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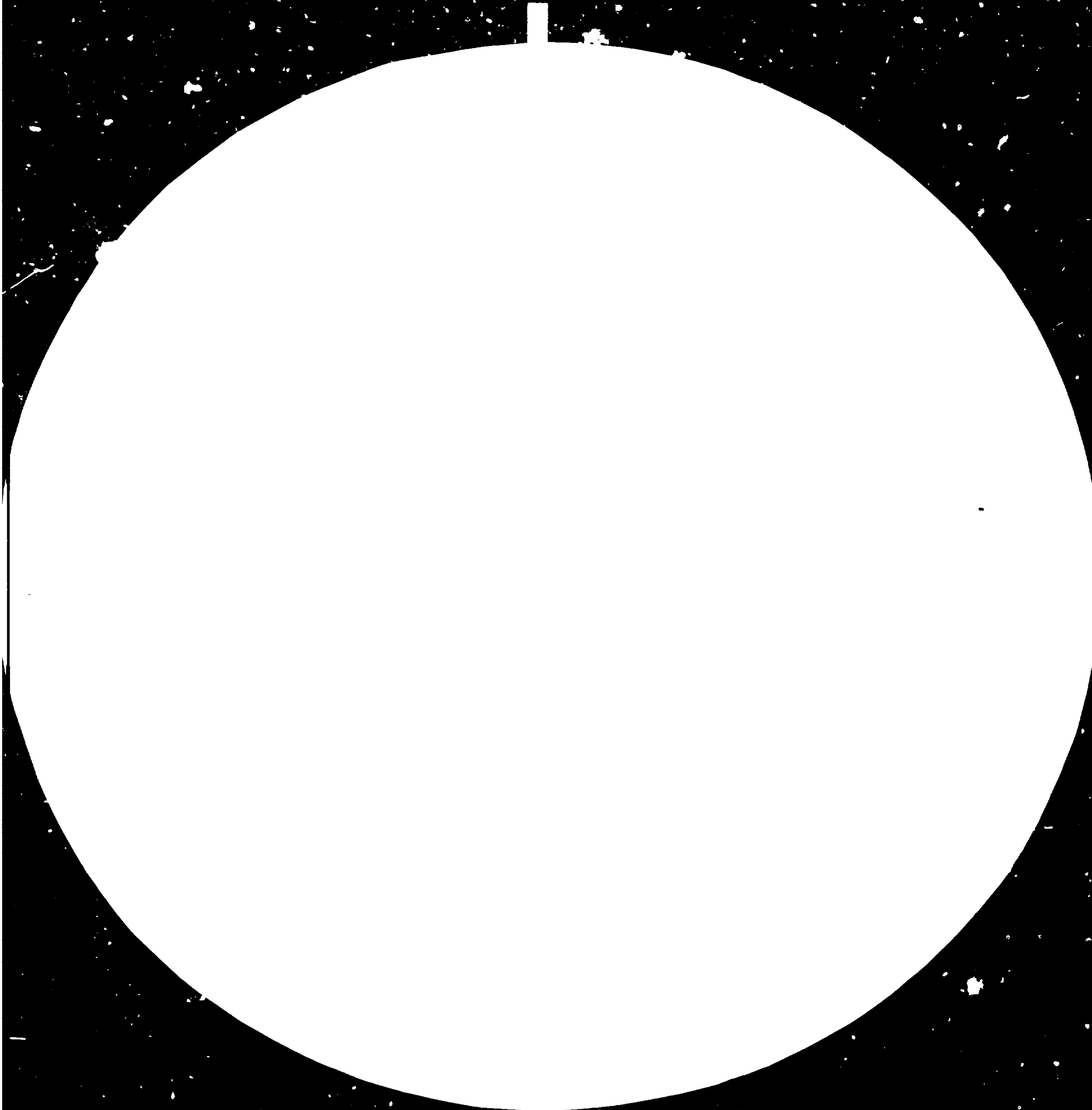

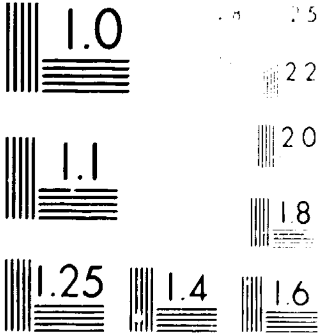
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Beginning of Hydro Electric Generation in Fiji Islands *

by

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GENERAL

The present (1981) Fiji maximum demand (peak load) of public electric power supply is about 65 MW excluding two major industries, sugar milling and gold mining, which generate their power internally. All power is supplied from diesel fuelled generators.

However early in 1983 the Monasavu Hydro Electric Scheme with 80 MW output (4 turbine 20 MW each) will be commissioned. Further potential hydro scheme sites with similar output, have been indentified for future development.

The major existing diesel generating plants (86 MW installed capacity) located on the opposite sides of the main island Viti Levu will be left as "standby". They have been linked already with the Monasavu Hydro Electricity Scheme by 132 KV line across the island.

There is only one other island - Vanua Levu - with a significant load; the peak load is about 5 MW. Investigation is in progress regarding its future electricity generation options: hydro schemes, bagasse, wood waste and geothermal are being assessed. All other islands have no significant industry and small quantities of electricity are generated and supplied at 240/415 V from local diesel generating sets rated from 5 to 100 kVA. Over the last 4 years, 65 such generating plants have been installed under the Government subsidised rural electrification programme.

MINI-MICRO HYDRO ELECTRIC POTENTIAL

Potential for small-scale hydroelectric development has been investigated but is far from being complete. In 1977 a team of consultants from India indentified sites and prepared technical documentation for installation of four 50 KVA hydro electric schemes (at Waimboteingau - Gau Island, at Ngaselo - Kadavu Island at Nabuna - Koro Island and of Nakorovusa - Moala Island). Another team of consultants from New Zealand prepared preliminary documentation for Somosomo, Taveuni Island, Waimbula, Taveuni, and Drakoniwai, Vanua Levu Island.

A Chinese Government team visited the Somosomo site about late 1979 to study the possibility of implementing the project with Chinese technical assistance. However the scheme was not implemented.

A Company from Japan, Sumimoto Corporation offered to supply and install one micro hydro electric scheme with their model H-5M turbine made by Osaka-Somitsu Co. Total costs (of supply, installation civil works, electrical wiring and reticulation) will be borne by the donor company. The selected site for the scheme is Dakuivuna Village - about 40 km from the national capital Suva. The plant is 6 kVA, H 10m, Q100 l/sec. The work will be put in hand this year.

There is one micro hydro scheme in operation. It was installed by the Department of Public Works (under the Government subsidised rural electrification programme). This scheme at Vatukarasa Village will be described in detail. To complete the list there is also one 40 kW hydro scheme at Tutu Catholic Mission, Taveuni Island. A German made Ossberger turbine was installed there some years ago. The operation of the scheme is intermittent as a result of an intermittent water flow and more so as a result of malfunctioning of the electronic voltage regulator (governor). It has been also reported recently that there are two micro hydro schemes under construction for private individual owners.

Significant hydrological information has been compiled regarding future potential for hydro schemes and these are being updated and extended. Their implementation however is not expected to be rapid. There are about 600 villages in Fiji with 20 or more households considered suitable for Government subsidiesed electrification. Most of them are within the two largest islands: Viti Levu island where the electricity supply from the 80 MW Monasavu Hydro Scheme will eventually become available through extensions of the Fiji Electricity Authority's (FEA) network; and Vanua Levu island, where the FEA supply/generation is gradually expanding and where co-generation in the Fiji Sugar Corporation mills, fuelled by bagasse (byproduct of the sugar cane milling process) is promising.

Mini and micro hydro electric schemes are not being given high priority mainly due to high initial costs and budget limitations. This is because either the potential schemes are located too far from the villages or the villages are too small. Only the very attractive are being considered. Under a proposed "minimal basic rural electrification concept" based on a 3 kVA diesel generator with a maximum load of 100 W allowed per village house, the average cost of installation per consumer/house is only $270. Thus the micro hydro schemes, because of their relatively high initial-capital costs notwithstanding their low running costs, remain as yet only seldom competetive.

The schemes investigated so far in detail by the New Zealand and Indian teams range in output from 50 kW to 1000 kW. If implemented there would generally be a problem of absorbing the power by the small local rural population who lead a quasi-subsistence rather than market-oriented village life style. Electricity consumption in a village is used predominantly for lighting. As will be noted from the detailed description of the Vatukarasa micro hydro scheme, even its 1.5 kW output is underutilised by the village consisting of 20 households. Many other inhabited smaller islands do not have sustained water flows.

Notwithstanding all the above, there are many rivers and continuously flowing streams, though without waterfalls, within the major islands. Along them a number of small villages exist. A low head small hydro turbine with simple civil works might be an attractive option. This would be very applicable to villages with <u>no regular access</u> and where terrain is difficult for electricity mains extensions. We look forward to have the micro hydro scheme installed by the Japanese company at Dakuivuna Village. We are also expecting more information on the French low head submersible hydro turbine from Leroy-Somer MCH, Usine de Sillac, 16015 Angouleme Cedex, France.

VATUKARASA MICRO HYDRO ELECTRICITY SCHEME

History

The Vatukarasa scheme is described in detail because it illustrates the care that must be taken in the implementation of a hydroelectric project of even very modest size. It is hoped that the lessons learnt will be of use to others.

The first micro hydro scheme built by the Department of Public Works (under the Government subsidised rural electrification programme) was commissioned in 1978. The work was done on the instigation of the Central Planning Office with considerable help from a group of enthusiasts from the local university (University of the South Pacific) and some others. They did not have any first hand experience in this field and the main purpose was to gain some experience in installation, operation and maintenance. A pelton wheel and an electronic load controller were obtained and around these a prototype hydro turbine with 8 kVA alternator evolved and was built in PWD workshop. The main components of the scheme (see Fig 1) consist of the following:-

- 20 ft x 5 ft x 2 ft reinforced concrete dam;
- 180 ft long of 6 inch diameter PVC penstock sloping approximately 15 degrees;
- 36 cubic feet settling tank;
- 7 ft x 4 ft x 4 ft turbine chamber;
- Pelton turbine;
- 8 kVA, 240 V single phase (belt driven) alternator.

The scheme was installed at a cost of approximately F$9,000 (US$10,000) to provide lighting to the village. 30 fluorescent lights were installed (approximately 1.5 kVA)

Failures

The original system malfunctioned and eventually failed completely in 1979 i.e. within a year. There were many different reasons: unsatisfactory design of the civil works, careless maintenance, faulty equipment etc.

Faults

(1) No provisions were made in construction of the dam to allow the reservoir to be scoured. This resulted in the screened outlet from the dam to be clogged repeatedly with debris and sediments following heavy rains.

(2) The turbine chamber, being located 18 feet below the recorded flood level, was completely flooded on several occasions.

(3) The electronic load controller failed and could not be repaired locally resulting in the alternator hunting in the range of 180-340 volts which damaged the fluorescent light fittings.

A 2.5 kVA diesel generating set had to be installed pending the repairs and redesign of the hydro plant. Necessary funds $7000 - were eventually made available and in 1981 the hydro scheme became operational again.

Improvements

The following improvements were made:

(1) The intake pipe between the dam and the setting tank was moved to a higher level.

(2) An outlet with a valve was installed near the bottom of the dam to scour the dam. The same was installed on the settling tank.

(3) The 8 kVA alternator was replaced with a 3 kVA alternator. The first one was oversized as the flow of water most of the time is only Q = 0.7 cubic feet per sec. and the head is H = 64 feet thus the net horsepower available is:

$$\frac{Q \times H \times E}{8.8} = \frac{0.7 \times 64 \times 0.5}{8.8} = 2.5 \text{ HP}$$

equivalent to approximately 1.9 kW.

(4) A water-tight inverted cover was fixed over the turbine and alternator assembly to act as a 'marine bell'. Flood water rising in the turbine chamber traps air in the 'bell' thus the generator is not submerged.

(5) A float switch was installed to activate an alarm to top the turbine should the water level raise above the turbine pulley.

(6) One 200 litre water tank with 1.5 kW electric resistance water heater was installed. The villages have two options: either to use lights (1.5 kW load) or the 1.5 kW water heater.

(7) Change-over switches were installed to run the lights or the water heater from either the hydro electricity plant or form the standby diesel generator.

(8) An alarm bell was fitted which is actuated by excessively high or low currents. In this way the system works without a governor or automatic voltage regulator: the village operators keep the domestic load at 1.5 kW or change over to the 1.5 kW heater.

(9) A shower was installed for the villagers to have hot bath, and/or hot water for other purposes.

Future capability

The existing system is underutilised though it satisfies the basic village needs. They system potential is 1.5 kW continuously for 365 days per year or 12,300 kWh. Only about 30% of this is being utilised for lighting and water heating.

The village is aware that further uses of the power could be:

a) Refrigeration, say 300 W medium size freezer operating 12 hours per day (daytime and boost after midnight) Total 1310 kWh per year;

b) Crop drier fan: solar drier with 1 kW fan for cocoa and other. Operating say 10 hour per day.

c) Ironing, say 300 W for 3 hours per day.

d) Radio and other audio/video equipment.

e) Grass mover.

f) Workshop tools, hand drill, battery charger electric saw, polisher etc, sewing machine.

Full operation of the total system with all the facilities mentioned could only be possible with an electronic load control unit (Fig. 4). This allows to keep the voltage steady 240 V. Surplus power goes to the water heater so the generator always supplies 1.5 kW.

Note that dominant power consumption (e.g. total lighting, refrigerator, drying fan) would have to be on a time switch control. This illustrates that an optimised system needs to carefully consider end-use, demand management, and choice of equipment. Generally planners concentrate on the supply of the power but ignore the constraints and potential on actual use by the consumer.

Electronic load controller and the equipment mentioned would however cost a couple of thousand dollars. The money can not come from the Government but from the village. The villagers in the meantime (for the next few years anyway) have other priorities despite the above described potential benefits from the hydro electric scheme.

July 1982

* The following analysis draws in part on work done by Dr John Twidell of the Energy Studies Unit of Strathclyde University in Scotland, who spent part of a sabbatical in the Ministry.