Energy Resources and Consumption in Fiji: an Overview

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FIJI

ABSTRACT

Fiji has always relied on imported petroleum products for all its transportation needs as well as for electricity generation and industrial uses. Since 1983, the major island of Viti Levu has been provided with electricity from a hydroelectric power station. Energy for domestic cooking and heating has been dominated by biomass which has also provided energy to four sugar mills in Fiji through bagasse, the waste product of the sugar producing process. Biomass also provides energy for commercial, industrial and agricultural use. The major energy sources are biomass, hydropower and petroleum products.

This paper presents an overview of the energy situation in Fiji. The current supply and end uses of energy in all its forms are examined and the historical trends over the last 15 years are detailed. The locally available resources and imported energy are put in their proper perspective along with the energy consumption pattern and efficiency of generation.

1. INTRODUCTION

Fiji has relied very heavily on petroleum products for transportation, industries and electricity generation. Since 1983, hydropower became the major source of electricity for the country.

The Monasavu hydroelectricity scheme, located in the center of Viti Levu, with a rated capacity of 80 MW, supplies most of Viti Levu with electricity. This leaves Vanua Levu and all the other islands still dependent on electricity from diesel-fuelled power stations. Electricity from the hydropower station is not enough to meet the demands in Viti Levu, with the result that several major industries, including the Vatukoula gold mine, as well as many remote communities still rely on electricity from diesel power plants.

In 1993, around 47% of the population of Fiji had electricity supplies. This consisted of grid electricity from the Fiji Electricity Authority (FEA) as well as village or community-based diesel generated electricity. The total number of domestic consumer of grid electricity was 143,000 households in 1993, representing less than 47% of the total population. Some 8000 consumers have access to electricity from diesel-fuelled power plants, representing 5.5% of the population. Thus as in 1993, around 150,000 household had electricity available.
2. THE CURRENT ENERGY SUPPLY SITUATION

Currently, the major energy sources are petroleum products, biomass, hydropower and coal. Energy from coal contributes less than 5% to the total energy supply. Biomass and petroleum make up over 70% of the total primary energy. Table 1 shows the energy supply since 1981 and Fig. 1 shows a graphical plot of the same. Before the commissioning of the Monasavu hydroelectric power scheme in 1983, electricity was generated by diesel-fuelled power stations. Since 1983, however, electricity has largely been generated from the Monasavu hydropower system, with around 95% of all electricity for the island of Viti Levu coming from it. Electricity for consumers outside Viti Levu comes from diesel power stations operated by FEA.

Biomass, mainly in the form of bagasse from the four sugar mills, and wood bark and chips from the Drasa sawmill, also is used to generate electricity (and process heat), for industry. The Fiji Sugar Corporation (FSC) has a collective electrical generating capacity of 27 MW in its four sugar mills. The mills utilize the combustion of bagasse to generate steam and electricity. In 1993, 43 823 MWh of electricity was generated from 940.5 million kg of bagasse. The Drasa sawmill in Lautoka has a 3 MW power station, which supplied all the energy requirements for the sawmill. The bark and chips-fired boiler consumes 24 000 kg of fuel daily to generate steam for process heat and for electricity.

Table 1 shows energy supply data for Fiji between 1981 and 1992. The mix of imported and indigenous primary energy supply, along with the individual components of each category are shown in energy units as well as in percentage terms. Figure 1 shows the historical trend in the primary energy supply.


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3. CONVERSION TECHNOLOGIES

Industrial energy supply consists of electricity, thermal energy (hot air and steam) and mechanical energy (from electricity, biomass, oil, gas and coal). The basic conversion technology is combustion of fuel to produce electricity, mechanical and thermal energy output.

3.1 Electricity Generation

Electricity is generated mostly through three methods, namely, hydroelectricity generation, generation from diesel-fuelled power stations and biomass-fuelled electricity (sugar mills, sawmills). Apart from the sugar mills and a large sawmill, electricity is generated by the Fiji Electricity Authority either through the Monasavu hydroelectricity generating system (for most of Viti Levu) and through its thermal power plants fuelled by diesel fuel. The Public Works Department, a government department, is charged with the responsibility of generating electricity, through small and medium scale diesel generating plants for remote and rural communities.
Industrial and commercial energy use

![Graph showing energy use from 1981 to 1992](graph.png)

Fig. 2. Electricity generated from various sources: 1981-1982.

Figure 2 shows electricity generated by various sources since 1981. Electricity generated from the rural diesel power systems are not included; nor is that generated by the Vatukoula gold mine. The latter generates its own electrical power requirements through diesel power systems.

4. ENERGY USE

4.1 Energy for Industry

While Fiji is not heavily industrialized, compared to its developed neighbors such as Australia and New Zealand, it does have several mainly light industries and expends a considerable amount of energy on these. These industries include manufacturing ones such as sugar, cement, building materials (timber, nails, concrete blocks, etc.), coconut oil, soap, food processing and packaging, cooking oils, vehicle assembly; agricultural, fisheries and forestry-related industries and others.
Figure 3 shows the use of energy for industrial and commercial activities since 1981, with the total energy used as a comparison. The commercial and industrial consumption does not include energy used for transportation for these sectors, which would be significant.

4.2 Agricultural and Household Energy Use

Almost a third of the total energy consumed in the country goes towards domestic or household activities. This is a reflection firstly of the relatively low level of industrial activity and secondly of the increasing availability of electricity to the domestic sector, particularly in the rural areas through the extension of the national electricity grid.

Energy used in the agricultural sector includes agriculture, fisheries and forestry activities, particularly large-scale government and private projects. These include rice schemes, copra plantations, pine plantations, and fisheries projects such as PAFCO, the Pacific Fishing Company.
Agricultural and household energy use

Figure 4. Household and agricultural energy consumption: 1981-1992

Figure 4 shows the energy consumed by the agricultural and domestic sectors since 1981. The energy consumed by these two sectors has remained relatively stagnant even though, in the case of the agricultural sector, the economy of the country was growing between 1981 and 1987. The energy used by the agricultural sector is around a quarter of that consumed by the households.

4.3 Sectoral Energy Use

In this section sectoral energy use as well as final end-use are considered. Sectors that need energy include household (domestic), industry, commerce, institutions, agriculture, government, and others. Final end-uses include what energy is actually used for in terms of the final output. Thus cooking, heating, crop drying, cooling, refrigeration, air-conditioning, lighting, running machinery, and transportation are all inclusive of energy end-use. Table 2 shows the final energy consumption by energy source from 1981 to 1992.

Table 3 shows energy used in Fiji by sectors from 1981 to 1992. Figure 5 shows sectoral energy use for three sectors, namely, industrial and commercial, transport, and household, between 1981 and 1992. It is noted that transportation consumes the largest amount of energy, with over 39% of primary energy used in 1992. For this time period, the highest energy consumption for transportation was in 1981 with 42%. The fraction of energy for transportation has been decreasing since 1981 up to 1988 whereafter it has shown a steady increase. Household energy has been more or less steady between 1981 and 1986, has increased thereafter until 1988 and has been decreasing steadily since then.
Table 2. Final energy consumption by energy source.

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Final energy use in Fiji

Fig. 5. Sectoral energy consumption: 1981-1992.
Energy for industry and commerce shows some interesting variations. Between 1982 and 1986, there has been a steady increase, peaking to almost 22% in 1986. Since 1987, there has been a slight increase in consumption, reaching a value of 18% in 1992.

4.4 Final Energy End-Use

Due to the unavailability of data for energy end-use on a national scale, it is impossible to comment on energy end-use. However, on the basis of several studies on energy end-use for particular situations, some general observations can be made.

For the household sector, the most common end-use include lighting, cooking, cooling, refrigeration, entertainment, operation of appliances other than for the above (e.g., power tools) and, to a limited extent, air-conditioning.

For the industrial sector, energy end-use is dominated by the running of electrical machinery (motors, pumps, compressors and many other special machinery and tools), lighting, air-conditioning, cooling, process heat and refrigeration. The commercial sector uses the above but to a different extent, particularly for machinery.

For transportation, the end uses are the same in that energy is used for running engines for vehicles, aeroplanes, ships, trains and other means of transportation.

5. ENERGY EFFICIENCY

In this section, the efficiency of electricity generation, in particular, and energy conversion, in general are considered. Four categories of energy systems are considered: the hydroelectricity generation, the FSC mills, the FEA diesel power systems taken as a whole and the rural electrification system, using small and medium diesel gensets.

It is instructive to compare the efficiency of the rural diesel power systems to large scale electricity generation systems. In Fiji, there are three major ways of generating electrical power: thermal power systems using diesel fuel, hydroelectric power generation and electricity generation using biomass (wood or bagasse).

Figure 6 shows the efficiency of these systems for the years 1981 to 1992. The efficiency of rural diesel power plants is compared to those of the FSC thermal power generation, the Monasavu hydroelectric scheme and the FEA thermal power systems as a whole.

It is noted that the efficiency of the rural diesel power systems is the lowest. The average efficiencies of the other systems are 24% (FSC thermal systems), 27.5% (Monasavu hydroelectricity system) and 32% (FEA thermal systems taken as a whole).

There is abundant biomass resource, in the form of forest as well as agricultural and industrial waste, to warrant serious consideration of biomass-fuelled power systems. The two major options are direct combustion systems using a steam engine or turbine connected to an alternator and power gasification systems. The sugar mills, for instance, use bagasse to generate all their electrical energy requirements; a few sawmills generate electricity and steam on-site and a 25 kW wood-fired steam power cogeneration system supplies electricity and heat for drying copra at a plantation in Taveuni.

Electricity from the 80 MW Monasavu hydroelectricity scheme in the interior of Viti Levu, the largest island in Fiji, is distributed to over 90% of the electricity consumers supplied by the FEA. Apart from this large hydropower scheme, two mini hydro-schemes (with a total capacity of 250 kW) supplies electricity to two remote communities. There is very significant potential for greater use of hydroelectricity, generated from small-scale micro-units or medium mini systems.
Electricity generation in Fiji: Efficiency

Fig. 6. Overall efficiencies of electricity generation in Fiji.
5. CONCLUSION

In Fiji, energy comes from a number of sources of which the three dominant sources are petroleum products (for transportation, household and industrial use and for electricity generation), hydropower (for electricity generation) and biomass (for cooking, process heat and electricity generation). Other sources include coal (for industrial use), solar energy (for hot water and lighting), geothermal (mainly for cooking).

Electricity is generated using hydropower, diesel fuel and bagasse (for the sugar mills). Biomass, in the form of firewood, sawdust, bark and agricultural waste (mainly coconut husk and shell), is used to provide process heat for industries and commercial enterprises as well as to generate electricity.

The efficiency of energy conversion varies considerably, depending on the source of energy and the scale of conversion. Rural electrification diesel generator sets are fairly inefficient, with conversion efficiencies of 15%, while the Monasavu hydroelectric power station has an overall efficiency of 30%.

The sugar mills use bagasse to generate all their electrical demand and the overall efficiency of conversion (bagasse to electricity) is only around 1% (an energy content of 20 MJ/kg is assumed for the bagasse). If the use of steam is considered, then the overall efficiency increases considerably.

While there is good scope for greater use of renewable (such as hydropower and biomass) for electricity generation, it appears unlikely that these will make significant inroads. However, there are industries such as the sugar mills, sawmills, copra mills and other industries that are looking increasingly at the feasibility of generating their own power through the use of the waste products they generate.

Thus, Fiji's electricity generation will continue to be dominated by the hydroelectricity facility at Monasavu (for most of Viti Levu) while the rest of Fiji will continue to rely upon diesel generation, through large central power stations or small diesel generator sets for the rural and remote communities.

6. REFERENCES

2. Datasheet on diesel and petrol engines from several manufacturers, including Suzuki and Honda.