

Ministry of Environment Commissioned Project for 2004

CDM / JI Feasibility Study in 2004

**JATROPHA CURCAS**  
**METHYL-ESTER BIODIESEL PROJECT**  
**IN**  
**SOUTH AFRICA**

Project Summary

March 2005

Mitsui & Co. Ltd.

CDM/JI Project Study and Global Warming/  
Clean Development Mechanism Project Study (Summary Form)

(1) Basic elements relating to project implementation

General outline of the proposed Project and background for Project Planning

The Government of South Africa is strongly committed to the international movement to tackle the global warming issue as it ratified the Kyoto Protocol in March 2002 and established the Designated National Agency (DNA) in December 2004. As for CDM projects, the Development Bank of South Africa (DBSA) supports the development and formation of new projects as the local contact for the World Bank's Carbon Credit Fund. The Government is also actively involved in promotion of renewable energy sources. In August 2002, it set forth a target to increase supply of renewable energy (biomass, wind power, solar, etc.) by 5% toward the year 2012.

The proposed Project follows this move and is designed to produce and sell bio-diesel oil from *Jatropha Curcas* seeds – at a rate of 100,000 tons per year – to chemical companies in South Africa and elsewhere, for the purpose of using it as fuel in mixture with the ordinary diesel fuel, thereby to reduce CO<sub>2</sub> and SO<sub>2</sub> emissions and to gain the carbon credit.

In addition, as the Project includes the establishment of *Jatropha Curcas* plantations for a stable sourcing, it will ultimately create around 50,000 jobs, including the bio-diesel oil refinery and the plantations, thereby contributing to the reduction of the unemployment rate and regional development in the country.

General profiles of the host country

The Republic of South Africa has a land area of approximately 1.22 million km<sup>2</sup>, which is around 3.2 times of that of Japan. It belongs to the anticyclonic, subtropical climate with relatively dry weather. It has 44.83 million populations, of which blacks account for approximately 80%, while Christians represent 80% of the total. The country was democratized in 1994. The present Mbeki administration, with an aim to cope with the poverty and underdevelopment issues, implements policies and programs to create employment opportunities through economic development and to build the social security system to promote the eradication of poverty. At present, the country is classified into one of middle-income economies, with GDP per capita of approximately \$2,600, but there is a large disparity between the rich and the poor.

The country's major industries are agriculture, mining and manufacturing. Thanks to rich mineral resources including gold and diamond, the country maintains a trade surplus, \$38.5 billion (export) vs. \$34.7 billion (import) in 2003.

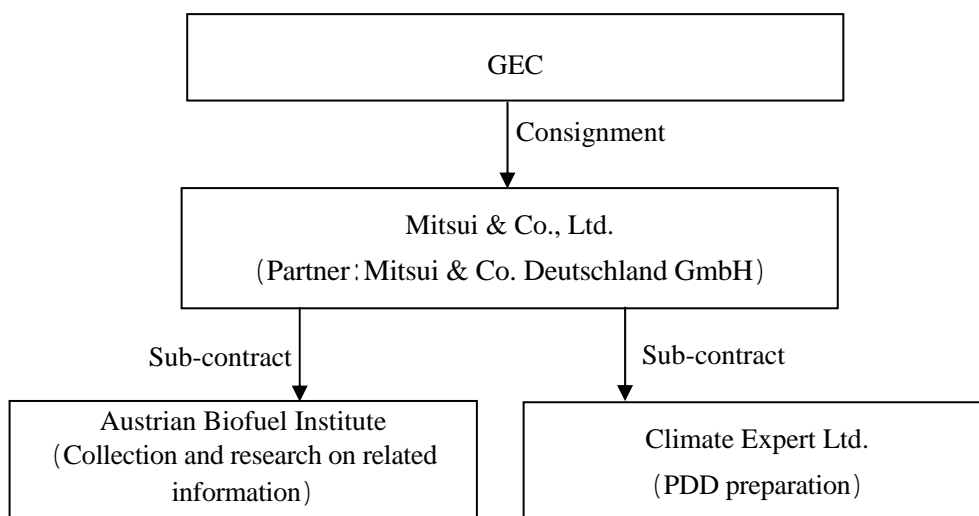
While the country is endowed with rich coal reserves, it lacks petroleum and natural gas. To correct the energy structure, South Africa has a company to produce coal-liquefied fuel, world largest of this kind. Furthermore, the Government aggressively introduces and commercializes renewable energy sources as well as biomass fuels.

Policy and current state relating to CDM/JI, including the host country's criteria to accept CDM/JI and the current state of DNA installation

The Government of South Africa ratified the Kyoto Protocol in March 2002, and the country has been categorized in a Non Annex I Party, which does not become obliged to reduce global warming gas emissions until 2012. The Government has been actively involved in formation of CDM projects. In December 2004, the Designated National Agency (DNA) was established within the Department of Mineral and Energy to develop a framework for accreditation of actual CDM projects, such as reduction of emissions and emission trading. In particular, South Africa has a very high potential for CDM formation as it emits 363 million tons of CO<sub>2</sub> annually, which account for 3.4% of global warming gas emissions in the world. In Africa, it has the largest potential for reduction of global warming gases and third country to develop CDM project following to China and Brazil.

Study implementation structure (local, host country, others)

This study has been implemented to study a feasibility of the project to construct the bio-diesel oil refinery in South Africa and its viability as a CDM project. It was conducted under the following scheme.

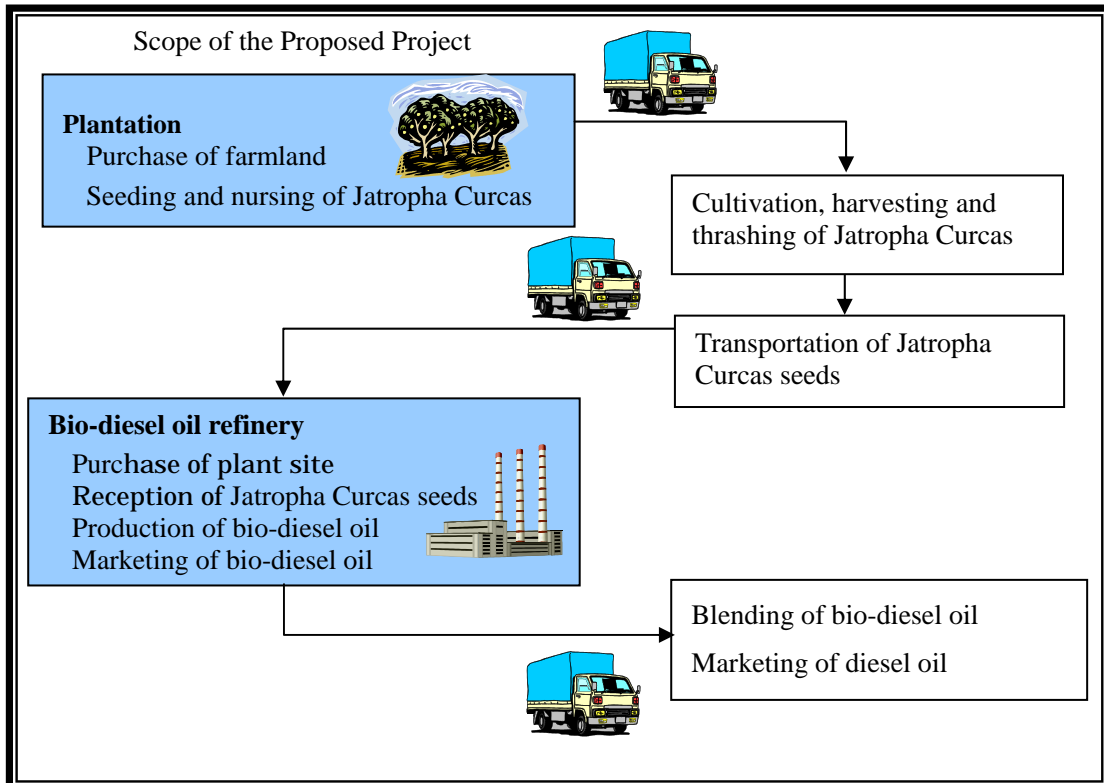


## (2) Project design

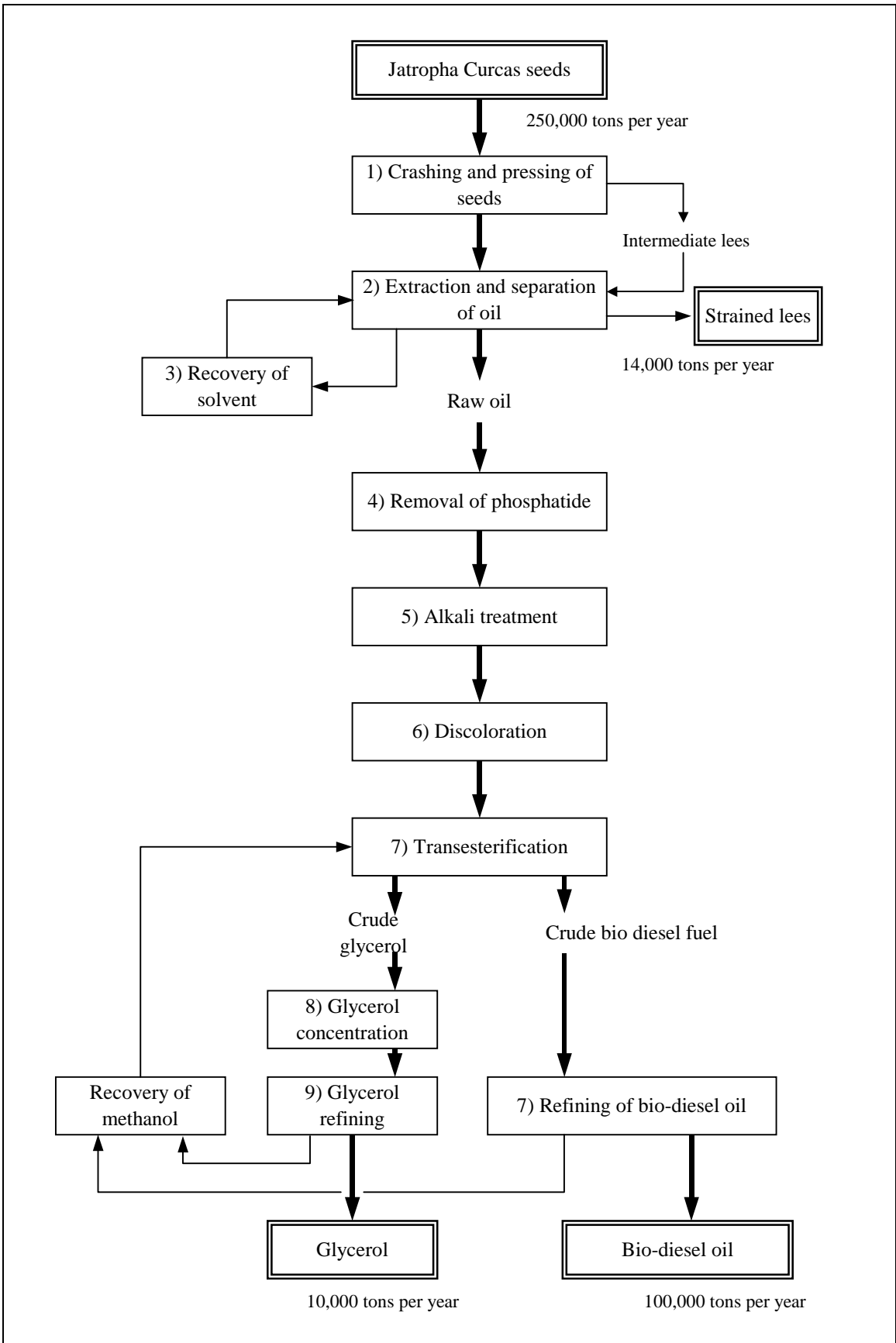
### Project description

The proposed project is designed to develop *Jatropha Curcas* plantations, collect and extract oil from *Jatropha Curcas* seeds, and produce bio-diesel oil through the esterification process to react the *Jatropha Curcas* oil with methanol.

The scope of the project is illustrated as follows.



The plant site will be located within the Richards Bay Industrial Development Zone, uMhlathuze, uThungulu District Municipality, Kwazulu-Natal. The bio-diesel oil refinery has the following processes: crushing and pressing of *Jatropha Curcas* seeds; oil extraction and separation; recovery of solvent; removal of phosphatide, alkali treatment, discoloration, esterification conversion, glycerol concentration, and glycerol refining. The block flow of the refinery process is shown below.



Investment requirements for the proposed project are summarized as follows.

No.	Item	Cost	
		Rand	US\$
1)	Acquisition of farmland for cultivation of <i>Jatropha Curcas</i> (plantation)	105,000,000	16,154,000
2)	Acquisition of plant site	6,200,000	947,000
3)	Construction work	18,000,000	2,770,000
4)	Equipment and Machinery (CIP)	110,500,000	17,000,000
5)	Installation work	22,100,000	3,400,000
	Total	261,900,000	40,271,000

Note: exchange rate – 6.5 Rand/US\$

Project boundary, the baseline, and the additionality

Project boundaries are established as follows:

- Farmland for *Jatropha Curcas* cultivation
- Transportation to the bio-diesel oil refinery
- Refinery
- Transportation from the refinery to the bio-diesel oil station
- Bio-diesel oil stations
- Vehicles powered by bio diesel fuel

The baseline was established using the lifecycle assessment technique and for the following three stages.

- Stage 1: Cultivation of *Jatropha Curcas*
- Stage 2: Production of bio-diesel oil
- Stage 3: Consumption of bio-diesel oil

The baseline was established as follows:

While *Jatropha Curcas* is cultivated, there will be no additional removal of CO<sub>2</sub>. Fossil fuel-based diesel oil is used in an amount equivalent to bio-diesel oil to be produced under the proposed project, which will cause emissions of global warming gases.

Verification of the additionality:

Given the following barriers, it is verified that the proposed project has an additionality as a CDM project.

- In South Africa, no project similar to the proposed one is not implemented, which indicates a presence of a technical barrier.
- Feasibility analysis indicates the IRR of 4.4%, which is much lower than the long-term interest of 11.5% in South Africa. Thus, the project is not attractive to investors unless the carbon credit is created. As a result, there is an economic barrier.

- In South Africa, bio-diesel oil to be produced under the proposed project is not produced at all, which indicates a presence of a barrier to penetration to customers.

#### GHG reduction (CO<sub>2</sub> absorption) and leakage due to project implementation

The GHG reduction is estimated at approximately 260,000 tons per year (tCO<sub>2</sub>eq), which is equivalent to 2.6 million tons of CO<sub>2</sub> for the overall credit period of 10 years. The calculation result is explained as follows.

- GHG emission due to the project : 98,000 tons/year (tCO<sub>2</sub>eq)
- Leakage : 12,000 tons/year (tCO<sub>2</sub>eq)
- Total GHG emission due to the project : 110,000 tons/year (tCO<sub>2</sub>eq)
- Baseline emission : 370,000 tons/year (tCO<sub>2</sub>eq)
- GHG reduction : 260,000 tons/year (tCO<sub>2</sub>eq)

#### Monitoring plan

After implementation of the project, monitoring will be conducted for the items listed below for the purpose of verifying the actual GHG reductions.

No.	Data used	Data source	Unit	Measurement(m)/calculation(c)/estimation (e)	Recording frequency	Monitoring coverage	Data recording media (electronic/paper)
P1. FF <sup>BFP</sup> <sub>heavy oil, y</sub>	Steam supplied to the process plant (CO <sub>2</sub> from fuel oil boilers)	Gravimeter and other instruments	[kilo liter]	m	Daily	100%	Electronic
P2. COEF <sup>FF</sup> <sub>heavy oil</sub>	Fuel oil's LCA CO <sub>2</sub> emission factors (including the oxidization factor)	Statistical data provided by fuel suppliers or scientific research papers	[tCO <sub>2</sub> / kilo liter]	c	Once in the beginning of the credit period	100%	Electronic
P3. BF <sup>mass</sup> <sub>y</sub>	Annual sales volume of bio-diesel oil	Gravimeter	[ton-BioFuel]	m	Daily	100%	Electronic
P4. COEF <sup>FS</sup>	CO <sub>2</sub> emission factors due to no-bio-originated materials contained in the bio-diesel oil	-	[tCO <sub>2</sub> /ton-BioFuel]	c	Once at the time of PDD preparation	100%	Electronic
P5. PE <sup>Transpl</sup> <sub>y</sub>	CO <sub>2</sub> emission relating to transportation from plantations to the refinery	-	[tCO <sub>2</sub> /yr]	c	Monthly	100%	Electronic
P6. EN <sup>TR</sup> <sub>model, y</sub>	Energy consumed by transportation mode i	Receipt	[kilo liter]	m	Monthly	100%	Electronic
P7. COEF <sup>TR</sup> <sub>model i</sub>	CO <sub>2</sub> emission factor for transportation mode i	Statistics	[tCO <sub>2</sub> / kilo liter]	c	Once at the time of PDD preparation	100%	Electronic
P8. PE <sup>Plantation</sup> <sub>N<sub>2</sub>O<sub>y</sub></sub>	N <sub>2</sub> O emission due to use of fertilizer in plantations	-	[tCO <sub>2</sub> eq/yr]	c	Monthly	100%	Electronic
P9. Fertilizer <sup>n</sup> <sub>y</sub>	Fertilizer consumption	Gravimeter	[ton-fertilizer]	m	Monthly	100%	Electronic
P10. UREA_EQ <sup>n</sup>	Urea equivalent factor of fertilizer (N component)		[ton-urea/ton-fertilizer]		Every time when fertilizer is changed		Electronic

<sup>1</sup> "Transportation mode" includes rail, road, maritime, and other modes of transport.

Environmental impacts/other indirect impacts (including risk study for reforestation)

The Government of South Africa has been focusing on environmental policy. After setting forth a general framework for environmental policy by publishing the White Paper on Environmental Management in October 1997, the Government enacted the Environmental Management Law in 1998 to promote harmonization of environmental laws and regulations of different departments and agencies, requiring related departments to develop the “environmental implementation plan” and the “environmental management plan” every four years.

While efforts are being made to establish stricter environmental standards under the following principles prescribed in the new Environmental Management Law, they have not been established yet to this date.

To construct the project facilities, environmental impact assessment is required under the Environmental Management Law. It will be conducted by the project implementation body, “Bio-Diesel Oil Refining Company (tentatively named),” according to the procedures and methods set forth in the law, once the implementation of the project has been decided.

Environmental impact assessment will be checked and approved by the Environment Bureau covering the plant site.

Comments from stakeholders

As the proposed project has a good prospect for making significant contribution to the South African Government’s policy on the promotion of renewable energy and on supporting CDM projects, not to mention the job creation effects, it is expected that the strong cooperation of the South African Government and other counterpart organizations can be expected. . As it is planned to find formal partners that participate in the project on the basis of the results of the proposed study, the detailed implementation plan will be prepared in the process of selecting partners and developing a detailed project plan.

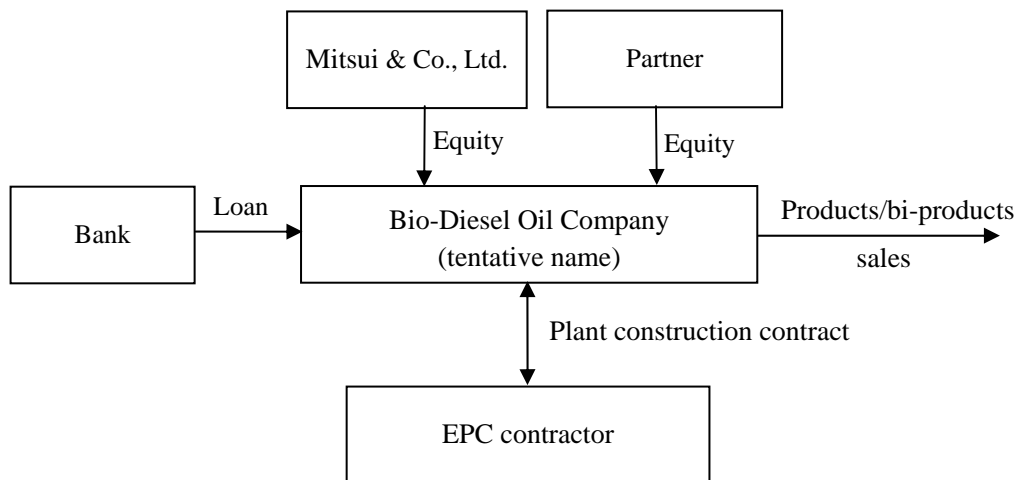
(3) Commercialization

Project implementation structure (Japan, host country and others)

The proposed Project will be implemented by a private company to be established in South Africa, which will own and manage the Jatropha Curcas plantations and the bio-diesel oil refinery.

The company will be founded under equity participation of Mitsui & Co., Ltd. and some leading companies in South Africa and Europe. As Mitsui is to call the partners after verification of the further study, partners and their contribution have yet to be decided.





#### Financial plan for project implementation

The total amount of investment required for construction of the proposed project is estimated at around \$40 million, which will be financed as follows.

Total investment requirement US\$40 million	<table border="0" style="width: 100%;"> <tr> <td style="padding: 5px;">Owned capital (equity)</td> <td style="padding: 5px;">US\$16 million ( 40% )</td> </tr> <tr> <td style="padding: 5px;">Loans</td> <td style="padding: 5px;">US\$24 million ( 60% )</td> </tr> </table>	Owned capital (equity)	US\$16 million ( 40% )	Loans	US\$24 million ( 60% )
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Low-cost, long-term loans can be obtained from the following financial institutions, provided that the South African government provides guarantee.

- Financial institutions in South Africa
- Japanese Bank of International Cooperation (JBIC) export or overseas investment loans
- Multi-lateral agency loans such as the World Bank group and the Asian Development Bank

#### Cost/benefit evaluation

As outlined above, the proposed project consists of the refining of bio-diesel oil and the cultivation of *Jatropha Curcas* seeds. Thus, it is characterized as a self-support project that combines a forestation project to absorb CO<sub>2</sub> in the air and a refinery project to produce a fuel alternative to the existing diesel fuel.

It should be noted, however, that cultivation of *Jatropha Curcas* will not meet demand for seeds to be used for refinery operation in the startup stage, and the raw material should be imported from neighboring countries for two years.

The project will produce bio-diesel oil and pharmaceutical-grade glycerol. In consideration of market prices and other factors, the internal rate of return on investment (IRR ROI) is calculated to be at 4.43%, which is not considered profitable.

#### Prospect for project implementation and major issues

Profitability is the concern for the realization of this project, and it is the key how to manage the variance of the products and feedstock price.

To implement the proposed project successfully, the following factors are critical; (1) to select good partners; (2) to operate the *Jatropha Curcas* plantations commercially to ensure steady supply of *Jatropha Curcas* seeds for bio-diesel oil production; (3) to find markets for two principal products, bio-diesel oil and glycerol/strained lees; and (4) to obtain the carbon credit as expected in order to raise the project's profitability.

Market opportunities for the proposed products are described as follows.

#### **Bio-diesel Oil**

The following companies are considered as potential customers for bio-diesel oil.

- SASOL (the largest oil & petrochemical company in South Africa)
- De Beers (diamond mining)
- BHP Billiton (aluminum smelter)
- Moss gas (national gas company, producing liquid fuels (gasoline, diesel fuel, etc.) from natural gas)

Actual terms and conditions, such as the amount of purchase, and time and means of delivery, will be negotiated in parallel with the actual progress of the project.

#### **Glycerol**

Protea Chemicals (local pharmaceutical manufacturer) shows interest in purchasing pharmaceutical-grade glycerol.

Product quality is a critical factor for glycerol trade. Negotiation will be made with Protea Chemicals in parallel with the actual progress of the project, by offering product specifications expected from the project.

#### **Strained lees**

As strained lees obtained from pressing of *Jatropha Curcas* seeds cannot be used for animal feed because of toxicity, they will be used as organic fertilizer under the project. At the same time, research and study will continue to develop and commercialize a technique to remove toxicity for animal feed use.

(4) Validation / determination (if the project is implemented)

Outline of validation (determination) or desk review

- Out of scope

Progress of discussion with OE

- Ditto