TECHNOLOGY FACTSHEET
COGENERATION WITH BIOMASS[1]

1. **Sector**: Energy/ Industry

2. **Introduction**

Many industries in Sri Lanka generate steam at a pressure of about 5 to 10 barg for process heat applications. The steam outputs from these boilers vary from about 1 tonne per hour to over 10 tonnes per hour. While some of these boilers operate only for 8 hours per day, many boilers operate continuously for 24 hours per day. As the cost of biomass fuel is less than halve the cost of petroleum fuels, many of these boilers use biomass fuels.

A more profitable and efficient way of generating process steam is to first generate steam at much higher pressure and temperature and then pass such steam through a back-pressure turbine. The pressure and temperature of the exhaust steam from the steam turbine is designed to match the process steam requirements. The steam turbine while expanding the stem from high pressure to the desired pressure is made to drive an electric alternator, thus generating electrical energy.

The advantage of this technology is that the net efficiency of a back-pressure turbine is very high (over 90%) as the exhaust stem is directly used as process steam. In a conventional thermal power plant, the exhaust steam from the turbine is sent to a condenser. In the condenser nearly 65 to 75% of the total energy input is removed by the condenser cooling medium. This heat is at a very low temperature. Hence it cannot be used for any practical applications.

One limitation in this process of using a back pressure turbine is that the electrical output will be directly proportional to the flow of steam passed through the turbine. This steam flow rate is determined by the process steam demand of the factory. Hence the electrical output from this system will vary according to the steam consumption rate in the factory.

In Sri Lanka, the Sri Lanka Sustainable Energy Authority and the Ceylon Electricity Board (CEB) have formulated a scheme, where any renewable energy based electricity generation, including biomass, could be sold to the CEB at the price specified in the Standardized Power Purchase Agreement (SPPA). For biomass based electricity generation, the present price applicable is Rs. 20.70 per kWh. This may be compared to the price charged from industries for electricity consumption is arpund Rs. 14 per kWh. Hence by selling this electricity to the CEB, the factory would make financial gain.

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[1] **This fact sheet has been extracted from TNA Report – Mitigation for Sri Lanka. You can access the complete report from the TNA project website** http://tech-action.org/

Moreover, under the SPPA, CEB is obliged to purchase all the electricity generated by the producer. There are no penalties imposed for variations in the rate of output of electrical power (provided it conforms to the required voltage and frequency and other specifications).

By introducing this technology, the industries presently generating process steam could obtain an additional revenue by the sale of electricity to the CEB. The additional fuel cost incurred for the generation of electricity will be very small compared to the price paid by the CEB for the electricity.

3. Technology Name: Cogeneration with Biomass

4. **Technology Characteristics:** (Feasibility of technology and operational necessities*)*
Cogeneration has been practiced in many parts of the world for many decades. In Sri Lanka this principle has been practiced to a very limited extent. Presently there are three installations in Sri Lanka where this principle is practiced. All these three use biomass as the fuel.

There is doubt about the technical feasibility of using this technology in Sri Lanka. We need to demonstrate the practical and economical aspects of this technology in an industrial environment. The economical aspects has become a reality with the introduction of government policy on generation of electricity and the introduction of an attractive Standardized Power Purchase Tariff for biomass based electricity generation.

The implementation of this technology in the industrial sector would enable these industries to earn an additional income by generating electricity s a byproduct and selling it to CEB at an enhanced price provided through the SPP tariff.

5. Country specific applicability
The following situations prevailing in Sri Lanka make this technology applicable here.

Government Policy to generate at least 10% of the electricity through Non Conventional Renewable Energy sources by the year 2015 and 20% by the year 2020.

An attractive power purchase tariff for biomass based electricity well above the selling price of electricity for the industrial sector.

A suitable multipurpose tree (Gliricidia sepium) has been identified as a suitable tree for the production of sustainable biomass fuel. This tree has been declared as a plantation crop.

Biomass fuel is the most dominating fuel (nearly 80%) for the generation of heat in the industrial sector. The primary reason for this preference by the industries of this fuel compared with petroleum fuels is the low cost of this fuel. Many industries already use biomass fuel fired steam boilers to generate industrial process heat. Introduction of cogeneration technology amounts to an extension of the existing system.

The high cost of labor, electricity and petroleum fuels are compelling industrialists to lookout for all possible means of increasing revenue and reduction in expenses to make these industries viable.

6. Status of the technology in the country and its future market potential:

There are three installations in Sri Lanka where this technology is practiced. Two of these are very old and were compelled to adopt this technology as in these specific locations at the time these industries were established, the national electricity grid was not available in these locations. More over these industries are both sugar factories using bagasse generated in the factory itself as the fuel in their boilers. This being the practice all over the world, it was natural for these two factories to adopt cogeneration. The third is an activated carbon plant using very low pressure (1bar g) steam for their process. However, for a strange reason, the factory used a steam boiler capable of delivering 10 barg saturated steam. Hence, the engineers at this factory decided to retrofit a supper heater and a back pressure turbine-alternator and generate some quantity of electricity. The cost of retrofit was recovered in a short period.

To estimate the national potential, it assumed that 10% of the national industrial heat energy generation could be utilized for this technology. For the year 2007, the national industrial heat generation was 1,800 ktoe. Hence 10% would be 180 ktoe. This would amount to 3 million tones of steam per year. Hence the amount of electrical energy which could be generated through this technology would be 166 GWh/y.

7. Barriers: *After completion of barrier analysis and only for selected technologies.*

8. Benefits: (How the technology could contribute to socio-economic development and environmental protection).

The introduction of this technology in Sri Lanka would bring the following benefits:

Social Benefits:

- A new technology is introduced to the country.
- Installation, commissioning and operation of high pressure boilers, turbines, generators etc. would require skilled and semi-skilled workforce. Hence employment opportunities in this sector.
- The additional biomass fuel required need to be produced from new Gliricidia plantations. This will provide additional employment opportunities in the rural

locations. The harvesting and transporting of these additional biomass will also increase employment opportunities.

Economic Benefits

- Industrial sector will be able to earn a significant income from the sale of electricity generated at very low cost.
- The additional biomass fuels would increase the revenue for the rural communities engaged in the production of such fuels.
- The country would reduce the amount of imported fossil fuels used for the generation of electricity, thus conserving foreign exchange.

Environmental benefits

- Lower emissions of SOX, NOX and hazardous particulate due to reduced generation of electricity from fossil fuel, particularly from coal.
- Lower GHG emission. National reduction estimate from this technology: 126,160 tCO_2/y.
- Additional Glilicidia trees planted to produce the additional biomass fuel requirements would increase the green cover in the country.

9. **Operations:** *After completion of barrier analysis and only for selected technologies.*

10 Costs:

The capital cost is based on the value assigned by Sustainable Energy Authority for biomass based power generation in the latest tariff published. On this basis the 50 kW co-generation plant (the incremental cost attributable for power generation– excluding the cost attributable for the thermal part) would cost: 50 x 228,000 = Rs. 11,400,000. The 50 kW generator would generate 219 MWh of electricity per year. = (219/1000) x 240 = 525.6 toe. Hence the capital cost required to generate 1 toe = 11,400,000/525.6 = Rs. 21,689/toe.

The total cost to be incurred to harness the ntionl potential would be Rs. 8,600 million.

11. **References:**

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