Feasibility Study Report
Methane Recovery from Tapioca Wastewater in Lampung, Indonesia
(Summary)

March 2008

JFE Techno-Research Corporation

Contents

1. Outline of Research

The envisaged project is to utilize high concentration methane gas produced from tapioca wastewater as a fuel for gas engine for power generation. Wastewater is produced in the process where starch content (tapioca) is separated from cassava. Before releasing into adjacent river system, wastewater is treated through a number of anaerobic open lagoons to reduce elements such as COD that have negative impacts on the environment. In this process, wastewater also generates methane gas. This project is to collect this methane gas to feed into a new biogas power generator that replaces existing diesel generators. Generated electricity will be used in the tapioca factory.

The planned project is for a tapioca process factory in Kedaton, East Lampung Prefecture of Lampung Province, Sumatera, Indonesia, The factory is run by the counterpart, P.T.WIRAKENCANA ADIPERDANA (PT Wira). See Table 1 for the outline of the counterpart. As one of the largest tapioca producers in Lampung Province, PT Wira is an environment-conscious enterprise, and has been awarded a BLUE ranking in PROPER assessment, which means PT Wira satisfies the statutory and administrative requirements for environmental protection. At the same time, PT Wira is highly concerned about its cost competitiveness that is considered lower than that of Thailand in general. This is the background where PT Wira showed its keen interest in our research in their Letter of Interest (LOI).

Table 1 Outline of the counterpart

Name	Location	
	Headquarters	factory
PT.Wira Kencana Adiperdana	1 Jl.Soekarno Hatta Km.6 Ketapang panjang Teluk Betung Bandar Lampung Lampung Indonesia	Ds.Kedaton Kec.Sukadana Kab.Lampung Timur

The technology planned for this project is of the closed fermentation tank system that enables steady methane fermentation with a short hydraulic retention time (HRT). Onggok, which is a by-product in the tapioca production process, is added to the process at the initial stage as a bio immobiliser for a shorter HRT and stable fermentation activity. Its outline flow is indicated in Figure 1.

By implementing this project, the reduction amount of GHG (ER_y)is expected about 29,000 ton-CO_2e per year.

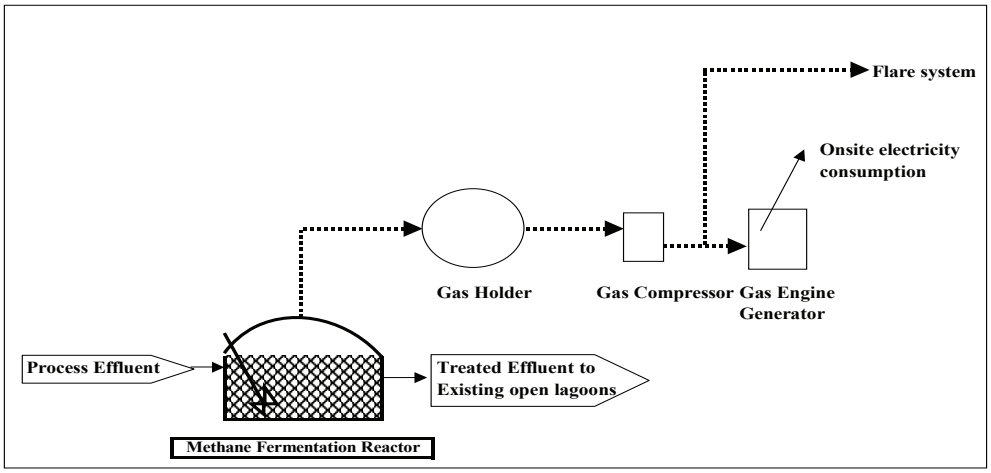

Figure 1 Outline flow

2. Results of Previous Research

Lampung Province is located at the southeast end of Sumatera Island with eight regencies, two cities, 162 counties and 2,143 villages as of 2002.

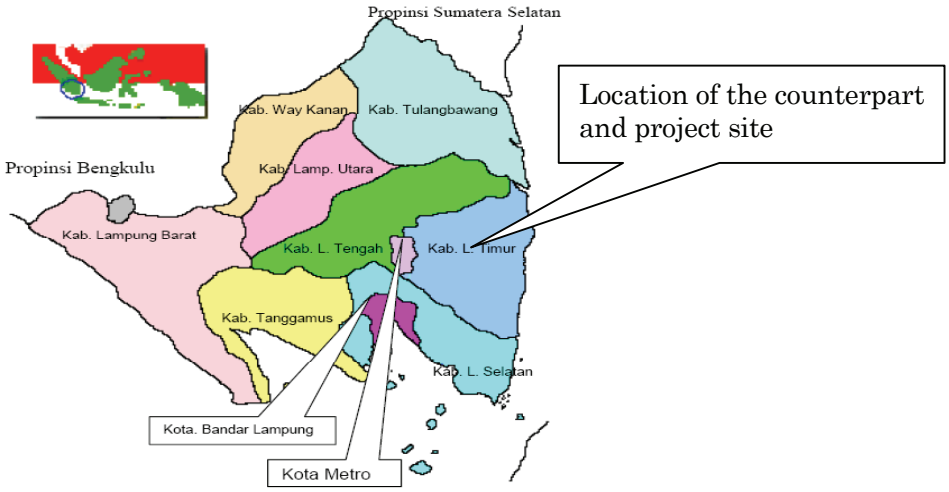

Figure 2 Map of Lampung

Tapioca production companies now recognize that application of the proposed technology to provide an alternative energy resource will largely enhance the cost competitiveness of Lampung made tapioca that is considered lower than that of Thailand in general.

3. Policy of Indonesian Government

Following are the laws and the regulations relating to the environment protection and the energy conservation.

(1) Environmental Ministerial Order No. 3 of 1998 for Quality Standard of Liquid Waste

(2) Environmental Ministerial Order No. 13 of 1995 for Quality Standard of Emission from Solid Waste

(3) Lampung Governor's Ordinance No. 17 of 2006 for Industrial Waste Disposal Standard

(4) Regulation of East Lampung Prefecture No. 10 of 2004

(5) Regulation of East Lampung Prefecture No. 11 of 2004

(6) PROPER (Assessment Programme of Industrial Waste Producing Enterprises)

(7) Presidential Order No. 5 of 2006 about National Energy Policy

(8) Presidential Instruction No. 1 of 2006 about Use of Bio Fuel

(9) CDM Implementation Scheme

Fig.3 below shows the CDM approval process in Indonesia.

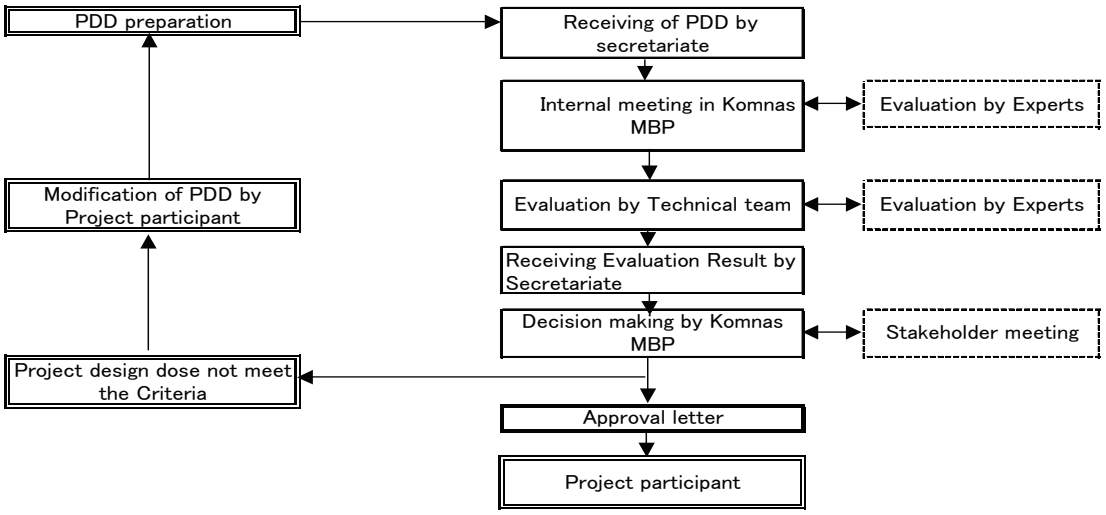

Figure 3 CDM Approval Process

- Above process will be completed in 11 weeks unless there is no revision of PDD.
- 8 projects have been registered with the Executive Board and 16 projects have been approved by DNA as of October 2007 in Indonesia

4. Planning of the Project

(1) Investigation of the Existing Lagoons

Wastewater from the tapioca factory is introduced to open anaerobic lagoons through open channels. There are ten lagoons in total; two anaerobic, two facultative, four aerobic, one sedimentation (first lagoon) and one adjustment (last lagoon). Photo 4-1 and 4-2 show the existing lagoons. Photo 4-2 shows No.1 anaerobic lagoon that was most active in methane fermentation at the time of the investigation.

Photo 4-1

Photo 4-2

(2) Boundary of the Project

Figure 4 shows the boundary of the project.

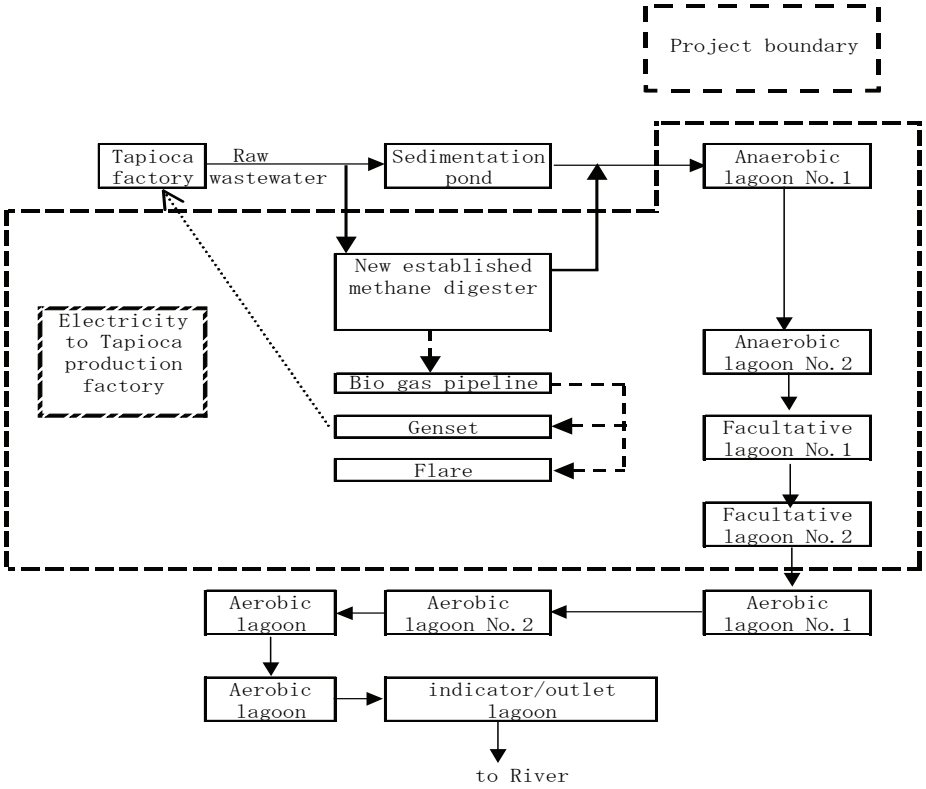

Figure 4　Project boundary

(3) Formation of the Research Activity

Figure 5 shows the formation of the research activity.

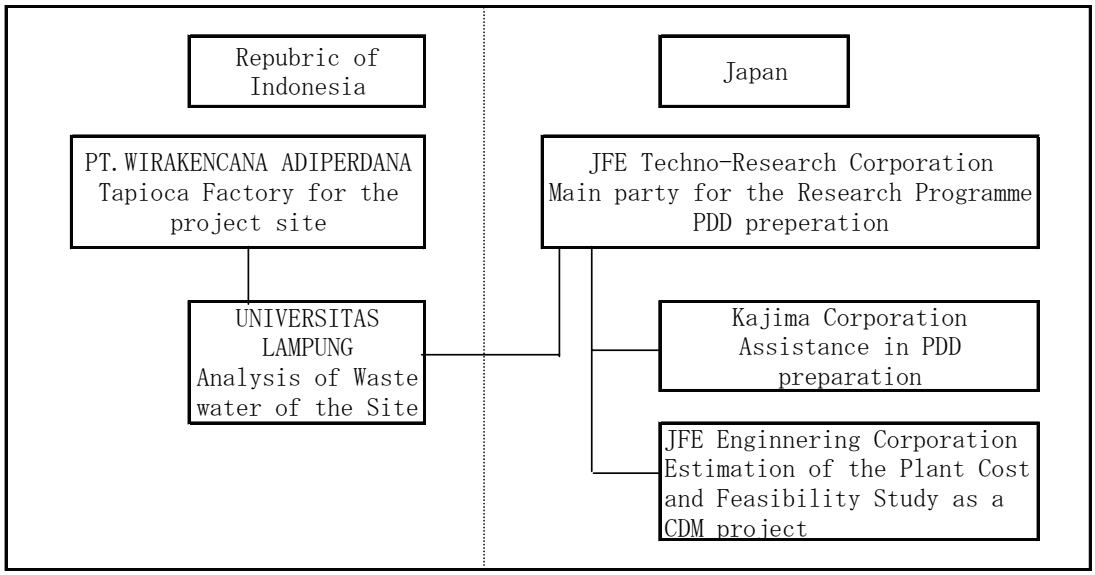

Figure 5　Formation of the research activity.

(4) Applicable Technology

Table 2 shows comparison with other technology.

Table 2　Comparison with other Technologies

Item	Technology planned for this project	Other technology A	Other technology B
Fermentation process	Complete mixing Closed Lagoon	Covered Lagoon	UASB
Bio immobiliser	Onggok	—	Granulated sludge
Material of roof	R.P.P	HDPE	Steel plate
HRT	7-10 days	20 days	2-3 days
COD decomposition rate	80-90%	80-85%	80-90%
Easiness of operation & maintenance	○	△	△

(5) Conditions for Planning

Table 3　Basic Conditions of equipment

Item		Planed condition
Tapioca production	ton/d	92.3
COD of liquid waste	T-COD (mg/l)	15,000
Flow rate of liquid waste	m^3/d	1,661
	m^3/m	35,988
	m^3/y	431,860
Number of operation days	d/y	260
COD Decomposition rate	%	86
Methane gas concentration in Biogas	%	56
Efficiency of Gas engine	%	36
Capacity of Gasflare	%	200

Table 4　Plant Capacity & Particulars of Equipment

Planned Capacity		Planned conditions	
Liquid waste for treatment	m^3/d	1,661	
Methane gas to be recovered	m^3/d	6,827	
Biogas to be recovered	m^3/d	12,191	
Capacity of GENSET	kW	1,024	
Capacity og Gas flare	m^3/d	24,000	
Main equipment			No.
Pump for Liquid waste feeding	1.73m^3/min x 7m		1
Methane digester	6,000m^3 Coverd by FPP		4
Gas holder	800m^3		1
Genset	1,024kW x 220V Electrical efficiency 36%		1
Gas flare	1,000m^3 /h x 500℃		1
Instruments for Monitering			No.
COD meter	HACH		1
Flow meter for Liquid waste	Electromagnetic type		2
Flow meter for Biogas	Wet gas meter		2
Methanegas concentration meter	Combustion method		1
other necessary items	1		

5. Study of Methodology

From the viewpoint of the small project size, application of AMS Ⅲ.H/ Version 08 may

be appropriate for the project. According to this methodology, however, the amount of CO_2 reduction is calculated as about a half of that calculated according to ACM0014. Application of ACM0014 has been found more appropriate for the project because of the following.

- Expected increase in CO_2 reduction amount due to bundling the existing three tapioca factories of PT Wira and further due to future expansion,
- Comparison between the total cost to realize this project under CDM and the revenue from the expected credit, and
- Counterpart's need to enhance commercial feasibility of the project

Table 5 shows how this project satisfies the required conditions. Table 6 shows the emission sources from the project boundary.

Table 5 Scenario applicable to the methodology

Historical situation	Project activity
The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions.	The wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and/or used to generate electricity. The residual from the anaerobic digester after treatment is directed to open lagoons.

Table 6 Emission sources from the project boundary

Source		Gas	
Baseline	Wastewater treatment	CH_4	Included
	Electricity Consumption/generation	CO_2	
Project activity	Wastewater treatment	CH_4	
	On-site electricity use	CO_2	
	On-site fossil fuel consumption	CO_2	

6. Study of baseline Scenario

Through the assessment, it is determined that the most plausible baseline option is the use of open lagoons for the treatment of the wastewater and electricity generation using fossil fuels in a captive power plant

7. Additionality

Additionality of the proposed project will be demonstrated and assessed using the "Tool for the demonstration and assessment of additionality" (version 04).

Current practice in tapioca starch processing plants is the application of wastewater treatment system in anaerobic open lagoons, resulted in still allowable effluent

discharged to water bodies as set by the prevailing Indonesian regulations. The system requires relatively low capital investment causing many tapioca industries to apply. Moreover, the technology and skilled labour for this type of system is already available in the host country.

In Lampung province, tapioca starch processing needs additional investment and technical skills for operation is not a common practice in the tapioca starch processing plant in the host country. Through the discussions above, it is concluded that the proposed project activity is additional.

8. Monitoring Plan

The project will be executed according to ACM0014. Figure 6 shows the monitoring plan.

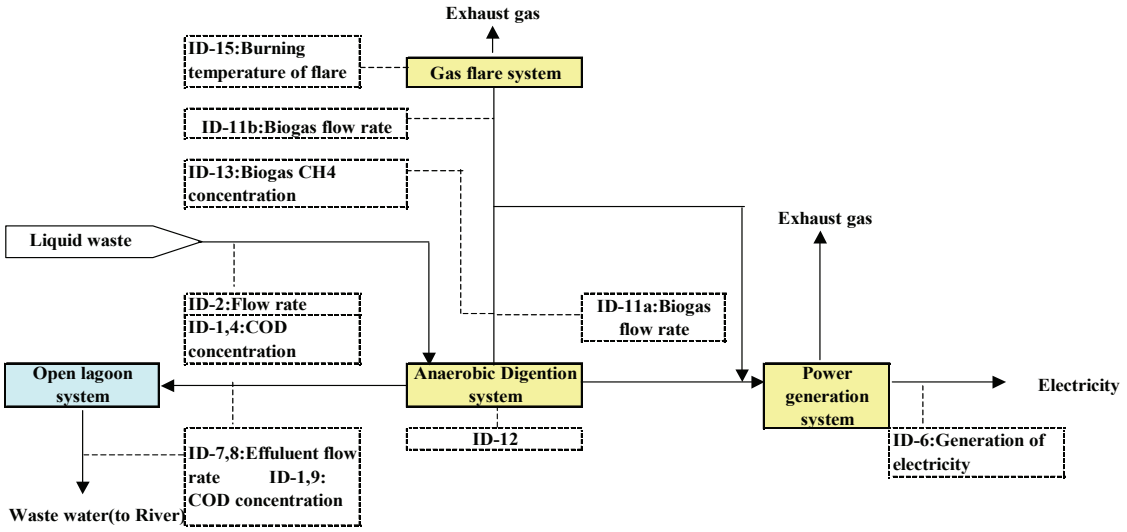

Figure 6 Monitoring plan

9. Reduction of GHG

Following Table 7 is the result of the calculation according to ACM0014/ version 01. Calculation was made according to the ORR method (the Organic Removal Ratio method).

Table 7 Estimation of reduction of GHG

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emissions reductions (tonnes of CO_2e)
Year 1(Mar. 2010-Feb. 2011)	1,545	30,206	0	28,661
Year 2(Mar. 2011-Feb. 2012)	1,545	30,206	0	28,661
Year 3(Mar. 2012-Feb. 2013)	1,545	30,206	0	28,661
Year 4(Mar. 2013-Feb. 2014)	1,545	30,206	0	28,661
Year 5(Mar. 2014-Feb. 2015)	1,545	30,206	0	28,661
Year 6(Mar. 2015-Feb. 2016)	1,545	30,206	0	28,661
Year 7(Mar. 2016-Feb. 2017)	1,545	30,206	0	28,661
Total estimated reductions (tonnesof CO_2e)				200,627
Total number of crediting years				7
Annual average over the crediting period of estimated reductions(tonnesof CO2e)				28,661

10. Assessment of Environmental Impact

By implementing this project, generation of GHG will be curbed, offensive odour around the site will be reduced, and the quality of the wastewater released to the river system will be improved. Additionally, operation of the gas engine will reduce amount of air polluting substances due to the quality of gas engine emissions. Thus favourable impact on the environment is expected.

Due to the Ministerial Order No. 11 of 2006, assessment of environmental impact (EIA/AMDAL) is not any more required for the construction of biogas recovery plants and power generation plants for the existing tapioca process factories. However the Environmental Management Plan (UKL) and the Environmental Monitoring Plan (UPL) still have to be submitted.

According to BAPEDALDA, a new application for EIA is not required because the expected amount of Onggok produced in the tapioca production process for the project is negligible.

11. Opinions of Stakeholders

Although no formal meeting with stakeholders has been made at this research stage, following are the opinions of some of the stakeholders.

- **Professor Muhajir Utomo, President of University of Lampung:**
  "University of Lampung (UNILA) was awarded a governmental fund for promoting Biomass Complex Programme. In line with this programme, UNILA would like to extend as much cooperation to this project as possible." (UNILA is a project promotion partner in Indonesia as a host nation.)
- **Mr. Sahid Alkarim, BAPEDALDA (Environment Monitoring & Control Dept.) of East Lampung Regency:**
  "We expect realization of this project will further help improving the environment. And to socialize this project, the significance and the safe aspect of this project must be propagated to the parties concerned."
- **Mr. Prasetyadi Utomo/Mr. Upik Sitti Aslia, Climate Change Division, Ministry of Environment:**
  "Our government would like to promote technology transfer from abroad to this country. Participation of UNILA is meaningful in view of responsibility sharing of the host country."
- **Ms. Tuti Hendrawati, Deputy for Environmental Pollution Control, Ministry of Environment:**
  "Implementation of this project is desirable both in view of environmental protection and of diversifying energy resources."

12. Plan for Commercialisation

(1) Project Timetable

Table 8 Project Timetable

	Description	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	Additional Research/Assesment of Applied technology	◆									
2	Consultation with partners	◆	◆								
3	Design of the Plant/Procurment of the Equipment		◆	◆							
4	CDM registration		◆	◆							
5	Construction of the plant			◆	◆						
6	Operation of the plant			◆	◆	◆	◆	◆	◆	◆	◆
7	Monitering			◆	◆						
8	CER Trading			◆ Mar. 2010	◆	◆	◆	◆	◆	◆	◆ Feb. 2017

(2) Project Formation

Project formation as shown in Figure 7 is now under discussion. It is planned that a Japanese engineering firm will undertake EPC (engineering, procurement and construction) while the tapioca factory will undertake operation of the plant.

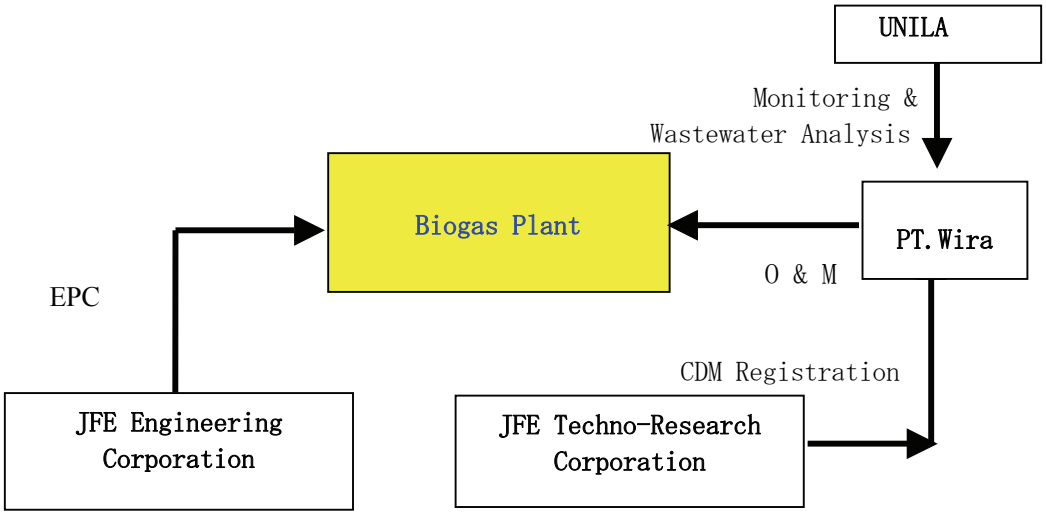

Figure 7 Project Formation

This formation is provisional and requires discussions among the parties for project execution. Participating parties are summarised in Table 9 below.

Table 9 Presumed Project Participants

PDD Preparation	JFE Techno-Research Corporation
Plant Construction	JFE Engineering Corporation firm yet to be determined through technical screening.
Acquisition of CER	A Japanese trading firm yet to be determined (CER to be sold to a Japanese Governmental body)
Plant Operation & Maintenance	PT Wira (yet to be confirmed)
Data Monitoring & Wastewater Analysis	University of Lampung(UNILA)

(3) Funding of the Project

It is presumed that a Japanese trading firm will finance the plant construction based on a scheme to recover the disbursed expense from the subsequent sales of CER and the pocket of PT Wira who will enjoy saving of fuel expense by dispensing with the existing diesel power plant. PT Wira is now spending approximately 140 million yen per year for the diesel power generation. This expense will be saved by operation of the proposed plant. It is expected that PT Wira can afford part of the construction expense within the magnitude of this saving. PT Wira, however, has a plan to expand its operation by increasing the input of cassava after the introduction of the proposed plant. Therefore a specific scope of funding is yet to be discussed among the parties. Figure 8 shows the flow of the project money.

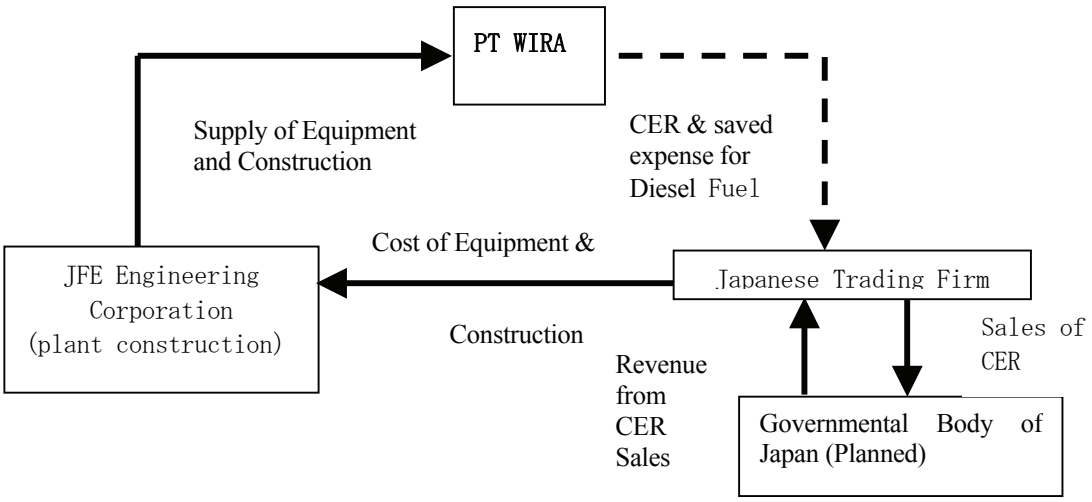

Figure 8 Flow of the Project Money

(4) Provisional Calculation of IRR

Following are conditions for the calculation.

The technology for this project is of the closed fermentation tank system that enables steady methane fermentation with a short hydraulic retention time (HRT). Suppliers of the equipment will be selected from the global market while the construction will be undertaken by a local contractor.

- Initial Investment (Plant Cost): ¥500 million
- Revenue from CER Sales: Trading starts in 2010, and continues even after 2012.
- Saving of Diesel Fuel Expense for Electricity Generation

  By implementing this project, about ¥140 million per year for purchase of diesel oil fuel for electricity generation will be saved. Assumption is made that a Japanese financing party will obtain 75% of this saving for the first three years, and 50% of it for the subsequent four years.

・ Project Duration: 7 years

Table10 shows calculated IRR (before interest and tax). IRR of 10% or more is considered as viable for a feasible project. Result shows the IRR of more than 10%, which is considered reasonably good in terms of commercial feasibility. Time required to recover the initial investment is calculated as four years. (Exchange rate: ¥108/US$)

Table 10 Provisional IRR Calculation

Period of CER Trading	Without CER Trading	With CER Trading		
		@US$10/$tCO_2$	@US$12/$tCO_2$	@US$14/$tCO_2$
7 years	3.7%	11.1%	12.4%	13.7%

In case there will be no market to trade CER after 2012, the IRR is calculated as about 2 % based on the trading price of US$18/$tCO_2$, which makes this project unfeasible.

(5) Risks related to Project IRR

Following four main risks are identified for this project.

・ Availability (amount of collected cassava and days of plant operation)
・ Amount of Wastewater and COD Concentration
・ Recovery Rate of Methane Gas (COD Decomposition Rate)
・ Reimbursement for Plant Construction Cost

The risk that affects the IRR most is that of availability. The lowest number of operation days for the last four years is 191. Result of sensitivity analysis based on this lowest availability is shown in Table 11.

Table 11 IRR Sensitivity Analysis
(Lowest Possible Availability and CER Price)

Period of CER Trading	With CER Trading		
	@10$/$tCO_2$	@12$/$tCO_2$	@14$/$tCO_2$
7 years	3.4%	4.6%	6.2%

In case enough amount of cassava is not secured for the plant operation, number of operation days decreases and so does wastewater volume. This then leads to decrease in recovered amount of methane gas and power generation. This means decrease in CER and in saving of fuel oil expense, thus largely affects IRR negatively.

Recovery of Plant Construction Cost substantially depends on the period of CER sales

and on the project formation. For realization of the project, further discussions among the parties are necessary.

(6) Issues for Successful Project

・Commercial Feasibility

Let alone the need for further minimising the initial investment cost to enhance IRR, continued existence of stable CER market is also indispensable for commercialisation. Keen attention should be paid to the situation after COP15 in 2009.

・Availability of the Plant Operation

As reviewed above, lower availability of the plant operation will negatively affect the project IRR. To minimise this risk, efforts by both public and private sector for the measures such as increase in productivity by breed improvement and introduction of fixed price sales system for cassava are required. By implementing this project, attractive pricing can be expected as a long-term incentive for cassava growing farmers.

・Operation and Maintenance

A certain skill level for operation and maintenance of the plant is necessary to steadily secure CER. In this project, the counterpart is presumed to take this role. At this stage, however, the counterpart is planning this project under the scheme of BOOT (build, own, operate and transfer) where the counterpart will only provide their site for the project and will neither fund the project nor operate the plant by themselves. Efforts to reach a mutual agreement through further explanation will be made. For realization of the project, the principle of burden/benefit sharing due to fluctuation of secured CER and fuel oil saving shall be specifically discussed and agreed upon.

・Time for CDM Registration

It is anticipated to take longer time to register the CDM projects in the host country. It is important to minimise the time loss for this process including selection of a DOE.

13. Conclusion

A CDM feasibility study was made for a project to recover biogas containing high concentration methane gas fermented from the tapioca wastewater. Collected biogas will be fed into a biogas power generation plant that replaces the existing diesel engine power generating plant. Produced electricity will be used only within the tapioca factory. The planned tapioca starch factory for the project is located at Kedaton, East Lampung Prefecture of Lampung Province, Indonesia.

In recent years, it is said that tapioca production cost in Lampung Province is said to be lower than that in Thailand, and that the industry is losing its price competitiveness.

Tapioca producers in Lampung now recognize that application of the proposed technology will realize a considerable cost saving to enhance its price competitiveness of its tapioca starch.

Procedure for CDM project realization has already been established in Indonesia, and 24 projects are now in the process of materialization. Environment and energy related laws and regulations have been also established in each level of the nation, the provinces and the prefectures.

ACM0014/version 01 - a new methodology by combining AM0013 and AM0022- and AMS Ⅲ.H/ Version 08 are the candidate methodologies for the project. As a result of their comparison methodology of ACM0014/version 01 will be applied to this project. The baseline scenario is that the wastewater is treated in the open anaerobic lagoons and that the electricity is generated by fossil fuel for in-house consumption. And the additionality of the project to this baseline scenario has been verified by the "Tool for the demonstration and assessment of additionality" (version 04).

To calculate the reduction amount of GHG (ER_y), analysis of the wastewater of the project site has been made respectively in Japan and in Indonesia (by the counterpart) based on the in-flow COD concentration of 15,000mg/liter and the annual wastewater flow rate of 431,860m^3. According to this analysis, the annual ER_y is expected as about 29,000 ton-CO_2e.

By implementing this project, generation of GHG will be curbed, offensive odour around the site will be reduced, the quality of the wastewater released to the river system will be improved, quality of emissions from power generation plant will be improved. Such favourable impacts on the environment can be expected.

Opinions and comments of concerned parties such as BAPEDALDA (Environmental Monitoring Control Department of East Lampung Prefecture), Climate Change Division of the Ministry of Environment, PT Wira as a counterpart, and President of UNILA as a project partner in the host country have been heard and reflected in the planning of the project.

Project IRR before interest and tax has been calculated based on the project period of seven years and the CER sales price of US$10 or more. Result shows the IRR of more than 10%, which is considered reasonably good in terms of commercial feasibility. Time required to recover the initial investment is calculated as four years. Meanwhile it has turned out that possible decrease in number of days of plant operation will have

significant negative impact on the IRR. To ensure the planned number of operation days or availability of the plant, efforts by both public and private sector for higher productivity by breed improvement and maintaining incentive pricing for cassava are essential. Other issues to be further studied are improving the IRR by suppressing the amount of the initial investment, securing stable CER market after 2012, identifying the party for operation and maintenance of the plant, and risk/benefit sharing among the parties. Additionally, minimising the time required towards materialization of the project is also important since it is said to take too long time before CDM registration of the project in the host country.