10.3 MW PALM OIL WASTE TO ENERGY POWER PLANT AT PANGKALAN BRANDAN SUMATRA, INDONESIA

1. Project Description

The Government of Indonesia has announced five initiatives to follow-up the UNFCCC ratification in 1994 :

- Promoting the utilization of renewable energy;
- Promoting the utilization of clean energy and energy-efficient technology in industrial and commercial sectors;
- Promoting the efficient use of energy;
- Gradually eliminating energy market distortions through stepwise removal of various subsidies; and
- Restructuring the energy sector to allow more participation of private entities.

Demand for electricity outside the islands of Java and Bali (especially in Sumatra) continue to increase rapidly, besides the fact that blackout occurs more often as a result of old generators. Many generator replacement and energy efficiency projects have been put on hold by PLN due to lack of funding. Therefore, initiatives to develop power generation units using local resources have been planned, although these have been delayed again.

Since April 2000, the government has taken steps to gradually accelerate schemes for the removal of subsidized prices for petroleum products and electricity. These steps have resulted in increase tariffs of electricity and oil refinery products. However, further policies to support undertaking in realizing GHG emissions reductions initiatives still need to be established. If no prudent policy measures are implemented, Indonesia may become a net oil importing country in 2010 because of national oil reserve constraints.

The well-established palm oil industry of Indonesia opens an alternative and renewable way of providing electricity. The palm oil industry must dispose about 1.1 ton of empty fruit bunches (EFB) for every ton of crude palm oil (CPO) produced. This biomass waste could be utilized to fuel a power plant generating electricity for sale to either national or local grid. A palm oil mill processing 200,000 ton/year fresh fruit bunches (i.e. producing 40,000 ton/year crude palm oil) could supply a power plant with 44,000 ton/year fresh EFB (65 % moisture content). As the heating value of dry EFB is 15.5 MJ/kg then, at 25 % energy conversion efficiency, this amount of EFB is equivalent to a generating capacity of 1.9 MWe. According to Directorate General of Estate Crops, Ministry of Agriculture, 5.3 million ton of EFB was produced throughout Indonesia in 1997. Utilization of this amount of EFB as power plant fuel would potentially result in generation of 229 MWe.

The project described in this report is a power plant combusting 220.000 ton/year empty fruit bunches (EFB) in a specially designed high-pressure boiler and generating 10.3 MW electricity with a steam turbo-generator. The plant will be located in Pangkalanbrandan (regency of Langkat), a small town about 80 km northwest of Medan, the capital city of North Sumatra province (see Map). The EFB is collected from six existing palm oil mills and transported to the site. EFB is a technically challenging fuel due to high moisture content, fibrous nature and the high potential of the ash to slag in the furnace. Equipment has been specifically designed for dealing with this waste. The estimated economic life of the power plant is 20 years.

The objective of this project is to generate electricity for sale to the grid of PLN (the State Electricity Company of Indonesia) through utilization of surplus biomass residue from palm oil mills. This renewable energy project will offset the requirement of diesel generation to satisfy the ever-growing demand of electricity in the surrounding area. Thus this project would fit well to the principles and rules of Clean Development Mechanism (CDM). Potential estimated net reductions in Greenhouse gases (GHGs) emissions are 55,650 ton CO_2-equivalent per year.

Figure 1. Map of Indonesia

Figure 2. Map showing Pangkalanbrandan in Northern Sumatra

The project fits in with the national drive for the inclusion of renewable energy technologies. With the recent implementation of regional autonomy, the regional PLN will be looking to source alternative means of electrical production.
This is particularly important in areas like North-Sumatra, which have an electricity deficit and require additional generation to support communities and industries. The project will provide many social and economic benefits and aid rural electrification, in accordance with government objectives.

The ultimate beneficiary of the project is the local community in the province of North Sumatra (especially in the area of Langkat and the neighborhood regencies), who would obtain a new supply of clean electricity from a power plant operating in their own area. The Indonesian local economy would benefit from the injection of US$6 million in local goods and services, up to 150 construction jobs and 42 permanent direct jobs. Indirect jobs and economic activities, e.g. for the transportation of the EFB fuel, will also be created in the surrounding area. In addition, the project will strengthen Indonesia's palm oil industry structure and aid rural electrification.

The other beneficiaries and stakeholders that will favorably be affected by or interested in the project are local and provincial governments, PT Catra Nusantara Bersama (CNB), Bronzeoak Limited, McBurney Energy Systems Ltd., PT Indonesia Power, PLN (State Electricity Company), Indonesian Palm Oil Business Association (Gabungan Pengusaha Kelapa Sawit Indonesia, GAPKI), Indonesian Renewable Energy Society, IRES (Masyarakat Energi Terbarukan Indonesia, METI), Center for Research on Material and Energy ITB (CRME-ITB), Directorate General of Electricity and Energy Utilization (DGEEU), Ministry of Energy and Mineral Resources.

2. Partner in Host Country

An independent joint venture company formed by PT Catra Nusantara Bersama (CNB), Bronzeoak Limited, and PT Indonesian Power (IP, a daughter company of PLN) will operate the power plant. The Annex 1 investor may also become a joint venture partner. Center for Research on Material and Energy

(CRME) Bandung could help coordinating the activities between the host and the Annex 1 investor. The Indonesian government is supportive of the project both directly and indirectly.

3. Project Scope/Boundary

The selected project site is located 1.5 km from an existing Pangkalanbrandan electrical substation of PLN (State Electricity Company) and close to a river of adequate size to ensure the security of make up water supply. The project scope is to utilize palm oil mill residues as fuel and produce electricity for uploading to the medium voltage (MV) side of the substation through a dedicated interconnection circuit at 20 kV.

CNB and Bronzeoak have already entered into a memorandum of understanding with IP for procuring the power produced. The boundary of the project for the purpose of monitoring and verification of Certified Emission Reductions (CERs) will be the physical boundary of the project.

4. Emissions Baseline Technology

New power plants are needed to satisfy the ever-growing demand of electricity energy in the surrounding area. Existing power plants run on fossil fuels and has environmental problem, particularly handling liquid waste and pollutant. This renewable energy project will provide 10.3 MW electricity and offset the requirement for diesel generation. The CO_2 emission of the latter technology is 0.87 kgCO_2/kWh.

5. Emissions Estimation and Monitoring and Verification Approach

The parameter that needs to be monitored for verification of CERs is power production. For this, the power sold and billed to the PLN will be used. CO_2 emissions from the baseline technology will be calculated from the produced power, electricity generation efficiency of a diesel power plant of comparable capacity, and other factors.

To estimate emissions reductions from an energy efficiency or fuel substitution project, the energy savings are estimated first and then translated into emissions reductions using fuel or grid electricity emissions factors. These emissions factor should be the same ones used to set the baseline emissions.

The methods used for estimations on this project :

1. on-site emissions : estimation using default emissions factors based on utility [IPCC];
2. on-site electricity savings and demand reductions : engineering algorithm method; and
3. upstream emissions reductions (emissions coefficients).

Assumptions and approaches used in the methods to monitoring and verification of GHG emissions reductions :

- ♦ lower energy savings due to market leaders/free riders effects will be cancelled out by increased savings from "free drivers" and market transformation effects outside the boundary, and vice versa; and
- ♦ "rebound effect" is very small and can be neglected.

6. Project Components and Costs

The capacity of the Pangkalanbrandan power plant would be 10.3 MW. The capital cost of the project is estimated to be USD 16.5 million. The components of investment costs are described in Table 1.

The time period that credits arising from the project can be claimed is not necessarily equal to the operational lifetime of the project activity. There are two options for the crediting period of CDM project :

- ➢ An initial period of seven years, which may be renewed at most twice – for a total of twenty-one years; or
- ➢ A maximum of ten years with no option of renewal.

The crediting period for this CDM project is ten years with no option of renewal. This option has been taken for the purpose of calculations.

The Protocol requires that 2% of CERs from CDM project activities be deposited into a designated CDM registry (account) to help meet the costs of adaptation. In addition to the provision to fund adaptation, a share of proceeds from CDM project activities will also be garnered to cover administrative costs. For this CDM project, the adaptation levy and administrative expenses are USD 3,950. Revenues generated via sales of CERs in the registry –which is administered by the Executive Board- will be forwarded to the countries in which CDM projects took place, and where there is a need for addressing the impacts of climate change.

Table 1. Investment costs

No.	**Components :**	**Cost (USD)**
1	Purchased equipment	6.740.315
2	Piping	782.860
3	Electrical works	52.190
4	Instrumentation	521.910
5	Utilities	52.190
6	Foundation	365.340
7	Insulation	104.385
8	Painting, fire protection, safety, miscellaneous	104.380
9	Yard improvement	52.190
10	Environmental control	521.910
11	Building	260.960
12	Land	104.380
13	Standby Gen-set for start-up	104.375
14	Grid inter-connection	104.380
15	Engineering services	521.910
16	Contractors fee	521.910
17	Contingency	1.304.770
18	Offsite facilities	1.069.910
19	Start up costs	1.069.910
20	Working capital	2.139.825
Total investment		**16.500.000**

Table 2. Equipment costs

No.	Equipment :	Cost (USD)
1	Fuel Preparation (Shredder)	874.080
2	Dryer	959.780
3	Boiler	2.144.160
4	Baghouse & Cooling Tower	140.045
5	Boiler feed water/deaerator	270.435
6	Steam turbine/generator	714.720
7	Cooling water system	318.725
8	Plant Control Syst.&Inf.	461.430
9	Water Treat. Plant	197.755
10	Laboratory Equipment	395.510
11	Workshop Equipment	263.675
Total Purchased Equipment		**6.740.315**

7. Investment Plan

In general, most companies will participate in the CDM to obtain emissions reduction credits to help meet their domestic emissions reduction targets in an economically efficient manner. However, companies that have no requirement to reduce GHG emissions may also choose to gain ownership of credits through the CDM at a low price to sell on the international market at a future date.

Regardless of the motive, a company participating in the CDM may choose from a variety of financial options :

- Full or Partial Equity – a company finances all or co-finances part of a CDM project in return to full or shared financial returns and emissions reduction credits;
- Financial Contribution – a company provides a financial contribution towards the cost of a CDM project equal to some portion of the incremental cost of the project over and above the baseline technology, or finances the removal of market barriers, in return for emissions reduction credits;

- Loan – a company provides loan or lease financing at concessional rates in return for emissions reduction credits; or
- Certified Emissions Reduction Purchase Agreement – a company agrees to buy certified emissions reduction credits as they are produced by the project.

The project will be funded by a long-term loan from a financial institution up to 60 percent of the project capital cost. The project joint venture partners will fund the rest of the investment required by way of equity. The Annex 1 investors can participate in the project through various options such as:

- Long term commitment to buy CERs at a (i) pre-determined price or (ii) reference price;
- Participation in equity along with commitment to buy back CERs at a pre-determined price or at market price at the time of generation of CERs; or
- Soft loan against likely realization of CERs.

8. Financial and Credit Analysis

Table 3 is shown the calculation of Internal Rate on Return (IRR) for total project and the CDM investor.

Table 3. Financial analysis

Project cost	USD 16.5 million
Means of financing	Debt 60% Equity 40%
Rate of interest on term loan	12% per annum
Plant load factor	82%
Annual electricity generation	10.285 million kWh
CERs generated per year	56,500 (tCO_2)
Proceeds to CDM Executive Board	2% of CER proceeds
Operatinal cost	USD 1.6 million
Calorific value of fuel	1,052 kcal/kg
Rate of fuel	USD 0.027/kg
Rate of power supply	USD 0.0625/kWh
Annual O & M expenses	1.0% of project capital cost
Project IRR without CDM funds	19.5%
IRR at CER price of USD 3.5	21.3%
IRR at CER price of USD 5	22.1%
IRR at CER price of USD 7.5	23.6%

Based on data in Table 2, this project promises Internal Rate on Return (IRR) value 19.5%. This IRR is higher than rate of interest on term loan (12%). So it concluded that this project is feasible and profitable.

Table 4. Operating and Maintenance Costs

No.	Components :	Cost (USD)
1	Raw materials	860.655
2	Utilities	141.900
3	Operating labor	339.855
4	Labor related cost	78.760
6	Consumables	137.790
7	Operating supplies	16.095
8	Local taxes, insurance	7.030
10	Research & Development	13.965
11	Adaptation levy and administrative expenses	3.950
Total Operational cost		**1.600.000**
12	Maintenance	500.000
Annual O & M expenses		**1.650.000**

9. Sensitivity Analysis

Estimation of the sensitivity of the financial viability and GHG emissions to changes in these parameters:

- investment cost
- power purchase
- manufacturing cost

In the same manner as described in Table 3, thus some principal things that can be concluded are :

- the change of investment cost that implemented in isn't make big impact to IRR value. If investment cost more bigger, thus more less profit could be get, then on the contrary;
- the change of power purchase very impact to IRR value. Decrease of profit –state as Net Present Value (NPV)- by change of selling rate is very steep then others variables. But decrease of sales until 10%, the project is still make a profit refer to IRR value 14.5% if compare with rate of interest on term loan 12%;

- the change of manufacturing cost is less impact then the change of investment cost and power purchase. Figure 1 shows that increase of manufacturing cost until 20%, still make a profit by IRR value 16% at rate of interest on term loan 12%.

Table 5. Sensitivity analysis

Internal Rate on Return (IRR)					
%-change	**-20**	**-10**	**0**	**10**	**20**
Investment cost	27,9	23,2	19,5	16,5	14,0
Manufacturing cost	23,0	22,6	19,5	17,7	16,0
Power purchase	9,6	14,5	19,5	24,6	29,8

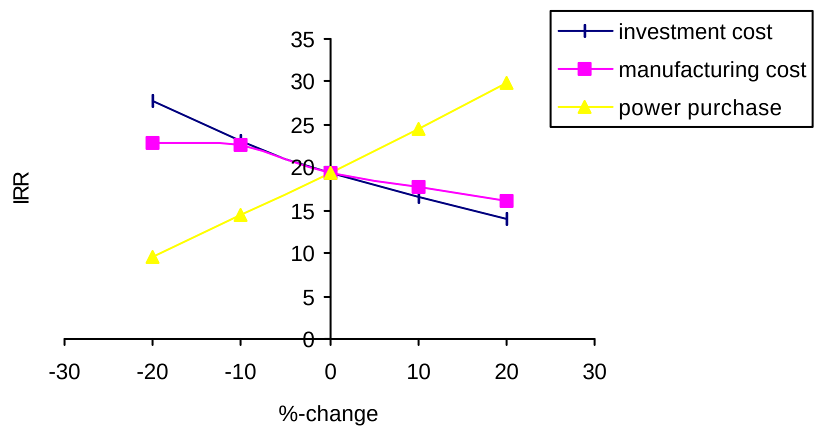

Figure 3. Sensitivity curve