PALM OIL BIOMASS FOR ELECTRICITY GENERATION IN MALAYSIA

By: NA Ludin[1], MA MBakri[1], M Hashim[1], B Sawilla[1], Ir. NR Menon[2], H Mokhtar[3]
[1]Pusat Tenaga Malaysia [2]Malaysia Palm Oil Board [3]SIRIM Berhad

INTRODUCTION

The target share of renewable energy is 5% of the total energy supply by the end of the Eighth Malaysia Plan. Biomass residues from the oil palm sector have been identified as one of the biggest potential resources of energy to meet the target. Even though statistically this resource is widely used in Malaysia for heat and power generation through combustion, it is being utilised inefficiently. A few studies show that the excess power from a combined heat and power plant using palm oil biomass is viable to be connected to the national grid system. Currently, the total power generation capacity from oil palm residues for internal consumption is about 211MWe.

However, this fuel resource should be pretreated before it can be burned in the boiler. A simple pre-treatment process is required for the effective use of biomass such as using a shredding machine to reduce the size and moisture content. Utilisation should be improved through an efficient biomass technology.

Palm oil mill effluent (POME) is the waste water discharged from the sterilisation process, the crude oil clarification process and the cracked mixture separation process. POME produces a huge amount of methane gas from its anaerobic process and methane has 21 times the Global Warming Potential (GWP) compared to the other gasses. However the GWP problem can be solved, if methane is utilised as fuel for power generation and cogeneration. Notwithstanding the huge potential, the existence of proven technologies and the availability of knowledge and incentives, biogas utilisation is still in a very early stage in Malaysia.

DEVELOPMENT AND COMMERCIALISATION OF BIOMASS ENERGY

The Eighth Malaysia Plan is a period to test, demonstrate and even commercialise several initiatives arising from a number of RE feasibility studies and awareness programmes undertaken in the last two years. A study conducted by DANCED in 1999 showed that the annual RE potential was estimated at 36.2MTOE with an equivalent value of more than RM26 billion. It was also estimated that the gross RE potential will be at 823MTOE for the period between 2000 to 2020 based on the equivalent average price of RM95 per barrel of oil. Findings and recommendations of the project form the basis of recent official statements on RE.

IMPLEMENTATION OF THE SMALL RENEWABLE ENERGY POWER PROGRAMME (SREP)

The launch of the Small Renewable Energy Power Programme (SREP) on 11 May 2001 is among the steps being taken by the Government to encourage and intensify the utilisation of renewable energy in power generation with the target 5% of total electricity generation by 2005. In terms of capacity, the 5% would translate into 500MW installed at the end of Eighth Malaysia Plan period.

Small power generation plants which utilise renewable energy can apply to sell electricity to the Utility through the Distribution Grid System. Under this Small Renewable Energy Power Programme, the utilisation of all types of renewable energy, including biomass, biogas, municipal waste, solar, mini-hydro and wind, are allowed. The maximum capacity of small renewable energy plants designed for sale of power to the grid must be 10MW. A Special Committee On Renewable Energy (SCORE) has been set up under the then Ministry of Energy, Communications and Multimedia (now the Ministry of Energy, Water and Communications) to coordinate the programme. A secretariat functioning as a one-stop centre at the Energy Commission facilitates industry participation in the programme.

Up to today, 62 SREP projects have been approved (Table 1). Out of these approved projects, 32 projects use biomass as the fuel source, of which 25 of them use palm oil wastes, and the other 7 projects use rice husk, wood waste, municipal waste and bagasse. In addition to biomass-fuelled projects, there are 5 landfill gas projects and 25 mini-hydro projects. However, due to the lack of financial support and other difficulties, only 6 SREP developers have requested for and were given licenses to proceed with the implementation of their projects.

IMPLEMENTATION OF THE BIOMASS-BASED POWER GENERATION AND COGENERATION IN THE MALAYSIAN PALM OIL INDUSTRY (BIOGEN)

To further catalyse the development of the SREP programmes, the government has implemented a national project called the **Biomass-**

TABLE 1: STATUS OF SREP PROJECTS APPROVED BY SCORE AS OF SEPTEMBER 2004

No.	Type	Energy Resource	Approved Application	Grid Connected Capacity (MW)	%
1	Biomass	Empty Fruit Bunches	25	165.9	52.8
		Wood Residues	1	6.6	2.1
		Rice Husk	2	12.0	3.8
		Municipal Solid Waste	1	5.0	1.6
		Mix Fuels	3	19.2	6.1
2	Landfill Gas		5	10.0	3.2
3	Mini-hydro		25	95.4	30.4
4	Wind and Solar		0	0.0	0.0
	Total		**62**	**314.1**	**100.0**

based Power Generation and Cogeneration in the Malaysian Palm Oil Industry project, which now is in its second year of implementation. This project will facilitate the maximum utilisation of the excess wastes from palm oil mills for power generation in reducing the greenhouse gas (GHG) emissions in Malaysia. For the year 2003, the project has prepared the groundwork to develop the first Full Scale Model (FSM) project. The project is expected to launch its first FSM soon and three more are expected during the Second Phase of the project (2005-2008). A Renewable Energy Business Facility (REBF), which will serve as the financial support mechanism for the FSM's development, has now been set up.

The strategy involves the implementation of barrier-removal activities, including the implementation of biomass-based grid connected power generation and CHP in Malaysia. The BioGen Project, which will be carried out over a five-year period, represents collaborative efforts of the global community in the form of United Nations Development Programme (UNDP) and Global Environment Facility (GEF) together with the Malaysian Government and private organisations. This five-year project consists of two phases, the first phase being a two-year project with 2003 as the start of the first year. Phase 1 begins with activities that are considered technical assistance, focusing on the removal of primary barriers that hinder the widespread application of biomass-based power generation and cogeneration using both biomass and biogas generated from biomass resources. Phase 2, a three-year activity, will involve the implementation of an innovative loan/grant mechanism that will be worked through the Malaysian banking sector. However, the approval of Phase 2 depends on availability of resources from financing sources and the successful implementation of Phase 1.

FIRST GRID CONNECTED BIOMASS-BASED POWER GENERATION PROJECT FROM THE PALM OIL INDUSTRY

TSH Bio-Energy (TSHRB) is the first local company to sell renewable energy from oil palm waste to Sabah Electricity Sdn Bhd (SESB), which is 80% owned by TNB. TSHRB expects its 14MWe renewable energy biomass power plant at Kunak, Sabah to be commissioned in October 2004 to generate an annual profit of RM8–10 million (€1.75–2.2 million) through the sale of power to SESB. This company will sell up to 10MWe at 21.25 sen (€ cents 4.66) per kWh through a 21-year renewable energy power purchase agreement (REPPA) to SESB. This plant will use palm oil residues such as Empty Fruit Bunches (EFB) or Fibre/Shell, providing an effective avenue to dispose the processed residues from palm oil milling activities while generating additional income. This project is the first Palm-EFB-Fired Grid Connected Cogeneration Plant with a high pressure modern boiler of 80 tonne/hour, 66.5 bar(g) and 402°C in the world. It is also the first EFB-fired boiler employing the well-proven Vibrating Membrane Grate in South East Asia (COGEN 3 and SIRIM, 2004).

The total investment costs amount to €9 million, excluding civil works and building foundations. The expected pay back period is 4 years after

commissioning. The boiler pressure parts, as well as the Vibrating Membrane Grates, are designed by world-renowned BWV, but fully fabricated locally at ENCO's modern factory in Rawang, Selangor. The boiler materials are imported from Germany and France, while the high pressure boiler fittings and instrumen-tation are also sourced from Europe. The boiler is constructed with fully-welded membrane walls, with only sealing refractory works. The boiler's overall height is about 25 metres. It is fitted with a steam drum of approxi-mately 10 metres in length with a shell wall thickness of 60 mm, and weighs approximately 28 tonnes dry. The boiler house is fitted with an elevator to facilitate vertical travel by the boiler operators. The boiler control system is fully-automatic, controlled by a PLC in conjunction with a SCADA system. The whole control system is designed by ENCO, together with input from BWV and other local partners (COGEN 3 and SIRIM, 2004).

This project will provide socio-economic benefits to the surrounding area, as up to 40 locals will be employed for the operation of the plant. It is estimated that between 40,000 to 50,000 tonnes of carbon dioxide (CO_2) will be mitigated annually (COGEN 3 and SIRIM, 2004).

POTENTIAL OF BIOMASS ENERGY RESOURCES

A large portion of renewable resources are contributed by biomass, namely oil palm waste and wood waste, which are used to produce steam for processing activities and also for generating electricity. Biomass fuels contribute about 16 percent of the energy consumption in the country, out of which 51 percent comes from palm oil biomass waste and 27 percent, wood waste (Hagler Bailly, 2000). Other biomass energy contributors are from plant cultivation, animal wastes and urban wastes. There are currently more than 300 palm oil mills in operation, which self-generates electricity from oil palm wastes not only for their internal consumption but also for surrounding remote areas. Studies also found that 75.5 percent of the potential biomass that can be harnessed in Malaysia is unutilised and wasted (Lim, et. al. 1999.)

OIL PALM SOLID RESIDUES

The oil palm industry generates solid residues during the harvesting, replanting and milling processes. The residue that comes from the milling processes are fruit fibres, shell and empty fruit bunches. Other residues such as trunks and fronds are available at the plantation area. Currently shells and fibres are used as boiler fuel to generate steam and electricity for the mill's consumption. The empty fruit bunches is returned back to the plantation for mulching. This is only practiced for bigger plantations such as Golden Hope, Guthrie, Sime Darby and United Plantation. For old palm oil mills, the empty fruit bunch is burned in the incinerator to produce fertilizer. However, there are still a few companies disposing of the empty fruit bunches using the landfill method, particularly mills without enough plantation or estates.

A study on alternative uses of oil palm biomass residues indicates that there is a huge amount of readily exploitable oil palm residues to be utilised as fuel for power generation in Peninsular Malaysia (Koh, 2002). Although the quantum of oil palm residues available to be utilised as fuel in electricity generation is a key factor in assessing the viability of projects that use these residues for power generation, there are also other aspects that need to be studied. These include assessing the economic and financial costs and returns, technological, environmental and other factors to determine the viability of the projects (PTM, 2003).

OIL PALM LIQUID RESIDUES

The overall power generation potential from effluent treatment can be estimated based on the calculated methane yield from anaerobic POME treatment. According to the Malaysia Palm Oil Board (MPOB), 0.65m^3 POME is generated from every processed ton of Fresh Fruit Bunch.

TABLE 2: POTENTIAL POWER GENERATION FROM PALM OIL MILL SOLID RESIDUES

Type of Industry	Production (Thousand tonnes)	Residue	Residue product Ratio (%)	Residue Generated (Thousand tonnes)	Potential Energy (PJ)	Potential Electricity Generation (MW)
Oil palm	59,800	EFB at 65%MC	21.14	12,641.7	57	521
		Fibre	12.72	7,606.6	108	1032
		Shell	5.67	3,390.7	55	545
	Total			**16,670.6**	**220**	**2098**

Based on the annual figure of 59,800,000 tons of Fresh Fruit Bunches processed, the resulting effluent generation is 38,870,000m^3. Assuming that the effluent is treated properly under anaerobic conditions, the total methane production amounts to 0.707×10^9 m^3. The calorific value of methane is stated as 10 kWh/m^3. The annual energy content of the generated methane gas can be calculated to be 7.07×10^9 kWh. Based on a conversion efficiency of 38 percent (gas engine), the potential annual electrical power generation would be 2.69×10^9 kWh. Assuming 100 percent availability of the conversion system results in an installed power generation capacity of 306 MW from POME derived methane gas.

In spite of the huge potential for biogas utilisation in Malaysia especially in the palm oil industry, only very few operational biogas utilisation applications could be identified. Deployment of biogas technologies such as the anaerobic biogas reactor would further lead to a drastic reduction of GHG emission and could also become a profitable energy business in the future.

CONCLUSION

Biomass is an important energy source. Its main application is not only in the traditional domestic sector and small-scale industries, but also in modern systems for cogeneration and power generation. Oil palm residues have a huge potential for power generation. The potential power generation from the oil palm residues is about 2418MW based on the annual operating hours of 6100 and this output can be further improved if an efficient technology is implemented. However there are a lot of barriers that hinder the development of biomass power projects, such as fuel security, electricity pricing, competitiveness, alternative use of the fuel, etc. Other sources of biomass like paddy straw, rice husks and wood waste can also potentially be developed as fuel for power generation and cogeneration. In 2002, it is estimated that about 205.46MW of potential power generation can be harnessed from these biomass resources.