BIOMAS POWER PLANT
FROM WASTE ENERGY PALM OIL

Oleh
Dr. Ir. Didik Notosudjono Msc.
Dekan FT Universitas Pakuan
Researcher BPP. Teknologi

SEMINAR NASIONAL KOPERTIS WILAYAH IV
TEKNOLOGI INOVATIF YANG EFISIEN DAN EFEKTIF
2006 - JATINANGOR 18 JULI 2006

Biomass Power Plant
From waste energy in Palm oil

Oleh
Dr. Ir. Didik Notosudjono Msc.
Dekan FT Universitas Pakuan
Researcher BPP. Teknologi

ABSTRAC

Use of renewable energy addresses all three of the pillars of sustainable development: economic progress, development and social improvement, and an improved environment. Some renewable energy technologies are maturing rapidly and are increasingly cost competitive. For example, micro hydro and biomass are often the most cost effective options to provide energy services in off-grid areas in developing countries. This is particularly important in areas like Sanggau Regency, West Kalimantan province especially for Gunung Meliau area, which has an electricity deficit (shortfall) and requires additional generation to support existing communities and industries. The project will provide many social and economic benefits and is consistent with and supported by government policy for rural electrification. The biomass technology for electrical power generation has been in service in the POM for some time. However, the current technologies are deliberately designed to be inefficient as they serve a dual function for energy production and as a solid waste reduction technology. In my Presentation the biomass power plant is an efficient and reliable automatic system. The design originates from a typical steam power plant where the main motive driver is steam generation for processing by the boiler. The energy in the steam is also expended in steam turbo alternators to also generate electrical energy.

Pemanfaatan Energy terbarukan ditujukan kepada 3 pilar utama dari pembangunan yang berkelanjutan, yaitu : kemajuan ekonomi, Pembangunan dan perbaikan social serta pemeliharaan lingkungan hidup. Beberapa teknologi dari energi terbarukan telah berkembang dengan cepat dan harga kompetitif yang cenderung meningkat. Sebagai contoh, mikrohidro dan biomassa merupakan pilihan harga yang paling kompetitif untuk menyediaan pelayanan energi listrik dalam area Off-Grid di negara berkembang. Hal ini terutama sekali sangat penting dalam daerah seperti Kabupaten Sanggau, Provinsi Kalimantan Selatan terutama di daerah Gunung Meliau dimana terdapat kekurangan energi listrik dan memerlukan pembangkit listrik tambahan untuk mendorong komunitas masyarakat yang tinggal di daerah tersebut dan juga sektor industri. Proyek ini akan menyediakan manfaat aspek sosial dan ekonomi secara konsisten dan didukung oleh kebijaksanaan pemerintah untuk listrik pedesaan. Teknologi Biomassa untuk pembangkitan energi listrik telah dikembangkan dalam POM sejak beberapa tahun lalu untuk keperluan lokal Pabrik. Desain yang dipkai kurang efisien ketika mereka melayani fungsi ganda untuk produksi energi listrik dan sebagai teknologi pengurangan sampah padat. Pada Presentasi ini ,Pembangkit Listrik Biomassa menjadi efisien dan secara otomatis dapat dipercaya. Desain tersebut berasal dari pembangkit listrik tenaga uap dimana penggerak utamanya adalah pembangkit uap untuk pemrosesan menggunakan boiler. Energi yang dihasilkan dalam bentuk uap juga digunakan di dalam alternator turbo uap untuk membangkitkan energi listrik.
Keywords : Pembangunan yang berkelanjutan, Energi Terbarukan, Biomassa

I. BACKGROUND

The biomass power plant is an established technology for energy conversion using the steam power generation concept. The main difference is the use of mainly EFB as the source of fuel. Recent developments in pre-processing EFB to eliminate clinker formation have greatly enhanced the operational efficiencies of this technology. It is now feasible for biomass power plants to convert large amount of POM biomass into useful energy and also resolve the solid waste disposal difficulties and associated air

emissions, particularly those that are incinerated or indiscriminately dumped.

The largest energy source used for electricity generation in West Kalimantan is originally from fossil fuel (typically diesel oil). This energy sources are being used by both PT PLN (persero) Wilayah West Kalimantan or by private company to meet their electricity demand (captive power). Referring to the statistic data of PLN, the West Kalimantan province has an installed electricity capacity of 298.81 MW comprising of Diesel power plant of 264.81 MW (include rental) and 1 unit Gas Turbine of 34 MW (fuelled with high speed diesel/HSD). This total capacity excludes captive power of 170 MW owned by private companies. The captive power is mainly diesel based generation.

Electricity generation in West Kalimantan consist of 6 (six) independent sub systems and 1 (one) isolated/spread system, namely Pontianak System (151.9 MW), Singkawang Sambas System (53.3 MW), Ketapang System (17 MW), Sanggau System (10 MW), Sintang System (11.6 MW), Putussibau System (5.7 MW). This 7 system is not interconnected to each other, except Pontianak and Singkawang System.

Sanggau system consist of 11 unit diesel power plant (10 unit of PLN and 1 unit rental), whereas captive power in Sanggau Regency is around 12.220 MW.

II. BASIC DESIGN CONCEPT

The basic design of the biomass power plant is based on a steam power plant. Steam is generated in a boiler at appropriate pressure and temperatures. The steam would be used to turn the turbines and the turbine turns the alternator that produces electricity. The electrical energy would be used for some house loads while the remaining amount could be exported into the existing nearby power grid.

The proposed power plant would be a 7.4 MVA or 5.92 MWe power plant comprising of main plant and equipment for a steam power plant. The steam boiler design is a Danstoker 24.8 t/h, 68 bar, 450 ^{0}C with inclined vibrating grate capable of combusting pre-treated EFB of moisture content 40% and wood at 25 mm^3 complete with front end EFB fuel treatment and handling plant, and back end de-ashing system. The power generating unit is a Shinko 7.4 MVA (5.92 MWe) at power factor 0.8 capable of handling a maximum of 25,000 kg/hr of steam at 450 0C and 50 bar.g pressure. The fully condensing system is equipped with water cooled cross flow cooling tower with total circulation of 1,600 m3/hr with guaranteed evaporation and drift loss not exceeding 2 % of circulation water. The specific steam consumption of the turbine is about 4.22 kg/kWh. Other plant parameters such as control system, raw water intake, civil and structural and other soft cost such as financing, interest during construction and miscellaneous on-site expenses are included in the estimate. shown in picture 1

Picture 1 Alternative Biomass Power Plant

The most critical component of the power plant will be the high pressure boiler. The boiler with capacity of 24.8 tons per hour delivers steam at 50 bar.g pressure and 450 degrees C temperature. The high quality steam also determines the efficiency of conversion to mechanical and electrical power where the typically 17-22kg/kWh specific steam requirement is reduced to about 4-5kg/kWh. The complete and efficient combustion reduces particulate emissions and the about 85% of the energy from the biomass can be transferred into the steam media.

The turbine is a multistage fully condensing turbine that will be able to turn a 7.4MVA turbo alternator to produce 5.92 MWe of electricity at a power factor of 0.8. The turbine is equipped with cross flow cooling tower to condense the steam for the subsequent cycle of steam generation. The system has been tested in several locations in Malaysia and the performance is predictably good.

The summary of the cost structure is shown in table 1 : Project Cost Structure of 5 MWe Biomass Power Plant .

Table 1 : Project Cost Structure of 5 MWe Biomass Power Plant

Table 1 : Project Cost Structure of 5 MWe Biomass Power Plant

ITEM	**EPC Cost**	**Unit Price USD**	**Quantity**	**Total**
A	**EPC**			
1	Preliminaries & General	11,650.00		111,650.00
2	Proprietary Items	40,000.00		40,000.00
3	Civil and Structural Works	670,390.00		670,390.00
4	Water Treatment	168,364.86		168,364.86
5	EFB dewatering, cutting and reduction system	302,327.93		302,327.93
6	Steam (Boiler) generation	2,304,307.21		2,304,307.21
7	Power (Turbine) generation	2,861,400.00		2,861,400.00
8	Control & monitoring system	153,700.00		153,700.00
9	Electrical works	876,030.00		876,030.00
	Sub Total EPC			**7,488,170.00**
B	**Other Costs**			
1	Land (Client Owned)	1.35	30.000 m2	40,500.00
2	Pre-Development		0,75% EPC	56,161.28
3	License	5,000.00	1	5,000.00
4	Professional fees		8% EPC	599,053.60
	Sub Total Other Costs			**700,714.88**
C	**Financing Fee & Contingencies**			
1	Financing Fees		1.25%	86,199.94
2	Interest During Construction		12%	827,519.38
3	Contingencies-for turnkey EPC cost		10% EPC	748,817.00
	Sub Total Financing Fee & Contingencies			**1,662,536.32**
	TOTAL PROJECT COST			**9,851,421.19**

The summary of Operational Expenditure is shown in table: Table 2: Operational Expenditure Summary.

Table 2: Operational Expenditure Summary

Item	**Description**	**% of EPC**	**USD**
	Fixed Costs		
1	Salaries & Related Costs (Per Annum)		111,600.00
2	Maintenance cost plant		137,985.61
4	General & Admin Costs		114,580.00
3	Major Overhaul - every 5 years	5%	374,408.50
5	EPC Insurance	0.50%	37,440.85
	Total Fixed Costs		**776,014.96**

	Variable Costs		
1	Biomass Fuel cost		183,286.09
2	Other operating expence		70,840.00
	Total Variable Costs		**254,126.09**
	Total Fixed And Variable Cost		**1,030,141.05**

III. RAW MATERIAL STRATEGY

Supply of EFB and PKS would come from several palm oil mills at Gunung Meliau cluster. The dewatered EFB intended for incinerator in the POMs could be sent to central biomass power plant that can efficiently convert the energy from the biomass into heat and power. The assessment of the raw material availability is further described below.

For the purpose of raw material analysis, the four out of four POM near to the proposed biomass power plant site in Gunung Meliau Cluster were surveyed. The POMs were evaluated on the current operational conditions as well as the current alternative use of the EFB.

Among the POM visited, PT Perkebunan Nusantara XIII unit Gunung Meliau (PTPN XIII Gunung Meliau) is considered as the anchor POM where a considerable amount of the EFB will be secured from the POM. It is also close to the proposed biomass location. Treatment of the PTPN XIII Gunung Meliau POM is intentionally is more elaborate in this report. Please refer to the map in.

PTPN XIII Gunung Meliau has the potential to supply EFB and shell. The POM capacity is 60 tons FFB/hr, mill processing an average of 800-1,000 tons/day FFB operating for 300 days a year. The annual FFB volume is about 233,000 tons and the POM receives 90% of its owned plantation and the rest (10%) of its fruits from private suppliers.

Currently, the mill processes 16,000 tons FFB/month (average at low crop) and may increase to 21,000-25,000 tons/month during peak crop (August December). The average operation time of the mill at low crop is 14 hours/day while at the peak crop may reach 20 hours/day.

The POM generates EFB at an average of 23% FFB and 100% of EFB produced is disposed of in the palm plantation. The mill produces fibers of about 11% of FFB from which 100% of it is sent into boiler. PKS of about 6.5% of FFB are also used as fuel for the boiler (30%), the rest (70%) is for road hardening. At early operation (start up) of the mill the electricity is supplied from the diesel generator. The average diesel fuel consumption is 750 liter/day when the boiler operation is extended but it may increase up to 1500 liters/day during low crop. The POM uses about 20,000-40,000 liters/month of diesel purchased at industrial rate.

The diesel is used for the generation of electricity primarily for the use of the POM housing estate when the POM is not operating. Two unit of 370 kVA generating set are supplemented for electricity generation. Total electricity

required for mill operation and domestic use is in the range 1,000 to 1,100 kWe.

The POM is equipped with three biomass boilers, a 3x25 tons/hr, 21 bar.g Takuma boilers. These boilers supply steam for processing in the mill and generate power. Three power generation units are 3 x 700 kVA Shinko backpressure steam turbo alternators with 3.5 backpressure steam delivered for process. The specific steam consumption of the turbo alternator is around 17 kg/kWh
.

Table 3 : Availability of PKS For Cluster Project

No	POM	Size t/h	FFB t/yr '000	PKS used as fuel	PKS available t/yr '000	
1	Gunung Meliau	60	233	30%	15.1	10.6
2	Rimba Belian	30	158	50%	10.2	5.1
3	Bintang Harapan Desa	30	150	50%	9.75	4.8
4	Surya Borneo Indah	30	150	50%	9.75	4.8
Total PKS available for the Cluster Project (1000 t/y)						25.3

Note: The biomass availability in Bintang Harapan Desa and Surya Borneo Indah are assumed as the sites were not surveyed by the team.

IV. CLEAN DEVELOPMENT MECHANISM

The biomass power plant can also attract the revenues from sale of CER. For a proposed 5 MWe block exporting power for 8,000 hours a year replacing diesel, the potential CO_2 emission reduction at a rate of 0.8 kg/kWh is 29,000 tons per year. Assuming the prevailing rate of USD 7.2 /ton CER, the annual potential income from CER 211,000 USD.

V. CONCLUTION

The environmental benefit of the biomass power plant is displacement of fossil fuel diesel. Utilization of mineral diesel result in generation of CO_2 emissions that will be replaced by CO_2 emissions from RE. The utilization of biomass power plant will decrease utilization of fossil fuel diesel and therefore overall gas emission will decline.

One of the main concerns of PLN with respect to biomass power plant is the continuous availability of biomass. The

supply of fuel is a critical issue in any power generation plant. Hence a well defined fuel procurement and management strategy need to be established. Experience in Malaysia shows that the bankers (lenders) would want to see a good long term contract and a well defined fuel management strategy in order to achieve financial closure.

VI. REFERENCE

1. Abdulkadir, Ariono,;Sotion Arjanggi. : Pemikiran Tentang Harga Listrik Dalam Rangka Menunjang Penyediaan Tenaga Listrik Secara Berkesinambungan, KNIWEC, 31 Agustus – 2 September, Jakarta,1993.
2. Energiewirschaftliche Planung fuer die Netzintegration von windenergie in Deutschland an Land und Offshore bis zum Jahr 2020 (dena-Netzstudie)
3. Google Image Result for www_tiscali_co_uk-reference-encyclopaedia-hutchinson-images-c04929_jpg.htm
4. GTZ, Masterplans for Electric Power Supply,TZ-Verlagsgesellschaft mbH, Rossdorf 1 Germany,1980.
5. Fink, Horst; Oelet; Gerhard, : A guide to the Financial evaluation of Intvestment Project in Energy Supply, GTZ, Eschborn, 1985.
6. Notosudjono Didik, dkk, Date Base Renewable Energy in Indonesia, BPP. Teknologi-UNESCO, Jakarta, 1999.
7. Notosudjono Didik, Ländliche Entwicklung durch erneuerbare Energie - Energiepotentiale, Entwicklungs- und Marketingkonzepte in Indonesien, Universitaet Flensburg, Germany, 2000.
8. Notosudjono Didik, Ir,Msc.,Strategi Pengembangan Penyediaan Energie Terbaharukan di Daerah Pedesaan dan Kemungkinan untuk kegiatan Produktsi, Lokakarya Energie 1993,KNIWEC, Jakarta Indonesia.
9. Notosudjono Didik,Ir,Msc., Rencana Terpadu untuk Adaptasi teknologi di Pedesaan Indonesia, Prosiding Presentasi Ilmiah, Direktorat Teknologi Energie, BPPT, Desember 1992, Jakarta Indonesia.
10. Notosudjono Didik, Ir.Msc, dan Abubakar Lubis, Drs, MSc, Hybrid System (small Wind Energy and DC Diesel Generator Sets) for Electricity in the village Ciparanti, Western Java, Windpower'93 san Francisco, CA, July 12-16, 1993.
11. Notosudjono Didik, Ir. Msc. Selbstbau Wasserkraftanlagen auf Bali und Kecamatan Doko sowie Möglichkeiten ihrer Optimierung für Produktive Nutzung, Universität Flensburg, Flensburg, 1991
12. KNIWEC, Penyediaan Tenaga Listrik secara berkesinambungan, Jakarta, September 1993.
13. KNIWEC, Penerapan Teknologi Tepat guna dalam Penyediaan dan Penggunaan Energie yang berwawasan lingkungan, Jakarta, Oktober , 1994

RIWAYAT HIDUP

Nama : DR.Ir.Didik Notosudjono Msc.
Tempat dan Tgl. Lahir : Kediri, 24 September 1960

Lulus sarjana Teknik Elektro Universitas Brawijaya Malang

1991 *Lulus Magister Scientiae di Universitas Flensburg Germany di bidang renewable energy*

2001 Lulus Program Phd.(S3) di Bidang renewable energy di Universitas Flensburg Germany. Dengan konsentrasi renewable energy dan Konsep Marketing.

- *Staff Pengawasan Teknis di Biro Pengawasan 1985 –1991.*
- *Kepala sub Bagian Pengawasan Teknis Perlengkapan 1991-1994*
- *Kepala Bagian Pengawasan Teknis Perlengkapan 1994-1995*
- *Peneliti di Bidang renewable energy di Direktorat Pusat Pengkajian dan Penerapan Konversi dan Konservasi Energi, BPP. Teknologi sejak 1991.*
- *Ketua Kelompok Konversi dan Konservasi Energi di Direktorat Pusat Pengkajian dan Penerapan Konversi dan Konservasi Energi, BPP. Teknologi sejak 2002.*
- *Dosen Teknik Tenaga Listrik di beberapa Universitas di Jakarta dan Bogor sejak 1985-1994*
- *Ketua Jurusan Teknik Tenaga Listrik di Universitas Ibnu Khaldun, 1991-1995.*
- *Dekan FT dan Ketua Jurusan Teknik Tenaga Listrik di Universitas Surapati 1992-1995*
- *Dosen pasca sarjana (S2) di Sekolah Teinggi Ekonomi di Jakarta dengan konsentrasi Marketing dan MPO.sejak tahun 2000.*
- *Kepala Instalasi Keselamatan Sistem Laboratorium di Lembaga Biologi Molekuler Eijkman sejak 1999*
- *Pimpinan Proyek di Lembaga Biologi Molekuler Eijkman, sejak 2000.*