Clean and Efficient Biomass Cogeneration Technology in ASEAN

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For more than 10 years, the EC-ASEAN COGEN Programme has been supporting the implementation of proven, clean and efficient biomass cogeneration projects. New technologies from Europe have been introduced in the ASEAN rice, sugar, palm oil and wood sectors. Some biogas plants have also been implemented in other sectors.

In the meantime, institutional frameworks in most South East Asian countries have been adjusted to promote the use of renewable energy in general and biomass in particular. Small Power Producer programmes have offered the possibility for agro-industries producing more biomass residues than what they actually needed to cover their own energy requirement, to sell excess power to the national grids.

Those measures encouraged the industries to replace their old, inefficient and polluting energy plants by modern efficient and clean equipment to optimise the conversion of their rice husks, sugarcane bagasse, oil palm wastes and wood residues into useful energy.

The demonstration projects that have been implemented are now considered as reference projects in ASEAN. Their replication in the whole region opens a new potential for new power capacity of several thousands of MWe.

Examples of the implemented projects, their technical characteristics and their economic and environmental benefits are presented.

1. Introduction

Many ASEAN industries such as sugar, palm oil, rice and wood have been utilising biomass as a fuel to cover some or all of their energy requirements. Biomass is one of the most important sources of renewable energy in the region. Despite its wide use already, there is still much to be done to optimise the utilisation of biomass for cogeneration.

Power-demand growth in ASEAN is still high. Favourable government policies and financing conditions for cogeneration have stimulated the development of small as well as large cogeneration systems in wood and agro-industries. These systems provide the energy necessary for the industrial operation. Excess energy can also be sold to nearby industries or to the national grid.

2. Biomass Cogeneration in ASEAN

Most ASEAN countries are large producers of wood and agricultural products which, when processed in industries, can produce large amounts of residues, varying between 20 to 70 % of the raw material input. These residues often have a very low economic value, sometimes even negative, because of the costs involved in disposing

them. Every year, more than 120 million tonnes of biomass residues are generated in the region, which could be used to fuel high efficiency cogeneration with a capacity of about 10 GW. An increasing trend for biomass related industries is to use cogeneration to satisfy their energy demands and to boost profitability.

In the sugar industry, bagasse is the fibrous residue produced after the extraction of juice from sugarcane. It has traditionally been used as a fuel to produce power and steam for internal consumption in the mills. In ASEAN, cogeneration in most sugar mills today is still limited to outdated equipment using conventional steam thermal technology based on old cogeneration plants. The equipment comprises basic conventional low pressure boilers with spreader stokers operating at 20-25 bar and back pressure turbines. Modern installations are operated at 40 bar and above using extraction-condensing turbo-generators. They can produce up to 3 times the amount of power generated by conventional systems. Excess power is then exported to the grid.

In the palm industry, as much as 70% of the fresh fruit bunches (FFBs) are turned into wastes in the form of empty fruit bunches (EFBs), fibers and shells, as well as liquid effluent. Fibres and shells are traditionally used as fuels to generate power and steam. Effluents are sometimes converted into biogas that can be used in gas-fired gensets.

Like sugar mills, palm oil mills have traditionally been designed to cover their own energy needs (process heat and electricity) by utilising low pressure boilers and back pressure turbo-generators. Heat and power demand in the palm oil industry is generally met by operating low-pressure horizontal fixed-grate three-pass boilers of a simple design producing saturated steam at 15-20 bar.

More efficient energy conversion technologies that utilise all solid palm oil residues, including EFBs, are currently available and are being implemented. Thus, palm oil factories have the potential of generating large amounts of electricity using their own residues. Extra power can be exported to the national grids.

Rice mills produce a large amount of rice-husk as solid residue (around 20% of paddy input), which can also be used as a fuel in a cogeneration plant. In contrast with the sugar and palm oil mills, there are very few installations of cogeneration systems in rice mills in ASEAN. As rice is the staple food and as it is a widely exported agricultural commodity in this region, cogeneration systems with medium pressure boilers (over 30 bar) and efficient extraction condensing turbines seem to meet the challenges posed by rice husk disposal. The sale of ash produced during the combustion of rice-husk can yield revenues of over 100 USD/tonnes of prime quality amorphous silica ash, which adds to the profitability of such systems.

3. Examples of Biomass Cogeneration Plants implemented in ASEAN

The EC-ASEAN COGEN Programme has been supporting the implementation of proven, clean and efficient biomass cogeneration projects. New technologies from

Europe have been introduced in the ASEAN rice, sugar, palm oil and wood sectors. Some biogas plants have also been implemented in other sectors.

The following examples are related to the sugar, palm oil and rice sectors.

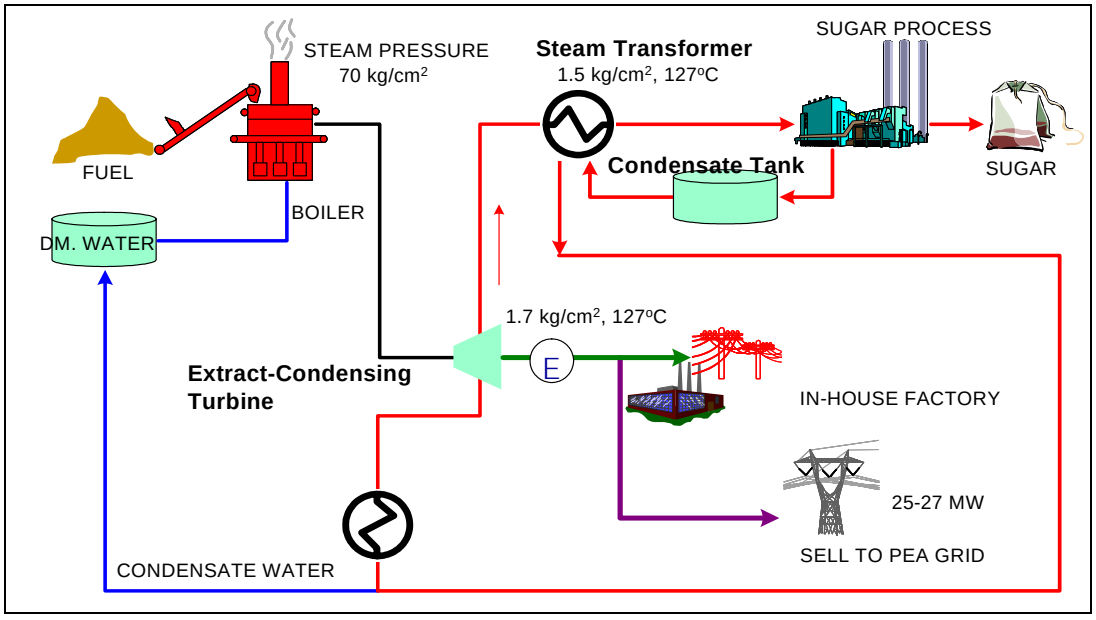
3.1 Dan Chang Bio-Energy

The Dan Chang Bio-Energy project has been implemented by the Mitr Phol Sugar Group, Thailand. The Mitr Phol Sugar Group has been in the sugar business for more that 45 years. In 2004, the total cane crushing capacity of the group stands at 109,000 tonnes per day. It generates a total of 32,000 tonnes of bagasse which is the major by-product of the sugarcane crushing.

Their new 41 MWe bagasse-fired cogeneration project is designed not only to provide the steam and electricity requirements of the sugar mill but also to produce 24 MW of excess electricity to be exported to the national grid through a firm contract of 21 years.

The project consists of the following components:

- a 41 MWe extraction condensing steam turbo-generator;
- two vibrating grate boilers with an hourly capacity of 120 tonnes of steam at 68 bar (a) and 510^{o}C each.



The total investment cost for the project is around Euro 35.5 million, excluding civil works and building foundation. The expected payback period is 5 years after commissioning. The major revenue for the project is coming from the sales of excess electricity to the national grid. The project will also earn revenue selling steam and electricity to the sugar mill. As the generation is located near the mill,

there is minimal transmission and distribution cost and electricity loss. The total Green House Gas (GHG) Mitigation by implementing this bagasse-fired project is expected around 278,610 tonnes of CO_2 equivalent per year.

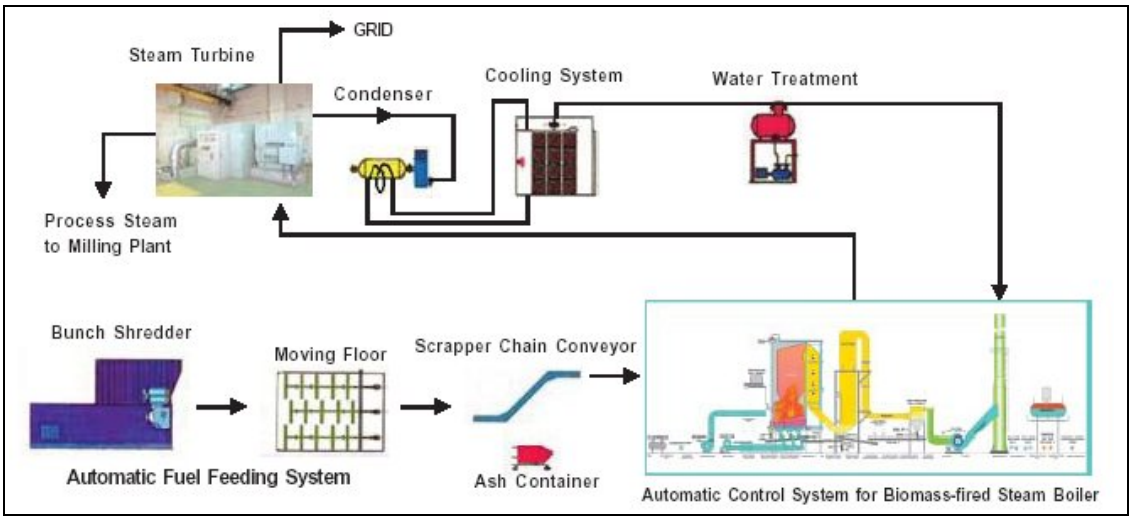
3.2 TSH Bio-Energy

TSH Bio-energy, a subsidiary of TSH Resources Bhd, is involved in oil palm plantation, palm oil milling, timber products and power generation.

The new cogeneration plant is using empty fruit brunches as fuel. It is located at Kunak, Sabah, East Malaysia. The total capacity of the project is 14 MWe with a total live steam capacity of 80 tonnes per hour at 66.5 bar (g) and 402 ^{o}C. 10 MWe will be exported to the local grid, while 25 tonnes of steam will be used for palm oil processing.

The plant consists of the following components:

- a fuel conveying system;
- a water-cooled inclined vibrating membrane grate
- a water-tube steam boiler with a capacity of 80 tonnes per hour, 66.5 bar (g);
- an automatic de-ashing system;
- a multi valve steam turbine, with inlet pressure at 50 bar (g);
- a turbo-alternator with rated output of 17,500 kVA.



The total investment cost of the project is around Euro 9.0 million, excluding civil works and building foundation. The expected payback period is 4 years after commissioning.

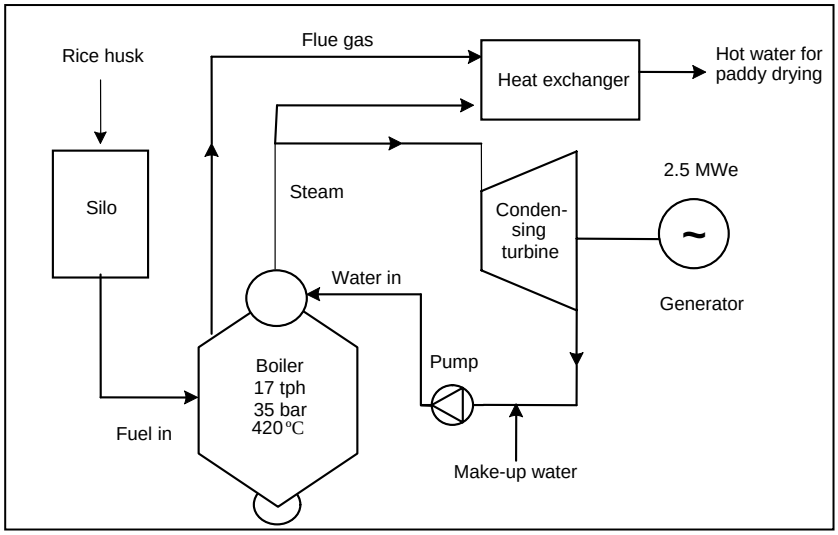
The energy use of palm oil residues constitutes an elegant way to dispose the processing residues from palm oil milling activities, while generating additional income. It is estimated that between 40,000 to 50,000 tonnes of CO_2 equivalent will be mitigated annually thanks to the use of the EFBs.

3.3 Chia Meng Rice Mill:

Chia Meng, one of the biggest rice mills in Thailand with a milling capacity of 700 tonnes of paddy per day, have implemented a 2.5 MW cogeneration plant which utilises rice husk as a fuel. The plant was commissioned in March 1997. The Chia Meng Rice Mill is located in Nakhon Ratchasima province. The rice mill produces about 140 tonnes of rice husk per day which is used as fuel.

The plant consists of the following components:

- a rice husk silo, a conveying and automatic boiler feeding system;
- a step grate/boiler producing 17 tonnes of superheated steam at 35 bar and equipped with automatic ash removal system;
- a 2.5 MW multi-stage fully condensing turbo-generator;
- heat exchangers using boiler flue gas and/or superheated steam to generate hot water for paddy dryers.



The total investment cost of the project was Euro 3.6 million, excluding civil works and building structures. The major revenues are coming from savings in fuel oil, electricity purchase and rice husk disposal. An additional income comes from ash sales. The payback time of this project was 3.6 years after implementation of the plant. Total GHG avoided by implementing this rice husk boiler is around 7,000 tonnes of CO_2 equivalent per year.

4. Conclusions

Many countries in ASEAN are implementing biomass cogeneration plants, as biomass is abundantly available. It is relatively cheap, clean and environmentally friendly. Biomass residues can help meet the increasing demand for power in developing countries. When used in modern medium to high pressure cogeneration systems, big improvements in efficiency and fuel utilisation are realised.

Industry leaders see cogeneration as one of the means to reduce costs in order to increase their competitiveness, while selling excess power to the grid and solving their waste management problems.

From an economic point of view, the use of biomass offers many benefits such as reducing dependence on imported fuel resources and increasing local economic sustainability. It generates high environmental benefits through the mitigation of GHG emissions and a substantial reduction of SOx and NOx emissions, when compared to the use of fossil fuels.

References

Information for this article has been gathered and compiled from the reports and papers produced by COGEN3. For more information please visit our website www.cogen3.net