FEATURE ARTICLE

GREEN ENERGY EVOLUTION IN PALM OIL MILLS

N. Ravi Menon

Malaysia is one of the few countries in the world, where oil palm biomass is grossly underutilized. While most of the fibre and shell are used for power generation in the mill, large quantities of empty fruit bunches (EFB) are either mulched in plantation or are thrown away. Although mulching does help in conditioning the soil and contribute towards some fertilizing function, its overall advantage for this purpose is not significant enough to reject its use as a boiler fuel. Another problem associated with mulching is its non-consistent evacuation from the mill resulting in large backlogs, sometimes accumulating into menacing proportions.

While the developed nations are swinging towards green energy with whatever biomass they have, we appear to be lacking in dynamism in surging forward and be either with them or be ahead of them. The direction taken by countries like Denmark and USA in green energy evolution is the future direction for all of us as world reserve of fossil fuel is finite and its depletion is certain. Every one knows that. Do we have to wait till it is totally depleted before we start thinking of alternative sources of fuel? Of course, it will not happen during our lifetime but then the future generations will have to face this reality.

Co-generation using oil palm biomass is not new to palm oil industry. Ever since we started our first mill, we had been doing this although we did not connect the generated power to the national grid. There is no new technology involved. We do not have to import any technology from developed countries. This is something which every palm oil mill is capable of doing. So what is the obstacle? EFB is needed by the plantation as there are big savings in fertilizer cost if used for mulching. But if its use as a boiler fuel in power plant can give better returns, why not go for it? At the same time, there is no more evacuation problems and the mill will look tidy all the time.

If all the wasted fuel from the plantation and mills are converted to electrical energy, the country can save a lot of money in foreign exchange by cutting down fuel imports. If palm oil price is the same as the imported fuel and palm oil stock is not moving, it can easily be substituted for fuel oil to maintain its price. The palm oil mill biomass fueled boilers can be designed to burn either empty bunches or palm oil. The calorific value of palm oil is close to diesel oil and its viscosity after heating should not pose any great problem in burning if properly atomized. It may be difficult for some to visualize boilers operating on palm oil and hence, the resulting difficulty in shifting their paradigm as the concept appear to be new.

All along, palm oil mills have been generating electricity for mill machinery operation as well as for domestic consumption of mill personnel. All they need to do is expansion of the operations to supply some of the power generated with the excess fuel to the national grid. Once started and the mills start earning the extra money, it is likely that the concept will pick up momentum and more biomass generated-electricity will flow to the grid. The biomass potential in our plantation is big as the trunks and fronds also can serve as possible fuels in specially designed combustion chambers of boilers. In Malaysia, we make boilers and all mill machinery and in this respect, we do not need technical assistance from outsiders. All we need is the confidence that we can do it and do it well.

Let us take a critical look at some of the statistics we have and try to analyse them. In 1999, the palm oil mills in Malaysia produced 56.5 million tonnes of FFB. Approximately, 18 kWh is needed to process 1 t of FFB. This means that approximately 1 million MWh electricity was produced by the mills in Malaysia to operate the mills. If we assume that we used all the shells and fibre for this, we still have the empty bunches for additional power generation.

If EFB production rate is approximately 23% to FFB, we would have produced 13 million tonnes of EFB in 1999. Every tonne of this can produce 938 860 kJ of heat in a boiler [at a boiler efficiency of 0.5 (the worst case) and EFB nett calorific value of 8164 kJ kg^{-1} at 50% moisture level]. Heat required to raise the temperature of water at 28 °C at atmospheric pressure and heat to 21 bar (a) pressure with a super heat of 45 °C is 2765 kJ kg^{-1} steam.

Hence, 1 t of EFB can generate 340 kg of superheated steam at 21 bar (a) from water at ambient temperature and pressure. Thus, 13 million tonnes of EFB can produce approximately 4.5 million tonnes of steam. Using this in a condensing turbine consuming 9 kg steam kWh^{-1}, this can generate 500 million kWh of electrical energy. This is worth

RM 85 million at 17 sen kWh^{-1}. Even if we are capable of utilizing only one-fourth of this due to practical limitations, we can still earn RM 20 million a year.

Let us take a typical 60 t FFB hr^{-1} mill and analyse the full energy potential of the mill. Some of the assumptions are approximate but reasonably accurate.

The biogas can be used in other ways as well. As it contains 60% to 70% methane and 30% to 40% carbon dioxide, partial removal of carbon dioxide can make this a suitable fuel for the combustion chamber of 70 kW micro gas turbines, which are gaining popularity in USA. Even in individual houses, they operate these micro power generators running on natural gas or gasoline. One such unit is already in Malaysia and awaiting trials with palm oil mill biogas. The methane has to be enriched to make it suitable to operate these generators.

Fibre/shell production rate at 18% to FFB	= 10.8 t hr^{-1}
Steaming potential at 3.5 kg steam kg^{-1} fuel	= 37.8 t hr^{-1}
Mill steam consumption at 450 kg t^{-1} FFB	= 27.0 t hr^{-1}
Balance steam available	= 10.8 t hr^{-1}
Production rate of EFB at 23% to FFB	= 13.8 t hr^{-1}
Steaming potential from EFB at 0.344 t t^{-1} EFB	= 4.8 t hr^{-1}
Total surplus steam available for co-generation = 10.8 + 4.8	= 15.6 t hr^{-1}
Assuming consumption of 9 kg steam kWh^{-1} in a condensing turbine, energy produced	= 1733 kW
If mill operated average 16 hr day^{-1}, energy available	= 27 728 kWh
At 17 sen kWh^{-1}, revenue per day	= RM 4714
For 300 days yr^{-1}, mill revenue = RM 4714 x 300	= RM 1.4 million

Probably, the money generated is all you need to operate the plant for the whole year. You can process the crop free of charge!

Till recently, we were burning the EFB in incinerators to recover bunch ash at the rate of 0.5% to FFB. In this case, we are trying to use the heat to raise steam to produce electrical energy. Unlike incineration, which often causes choke ups in peak-crop months resulting in EFB backlogs, boilers can wipe them clean and the mill will not have to suffer EFB backlogs. The end result is a clean mill and additional revenue.

In addition to this, once the mills get started with grid connected co-generation, they are not going to stop with just empty bunches. The other sources of fuel like biogas, even palm trunks or fronds may find their way to the mill boiler furnace because there is money to be made. At the moment, there is no real incentive to recover the large quantity of biogas liberated from the mill effluent ponds which is slowly and surely damaging the ozone layer. Let us look closely at this potential which nobody is claiming has better uses. It can be considered to be something that is not only wasted but is harmful to environment.

The biogas production rate is approximately 14 m^3 t^{-1} FFB processed. Using the average gross calorific of 22 000 kJ Nm^{-3}, the biogas has a heating value 308 000 kJ t^{-1} FFB. This means for 56.5 million tonnes of FFB processed in 1999, we lost something like 17 402 million kiloJoule of energy to the atmosphere. Converted to steam, this would have produced 6.38 million tonnes of superheated steam at 21 bar (a) capable of generating 700 million kWh of electric energy at an estimated value of RM 119 million! This is what we willingly and deliberately waste in one year.

In USA, the households having the micro power generators sell power in excess of their requirement to the grid. The concept of *distributed generation* based on putting generators close to consumption is gaining popularity. In *Business Week* (30 August 1999), some interesting feedback on the changing paradigms just like personal computers (PC), which replaced most of the main frame computers – something nobody dreamt of a few decades ago.

Personal power plants have come a long way from the 20th century, when they mostly made a racket on camping trips. Now they are everywhere, purring like a kitten. Sure there are still central generating plants, just as there are still main frame computers. But the hot trend is distributed generation putting generators close to consumption. That way, the utilities can dismantle their nuclear and coal fired plants and there is no need to tear up the streets to place power distribution cables.

The future prediction quoting *Business Week* is:

"Most everybody has a personal turbine (PT?) in the 21st century. They can run on palm oil or manure gas, keep things purring in the house and if there is excess you can sell it back to the grid."

This looks like reality of the future and resisting this trend will only drag us backward preventing us from rising towards our goal of being a fully developed nation.