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## Current and Potential Utilization of Biomass Energy in Fiji

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### ABSTRACT

Energy from biomass accounts for an average of 43 % of the primary energy used in developing countries, with some countries totally dependent on biomass for all their energy needs. The most common use for biomass for energy is the provision of heat for cooking and heating; other uses include steam and electricity generation and crop and food drying.

Fiji, a developing country, uses energy from wood and coconut wastes for cooking and copra drying. Bagasse from the country's four sugar mills is used to generate process steam as well as some 15 MW of electricity, for mill consumption and for sale to the national grid. Other, relatively small scale, uses for biomass include the generation of steam and electricity for industry.

This paper attempts to quantify the amount of biomass, in its various forms, available in Fiji and assesses the current and potential utilization of biomass for energy in Fiji.

### INTRODUCTION

Around 13 % of the world's primary energy is currently derived from biomass resources (Hall and Overend, 1987). Biomass energy plays a significant role in the energy needs of many developed countries, particularly in the rural areas where biomass is the most important source of fuel.

In the case of the developing world, biomass energy plays a dominant role, with some 43 % of the primary energy requirements met from biomass. Some countries such as Nepal, Ethiopia and Burma depend almost entirely on biomass for all their energy needs (Hall and Overend, 1987).

In most of the island nations of the South Pacific, and, in particular, Fiji, Solomon Islands, Vanuatu, Samoa and Tonga, biomass energy is used almost exclusively for cooking and heating in rural households. On average, biomass energy contributes up to 60 % of the total household energy use in Fiji. Over 70 % of the biomass used in Fiji is for energy, mostly for cooking in rural households. Other uses include copra drying, provision of heat for small industries such as bakeries, and heat for steam and electricity generation.

### FIJI'S ENERGY SCENARIO

The Republic of Fiji lies between latitudes 15 and 22 South and longitudes 174 East and 177 West and consists of over 300 islands scattered over a fairly large area of the South Pacific ocean. Of these, 120 islands are inhabited, with the two main islands (Viti Levu (10,653 square kilometres) and Vanua Levu (6,194 square kilometres)), accounting for 92 % of the total land area and just over 90 % of the population. The total land area is 18,272 square kilometres and the estimated

1992 population was 758,275. The average population density in 1988 was 39 persons per square kilometre.

The major sources of energy for Fiji include biomass, imported petroleum products and hydropower. These three sources account for over 99 % of the energy use in the country. Biomass energy, including firewood from forests, agricultural and commercial wastes and residues and coconut biomass, is used mostly for cooking, copra drying and steam generation. Biomass contributes over 50 % of the total energy needs of the country. Petroleum products include motor spirit, kerosene, industrial and automotive distillate fuel, aviation turbine fuel and residual fuel, are used mainly in the transportation, industrial and power generation sectors. In 1992, \$F 120 million was spent on buying 337 million litres of all forms of petroleum products (Bureau of Statistics, 1993). Over 95 % of the country's electricity is generated from the 100 MW-rated Monasavu hydroelectric scheme. In 1992, over 377 GWh of electricity, worth \$F 78 million, was consumed (Bureau of Statistics, 1993).

## BIOMASS ENERGY POTENTIAL IN FIJI

The major use of biomass resources in Fiji is for energy, mostly for cooking with smaller amounts used for steam raising and electricity generation for industries. These resources include wood from forests, waste wood from sawmills and crop wastes and residues. Many industries such as sugar, copra, soap and oil production, rice and timber mills, etc use wood for raising steam and for electricity generation. Boarding schools, abattoirs and even a few restaurants use wood for cooking and/or steam generation.

### Forests

Sixty five percent of the total land area of Fiji is covered by forests of some kind (FAO, 1990). Forests provide most of the fuel for domestic cooking in the rural areas, with over 200,000 tonnes of wood consumed every year by the rural population alone. In fact, the Fiji Forestry Department has estimated that over 80 % of the wood consumed in Fiji is for fuel.

Fuel resources from standing forests include dead trees and branches, offcuts from logging and other forest operations, trees from land clearings and those damaged by fires and cyclones. Sustainable yields from these of over 300,000 tonnes per year can be maintained (Country Report 1982 - Fiji). However, due to the location of the forest resources, while the biomass is **available**, whether it is readily **accessible** is another question. Thus, excluding the forest biomass from areas which are inaccessible or very expensive to access, the sustainable, accessible biomass is considerably reduced, by over 50 %. However, the amount which is accessible still represents a very significant biomass energy resource.

### The Sugar Mills

The sugar industry uses all the bagasse generated in the country's 4 sugar mills, as well as purchased wood, for process steam and for electricity, selling any surplus power to the utility.

The 1984 installed capacity of the sugar mills using biomass-fired turbines was almost 29 MW (Tata Report, 1985). Some 2.8 GWh of electricity was sold to the Fiji Electricity Authority in 1985 (FEA, 1986). Around 190 thousand tonnes of bagasse were used for electricity generation in the mills in 1986.

### **Sawmills and Timbermills**

There is a substantial amount of waste biomass in Fiji, particularly in the form of sawmill wastes such as sawdust and waste wood which can be taken virtually for free from most of the sawmills. Fiji has around 60 sawmills, from the very large to the quite small, village-level enterprises. The several large ones process more logs than the rest of the small ones combined. On average, about 50 % of the logs used by sawmills is waste wood, sawdust and bark (Fiji Forestry Department, 1984). Wastes produced by large sawmills with secondary processing reach up to 60 % of the input log volume. With a continuing increase in the output of the logging industry, sawmill wastes represent a significant energy resource.

While some of the sawmills are easily accessible by road and/or sea, most of the others are relatively far away from main roads or sea ports. Thus, the cost of transporting waste biomass is quite high, ranging from \$50 to \$100 per 7-tonne load for a 30 km journey. From a survey conducted on biomass energy resources in 1988/1989, the amount of combustible waste generated by the sawmills range from several tonnes to several thousand tonnes per year.

### **Coconut Plantations**

Coconut trees are widespread all over the country and particularly in the small islands. In the plantations, which make up over 80,000 hectares, the average density of coconut trees is around 100 trees/ha, the usual range being 50 to 300. The energy resources from coconut plantations are in the form of old, dead and decaying trees, coconut branches and fronds and husks and shells. An average coconut tree can yield between 50 and 100 nuts per year and each nut yields up to a kilogram of husk and shell. The waste resources from coconut trees are therefore considerable and from plantation coconuts alone, the resource exceeds 100,000 tonnes per year. Even more importantly, this resource is sustainable.

### **Pine Plantations**

Over the last decade, there has been a massive effort directed towards the planting of pine trees all over Fiji. In 1987, pine plantations covered some 46,000 ha, most of this in Viti Levu.

This represents a very valuable resource, not only for the building and furniture industries, but also for energy. Pine trees have begun to be harvested – mainly chips for export – and a 3MW steam/electricity system at Drasa in Lautoka uses pine wastes (bark, chips, waste timber, etc. ) for fuel. Pine wastes are also bought by some small industries for local steam and electricity generation. The annual planting of pine trees varies from between 2,500 and 3,000 ha annually. Since 1990, the annual harvesting rate has been around 1,400 ha. Most of the pine harvested is transformed into chips which is exported to Japan.

### **Other Biomass Resources**

A moderate quantity of wastes is produced from the rice industry. Around 20,000 ha of rice was planted in 1987, yielding some 20,000 tonnes of raw rice. In 1991, this dropped to 15,000 ha and an average yield of 2.28 tons/ha. Some 20 % of raw rice consists of husk which has no commercial value and is thus wasted. In addition, for every tonne of rice harvested, a tonne of straws is left behind in the fields. Both of these represent a significant biomass energy resource in the small rice growing areas of Fiji.

## **CURRENT UTILIZATION OF BIOMASS IN FIJI**

Currently, biomass is used for domestic cooking, mainly in the rural areas, cooking and steam generating for small commercial and industrial activities (mills, factories, etc.) and for steam and electricity generation (sugar mills, village power systems).

### **Cooking**

Siwatibau (1981) carried out a detailed study of biomass energy use in rural homes and estimated that a rural family used an average of around half a tonne of wood per person every year, mainly for cooking. This amounts to 2-6 tonnes of wood per family per year. With an average household size of 5.7 persons per household, and a higher household size in rural areas, she determined that over 200,000 tonnes of wood are used by the rural sector (rural population accounting for over 60 % of the total) and around another 50,000 tonnes are used by semi-urban and urban families per year.

### **Copra Drying**

The drying of copra, the meat from coconuts, is an important process in the copra industry which ranks second to the all-important sugar industry on the agricultural front. Wood and coconut wastes (husks and shells) fuel the dryers, although some diesel dryers are also used. Because of the generally wasteful nature of the wood burning, copra drying consumes a fair amount of biomass. Although figures vary widely from place to place, it would appear that to dry a tonne of raw copra requires anything from half a tonne to one and a half tonnes of biomass fuel.

### **Steam and Electricity Generation**

Electricity generation, both small and large scales, using biomass fuels has been advocated by several studies. The United Nations Pacific Energy Development Program (UNPEDP)-funded study on the energy prospects for Pacific island countries (Country Reports, 1982) concluded that biomass could be used for the economic generation of electricity in Fiji. However, to date not a great deal has been done in this area.

The 4 sugar mills in Fiji utilize bagasse for electricity generation during the harvesting season. Power in excess of the needs of the mills is sold to the Fiji Electricity Authority.

A 3 MW steam power system is used to supply all steam and power requirements to a sawmill complex in Lautoka. Pine chips supplemented by wood are used as fuel.

Various industries use biomass to generate process steam for on-site consumption. Examples include the soap factory in Lautoka and the copra mill at Savusavu. The Malau sawmill near Labasa uses wood chips to generate steam for running various machinery and is considering generating electricity as well.

A 30 kW electricity/heat cogeneration system, fuelled mainly by coconut husks and shells, has been operating since 1979 on the island of Taveuni. Located in a coconut plantation, the system provides electricity to the plantation, using exhaust steam from the steam engine to dry copra.

## POTENTIAL UTILIZATION OF BIOMASS

In Fiji, a clear and pressing need exists for the provision of electricity to people without it. The need is recognized and is generally given a high priority by respective governments (e.g. Development Plans of South Pacific island nations).

Sustainable and environmentally sound use of biomass can contribute significantly to the electrification of such rural and remote areas. Reliable and cost-effective electricity supply can provide many benefits to people as individuals and to communities as a whole. Apart from the advantages of a convenient form of power for domestic uses, there may be good potential for establishing rural industries and village level enterprises, including cottage industries. Some of these industries/enterprises – baking, brick production, coconut industry, food and beverage preparation, fish smoking and drying, and jewellery and pottery, to mention a few – can have a significant effect on the economy of not only the rural areas but of the whole country, improving rural lifestyles and generating income and employment.

Other approaches for biomass utilization include integrated systems whereby a particular resource is grown, harvested, processed, and its products and wastes used in many different ways, all in one inter-related system. One obvious candidate for such a system is the combination of forest and sawmill industries, with on-site steam and electricity generation.

There is also an evident need in many rural and agricultural areas for efficient crop drying. A way to meet both needs is through a cogeneration system, generating both electricity and heat (for crop drying), this being a more economical way than that of producing electricity or heat only (Prasad, 1988).

## CONCLUSIONS

Biomass is a very important energy source for developing countries, mainly for rural domestic cooking and, increasingly, for the generation of process steam and electricity for industries and for rural and remote areas where biomass is readily and cheaply available. In Fiji, over 70 % of all biomass used is for energy.

A substantial amount of biomass is available as a waste product, particularly agricultural and sawmill wastes, which can be used on-site for steam and electricity generation to power the industrial process. Over 100,000 tonnes of waste biomass are generated annually from sawmills alone with little or no use made of it.

There are good prospects for the sustainable use of biomass for the generation of steam and electricity for industries, power for rural and remote communities, for the provision of heat for food and crop drying, and for energy for domestic cooking.

Several biomass energy survey/conversion projects are currently underway in Fiji, initiated by local research institutions (such as University of the South Pacific), the Government (Department of Energy and Rural Electrification) as well as by aid agencies. Detailed surveys of energy use, particularly biomass energy, are essential to arrive at a more accurate picture of energy utilisation. The government should encourage and promote the commercial generation of steam and electricity using biomass in areas which do not have access to electricity. This has been done to some extent, for example the village biomass power system in Taveuni, but more remains to be done.

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