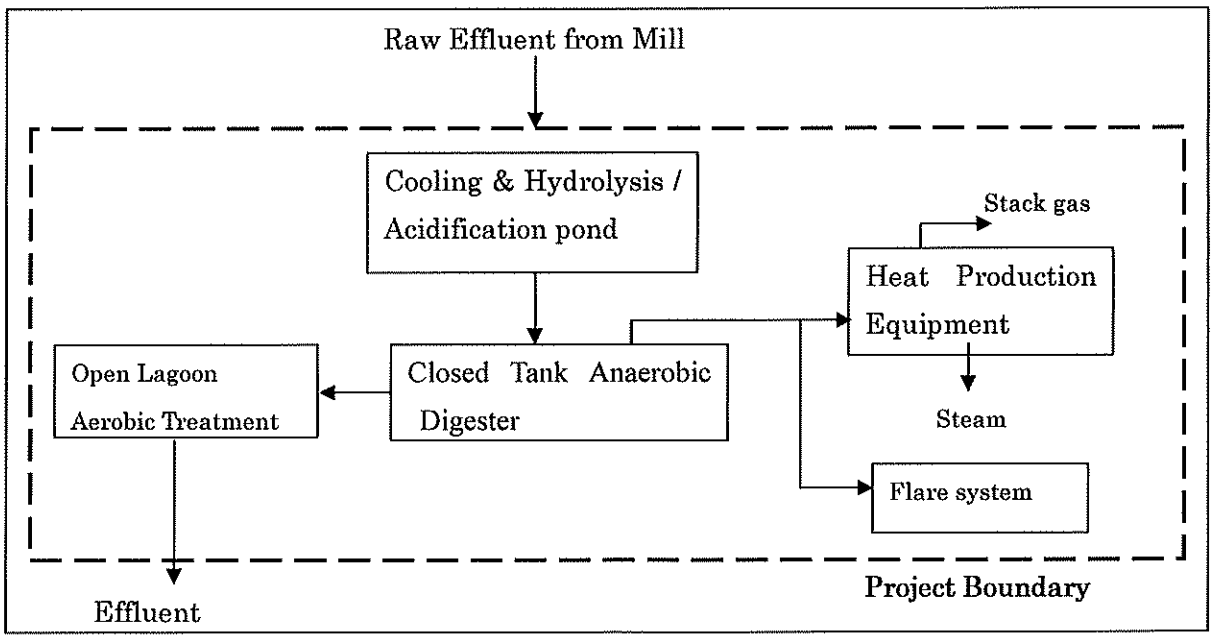


Chart 4 Project Boundary

8. Monitoring Methodology

The following figure summarizes the major monitoring points and the sequential numbers serve as the ID-numbering of the monitoring points.

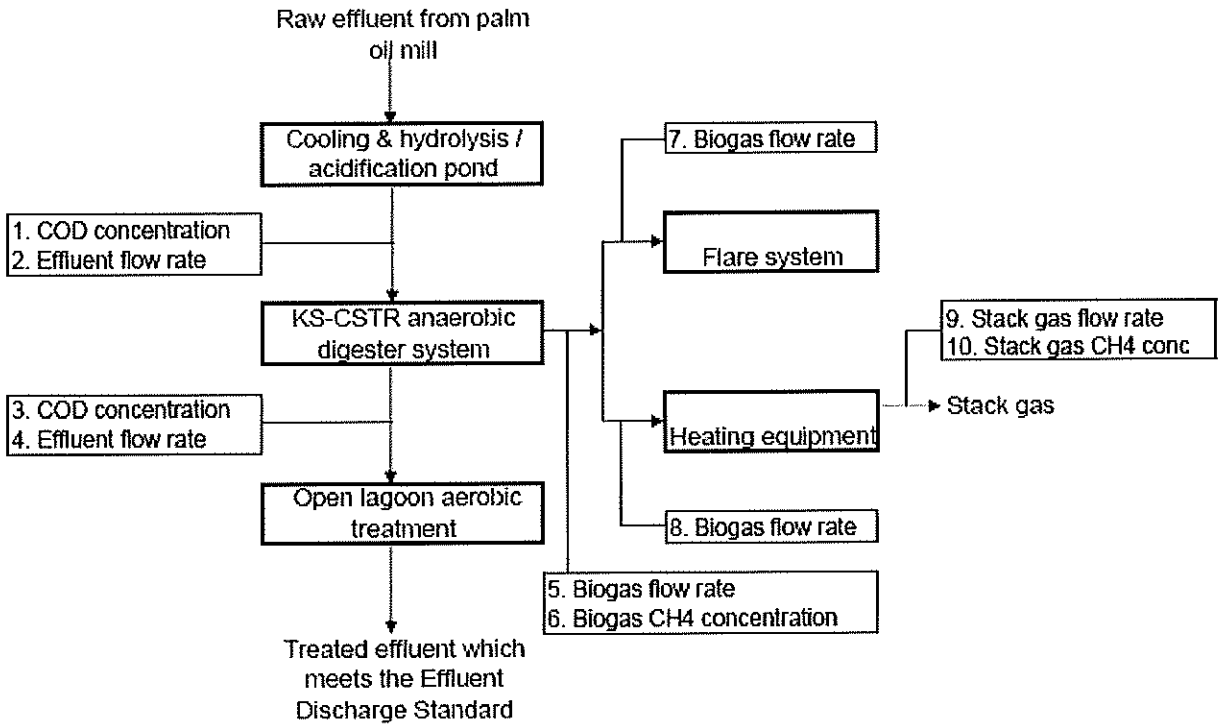


Chart 5 Monitoring points

Parameter	Data source (*ex ante* figures)	Monitoring after project implementation	Value used for *ex ante* baseline calculation
Production capacity palm oil plant	Plant operator	--	800 tonnes/day
Production days	Plant operator	--	300 days/year
Flow rate of effluent (as generated by production process)	Plant operator, Measurement	Yes	480 m^3/day
COD concentration of effluent (digester inlet)	Plant operator, Measurement	Yes	64.5 g/litre
Reduction of COD in	Measurement	Yes	80%

tank digester			
Biogas production	Measurement	Yes	13,150 m^3/day
Biogas producing capacity (Bo)	Default value as specified in AM0013, based on IPCC default values	--	0.21 kg CH_4/kg COD
Methane conversion factor (MCF)	Default value as specified in AM0013, based on IPCC default values	--	0.738
Electricity supplied to grid	Technical specifications, installation planning	Yes	0
CH_4 Global warming potential	UNFCCC	--	21
Calorific value biogas	Feasibility Study	Yes	19.8 MJ/m^3
Calorific value palm kernel shells	Palm Oil Industry value in Malaysia	---	13.8 MJ/kg
Regulations on discharge limits (COD)	Environmental Quality Act, 1974, Malaysia	Yes	No applicable regulations on COD

Chart 6 . Key information, data and Monitoring points

9. Expected GHG Emission Reduction and Project Effects

The estimated amount of emission reductions over the first crediting period of 3 x 7 years is summarized in the table below.

Years	Estimation of annual emission reductions, t CO_2-eq
2008	24,172
2009	24,172
2010	24,172
2011	24,172
2012	24,172

2013	24,172
2014	24,172
Total estimated reductions	169,204
Total number of crediting years for the first	7
Annual average over the crediting period of Estimated reductions	24,172

Chart 7. Estimated amount of Emission Reduction for the first 7 years of the project

9.1 Total project emissions

1. Lagoon project emissions	6,048 t CO_2-eq/yr
2. Physical leakage from digester	Negligible
3. Digester auxiliary equipment	Negligible
Total	6,048 t CO_2-eq/yr

9.2 Lagoon baseline emissions

POME flow rate	480 m^3/day	
POME COD conc.	64.5 kg/m^3 COD	
Production per year	300 days/yr	
Total COD load	9,288,000 kg COD/yr	
CH_4 emissions	1,439,000 kg CH_4/yr	**1,439 t CH_4/yr**
		30,219 t CO_2-eq/yr

9.3 Emission reduction

Expected baseline emissions 30,219 t CO_2-eq/yr

Expected project emissions 6,047 t CO_2-eq/yr

Expected emission reductions (*ex ante*) 24,172 t CO_2-eq/yr

10. Comments by Assumed Stakeholders and Environmental Impacts

10.1 Comments by assumed stakeholders

Comments by assumed stakeholders are not gathered.

10.2 Environmental impacts

According to the Malaysian environmental laws and regulations, specifically the Environmental Quality Act 1974 and the Environmental Quality (Prescribed

Activities) (Environmental Impact Assessment), no environment impact assessment is required for the proposed project activity.

The project must comply with the environmental laws and regulations and the project proponent must obtain the necessary approvals before project implementation.

The project involves an upgrading of the existing POME treatment system at the palm oil mill. Significant environmental improvements and benefits can be realized through the implementation of the proposed project activity involving the installation of an advanced anaerobic digester system based on the CSTR technology for methane recovery, in place of the existing open lagoon system for POME treatment.

11. Outline of the Project Implementation Plan

Four closed tank digesters capacity of 3,000m^3 are installed and steam boilers are improved to utilize the recovered methane for fuel.

12. Profitability

The investment and incomes of the project is shown as following table;

Investments and incomes	RM
1. Initial investment	
1.1 Total capital costs for closed tank anaerobic digester system	3,000,000
1.2 Capital costs for conversion of biomass-fired boiler to biomass-biogas dual-fired boiler	200,000
2. Average annual expenditure	
2.1 O&M (5% of total investment per annum)	170,000
2.2 Personnel (1 technician + 1 laborer)	48,000
2.3 Average loan interest	96,000
3. Annual income	
3.1 Sale of palm kernel shells displaced	250,000

Remarks

1. Interest rate of credit at 5% per year; for first 7 years of operation
2. Palm kernel shells price of RM50/t; 5,000 t/year kernel shells displaced per annum

The range of expectation of additional income generated by selling CERs is RM453,226 – 906,452 annually. These figures are based on assumed CER prices of US$5.0/CER and US$10.0/CER, respectively.

Income through CERs	US$	RM
@ US$5.0 /CER	120,860	453,226
@ US$10.0/CER	241,720	906,452

- IRR and the investment recovery years

CER price			$5/$CO_2$-t	$10/$CO_2$-t
I	Credit period	7 years	-0.1%	16.2%
R		14 years	10.2%	23.2%
R		21 years	12.4%	24.2%
Investment recovery years			6.6years	3.4years

- GHG reduction cost：

(Investment) ÷ (Amount of ER volume (Eq to CO_2)

Credit period	7 years	¥626/t-CO_2
	14years	¥313/t-CO_2
	21years	¥157/t-CO_2

12. The Afterward

12.1 The problem toward the commercialization

a. The securing of the end of the acceptance of the palm waste such as the shell, and the adjustment of the sales price.

b. Validation

This FS is excepting the validation, so there should be required more effort to complete the PDD and validation.

c. Installation Costs

The cost does not satisfied to commercialize the project, so the effort to reduce the cost from now on.

d. The financing

Sanwa Engineering Co. and The Bell group Company are not adequate for receive the public or national such as JBIC and World Bank. The two-step loan by JBIC is

reviewed application for this project, but the interest rate is not so low that the commercialization would have some difficulties.

By all means, it is keen to review and service a good financing scheme for small scale project.

e. The model case for CDM FS of Palm Oil Mill

BPI uses shell and fiber from palm oil mill waste as a fuel for the steam boilers, and supplies steam and electricity required by the mill process, so BPI does not use the fossil fuel and grid electricity.

Almost all mills in Malaysia is utilizing the waste shell and fiber for the boilers fuel, so we hope this CDM FS will be a model case for palm oil mill in Malaysia and nearby countries.

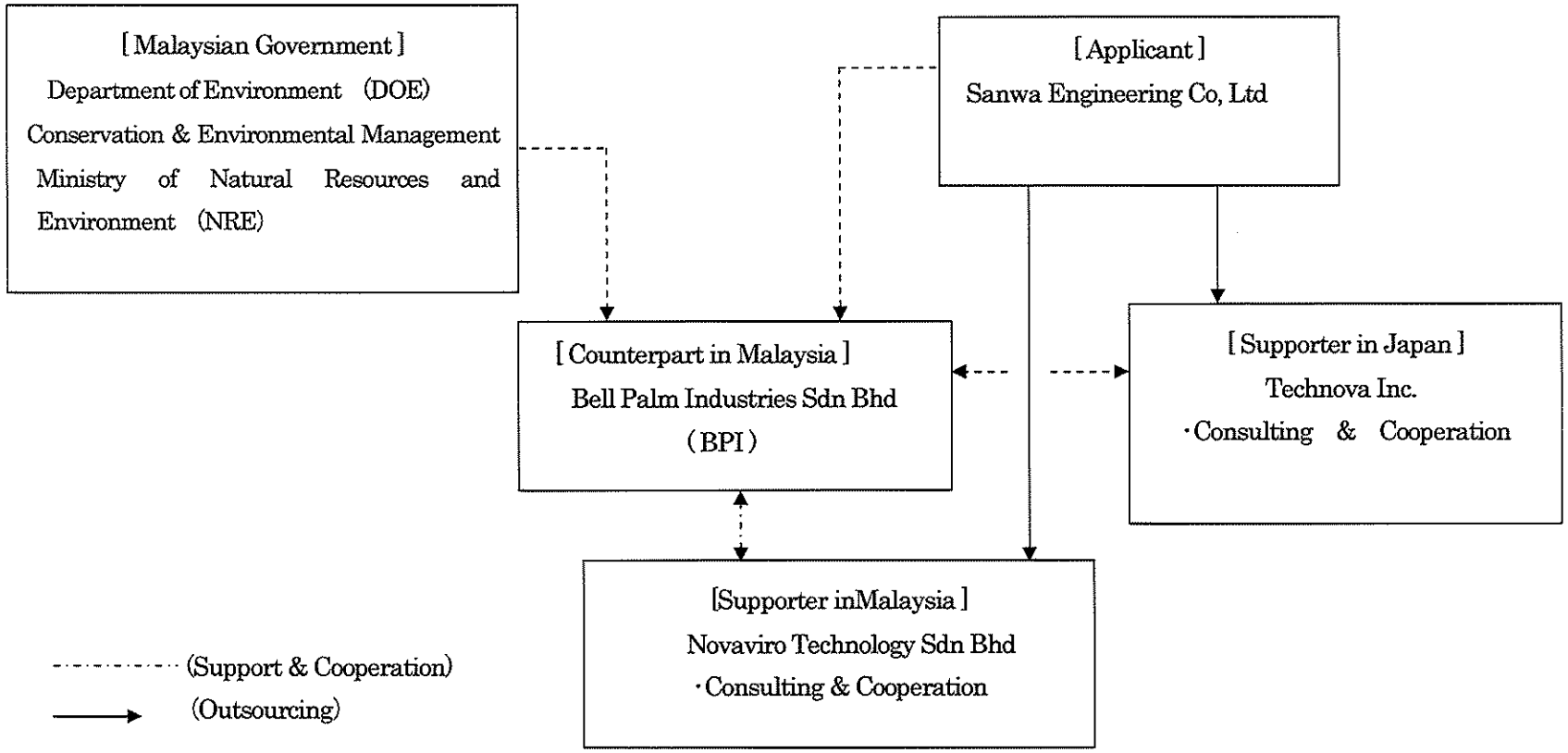
Thanks to cooperation

We, Sanwa Engineering Co., Ltd. would like to express the many thanks to the cooperation by Bell Group Company, Bell Palm Industries Sdn. Bhd.., Technova Inc.(Japan), Novaviro Technology Sdn. Bhd.(Malaysia) and other companies who gives us good information and supports.

Appendix 1. Scheme Chart for the investigation & FS

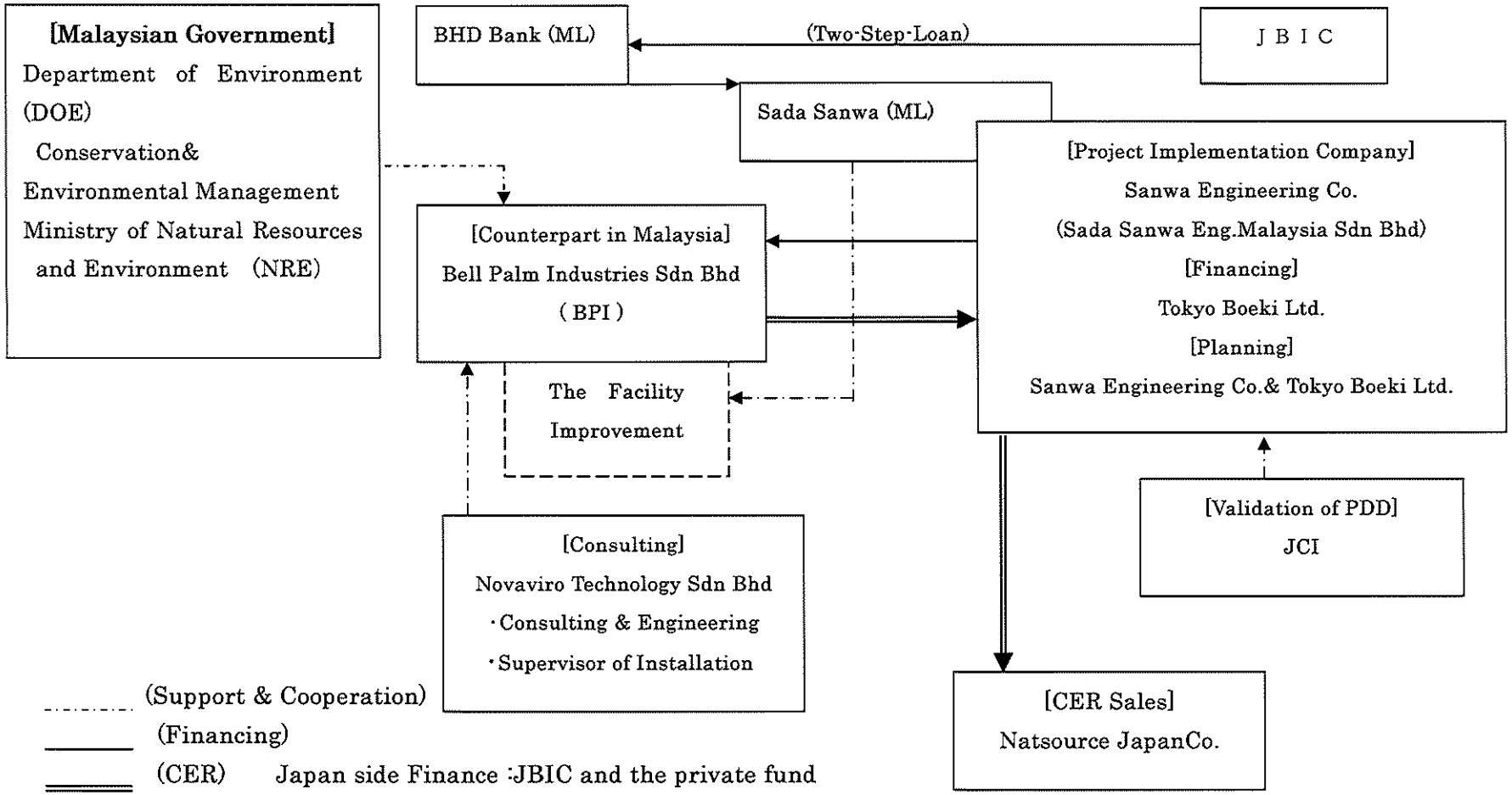
Feasibility Study on Efficient Methane Recovery and Heat Generation in Palm Oil Mill in Malaysia

(the Ministry of the Environment / GEC Sponsoring CDM Project FY2005)



Appendix 2. Scheme Chart for the Implementation

Feasibility Study on Efficient Methane Recovery and Heat Generation in Palm Oil Mill in Malaysia
(the Ministry of the Environment / GEC Sponsoring CDM Project FY2005)



Appendix 3　Site survey pictures

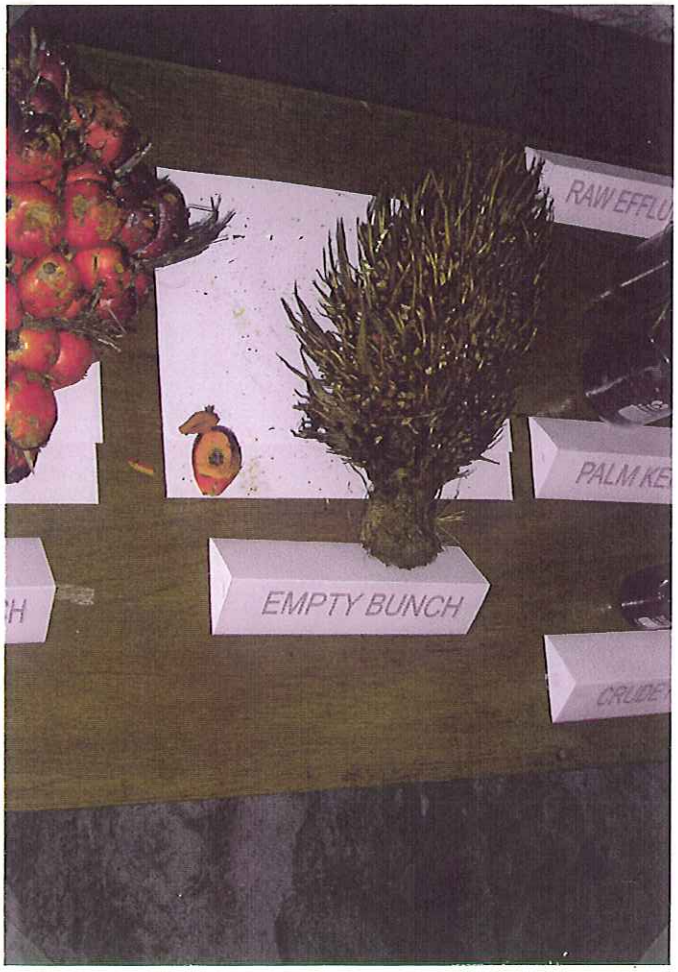
Palm plantation neighboring with factory

Planning installation site of digesters

Site survey member

Meeting at site survey

FFB (Fresh Fruit Bunches)



EFB (Empty Fruit Bunches)

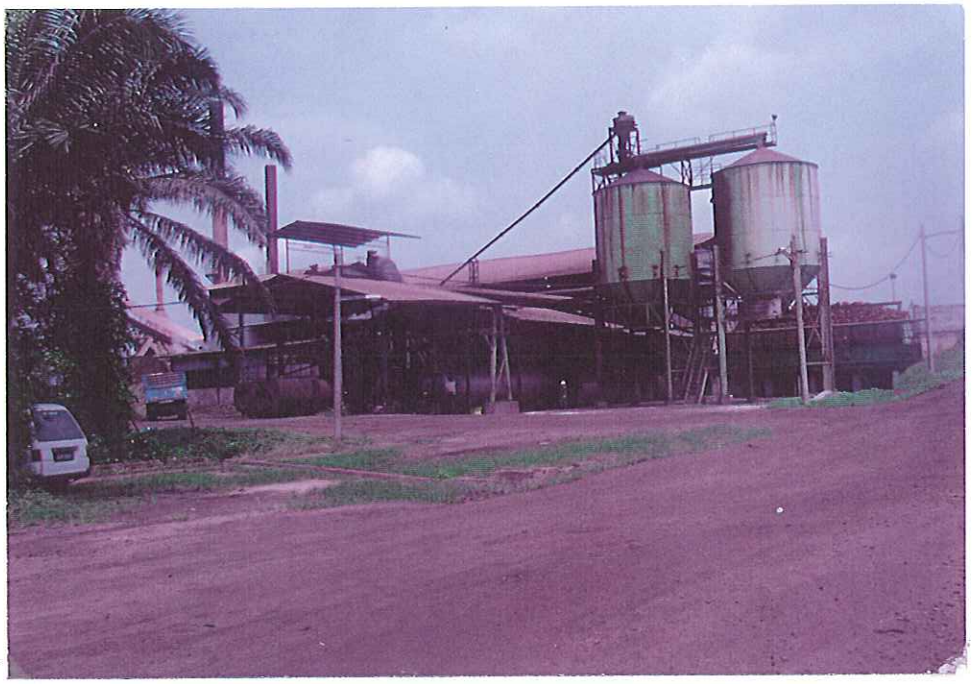
Shell and Fiber

Anaerobic treatment pond (Lagoon)

Aerobic treatment pond (Lagoon)

Sterilizer

Fiber and Shell



Shell silos

Shell

PTM office

PTM office entrance

FFB carry truck and scale

SPKS factory