Report No. 4462-FIJ

# Fiji: Issues and Options in the Energy Sector



June 1983

**Report of the Joint UNDP/World Bank Energy Sector Assessment Program**

JOINT UNDP/WORLD BANK ENERGY SECTOR ASSESSMENT PROGRAM

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# FIJI

# ISSUES AND OPTIONS IN THE ENERGY SECTOR

June 1983

This is one of the series of reports of the Joint UNDP/World Bank Energy Sector Assessment Program. Finance for this work has been provided, in part, by the UNDP Energy Account, and the work has been carried out by the World Bank. 

TITLE: FIJI: ISSUES AND OPTIONS IN THE ENERGY SECTOR

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ABSTRACT: Fiji's performance in the energy sector has been remarkably good during the past ten years. The main issues for the future are essentially related to institutional and, to some extent, pricing arrangements to ensure that: (i) an appropriate mix of indigenous energy resources is used; (ii) energy supplies are available to rural and urban areas; and (iii) current efforts to encourage efficient use of energy are continued. The report discusses the adequacy of power supplies until the early part of the 1990s under two economic growth scenarios and their implications for the petroleum product demand mix. In reviewing the fuel ethanol, the report finds the economics of this project to be marginal. The report recommends a new approach to procure petroleum supplies and outlines technical assistance programs for institutions, rural electrification study, and oil and gas exploration.

## ABBREVIATIONS

| | | |
|---|---|---|
| ADAB | - | Australian Development Assistance Bureau |
| ADB | - | Asian Development Bank |
| ADO | - | Automotive Diesel Oil |
| AFRA | - | Average Freight Rate Assessment |
| BGS | - | Base Growth Scenario |
| CHOGRM | - | Commonwealth Heads of Government Regional Meeting |
| CPO | - | Central Planning Office |
| DOE | - | Department of Energy - MEMR |
| EDF | - | European Development Fund |
| FD | - | Forestry Division |
| FEA | - | Fiji Electricity Authority |
| FMA | - | Fiji Monetary Authority |
| FSC | - | Fiji Sugar Corporation |
| FPC | - | Fiji Pine Commission |
| GOF | - | Government of Fiji |
| MAF | - | Ministry of Agriculture and Fisheries |
| MEMR | - | Ministry of Energy and Mineral Resources |
| MFARD | - | Ministry of Fijian Affairs and Rural Development |
| MRD | - | Mineral Resources Department of MEMR |
| OGS | - | Optimistic Growth Scenario |
| PEP | - | Pacific Energy Program |
| PIB | - | Prices and Incomes Board |
| PWD | - | Public Works Department |

This report is based on the findings of an energy assessment mission which visited Fiji in December 1982. The mission comprised Messrs. Zia Mian (Mission Chief), Anthony Ody (Economist - Industrial Projects), Amarquaye Armar (Energy Planner), Robert Chronowski (Consultant - Biomass Utilization), Vladimir Bohun (ADB - Senior Power Engineer), Stephen Zorn (Consultant - Petroleum Economics), and B. Yates (Consultant - Fuel Ethanol). The mission benefitted from discussions with the UNDP/SPEC energy team who have also prepared a country energy report on Fiji for the Pacific Energy Program. Secretarial assistance was provided by Ms. Lydia Hancock. The report was discussed with the Government of Fiji in Suva in June 1983 and up-dated to include recent information from the Government.

## CURRENCY EQUIVALENTS

| | | | |
|---|---|---|---|
| US$ 1.00 | = | F$ 0.9616 | (3rd Quarter 1982) |
| F$ 1.00 | = | US$ 1.0399 | (3rd Quarter 1982) |
| A$ 1.00 | = | F$ 0.9161 | (3rd Quarter 1982) |

## ENERGY CONVERSION FACTORS

| FUEL | TOE PER PHYSICAL UNITS 1/ |
|---|---|
| Liquid Fuel (tonnes) 2/ | |
| LPG | 1.08 |
| Avgas | 1.04 |
| Gasoline | 1.05 |
| Kerosene/Turbo Fuel | 1.03 |
| Diesel Oil (ADO) | 1.02 |
| Electricity (MWh) 3/ | 0.25 |
| Biomas Fuels (tonnes) | |
| Bagasse | 0.45 |
| Firewood | 0.33 - 0.35 |
| Coconut Husk | 0.41 |
| Coconut Shell | 0.51 |
| Coconut Palm Wood | 0.27 |
| Coal (tonnes) | 0.62 |

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1/ 1 TOE (toe) = 10 million kcal
= 6.61 boe
= 39.68 million Btu

2/ Avgas (Aviation Gasoline) = 1413.6 liters/tonne
LPG (Liquified Petroleum Gas) = 1729.1 "
Gasoline (Motor Spirit) = 1356.8 "
Kerosene/Turbo Fuel = 1229.1 "
Diesel (ADO) = 1186.5 "

3/ Converted at thermal efficiency of 34% or 4 MWh per toe.

## MEASUREMENTS

| | | | |
|---|---|---|---|
| BTU (Btu) | British thermal unit | = | 0.252 kilocalories |
| Bbl. | Barrel | = | 159 liters; 42 US gallons |
| boe | Barrel of oil equivalent | = | 6 million Btu. |
| $m^3$ | cubic meter | | |
| GWh | gigawatt hour | = | 1,000,000 kilowatt hours |
| km | kilometer | - | 1,000 meters |
| kV | kilovolt | = | 1,000 volts |
| kVA | kilovolt ampere | = | 1,000 volt amperes |
| kW | kilowatt | = | 1,000 watts |
| kWh | kilowatt hours | = | 1,000 watt hours |
| M | thousand | = | 1,000 |
| MW | thousand kilowatt | = | 1,000 kilowatt |
| MM | million | = | 1,000,000 |
| MB | thousand barrels | = | 1,000 barrels |
| MWh | megawatt hour | = | 1,000 kilowatt hours |
| MVA | megavolt ampere | = | 1,000 kilovolt amperes |
| p.a. | per annum | | |
| tonne | metric ton | | |
| Tpa (tpa) | tonnes per annum | | |
| TOE (toe) | tonne of oil equivalent | = | 39.68 million BTU (10 million kilocalories) |
| MTOE (Mtoe) | thousand TOE (toe) | = | 1,000 tonne of oil equivalent |
| US Gallon | | = | 0.833 imperial gallon; 3.785 liters |

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IBRD Map No. 16803
IBRD Map No. 16936
IBRD Map No. 16897

# SUMMARY OF FINDINGS AND RECOMMENDATIONS

## INTRODUCTION

1. Fiji's performance in the energy sector has been remarkably good during the past ten years despite its complete reliance on imports for the supply of petroleum products. The main issues for the future are essentially related to institutional and, to some extent, pricing arrangements to ensure, first, that an appropriate mix of a variety of indigenous energy resources is used, second, that energy supplies are available to rural and urban areas on each of the two main islands of Viti Levu (with 75% of the population) and Vanua Levu (15%), as well as over 300 other islands, and, third, that current efforts to encourage efficient use of energy are continued.

### Energy Outlook

2. With the completion of the Monasavu hydro project, there will be sufficient power capacity to meet Viti Levu's needs until the early part of 1990. 1/ Total petroleum demand will decline by 6.8% p.a. up to 1985 and thereafter will increase at about 1.9% p.a. (2.03). It is expected to be the same in 2000 as in 1981 (Table 3.1). As the country's source of power for electricity shifts from oil to hydropower, the petroleum product demand mix will change, with greater emphasis on light products, expecially those needed by the transport sector. In this report the mission has used two scenarios from 1983: a base GDP/growth scenario (BGS) of 3.5% p.a. and an optimistic growth scenario (OGS) of 5.0% p.a.2/ Under both scenarios, total petroleum demand is not expected to increase significantly and growth in power demand will approximate the real GDP growth rate. Total energy demand under the optimistic growth scenario would increase at 2.1% p.a. and under base growth scenario at 1.8% p.a.3/ In neither case is per capita energy use expected to increase significantly.

### Power Sector

3. Due to the recent slowdown in the economy and increases in power tariffs, power demand growth during 1981-1983 is averaging about 2-3% p.a. Power demand in the future is expected to grow at 3.5% p.a. - 5.8% p.a. Maximum demand in 1990 would be 60 MW (BGS) to 66 MW (OGS) while in

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1/ This represents 95% of Fiji's needs.

2/ The Government hopes to achieve a 5% p.a. growth, but the mission believes that a 3.5% p.a. growth is realistic.

3/ The forecast energy demand assumes that the major growth will come from non-energy intensive sectors. No major construction projects needing large energy inputs like Monasavu are envisaged during the forecast period.

2000 it would be 82 MW (BGS) to 103 MW (OGS). The Fiji Electricity Authority (FEA) has recently revised its forecasts downward and these now match the mission's high growth scenario projections. The mission's projections indicate that the current generation and transmission facilities on Viti Levu are sufficient to meet the demand up to 1991 for the OGS and up to 1995 for the BGS. In 1985 there will be about 90 GWh of surplus energy (2.13). In the long-term, there are four possible hydro-power projects on Viti Levu for which provisions were made during the construction of the Monasavu hydropower development and Vaturu water supply schemes. These projects can be brought on stream fairly quickly with relatively small investment to meet the small increments in power demand beyond 1991 and 1995. Two additional hydropower projects are also under investigation (2.17). The total hydropower potential on Viti Levu is estimated at 300 MW (2.17). The mission commends the foresight and preparation work of the FEA and concludes that there is no urgency for undertaking further work, such as a long-term power master plan for Viti Levu (4.05).

4. For Vanua Levu, it is possible to replace diese-based power generation in Labasa and meet current maximum demand of 2 MW by a combination of a samll run-of-river hydro plant (providing energy mainly during the wet season), and a bagasse-based power supply from the Fiji Sugar Corporation (FSC) along with wood-based power generation from the Malau sawmill (in the dry season) (2.16).

5. Rural Electrification: About 25% of households in the rural areas and 50% in the urban and peri-urban areas are connected to electricity supply. Currently there are two rural electrification programs, one under FEA and the other under the Public Works Department (PWD). PWD provides power to isolated rural communities, and FEA extends its grid to rural communities located in its vicinity.

6. Rough estimates show that some 80,000 new houses would have to be connected to completely electrify Fiji, at a capital cost of about US$80 million (3.22). Although the additional load will not be large (10 to 15 MW), the magnitude of the financial needs, the logistics of supplying electricity to three times the number of current customers and such an ambitious plan will require a major planning effort. The mission supports the Government's decision to transfer the bulk of rural electrification activities to FEA to ensure a consistent policy with regard to technical standards, capital contributions by consumers and maintenance. ADB has agreed to provide technical assistance to develop a country wide rural electrification plan which should be based on appropriate economic justification. The study will include an evaluation of the number of villages to be electrified each year, estimates of costs, financing and technical standards, and establish a priority list for the electrification program based on economic calculations.

Liquid Fuels

7. Petroleum Exploration: Since 1978, when new exploration licenses were awarded, exploration has not proceeded at a satisfactory pace. Although considerable seismic work has been done, only seven wells up to a depth of 3,000 meters have been drilled and these have not found a promising source or reservoir rocks. In view of potential structures and traps which still remain untested, including deeper sedimentary layers (between 3,000-5,000 meters) at one of the wells, continued efforts to encourage exploration drilling are justified. To promote such a program, the Government will need to disseminate technical information to attract new concessionaires by holding promotional meetings. The mission recommends a technical assistance program for this purpose (Annex I, Part 2).

8. As far as the petroleum law is concerned, the mission bleives there is sufficient flexibility to permit several contract approaches. Existing contracts are straightforward concession agreements. Since the income tax abatement clause does not serve as a significant incentive, a production-sharing type of contract might be worth considering. This type of contract is widely acceptable to oil companies because it allows for rapid investment recovery and is relatively simple to administer. It would also allow Fiji substantial control and participation.

9. Petroleum Supplies: Fiji currently imports about 320,000 tonnes p.a. of petroleum. The products are brought in by three oil companies, and about 75% of supplies originate from Australia. LPG is imported by a non-established (non-major) petroleum trader. Products costs (excluding LPG) are calculated on the basis of a Singapore import parity. A recently completed study by consultants indicates that as Australia is much closer to Fiji than Singapore, Fiji is overcharged in freight. The mission visited Australia and Singapore to investigate this matter and concluded that while the AFRA freight rates 1/ applied to the transport of clean products carry a premium which is higher than that normally used in international trade, the import volumes of each company are too small to enable the country to bargain for favorable rates and therefore lower prices.

10. Under the current situation, the companies guarantee a continuation of supplies, which is advantageous to Fiji. It is true that GOF may be able to procure supplies from independent marketers in the short run at lower spot prices, but this may prove to be only a temporary advantage if, under different market conditions, such supplies were no longer available.

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1/ Average Freight Rate Assessment (AFRA) is calculated by the London Tanker Brokers Panel each month and is applied to nominal freight rates which are calculated and updated every six months by the World Scale.

11. However, it is possible both to procure supplies at lower than current costs and ensure the continuity of supplies. In this respect the mission recommends that:

(a) as a first step the storage/marketing and supply/transport functions be separated to allow for different companies to handle these two aspects. Such a separation would increase distribution efficiency and could be implemented without disrupting current distribution arrangements;

(b) the Governments of Fiji, Papua New Guinea and the Solomons should pool their requirements and seek bids from established international majors to supply the combined needs of the three countries. 1/ If possible, other countries in the region should be included in the supply pool; and

(c) the governments also negotiate with prospective suppliers for freight rates whch are in line with international standards, or arrange with independent companies to transport these products.

12. In the mission's view, these arrangements would be compatible with current petroleum supply logistics and would give a prospective supplier the incentive of access to a large market to quote lower than Singapore basing point prices. The mission's investigations confirm that such arrangements will be acceptable to the oil marketing companies. Indeed, Bougainville in PNG was able to procure fuel oil supplies from Gulf Oil at substantially lower than Singapore postings. A local refinery as a source of petroleum supplies is considered uneconomic.

13. Ethanol: In the feasibility study done for the Fiji Government, options based on either new sugar areas or a distillery using cane juice annexed to an existing sugar mill were found uneconomic. 2/ The molasses-based option for a free standing distillery was found to be marginal. The mission's review suggests that the economics of the molasses-based option could be improved if:

(i) the size of the proposed plant is reduced to meet only the domestic demand for ethanol for blending at 20% with gasoline (10-14 million liters);

(ii) the plant is annexed to the Lautoka Sugar Mill to take the advantage of installed capital equipment and excess bagasse available during part of the crushing season;

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1/ The combined demand of these three countries is about 985,000 tonnes p.a. (about 19,000 barrels/day), including the supplies to Bougainville.

2/ The report was prepared jointly by the FSC, British Petroleum South West Pacific (BP) and Colonial Sugar Refiners (CSR) of Australia.

(iii) arrangements are made to dispose of the plant effluent into the ocean in an ecologically acceptable manner, which would not affect tourism in the area: 1/

(iv) the plant is designed to operate year round, using pine chips from the Fiji Pine Commission (FPC) as a fuel in the off-season; and

(v) the capital costs are revised according to appropriate design and procurement arrangements.

The mission's evaluation shows that the project economics is marginal and highly sensitive to the prices of molasses and ethanol (3.17, 3.19). It is recommended that the Government review the mission's recommendations and if acceptable, partly base its decision on the terms at which potential commercial partners would be prepared to supply capital for the project.

Special Energy Programs

14. GOF has initiated several special energy programs since the establishment of the Department of Energy (DOE) in the Ministry of Energy and Mineral Resources (MEMR). The mission's assessment of some of these programs follows:

(i) Energy Conservation: The main thrust of the energy conservation program is in public organizations, and the initial goal is to reduce the electricity bills of government agencies by 20% (1983/84). In addition to tax incentives, GOF has allocated F$200,000 in the FY1983 budget to implement recommendations of energy audits started in 1982. The mission supports the fuel economy program of the Ministry of Agriculture and Fisheries (MAF) which is designed to replace outboard motors (used by small scale fishermen) with fuel efficient diesel inboard motors.

(ii) Gasification: The EEC is providing funding through the EDF for two pilot gasification projects. Both projects are to retrofit diesel engine generators. FEA plans to retrofit an existing 365 kVA generator with a medium-sized gasifier at its control center at Vuda Point. If tests are successful, the gasifier would be transferred to an outstation such as Savusavu. The scope of a second pilot project has not yet been defined. In the mission's view, FEA's choice of small charcoal gasifiers (20 to 50 kW)

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1/ These are strong feelings in Fiji against the disposal of effluent into the ocean.

rather than small steam engines is a sound one given that FEA's main objective is to retrofit diesel engines of the type used in isolated rural electrification schemes.

(iii) Stove Development: The DOE has been successful in adapting and developing wood and charcoal burning stoves for household use. In the mission's view, the next step, which involves dissemination and/or commercialization of the stoves, should be the responsibility of specialized divisions or agencies of the Ministry of Fijian Affairs and Rural Development (FARD) provided adequate staff is available for this purpose. 1/ DOE should, however, continue to provide the necessary technical backup for this program.

(iv) Biogas: The MAF has installed about 11 pilot biogas digestors to handle the waste disposal problem under its piggery dvelopment program. Because of the interest shown by farmers, MAF has approved a proposal to expand the pilot program by installing additional digestors on private piggeries. GOF has recently reduced MAF's initial allocation of F$10,000 to F$5,000 in the current budget (equivalent to F$500 grant per installation for 10 farmers). In order to maintain the program's momentum, the MAF could use unallocated farm improvement funds (currently F$16,000) to supplement GOF's direct budget support.

(v) Solar Energy: Several GOF organizations such as the Department of Posts and Telecommunications, have made significant progress in the use of solar energy technologies. GOF has also introduced tax and investment incentives to promote local manufacturing and assembling of solar systems such as water heaters.

Institutions

15. The role of the DOE within the MEMR needs to be clearly defined. It should be limited to planning and policy areas. MEMR should closely liaise with FEA and the Central Planning Office (CPO) to help identify the growth areas where power will be needed or can be used. This will help coordinate the planning process and remove the inconsistencies in various programs. The MEMR should also play a lead role in energy pricing policy. The mission recommends a technical assistance project to strengthen MEMR's institutional capabilities, particularly in the area of energy economics and petroleum supplies arrangements. The government has also indicated a need for short-term technical assistance for preparing strategy for petroleum supplies and negotiations of supplies contracts in 1984.

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1/ MFARD has now been split into two ministries.

Prices

16. Petroleum: Although retail prices fully reflect the cost of imports (2.05), disparities between taxes on gasoline (F¢16/liter) and diesel oil (F¢5/liter) continue to distort relative prices of these products (2.05). In the mission's view, there is sufficient scope to streamline the product prices and reduce the cost of imports. For this the mission recommends a three-step strategy for regional procurement of petroleum products (3.05). The mission also recommends a close working relationship between the MEMR and the Prices and Incomes Board (PIB).

17. Power Tariffs: There have been several tariff increases recently, and FEA has been able to offset major escalations in its operating expenses and comply with most covenants under the IBRD/ADB power loan agreement. Additional tariff increases were planned for January and July of 1982 (10% each). The Government believes that current tariff levels are high and decided to defer these increases (2.23). The mission recommends that, after the completion of Monasavu, the tariffs should be reviewed in the second half of 1983 based on long-run marginal costs.

Investments

18. Considering that: (i) the preparation of a power development program is not an immediate priority; (ii) the rural electrification program must be defined by the ADB study and the extent of implementation agreed by the Government based on its resources; and (iii) there are uncertainties about the oil and gas exploration program, estimates of future total investment in the energy sector are not needed at this time, even though the scope and areas of possible investments are identified under each energy subsector. More important is technical assistance of about US$1.1 million to cover petroleum, power and energy planning/management in the next three years.

# I. ENERGY AND THE ECONOMY

## Overview

1.01 Fiji comprises a group of more than 300 islands in the South Pacific, covering a land area of 18,371 sq. km. The country is divided into four administrative units (divisions). About 90% of the 658,000 (mid-1982 estimate) population lives on two main islands, Viti Levu (75%) and Vanua Levu (15%). About 60% of the labor force is employed in agriculture, forestry and fishing. These together contribute about 25% of GDP (Table 1.1). The other major contributors to GDP are the services (16%) and manufacturing (12%) sectors (Annex Table A.1). Although per capita GDP is relatively high (about F$1,057 in 1982), the economy is mainly dependent on sugar exports and tourism and is vulnerable to external trade fluctuations. After experiencing negative growth in 1980 and a recovery in 1981 (Annex Table A.1), in 1982 the growth in GDP has again reversed to -2.0%. This reversal was due to a decline in manufacturing, construction, and distribution activities (services sector including tourism). Due to prolonged drought, growth prospects for 1983 are also dismal (Table 1.1).

Table 1.1: GDP by Activity
(constant 1977 F$)

| Activity | 1977 | 1981 | 1982 (provisional) | 1983 (est.) 1/ |
|---|---|---|---|---|
| Agriculture, Forestry Fishing (%) | 23.3 | 24.2 | 25.2 | 24.0 |
| Manufacturing (%) | 10.7 | 12.5 | 12.4 | 12.3 |
| GDP (F$ million) | 606 | 709 | 695 | 693 |
| Population (000's) 2/ | 596 | 646 | 658 3/ | 671 3/ |
| GDP/capita (F$) | 1,016 | 1,198 | 1,057 | 1,033 |
| GDP Growth (% p.a.) | - | 4.0 4/ | -2.0 | -0.3 |

1/ The 1983 GDP estimates were prepared in April 1983 for the Macro Economic Sub Committee. Since then the production of sugar cane has been declining due to prolonged drought. The recent statistics on sugar production indicate that the 1983 GDP growth may lie in the range of -0.3% to -4.0%.
2/ Mid-year estimates.
3/ The mission estimates.
4/ Average annual growth between 1977 and 1981.

Source: Bureau of Statistics.

1.02 Between 1977 and 1982, the construction sector declined by 0.8% p.a., and in 1983 it is expected to drop another 8.9% after the completion of the Monasavu hydro project and Vaturu water supply scheme. Growth in the service sector was adversely affected by the worldwide recession which set in after the petroleum price increases of 1979. Falling sugar prices, accompanied by a high level of imports, have created balance of payments difficulties. With decline in sugar production due to prolonged drought, the GDP in 1983 is expected to decline by at least 0.3% (Table 1.1). In the long run the economy is expected to grow at 3.5% p.a. The mission agreed with the Government to use two GDP growth scenarios for projecting energy demand: base scenario of 3.5%, and an optimistic growth scenario of 5%.

1.03 Fiji's net 1/ petroleum import bill has increased from F$29 million in 1977 to F$82 million in 1981 and F$77 million in 1982 (Table 1.2). Although this represents an increase of about 22% p.a., the petroleum import cost as a percent of the total import bill (Table 1.2) increased at about 9.5% p.a. 2/

Table 1.2 Petroleum Import Costs

| Year | Total Import Bill (million F$) | Petroleum Products (Net of the re-exports) (million F$) | % |
|---|---|---|---|
| 1977 | 281 | 29 | 10.3 |
| 1980 | 459 | 53 | 11.6 |
| 1981 | 540 | 82 | 15.2 |
| 1982 (provisional) | 476 | 77 | 16.2 |
| change % p.a. | 11.1 | 21.6 | 9.5 |

Sources: Ministry of Energy and Mines; Bureau of Statistics; Budget address by the Minister of Finance.

1/ Net import costs are net of re-exports but include the cost of imports for bunkering and aviation sales.

2/ In Papua New Guinea, Kiribati, and Niue, the petroleum imports as a percentage of total imports are higher than in Fiji (1981/1982).

Energy Consumption

1.04 Annual per capita energy use in Fiji (1982) is about 0.63 toe (4.2 boe). Wood and bagasse (biomass) account for 55% of the total energy supplies. All commercial energy is imported (45% of total energy) and consists of petroleum products and coal, with petroleum comprising 43% of total primary energy. The energy balance for 1982 is shown in Table 1.3.

1.05 Industry and commerce account for about 57% of total energy use. This includes bagasse used by the sugar industry for combined process steam and electricity production. A major user of imported petroleum is the transport sector, which includes inter-island shipping using about 36% of petroleum energy. Wood is the main source of household fuel throughout the country; together, 18% of biomass, 20% of electricity, and 12% of petroleum (mainly kerosene) end up in the household sector.

Table 1.3 Fiji: ENERGY SUPPLY/DEMAND BALANCE 1982
(000 toe)

| | Coal | Petroleum | Elec. | Total Commercial | Fuel-wood | Bagasse | Total Non-Commercial | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 1. PRIMARY SUPPLIES | | | | | | | | |
| Production | - | - | - | - | 72.9 | 243.5 | 316.4 | 316.4 |
| Imports | 12.0 | 397.0 | - | 309.0 | - | - | - | 409.0 |
| Exports | - | (148.9) | - | (148.9) | - | - | - | (148.9) |
| Total | 12.0 | 248.1 | - | 260.1 | 72.9 | 243.5 | 316.4 | 576.5 |
| 2. CONVERSION | | | | | | | | |
| Power Generation | - | (66.4) | 66.4 | - | - | - | - | - |
| Sector use/losses | - | - | (20.5) | (20.5) | - | - | - | (20.5) |
| 3. NET SUPPLIES | 12.0 | 181.7 | 45.9 | 239.6 | 72.9 | 243.5 | 316.4 | 556.0 |
| 4. FINAL CONSUMPTION (BY SECTORS) | | | | | | | | |
| Industry and Commerce | 12.0 | 24.2 | 32.7 | 68.9 | 14.2 | 243.5 | 257.7 | 326.6 |
| Household | - | 22.5 | 9.4 | 31.9 | 56.6 | - | 56.6 | 88.5 |
| Transport | 0 | 133.9 | - | 133.9 | - | - | - | 133.9 |
| Others | - | 1.1 | 3.8 | 4.9 | 2.1 | - | 2.1 | 7.0 |
| Total | 12.0 | 181.7 | 45.9 | 239.6 | 72.9 | 243.5 | 316.4 | 556.0 |

Notes: Negative flows indicated by parentheses.

Source: The mission estimates.

## II. ENERGY SECTOR REVIEW

### A. Petroleum

2.01 Between 1975 and 1982 petroleum imports declined by 2.1% p.a., mainly due to a 7.2% p.a. drop in aviation fuels and a 13.6% p.a. decline in bunker trade (decreased shipping). Domestic petroleum use, excluding international bunkering and airlines, increased at about 1.4% p.a. between 1977 and 1982, compared with a GDP increase of 2.8% p.a., (income elasticity of demand of 0.5). Whereas the internal demand for most major petroleum products either declined or stagnated in this period, the demand for automotive diesel oil (ADO) increased by 8.4% p.a..

2.02 Power generation by the Fiji Electricity Authority (FEA) is currently based on industrial diesel oil (IDO). The FEA accounts for about 85.5% of total IDO use in the country. Historically, FEA demand has increased at 3.6% p.a. and has accounted for about 26% of petroleum imports (1981). The major proportion of these imports, together with the diesel and LPG currently being used in the construction of Monasavu, will decline with the completion of Monasavu hydropower project.

2.03 Table 2.1 gives a profile of petroleum use by various economic sectors. In 1981, power generation, industry and households together accounted for about 74% of petroleum use. Road transport is included in the consumption data for each economic sector. If the transport sector is taken separately, it would represent about 36% of total petroleum demand. 1/

Table 2.1. Petroleum Consumption by Economic Sectors
(1981)

| Sector | '000 toe | % |
|---|---|---|
| Shipping (domestic) | 20.0 | 7.6 |
| Aviation (domestic) | 6.2 | 2.3 |
| Power generation | 69.3 | 26.4 |
| Industry | 52.5 | 20.0 |
| Commerce | 31.0 | 11.8 |
| Government | 12.4 | 4.7 |
| Household | 71.5 | 27.2 |
| Total | 262.9 | 100.0 |

Source: Ministry of Energy and Mineral Resources.

1/ Assuming that 60% of ADO and 90% of gasoline goes into direct road transport.

Because of Monasavu the total petroleum demand is expected to decline from the current level of 262.9 thousand toe (1981) to 198.7 thousand toe in 1985 (a decline of 6.8% p.a.). Between 1985 and 1990, total petroleum demand is expected to increase at about 1.8% p.a.. Beyond 1985: (a) gasoline demand is expected to increase at 1% p.a.; (b) demand for distillates and kerosene is expected to increase at about 2% p.a.; (c) turbo fuel demand is expected to increase at 3% p.a.; (d) industrial diesel oil and aviation gasoline demand will remain static; and (e) LPG demand will increase at 10% p.a. (Table 2.2). 1/ Demand in 1990 is projected at 217.8 thousand toe (17.2% below the 1981 level). In 1990, clean products would increase to 84% of total petroleum demand compared with the current level of 64% (1981), and the total domestic market would only be about 4.4 thousand barrels per day (bd). At this demand level, the most economic way to supply the domestic market would still be by importing refined petroleum products from the cheapest supply center. Currently supplies are procured from Singapore (25%) and Australia (about 75%). A local refinery will not be economic for Fiji and the Government has already decided against it unless major changes occur in market conditions or petroleum is locally discovered.

Table 2.2 Petroleum Demand Projections 1/

| Product | Actual 1981 ('000 toe) | Projections 1985 ('000 toe) | 1985 Growth Rate | 1990 ('000 toe) | 1990 Growth (% p.a.) |
|---|---|---|---|---|---|
| LPG | 3.6 | 5.3 | 10.2 | 8.5 | 9.9 |
| Avgas | 0.4 | 0.4 | - | 0.4 | - |
| Gasoline | 44.8 | 45.0 | 0.1 | 47.3 | 1.0 |
| Kero/Turbofuel 2/ | 25.9 | 24.0 | (1.9) | 26.0 | 1.6 |
| Automotive Diesel | 92.7 | 92.0 | (0.2) | 101.6 | 2.0 |
| Industrial Diesel | 84.9 | 22.0 | (28.6) | 24.0 | 1.8 |
| Residual Fuel Oil | 10.6 | 10.0 | (1.4) | 10.0 | - |
| Total | 262.9 | 198.7 | (6.8) | 217.8 | 1.9 |

1/ Projections exclude international airlines and bunkering activities.
2/ Brackets show negative numbers.

Source: Mission estimates.

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1/ The projections assume that: (a) foreign exchange constraints will continue; (b) the past construction boom will not be repeated; (c) appropriate pricing and conservation policies will be followed; and (d) the main growth will come from non energy-intensive sectors such as agriculture.

Petroleum Prices

2.04 The Government controls the prices of gasoline, automotive diesel and kerosene. The Prices and Incomes Board (PIB) receives requests and submissions from oil companies to review their margins and adjust or change prices based on movements in ex-refinery prices, freight costs or exchange adjustments. If the PIB considers that the requested changes are just, it supports the request for approval by the cabinet. The Minister of Finance announces the changes under the powers conferred upon him under section 9 of the Counter-Inflation Act. Until February 1980, approved prices were based on the lowest cost oil company. Since 1980, the PIB has adopted a new pricing formula based on a weighted average cost of all marketing companies. This formula does not provide enough incentive to the high cost marketer to control its costs, and the mission therefore recommends that PIB revert to the pre-1980 basis. The Government determines the tax on various products according to its revenue needs; motor gasoline is currently taxed at F¢ 16/liter and automotive diesel at F¢ 5/liter.

2.05 Retail prices fully reflect the cost of imports (Table 2.3). Because of tax differentials initially there were large disparities between the prices of gasoline, diesel oil and kerosene. The trend has been to gradually remove these disparities by increasing the retail prices of diesel oil and kerosene at a higher rate than gasoline prices. However, the current tax rates on gasoline and diesel oil (2.04) continue to distort relative retail prices of these products. In the mission's view, there is scope to further streamline relative prices and reduce the cost of imports. The mission recommends that the MEMR develop an in-house technical capability to review petroleum prices and the need for rationalizing the distribution pattern, and for entering into joint purchasing arrangements for petroleum products. This need can be served by placing an energy economist in the DOE and maintaining a close working relation with the PIB. However, this may require changes in the legislation to allow review of pricing data and coordination between the PIB, Ministry of Finance and MEMR.

Table 2.3: Retail Prices for Petroleum Products
(F¢/liters)

| December | Gasoline | Automotive Diesel | Kerosene | Pre-Mix |
|---|---|---|---|---|
| 1978 | 28.7 | 14.9 | 18.0 | 18.3 |
| 1979 | 37.0 | 25.0 | 25.0 | 26.0 |
| 1980 | 44.0 | 31.0 | 32.0 | 33.0 |
| 1981 | 52.0 | 38.0 | 37.0 | 40.0 |
| 1982 | 55.0 | 43.0 | 43.0 | 48.5 |
| Increase % p.a. | 17.6 | 30.3 | 24.3 | 27.6 |

Source: The Prices and Income Board

Hydrocarbon Prospects

2.06 Initial interest in petroleum exploration in Fiji was generated in 1968-69, following a petroleum discovery in Papua New Guinea and oil seepages in Tonga. A seismic survey was done by Magellan Petroleum and Southern Pacific Petroleum in 1969, covering 769 km of onshore and offshore seismic lines. An exploration license was granted to two companies in December, 1969 for the Bligh water area north of Viti Levu. Between 1969 and 1975, five different groups carried out an additional 6,473 km of seismic lines, gravity, magnetic and related surveys. None of these surveys resulted in exploratory wells, and all five licenses were relinquished by 1975.

2.07 Four new exploration licenses were negotiated in 1978, basically for the areas that had already been subject to the earlier exploration work. Some 7,000 km of additional seismic line surveys were done in 1979-81. Since 1978, when the current round of exploration licenses was awarded, exploration has not proceeded at a satisfactory pace. A considerable amount of seismic work has been done, and seven exploratory wells have been drilled. Results of these exploration efforts, however, have not been favorable. The seven wells to date failed to encounter significant hydrocarbon shows, and source or reservoir rocks were less promising than had been hoped, although suitable formations are known to be found in Fiji. These drilling results will make it hard to convince oil companies of Fiji's potential. Considering that only a few potential structures and stratigraphic traps have so far been tested by drilling, and because the wells drilled so far have not sufficiently been tested the deeper sedimentary layers (from 3.000 - 5,000 meters), continued efforts to encourage further exploration by foreign oil companies are necessary.

B. Electricity

2.08 Supply/Demand FEA supplies power to a number of towns and villages on the main island of Viti Levu, in two towns on Vanua Levu, and in one town on Ovalau. About one-third of the population has access to power. Viti Levu accounts for 95% of FEA's power generation. The largest load centers are Suva, Lautoka and Nadi (combined load of 88%). FEA currently operates diesel power stations with a total installed capacity of 85 MW. This will change in 1983 when the 80 MW Monasavu Hydropower Station will come on stream. Hydropower will be supplied through a 132kV/33kV transmission system to all but one load center on Viti Levu and replace most diesel-based generation. Table 2.4 shows that FEA's generation grew from 92 GWh in 1970 to 237 GWh in 1981 (9.0% p.a. growth). The growth was higher before 1977 than after 1977. Because of a slowdown in the economy and the effect of several tariff increases, in 1980, the growth rate declined to 2% p.a. and in 1982 to 3% p.a.

Table 2.4: FEA Power Generation Trends

| Year | GWh | Annual Growth Rate % |
|---|---|---|
| 1970 | 92 | |
| 1977 | 201 | 11.8 |
| 1978 | 211 | 5.0 |
| 1979 | 226 | 7.1 |
| 1980 | 230 | 1.8 |
| 1981 | 237 | 3.0 |

Source: FEA

2.09 There are two large captive power producers: the Fiji Sugar Corporation (FSC using bagasse) and the Emperor Gold Mines (EGM using diesel), each with an annual generation of about 40 GWh. FEA has contract with the EGM to sell hydro power starting in 1983.

2.10 Transmission and distribution losses on the FEA system have risen from 8% in 1970 to 13% in 1981 due to network extensions to peri-urban and rural areas and a rapid growth in the number of customers. Average annual sales per customer decreased because of conservation by existing customers and low demand of the new rural customers.

Table 2.5: FEA Historical Electricity Statistics

| | 1970 | 1978 | 1981 | Growth Rate (1970-81) percent/annum |
|---|---|---|---|---|
| Power Generation (GWh) | 92 | 211 | 237 | 9.0 |
| Maximum Demand (MW) 1/ | 17 | 39 | 47 | 9.7 |
| Electricity Sales (GWh) | 85 | 186 | 206 | 8.4 |
| Number of Customers (000) | n.a. | 33.2 | 42.2 | 8.3 2/ |

1/ Figures in this Table do not necessarily represent the sum of coincident maximum demands in the individual load centers on the three islands. Current coincident maximum demand in the interconnected system of Viti Levu is 40 MW and the corresponding load factor is 63%. Monthly maximum demands show no marked seasonal variations except for a drop of about 10% from July to October.

2/ Growth rate relates to 1978-1981.

Source: FEA

2.11 Load Forecasts: Due to the unexpected slowdown in the demand growth, previous load forecasts for Viti Levu which were based on 7% p.a. growth are outdated. FEA has recently prepared a new load forecast using 5% p.a. growth which matches the mission's forecast under optimistic growth scenario of GDP. Under this demand forecast, a maximum demand of 66 MW is forecast for 1990 and 103 MW for 2000 (including sales to EGM). For the base growth scenario (BGS), the maximum demand is forecast at 60 MW for 1990 and 82 MW for 2000 (Table 2.6). On Vanua Levu, projections for 1992 are a maximum demand of 3.0 to 4.0 MW for Labasa and 0.3 to 0.4 MW for Savusavu.

Table 2.6: Load Forecasts for Viti Levu's Interconnected System

| Year | Base Growth Scenario GWh | Base Growth Scenario MW | Optimistic Growth Scenario GWh | Optimistic Growth Scenario MW |
|---|---|---|---|---|
| 1981 (actual) | 225 | 40 | 225 | 40 |
| 1985 | 296 | 51 | 304 | 53 |
| 1990 | 344 | 60 | 376 | 66 |
| 1995 | 400 | 70 | 568 | 82 |
| 2000 | 467 | 82 | 686 | 103 |

Source: The Mission estimates.

Power Development Program for the 1980s

2.12 Viti Levu: The first stage of the Monasavu Hydropower Project is now scheduled for commissioning in September 1983, which is more than one and a half year later than originally scheduled. Construction of the second and third stages (water diversion from additional catchments) is proceeding satisfactorily.

2.13 When fully commissioned in 1985, Monasavu will have an installed capacity of 80MW 1/ and an average annual energy of about 400 GWh. The latter would be more than 90% firm (guaranteed in dry years). This energy would meet the forecast demand until the early 1990s under the optimistic growth demand forecast, including sales to EGM. There will be a hydropower energy surplus of about 90 GWh in 1985, and there are no known new or existing major users on Viti Levu which could use this surplus. Despite this low utilization in the initial years, Monasavu provides cheaper energy than any other alternative source of generation, including the existing diesel plants. This is due to the low incremental cost of the third stage. In 1985, less than 50% of the incremental energy from the third stage (total 164 GWh) will be used. At this utilization factor the unit cost would be 7.5¢/kWh which is lower than the current fuel cost of diesel generation (7.9¢/kWh).

1/ Due to constraints in the hydraulic system size, the effective output may be 3 to 5% lower.

2.14 FEA's consultants have recommended to base power development planning on firm rather than average energy and keep one unit at Monasavu as reserve. 1/ If accepted, this would reduce the lead time for future system expansion. While still sufficient throughout the 1980s under the base growth forecast, additional hydropower capacity would be required by 1988 under the high growth forecast. The mission considers these recommendations conservative and their implications for FEA possibly costly. Rather than follow these recommendations, the FEA should compare the benefits of deferring the next hydropower project by 1-2 or more years against the cost of using diesel generation to meet possible energy deficits in dry years. In capacity terms only 60 MW will be available from Monasavu during two maintenance months (assuming a planned outage of two weeks per unit). However, this effect could be reduced by scheduling maintenance for summer months when system demand drops by about 10%. A further reduction in the maximum demand can be achieved through introduction of temporary load management measures for large users. A benefit-cost comparison should also be done to determine the extent to which it is justified to use the existing diesel power stations to meet peak load during Monasavu's scheduled maintenance. 2/

2.15 The transmission system for Viti Levu, with the current extensions to be fully operational by mid 1983, is considered adequate to meet power demand in the 1980s. To provide reserve capacity for 132kV transmission line outages in dry years, FEA will keep its two large diesel power stations in Vuda (Nadi) and Kinoya (Suva) in operating condition.

2.16 Vanua Levu: There are various possibilities of displacing current diesel generation in Labasa and Savusavu. In the mission's view a mix of: (a) run-of-river hydropower plant at Saguru; (b) surplus power from a wood-fired steam power plant under construction at the Malau sawmill; and (c) bagasse-based power from the FSC sugar mill should be considered for Labasa during the 1980s. Labasa has a maximum demand of 1.9 MW, projected to increase to 3 to 4 MW in 1992. The hydro plant sited at Saguru could potentially supply 0.9 MW during the wet season and 0.5 MW during the dry season. The FSC sugar mill can supply 1.1 MW through the existing intertie in the dry season while the Malau sawmill will have a surplus of 0.6 to 0.8 MW. For Savusavu, the forecast power requirements of 0.3 to 0.4 MW in 1992 could be met by gasification/diesel retrofit based on wood, woodwaste or coconut residues. 3/

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1/ The reserve can be provided by the existing diesel power station.
2/ For instance, if 10 MW of diesel plant had to be run for eight hours per day during two months, the fuel costs would be approximately F$0.4 million. The corresponding benefit of deferring by one year the next hydropower project recommended by the consultants is about F$1.6 million (10% interest applied to a capital cost of F$16.0 million).
3/ Sufficient local biomass resources are available to meet current and projected future demand.

Power Supply Options for the 1990s

2.17 Large Hydro Power: The combined capacity and average annual energy of promising projects identified in Viti Levu is about 300 MW and 1,600 GWh (Table 2.7). This potential is three times Viti Levu's power requirements at the end of this century. Four projects — Vaturu, Wainisavulevu, Wainikasou and Vaturu Trunk Main -- are closely related to the recently completed Monasavu Hydropower Project or the Vaturu Water Supply Scheme. Provisions for their implementation were made during the construction of Monasavu and Vaturu. These four projects have the advantages of: (a) low cost per kW installed; (b) short lead time; and (c) relatively small size matching the slow load growth expected for the 1990s. Two additional projects -- Upper Sigatoka/Ba and Navua -- are also under investigation. As there is no urgent need for these projects, the mission recommends limiting investigations to hydrological measurements and selected drillings for the time being.

Table 2.7: Viti Levu's Hydropower Resources 1/

| Project | MW | GWh (firm) | GWh (Average) | Cost F$ Million | Status |
|---|---|---|---|---|---|
| Monasavu | 78 | 61 | 396 | 198.6 | Under construction |
| Vaturu 2/ | 15 | 24 | 36 | 15.5 | Proven |
| Wainisavulevu Pondage 3/ | - | 18 | 20 | 7.5 | Proven |
| Wainikasou Power Station 4/ | 6 | 16 | 20 | 9.0 | Proven |
| Vaturu Trunk Main 5/ | 1.6 | | 3 to 14 | 2.0 | Proven |
| Upper Sigatoka/ Ba 6/ | 46 | 62 | 144 | 80.0 | Under investigation |
| Navua | 50 | | 340 | | Estimated |
| Others | 100 | | 600 to 700 | | Estimated |
| Total | 296.6 | | 1,559 to 1,670 | | |

1/ This summary covers promising projects, not the total technical potential.

2/ Power station located downstream of the Vaturu dam to utilize surplus water from the water supply scheme.

3/ About 10m high dam at the Wainisavulevu provides about one-month storage (8 million $m^3$), thus increasing Monasavu's power generation.

4/ Utilizing a drop of about 100m in the Monasavu water diversion system downstream of the Wainisavulevu pondage.

5/ Utilizing the water flow on its way from Vaturu reservoir to the water treatment plant.

6/ Run-of-river project involving a diversion of the Sigatoka River to the Ba River.

Source: FEA

2.18 Mini Hydro Power: In addition to identified hydroelectric potential on Viti Levu, a number of mini hydropower sites have been investigated on the other islands, particularly Vanua Levu and Taveuni. Sites on Vanua Levu are discussed in a report, 1/ Vanua Levu Energy Study. One site, near Labasa, is featured in FEA's plans for power generation on Vanua Levu. A New Zealand team has also completed mini-hydro engineering studies 2/ for a 240 kW installation at Somosomo on Taveuni. Other investigations have been made with bilateral assistance from India 3/ for microhydro sites (about 50kW) on the Ngau, Kadavu, Moro and Moala Islands. A review of these studies, particularly those done by the Indian team, should be included in the ADB's study on rural electrification (3.23).

2.19 Bagasse Generation: FSC has been supplying small quantities of power to FEA's substations at Ba and Rakiraki on Viti Levu, and to FEA's substation at Labasa, Vanua Levu. FSC uses surplus bagasse for power generation by its steam turbo generator sets. Although current installed capacity on Viti Levu exceeds FSC's in-house needs by 10 MW, the seasonal operations of the sugar mills, the limited quantities of surplus bagasse for power generation and the oncoming surplus hydro power limit FSC's supply capability to FEA. The main role for FSC power will be in Labasa (on Vanua Levu). The capacity of the existing substation which connects the Labasa mill to FEA's local grid is 1.1 MW. During the 1981 milling season, FSC supplied FEA with about 1.85 GWh of electricity. The net electricity export from FSC to FEA was, however, only 0.51 GWh because FSC had to purchase a large amount (1.2 GWh) of electricity from FEA during twelve weeks of the start up season. The FEA rate for purchasing electricity from the Labasa mill, currently fixed at F¢5/kWh, is the main issue. It costs FEA about F¢12/kWh to produce power. The FSC could increase the power supply to FEA provided appropriate power rates are negotiated. To increase power supply one or more of the following will be needed:

(a) investigate the feasibility of operating the 300,000 lb/h boiler, the 4.0MW turbo alternator, the shredder turbine and possibly other prime movers at 350 psig;

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1/ Report was prepared jointly by Shedden Pacific Pty. Ltd and Snowy Mountains Engineering Corporation of Australia, and submitted in September 1982.

2/ Somosomo Small Scale Hydro Electric Scheme for Fiji, Design Documents, November 1980. Also Feasibility study for Small Hydro Electric Schemes on Taveuni and Vanua Levu, by the New Zealand/Fiji Bilaterial Aid Project, Janaury 1977.

3/ Project Report on Micro Hydro Schemes in Fiji Islands; Waimboteingau, Ngasele, Nambuna, Nakorovusa, joint report by Central Water Commission and Central Electricity Authority, India, November 1976.

(b) investigate the feasibility of adding a superheater to the 300,000 lb/h boiler;

(c) modification and additions to the evaporation and juice heating plant to reduce process steam;

(d) installation of a condensing turbo-alternator of 4.0-5.0MW capacity; and

(e) investigate the feasibility of adding a five gas bagasse drying system to increase boiler efficiency and to increase the amount of surplus bagasse produced.

2.20 Detailed studies of the proposed schemes would be necessary to ascertain the technical and financial viability of each.

Table 2.8: Power Generation Capacity at FSC Mills
(kW)

| | Location | | | |
|---|---|---|---|---|
| | Lautoka | Rarawai | Penang | Labasa |
| Installed Capacity | 9,500 | 7,000 | 4,750 | 7,250 |
| Onsite Load | 4,300 | 3,800 | n/a | 3,000 |
| FEA Substation Capacity | 1,200 | 1,200 | 400 | 1,200 |

Source: FSC

2.21 Wood-based Generation: Biomass resources (wood and bagasse) represent a valuable long-term option which should be considered while planning for system expansion. FEA should maintain contacts with FSC and FPC to ensure that their expansion programs and plant modernization are planned in such a way to keep them compatible with the requirements of the public power supply. The four largest sawmills could get steam power generation from sawmill waste. The Fiji Pine Commission (FPC) plans to expand the Drasa sawmill and to build a chipboard plant. Assuming availability of 75,000 tonne residues by 1985, about one third could be available as surplus to support a 2 MW (10 GWh) power plant. Based on FPC's expansion plans, this power surplus could quadruple by the year 2000.

2.22 Apart from the generation of power from sawmill waste, there are other long-term options such as use of logging residues and fuelwood

harvesting. Of immediate interest is the plan by the Malau Sawmill to install a 1.2 MW wood fired steam plant. Current estimates are that 0.6 to 0.8 MW would be available year-round to supply FEA's Labasa system. Other resources, such as geothermal, solar, sea wave and wind energy, are considered of low priority for power generation.

Electricity Tariffs

2.23 The fuel cost per kWh increased from 1.8¢ in 1975 to 7.9¢ at the end of 1982, and currently accounts for about two-third of the FEA's operating expenses. By introducing several tariff increases in the past few years, FEA was able to offset the escalations in operating expenses and comply with most covenants under the loan agreement with the World Bank and ADB. At the last review in July 1981, the tariffs had been increased by 10%. An important change had also been introduced into the tariff structure, consisting of a flat energy charge per kWh instead of a declining block rate and the abolition of off-peak rates. The current tariff schedule distinguishes three consumer categories (domestic, commercial and industrial, and maximum demand) and is expected to generate an average revenue of 15¢/kWh in 1982. For January and July 1982, additional tariff increases of 10% each were planned to comply with the loan covenant calling for a net return of 8% on revalued fixed assets. In view of the already high level of tariffs, the Government decided to defer these increases. The FEA was compensated by the Government through a grant of F$4.5 million. The mission recommends that tariffs be reviewed in the second half of 1983 and be based on long-run marginal costs.

2.24 The slowdown in the load growth experienced in the past few years implies that the current high tariffs have stimulated energy conservation. New major investments on Viti Levu to achieve additional energy savings are not justified in the 1980s due to the forthcoming hydro energy surpluses which can be generated at zero marginal cost. 1/ Private consumers, of course, will continue with energy conservation measures to reduce their electricity bills. In the public sector, however, such investments should be deferred as long as there are major hydro energy surpluses.

2.25 As soon as Monasavu comes on stream, most of FEA's diesel generation will be displaced. The oil requirements for isolated load centers and for standby generation on the interconnected grid are expected to remain at about 5,000 tpa during the 1980s. In the 1990s, the incremental demand on both Viti Levu and Vanua Levu can be met from domestic resources such as hydropower and biomass.

2.26 A capital expenditure program recently prepared by FEA for 1982-

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1/ Besides the gold mine (EGM), there are no other major consumers of electricity on Viti Levu which could use the power surplus for the next 4-5 years.

1988 indicates a total investment of F$235 million. Of this, about F$100 million is for Monasavu and the associated 132kV transmission system, F$10 million is for generation facilities on the outer islands, and F$50 million is for new hydropower projects on Viti Levu, such as Vaturu which is scheduled for commissioning in 1987. In the mission's view, there is no need for additional hydropower projects on Viti Levu in the 1980s. The hydropower development program should be deferred by about four years. This would reduce the capital requirements during the 1980s by some F$40 million. Investments for sub-transmission, and distribution facilities and other miscellaneous items account for the balance of F$65 million. This includes a capital allocation for rural electrification of only about F$12 million, whereas the Government's desire for comprehensive rural electrification would require as much as F$80 million. The mission recommends that an appropriate allocation be determined on the basis of the ADB study (Annex I).

C. Biomass

2.27 Supplies: Natural tropical forests cover about 830,000 ha and yield between 100 and 200 $m^3$/ha of fuelwood. About 39,000 ha is covered by mangrove swamps which can sustain about 5-10 $m^3$/ha for fuelwood and charcoal production. Much of the northwestern parts of the larger islands have savannah vegetation, and hence fuelwood yields are low. Other potential sources of biomass fuels include about 58,000 ha of pine plantations managed by the FPC and the Forestry Department, and a total of 81,000 ha of coconut plantations. The distribution of natural and plantation forests by administrative divisions is shown in Table 2.9.

Table 2.9: Distribution of Forest Areas
('000 ha)

| Division | Natural Forest | Mangroves | Plantations | Total |
|---|---|---|---|---|
| Central/Eastern | 293.8 | 10.0 | 15.2 | 319.0 |
| Western | 187.8 | 14.2 | 33.5 | 232.5 |
| Northern | 369.5 | 14.4 | 9.6 | 393.5 |
| | 848.1 | 38.6 | 58.3 | 945.0 |

Source: DOE; Forestry Department.

2.29 The sugar industry processes about 4.3 million tpa cane 1/ (1982) yielding about 600,000 tonnes of bagasse. Most of the bagasse is used as boiler fuel. Only about 15,000 tonnes of bagasse is surplus. Cane production is expected to peak at 5.4 million tpa by 1990, thereby yielding about 700,000 tpa of bagasse. At current conversion levels, about 17,500 tonnes of bagasse would be available as surplus. If the energy efficiency of sugar production in Fiji could be brought up to the Hawaiian average (450 kg of steam per tonne of cane versus current 600 kg steam per tonne of cane), the potential surplus of bagasse would be 150,000 tonnes (at current production), and 175,000 tonnes by 1990. The surplus could be used to generate electricity for sale to FEA on Vanua Levu and to generate steam and power to support a proposed molasses based ethanol plant (if found economic). However, the main consideration for this potential surplus is to supplement hydropower in post 1990 power generation capacity expansion on Viti Levu. This alternative should be evaluated as a part of least cost power development program.

2.30 There are fifty-five sawmills in Fiji which handle about 233,000 $m^3$ p.a. of sawlogs (1980), and generate about 100,000 $m^3$ of offcuts and sawdust. The volume of sawlogs could increase to 770,000 $m^3$ p.a. by 2000, and residues would increase to 385,000 $m^3$. Although some offcuts are currently used as firewood, the sawdust (about 16%) mainly goes to waste. The Fiji Pine Commission (FPC), is also planning to produce 140,000 $m^3$ of woodchips annually starting in 1984/85. Estimates of total biomass supplies in Fiji are shown in Table 2.10.

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1/ Three mills process about 75% of the cane on Viti Levu; the mst is processed in one mill on Vanua Levu.

Table 2.10: Estimated Wood Potential
(cubic metres p.a.)

| | 1980 | 1985 | 1990 | 2000 |
|---|---|---|---|---|
| Source | | | | |
| Currently exploited natural forest | 340 | 540 | 450 | 300 |
| Past exploited natural forest | 300 | 300 | - | - |
| Non-commercial forests | 25 | 30 | - | - |
| Fuelwood plantations | - | - | 1300 | 1900 |
| Mangroves | 90 | 90 | 90 | 90 |
| Timber plantations: | | | | |
| Hardwoods | - | 30 | 50 | 200 |
| F.D. pine | 10 | 10 | 10 | 10 |
| Extension pine | - | 20 | 43 | 70 |
| FPC sawmill | - | 12 | 12 | 12 |
| FPC chipmill | - | 45 | 100 | 126 |
| Coconut Plantations | 300 | 300 | 150 | 150 |
| TOTAL | 1065 | 1377 | 2205 | 2858 |
| Oil equivalent ('000 tonnes) | 463 | 600 | 960 | 1240 |

Source: Frith Report.

2.31 Consumption: About 60% of rural and 6% of urban households cook exclusively with wood. In addition, 14% of urban and 28% of rural house holds supplement wood with kerosene. Recent surveys 1/ indicate annual per capita fuelwood consumption of 400 kg p.a. for rural and about 80 kg p.a. for urban areas. The extent of charcoal use by households is limited. The sugar industry uses about 5,600 tonnes of wood in addition to about 540,000 tonnes of bagasse during the crushing season (1982). Fuelwood is mainly used in the agricultural sector is to dry copra. About 38,000 tonnes of wood were used during the 1982 season. Table 2.11 shows estimated fuelwood use in 1982 by various sectors. Fuelwood demand

1/ see: Household Energy Use in Fiji: Report of the Nadi Lautoka Domestic Energy Survey, by Institute of Natural Resources, University of South Pacific, 1982; and IRDC Report No. 157e, Rural Energy in Fiji: A survey of domestic energy use and potential, 1981.

is projected at 262,000 tonnes by 1990, excluding potential consumption for power generation such as on Vanua Levu. Bagasse demand is projected at 690,000 tonnes by 1990, based on the current efficiency of use in the sugar industry.

Table 2.11: Fuelwood Consumption Estimates 1982

| | '000 tonnes | (%) |
|---|---|---|
| Urban Households | 19.9 | 9.0 |
| Rural Households | 151.6 | 68.6 |
| Sugar Industry | 5.6 | 2.5 |
| Other Agriculture 1/ | 38.0 | 17.2 |
| Institutions and Other | 5.9 | 2.7 |
| | 221.0 | 100.0 |

1/ Mainly for copra drying.

Source: DOE

2.32 Stove Programs: The GOF has sponsored a number of stove development programs 1/ to improve on traditional open-fire methods. However, the impact of these programs on fuelwood demand in the short term is not expected to be significant. The main issue is how best to disseminate information and extend the use of improved stove designs to local households. DOE wishes to maintain a lead role in this program but, in the mission's view, the appropriate agency for this should be the Ministry of Rural Development and Fijian Affairs (MRDFA), which has been supportive of the stove programs. Commercialization of charcoal stoves would also require the establishment of stove manufacturing enterprises, and for this the appropriate local agency should be the Business Opportunity and Management Advisory Service (BOMAS). DOE's role should therefore be limited to providing technical advice by and monitoring of implementation activities.

2.33 Biomass Gasification: The European Development Fund (EDF) is considering supporting two gasification demonstration projects in Fiji. The mission reviewed plans for the projects and concluded the following:

(i) FEA Gasifier Project involves retrofitting an existing 365 kVA diesel generator with a gasifier. FEA has selected one

1/ Ministry of Forests, Ministry of Health, DOE and National Food and Nutrition Committee have all contributed to the various stove programs.

of the standby units at its National Control Center at Vuda Point for this demonstration. Since the Center has the required engineering and technical personnel to execute the trials, the mission supports this effort. The mission also supports FEA's decision to use charcoal instead of wood as feedstock to minimize start-up and operating problems. Since there is no established charcoal industry in Fiji, funds have been allocated for charcoal production as a component of the initial phase of the project.

(ii) Small Power Project - yet to be finalized because of differing views on the choice of technology for the project. DOE would like to use wood fired steam engines with low power output (20 to 50 kW). FEA has, however, recommended small gasifiers as being more appropriate for retrofitting diesel engines now used in rural electrification schemes under the control of the Public Works Department (PWD). In the mission's view, steam engines are an expensive but commercially available option (up to US$3,000 per installed kW) for capacities under 200 kW. However, a demonstration project is needed to determine the feasibility of retrofitting small diesel generators with gasifiers (3.19) for application to the PWD rural electrification schemes.

As regards future applications of gasifiers, the mission's assessment is that gasifiers could be: (i) used to retrofit FEA diesel electric generators at two or three outstation locations including Savusavu; and (ii) used to convert engines in several medium- sized sawmills. Their potential role in rural electrification depends on the success of the second pilot project.

D. Non-conventional Energy

2.34 Geothermal: There are about 40 hotsprings on Vanua Levu and Viti Levu, all associated with fault zones surrounding several volcanic centers. The surface temperatures of hot springs on Viti Levu vary between 40° and 60°, while those occuring on Vanua Levu, near Labasa and Savusavu, have higher surface temperatures ranging between 60-100 degrees centigrade.

2.35 The mission does not support the view that geothermal energy development is a priority for Fiji. 1/ Since the electric power requirements on Vanua Levu are still relatively small and isolated, geothermal power supply such as from Savusavu hotsprings would not be appropriate. The mission recognizes the need for further investigations to delineate

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1/ See 'Justification and Financial requirements for Geothermal Energy Development in Fiji', UN Report prepared by J.R. McNitt, October 1981. See also 'Appraisal of Geothermal Prospects of Fiji' GOF report No. WD/OS/80/10 by K.H. Williamson, June 1980, and Geothermal Reports Nos. 1 through 5 of the Mineral Resources Department of Fiji.

geothermal reservoirs in the Labasa and Savusavu areas. However, in view of financial and manpower limitations of MRD, especially in relation to other priorities such as exploration and mapping of groundwater reservoirs in Fiji, this should be a lower priority.

2.36 Biogas: GOF regards the dumping of untreated effluents from piggeries 1/ a serious and unacceptable health hazard. To address this problem, the Piggery Department of the Ministry of Agriculture and Fisheries (MAF) introduced about eleven biogas digestors on a number of piggeries in their piggery develoment scheme. The digestors have been effective in controlling the waste disposal problem and currently nine of the experimental units are still in operation. 2/ Much interest has been generated for this option among farmers, and MAF would like to use the biogas system as a basis for increasing the level of energy self-sufficiency among pig farmers who typically set up operations in remote areas.

2.37 MAF therefore submitted a proposal (costing F$10,000) to GOF to extend the biogas scheme to some additional farms. Grants of F$500 were to be provided to selected farmers to cover the cost of materials. GOF has, in the November 1982 budget, reduced funding of this proposal to F$5,000 and with this, MAF plans to install 10 digestors. However, given the high level of interest, and the fact that the digestors have already proven to be useful for handling effluents from the piggeries, MAF should consider using part of the unallocated F$15,000 in farm improvement funds to supplement GOF's budget allocation. The mission recommends that MAF increase its collaboration with DOE in using biogas for cooking and lighting. DOE should assist farmers in identifying the appropriate appliances for using biogas.

2.38 Coconut Oil: The DOE has been interested in the use of coconut oil as a fuel alternative to diesel oil for engines operating in copra producing areas, i.e., in the eastern islands. 3/ It has allocated about US$150,000 funding from the EDF to test coconut oil in diesel engines, and has also made arrangements with UNIDO for consultants in this field. The objective is to substitute coconut oil for diesel.

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1/ There are currently about 100 medium to large scale piggeries in Fiji.

2/ Five of these units are of the Chinese Fixed Dome design and cost F$1000 when made of ferro-cement. The others are mostly Taiwanese design with floating steel gasholder.

3/ 60% of copra production originates in the Eastern Islands. About 60% of trees are more than 42 years old, and yields have declined to fewer than 0.6 MT/ha. Prices for coconut oil have varied in constant terms by a factor of three over the past two decades. The continued availability of a coconut oil surplus is also uncertain.

2.39 In the mission's view, this program should be given low priority in relation to other energy options. A pilot scheme to produce and test coconut oil in diesel engines is planned for Niue under the Pacific Energy Program (PEP) and similar work is proceeding in Western Samoa and Kiribati. GOF should therefore defer its coconut oil program until there is positive evidence of commercial viability. In the interim, GOF should limit its activities in this area to keeping abreast with similar schemes in the Pacific and Brazil, and by participating in UNDP's workshop to review developments with coconut oil fuels scheduled for 1984.

2.40 Solar Energy: Solar insolation levels vary within sub-regions of Vanua Levu and Viti Levu due to differences in cloud cover. In general, the southeastern parts of the large islands have frequent cloud cover. Although solar records are not extensive, the indications are that insolation levels vary within 10-14 $MJ/m^2$ during winter, and 16-20 $MJ/m^2$ during summer. Depending on the season and cloud conditions, 4 to 8 hours of sunshine occur daily.

2.41 The GOF recognizes the potential for utilizing solar energy, especially for conservation and special needs. GOF has also taken steps to promote the local assembly and manufacture of solar systems such as solar water heaters and offers incentives such as:

(i) a fuel economy investment (depreciation) allowance of up to 40 percent to individuals or enterprises that substitute electricity or oil derivatives with alternative sources of energy; 1/ and

(ii) a specific income tax allowance, based on a deduction of 20% of expenditure on locally assembled or manufactured solar appliances. A maximum deduction of F$200 is allowed.2/

The GOF has also extensively used solar PV power units for special telecommunications (IBRD Map 16936) and marine navigational applications. Currently, over 60 stations of the rural radio telephone network are

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1/ Allowances for Depreciation and Improvements (1976 Amendment to Income Tax Act of 1974).

2/ GOF Budget Statement (page 22), delivered 12 November 1982.

powered by solar PV systems; 1/ and power kits of about 13 marine navigational lights have been replaced by solar PV units. 2/

2.42 Wind Energy: The Department of Telecommunications uses some wind-electric charger at several of its rural radiotelephone stations (IBRD Map 16936), and is currently testing a large unit at the Dongowale microwave transmitter on Viti Levu. These tests are based on a hybrid system of: (i) a 2 kW Dunlite windcharger (100 watts continous power); (ii) a multipanel PV system; and (iii) a standby diesel generator. The mission recommends that special attention be given to monitoring maintenance requirements and costs of the windcharger. Other activities include specially designed windsails for boats.

2.43 Wave and Ocean Energy Potential: The MRD has made several preliminary investigations: 3/ wave power investigations of eight locations on Viti Levu in 1979 and 1980 involving Crown Agents (UK) and the USP, and investigations for land-based Ocean Thermal Energy Conversion (OTEC) applications at Somosomo Bay, Natadola Bay and Naidiri Bay on Viti Levu. The prospects for economic use of these options are small. In the mission's view, GOF should discontinue its direct budgetary support for wave and OTEC energy investigations except in the context of a globally or regionally sponsored project.

E. Special Programs

2.44 Energy Conservation: The National Energy Conservation Program encompasses the following objectives:

(i) Building up an accurate data base on energy use by sector and fuel type, through energy end use surveys.

(ii) Identifying industries or buildings with conservation potential.

(iii) Conducting energy audits in selected buildings and institutions and calculating economics of conservation measures.

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1/ The Department of Telecommunications routinely uses solar PV systems for stations requiring less than 20 amp-hours of current daily. A standard unit comprising a 1.2 amp (12 VDC) PV panel and a deep cycle battery (105 amp-hour storage capacity) is used.

2/ The Marine Division uses a standarized system comprising 3 PV panels (each 1.3 amps output), and one rechargeable battery (300-425 amp hour storage capacity), which provides 12 days back up and a pay back of 4 years.

3/ See 'Brief notes on Potential for Wave Engine (Passive) and OTEC in Fiji', Mineral Resources Department. No. BP 24/6, by J. Lum, January 1983, and several reports by R. Holmes, also of Mineral Resources Department.

(iv) Providing technical information and advice to commercial and industrial sector on energy conservation measures.

(v) Providing information to the public on energy saving options in private transport and residences.

(vi) Altering financial incentives and customs tariffs so as to promote investment in energy conservation.

(vii) Building up national capabilities in energy conservation through encouragement and support of local consultants, engineers and contractors.

2.45 The program is partially supported by recent legislation on tax incentives (2.55). GOF has also allocated F$200,000 this current fiscal year to finance new equipment and design work in selected Government buildings. Additional funding will be provided by the Australian Development Assistance Bureau (ADAB) and the EDF. The MEMR has, however, recommended that this tax incentive be replaced by an energy conservation loan scheme to encourage investment. The MEMR has instituted a national energy conservation award to recognize private efforts in this field. The initial thrust of the program is energy conservation in public organizations, and GOF's aim is to reduce its expenditure on electricity by 20% over the coming year. The mission recommends that, in view of the power surplus from Monasavu in the 1980s, a careful, case by case cost/benefit analysis should be done before investing large sums in the electricity saving equipment (2.24).

2.46 Fuel Efficiency: The Fisheries Division of MAF has successfully launched a fuel economy program for the artisanal fishing which currently relies on outboard motors. A new line of wooden fishing vessels, based on the standard FAO 28 foot fishing hull design, is being produced at the Lami boat building facility near Suva. The vessels are fitted with 20 hp. inboard diesel engines, 1/ and consume between 0.5 and 0.75 gallons of diesel per hour during normal operations, compared to about 2 gallons of fuel per hour for outboard motored vessels. Out of 32 vessels completed at the end of 1981, 13 were sold at cost (F$8,200) to licensed fishermen, and the remaining vessels allocated 2/ to graduates of the Rural Fisherman Training Programme Course. The mission supports this program.

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1/ The diesel engine and some of the fishing gear are donated to the program by the Government of Japan.

2/ The graduates are provided with loans from the Fiji Development Bank to cover the cost of the vessels.

# III. OPTIONS FOR THE 1980s

## Overview

3.01 In 1981, petroleum and coal imports constituted about 48% of total energy supply. By 1985, imports will represent only 33% of total energy supply. During the rest of this century imports will supply less than 35% of Fiji's energy needs. Because of Monasavu, petroleum demand will decline from 275 thousand toe (1981), to 211 thousand toe in 1985 (Table 3.1). After 1985, petroleum demand will increase only at 1.8% p.a. to meet the increase in non-power demand, changing the petroleum product demand mix away from heavier to lighter products (Table 2.2). In 1981, fuel oil and IDO represented 36.3% of petroleum demand; in 1990, this component would drop to 15.7%. All increases in future power demand will be met from hydro-power generation which will increase at 5.6% p.a. under the high growth scenario and 3.1% p.a. under the base growth scenario. The increase in the fuelwood demand will approximate the population growth. Although large volumes of bagasse are available, its use in the 1980s will remain limited due to surplus hydropower. The major use of this source for public power supply would be on Vanua Levu. The mission expects that total energy demand will increase at 2.1% p.a. under high growth scenario and 1.8% p.a. under the base growth scenario. No increases in the use of imported coal used for cement production are expected. The mission believes that the unit cost of imported energy in the future can be reduced by adopting appropriate policy measures and procurement methods (3.06).

## Investment Implications

3.02 To determine the plan of action and priority of various energy projects, petroleum exploration and rural electrification uncertainties should be clarified and recommended studies completed. In any event, investments in the energy sector during the 1980s will remain low because of the hydropower surplus. Petroleum exploration activities would require large capital inflows which should come from the private sector. The level of these investments would largely depend on the government's ability to attract new explorers and the rate of success during the first 3-4 years. On Vanua Levu, investments would be needed to supply power from biomass and hydropower resources. Approximate levels of investment for power sector development are discussed in Chapter II (2.26). More important, the mission estimates that a technical assistance program costing about US$1.1 million would be needed during the next 2-3 years. This would consist of petroleum exploration (US$0.6 million), a rural electrification study (US$0.2 million from the ADB), and energy planning/management (US$0.3 million). The scope of recommended technical assistance is defined in Chapter IV.

Table 3.1: Energy Demand Projections
('000 toe)

| SOURCE | | 1981 (Actual) | 1985 | 1990 | 2000 | Growth % p.a. |
|---|---|---|---|---|---|---|
| Imports | | | | | | |
| Petroleum | | 263 | 199 | 218 | 262 | - |
| Coal | | 12 | 12 | 12 | 12 | - |
| Total | | 275 | 211 | 230 | 274 | - |
| Indigenous | | | | | | |
| Hydropower | | | | | | |
| High Growth | | - | 77 | 96 | 174 | 5.6 |
| Base Growth | | - | 75 | 82 | 119 | 3.1 |
| Fuelwood | | 73 | 78 | 86 | 99 | 1.6 |
| Bagasse | | 230 | 276 | 312 | 314 | 1.6 |
| Total | High Growth | 578 | 642 | 724 | 861 | 2.1 |
| | Base Growth | 578 | 640 | 710 | 806 | 1.8 |

Source: Mission projections.

Supply Arrangements

3.03 Petroleum is marketed by three major oil marketing companies, Shell, BP and Mobil. Fiji Gas Company imports (from Australia) and markets LPG (100% butane). The shipping and procurement of LPG is handled by Boral Gas Co. The oil companies arrange for imports (jointly or individually) from Singapore and Australia but individually handle internal distribution. The combined storage capacity on all the islands approximates 910 thousand barrels. A new 330,000 barrel storage tank farm near Suva has been proposed. If this tank farm is built, total storage capacity in the country will increase to 1.2 million barrels compared with current domestic demand of 1.7 million barrels p.a. This would represent a storage facility for about 8 months, more than adequate for most situations.

3.04 Petroleum distribution involves two distinct functions. First is the purchase and shipping of products from refining centers in Australia/Singapore, and second is the storage, distribution and marketing within the country. Under current arrangements, both these activities are handled by the marketing companies operating in Fiji.

3.05 Although more than 75% of imports originate from Australia, the imports (excluding LPG), irrespective of the supply source, are costed on the basis of Singapore supplies. A recently completed study by consultants indicates that as Australia is nearer to Fiji than Singapore, Fiji is overcharged for freight costs. The mission reviewed the industry practices in Singapore and Australia and found that: (i) the AFRA freights used for the transport of clean product appear to carry a premium which seems to be higher than normal international practices; and (ii) the import volumes of each company are too small to let the importing country bargain for lower import prices. Under the current arrangements, the companies guarantee a continuation of supplies, which is advantageous to Fiji. GOF may be able to procure supplies from independent marketers in the short run at lower spot prices, but this may prove to be only a temporary advantage if, under different market conditions, such supplies were no longer available.

3.06 In order to procure the supplies at lower than current costs and ensure the continuity of supplies, the mission recommends that:

(a) the storage/marketing and supply/transport functions should be separated to allow for different companies to handle these two aspects. Such a separation could be implemented without disrupting current distribution arrangements;

(b) the Governments of Fiji, PNG and the Solomons pool their requirements and seek bids from established international majors to supply all three countries. If possible, other small countries in the region should be included in this pool; and

(c) the Governments should negotiate for freights which are in line with prevailing international freight rates or seek separate bids for the transportation of the petroleum products.

3.07 The mission believes these arrangements would fit into the current logistics of product supplies to the region and could give a prospective supplier access to a much larger market, thus enabling him to quote lower than Singapore import parity prices. The mission's investigations confirm that such arrangements will be acceptable to the oil marketing companies. As a matter of fact, Bougainville in PNG was able to procure fuel oil supplies from Gulf Oil at substantially lower than Singapore postings.

3.08 In view of the fact that the total petroleum demand in the next few years will decline, the mission believes that introduction of such arrangements and rationalization of the petroleum marketing network should be a government priority. Fiji, Papua New Guinea and Solomon Islands together represent about 92% of the region's petroleum market. If Western Samoa and Vanuatu are also included, they will cover 97% of total petroleum demand of the South Pacific Islands (1981 estimates).

Ethanol

3.09 A study on substituting imported liquid petroleum fuels by ethanol (from local biomass) was started in 1977. After preliminary analysis showed that a cassava-based option was costly, a study to produce ethanol from the sugar industry was commissioned by FSC, BP South-West Pacific and CSR. The study was to investigate a 21 million liter p.a. ethanol project, based on new cane areas to be established in the Central Division (the former sugar areas near the capital, Suva). This option was selected to create additional employment in this area and to involve ethnic Fijians in the sugar industry. It was stipulated that this course would avoid the complications arising from a need to revise the cane contract with existing growers. A second option was also added to consider the economics of an 'annexed distillery' based on juice from incremental cane to be supplied from an existing mill. When the study was under way a third option for a free-standing distillery based on molasses was also added. The consultant's report, the Fiji Ethanol Study (FES), was submitted in late 1981.

3.10 None of the options was found attractive in financial or economic terms. The study did, however, make it clear that the molasses-based project (which, due to time constraints, had received the least evaluation) appeared more attractive than the other two options. In the first option, the project would not only face a less-than-optimal cane cultivation environment but also the high capital costs for constructing the 'front-end' of a sugar mill. This expenditure would more than double the plant costs. In the second option, the project would be required to buy the cane at the current contractual rate of F$26/tonne, while the economic cost of cane production would be about F$22/tonne. 1/ The capital cost savings, compared with the first option, would be significant. Nonetheless, the feedstock cost was sufficiently high to make this only a second best alternative.

3.11 Although economically marginal, when compared to other choices the molasses project appeared to be the best alternative. The mission evaluated in detail this option. Although the "National Economic Analysis" in the study claimed a 19.5% real rate of return for the molasses option, this calculation is considered dubious. Conventional economic methodology would, in the mission's estimate, yield a negative rate of return for the project as defined in FES. Without modifications, therefore, the project is unlikely to be economic. The mission believes, however, that with modifications, project economics can be improved.

3.12 The FES does not explain the basis for selecting a capacity of 21 million liters p.a. The figure appears to have been based on a blend of 20% ethanol and 80% gasoline, using 1979 demand data (including the demand for other countries in the region) of 84.1 million liters which is projected to increase at 4.0% p.a. to 1985. It is not, however, clear

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1/ F$22/tonne is the shadow-priced factor cost of cane production.

whether Fiji could rely on exports to the other Pacific Island markets. The FES suggests that the trend in the larger markets may be away from using Fiji as an entrepot. In addition, the mission's projections indicate that gasoline demand in Fiji will increase at only 1.0% p.a. (Table 2.2). The prospects are not attractive for sales of ethanol other than for E20. In the mission's view, the FES may have been unduly optimistic about ethanol exports to Japan. Furthermore, substitution for diesel is questionable and 100% use of ethanol in custom-built vehicles would require special vehicle imports and a costly duplication of distribution facilities. The project size, therefore, should be based on domestic demand only. On this basis the E20 demand in the late 1980s and early 1990s is assumed at about 10-14 million liters p.a. In the mission's view, the effects of economies of scale for a molasses distillery are also overstated.

3.13 The mission considers that the cost of energy for the project could be reduced significantly by annexing the project to an existing sugar mill. This would allow the steam and power requirements to be met from 'free' surplus bagasse for up to 19 weeks p.a. The use of woodchips from FPC when no surplus bagasse is available would enable the distillery to operate year round. The year-round operation would be desirable because it could: (i) reduce the daily capacity and its capital costs; (ii) require less working capital (stocks of molasses being cheaper than corresponding stocks of ethanol); and (iii) produce less daily effluent.

3.14 Additional savings in capital costs could be made by reducing the sophistication of the fermentation and distillation processes and by procuring the equipment on an internationally competitive basis (FES cost estimates appear to have come mostly from high cost sources). A minor increase in benefits could also be achieved by marketing carbon dioxide which would be a by-product.

3.15 The most important and sensitive cost factor is effluent disposal. Distillation would result in a large volume of organic effluent. The biodegradation of this material imposes a heavy Biological Oxygen Demand (BOD), making it unsuitable for discharge into small rivers. In some estate-based sugar industries the stillage is fed back to the sugar fields but small holder cultivation in Fiji is too dispersed for this to be cost-effective. The FES proposed adopting a patented system to concentrate and incinerate the stillage, which would then be disposed of as ash. Unfortunately, this process is extremely expensive (as much as F$7.0 million). The fuel value of stillage and fertilizer value of ash are only minor offsets.

3.16 The mission understands that insufficient time was available for the FES to review ocean disposal of stillage from a molasses distillery. Since the cost penalty of the alternative is high, the mission recommends that the possibility of disposal into the ocean be investigated. One solution is to site the project near Lautoka mill and combine the stillage with Lautoka's domestic sewage to be fed into the 2.5 km ocean outflow line which is currently nearing completion. It is recommended that the Government commission an expert review of the mission's re-

commendations to evaluate the overall long-term ecological impact.

3.17 If the suggested modifications are possible, then in the mission's view, the project would cost about F$9.0 million (early 1983 contract signature) with a foreign exchange component of about 78%. The economic return of the project would be highly sensitive to the price of molasses and ethanol. The economic value of molasses input would correspond to the expected long-run price fob Lautoka for exports. FES took this to be F$55 per tonne. Trade sources contacted by the mission estimated F$45. Both figures are defensible and the return on the project has been calculated on both prices. The table also illustrates the sensitivity of the return to the assumed substitution ratio between ethanol and gasoline. Satisfactory arrangments would also have to be made on the price, if any, to be paid to FSC for steam and power from bagasse.

3.18 Table 3.2 shows estimated economic rates of return based on revised assumptions. 1/ Taxes and duties are excluded. Foreign exchange is shadow-priced at a rate of 1.12 and unskilled, semi-skilled and skilled domestic labor at rates of 0.6, 1.0 and 1.2, respectively.

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1/ Petroleum prices are World Bank projections.

Table 3.2: Ethanol Project: Revised Economic Rate of Return (%)

| | Ethanol to Gasoline Substitution Ratio 1/ | |
|---|---|---|
| Molasses price | 1:1 | 1.03:1 |
| $45 per tonne | 12.8 | 5.8 |
| $55 per tonne | 7.7 | -0.7 |

1/ Interfuel substitution between ethanol and gasoline (how much ethanol is required to replace one gallon of gasoline).

Source: Mission Estimates

3.19 These calculations, when compared with an estimated opportunity cost of capital at 8%, suggest that the project is marginal. They also illustrate its sensitivity to changes in basic assumptions. It is possible to reduce the operating costs slightly further. On the other hand, the capital cost estimates assume a highly competitive procurement process. If plant is sourced from traditional suppliers, costs could be higher than those assumed. The marginality of the project should not be surprising because Fiji is well-placed as a molasses exporter. In addition the government may wish to base its decision on the terms at which potential commercial partners are prepared to supply capital for the project.

Rural Electrification

3.20 Estimates show that more than one-third of the households in Fiji are already electrified. The degree of electrification is about 25% for rural areas and 50% for urban and peri-urban areas. The Government has assigned high priority to rural electrification in its development objectives. Apart from the principal goal of satisfying basic needs, rural electrification is regarded as a measure to counteract the drifting of population from rural areas to urban centers. There are also arguments in favor of accelerated electrification in the 1980s, such as the forthcoming surpluses of hydro energy, and the need to employ the labor force currently employed in the Monasavu and Vaturu construction. The mission reviewed the ongoing electrification programs which are based on two different policies with regard to capital contributions by consumers, technical standards, and mode of operation and maintenance (Table 3.3): (i) The PWD Program provides power to isolated rural

communities, 1/ schools and provincial offices. During 1978-1982, about 80 schemes with small diesel sets, serving a total of 4,000 consumers were installed; 2/ and (ii) the FEA Program which extends the grid to rural communities located in its vicinity at a rate of over 2,000 new customers each year.

Table 3.3: Comparison Of The FEA And PWD Rural Electrification Programs

| ITEM | UNIT | FEA | PWD |
|---|---|---|---|
| Type of Supply | - | Grid extension | Isolated diesel |
| Average Cost per Consumer | F$/cons. | 1,000 1/ | 550 2/ |
| Consumer's Contribution | F$/cons. | 400 | 50 |
| Subsidy | F$/cons. | 600 | 550 |
| | % | 60 | 91 |
| 1983 Budget | F$ million | 1.35 | 0.25 |
| Total Connections 3/ | - | 17,500 | 4,000 |
| Cost to Consumer | F¢/kWh | 15 | 33 |
| Cost of Supply | F¢/kWh | 25 | 64 |
| Period of Service | h/day | 24 | 3 to 5 |
| Waiting List | year | 1 | 3 |

1/ Excluding internal wiring.

2/ Including internal wiring.

3/ Domestic consumers only; refers to the end of 1982.

Sources: DOE, FEA, PWD.

3.21 To ensure a consistent policy, the GOF has recently decided that FEA be responsible for rural electrification on the four main islands of Viti Levu, Vanua Levu, Ovalau and Taveuni while PWD implement isolated schemes on the other islands. The mission supports this action, provided it does not impair FEA's financial performance. The mission recommends that, based on appropriate economic criteria, the cost implications of rural electrification be determined and GOF subsidies required to finance the program be earmarked each year for transfer to FEA for the implementation and operation of rural electrification.

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1/ Initially, local communities were required to contribute a third of the installation costs for each scheme but GOF has reduced this contribution to only one-sixth or F$50 per household.

2/ 12 additional schemes will be implemented in 1983, and PWD has 120 outstanding requests.

3.22 GOF estimates that some 80,000 houses would have to be connected to fully electrify Fiji at a capital cost of about $80 million. Although the additional load would be relatively small (10 to 15 MW), the magnitude of the capital needs as well as the fact that FEA consumers would almost triple, make thorough planning imperative.

3.23 The GOF has recognized the need for such planning and requested from ADB technical assistance in this matter (Annex I). This technical assistance should define a country-wide rural electrification program by determining:

(i) coherent policy with respect to selection criteria, organization, financing and technical standards;

(ii) the number of villages to be electrified;

(iii) the source of power supply for each of them; and

(iv) the capital requirements, their sources, and the corresponding annual allocations from the Government budget.

In the mission's view, this program will provide priorities and a basis for GOF decision making about the extent and time schedule of rural electrification and the level of subsidies to be allocated to FEA.

Hydrocarbon Development

3.24 In the mission's view, further work is required to integrate and correlate existing geophysical data to obtain: (i) a better understanding of the subsurface geology and stratigraphy; (ii) identify areas for additional seismic and related geophysical survey to better delineate promising drilling targets; and (iii) to drill additional test wells.

3.25 From GOF's point of view, there are several matters which also require action. All four current exploration licenses are due for renewal in 1983, with the relinquishment of 50% of the areas in each license. Moveover, in view of the recent withdrawal of Chevron from concessions 9 and 10, and the financial difficulties of Bennett Petroleum (concession 7), some of the existing concessions will be relinquished. By the end of 1983, the Fiji Government should be able to offer to foreign oil companies a substantial unlicensed acreage in which new exploration activity can be undertaken. If the momentum of exploration is to be maintained, immediate steps are needed to increase exploration activity in those areas. These are:

(a) Decisions on Basic Strategy: The government needs to determine a consistent strategy for seeking additional exploration effort. In particular, decisions need to be made concerning: (i) the procedures to be followed in seeking new licensees; (ii) the type of contract to be offered to interested exploration companies; and (iii) the schedule for awarding new concessions.

(b) Promotional Activity: The results of exploration activities to date are not encouraging. The government

therefore needs to attract new companies. For this, the government should: (i) prepare a "sales and license application package" for presentation to oil companies, which should include a summary of legislation, a proposed contractual format for obtaining licenses, a description of the areas likely to be offered, and a summary report on geological and geophysical information; 1/ (ii) organise promotional meetings (to be conducted by GOF officials), in either Houston, Singapore or Australia to interest reputable oil companies (see Annex I).

(c) License Awards and Renewals: A small team within the MEMR, supplemented as required by external assistance, should have overall responsibility for carrying out a coherent exploration promotion strategy. 1983 is a crucial year, because of the license renewal dates and relinquishment provisions, and momentum could be lost if a positive strategy is not immediately implemented.

3.26 Independent studies (including one by the UN Centre on Transnational Corporations, the UN Centre on Natural Resources, Energy and Transport, and the Commonwealth Secretariat) have commented on Fiji's petroleum law and existing contracts. In the mission's view, the following modifications may be necessary:

(i) Term of Licenses (Secs. 18 and 28): A total exploration period of perhaps seven years, with relinquishments after three and five years, would probably accelerate the pace of exploration activity. Likewise, a single production term of 21 years without automatic rights of renewals would be acceptable to most oil companies.

(ii) Size of Licenses (Sec. 15 (2)): The current maximum license size of 70 blocks, or more than 8,000 square kilometers, is too large to encourage efficient exploration. A maximum size of 2,000-3,000 square kilometers (15-25 blocks) would probably be large enough to interest oil companies and would be small enough for the government to adequately supervise.

(iii) Royalty (Sec. 71): The basic 10% royalty is lower than the prevailing world standard and probably does not act as an incentive (for example, in the United States, oil companies may have difficulty obtaining foreign tax credits if the royalty rate is less than 12.5%). A 12.5% miminum royalty seems reasonable.

3.27 The possibility of using a production-sharing type of contract, with a relatively high level (e.g., 40-50%) for "cost oil" so that the company's initial investment could be recovered rapidly, might be worth

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1/ This should also include a list of material available from the Minerial Resources Department.

considering. This would replace the concession type of contract now being used. In the mission's view, this production-sharing approach would: (i) be widely acceptable to the oil companies; (ii) be relatively simple to administer; and (iii) provide Fiji opportunities for increased participation, control and fiscal benefits, if and when petroleum is discovered in commercial quantities.

# IV. INSTITUTIONS AND TECHNICAL ASSISTANCE

## Energy Institutions

4.01 Department of Energy: The Ministry of Energy and Mineral Resources (MEMR) has recently been organized to include the Department of Energy (DOE) and Mineral Resources Department (MRD). The DOE consists of four units which report to the Director of Energy. The size and structure of the DOE is such that it does not match with changes in priorities and emphasis. The department needs to liaise closely with the FEA and Central Planning Office (CPO) to develop a consistent and well-coordinated energy policy, plan and work program. In the mission's view, the department needs to focus attention on policy matters and strengthen its capability to monitor the implementation and progress of various policy decisions and plans. The work program of the department remains to be defined and agreed by the Government. All senior positions in the DOE are filled by expatriates. Considering the complexities of energy issues, it is necessary to recruit, train and develop local staff to run the energy administration. Energy economic aspects of the DOE need to be strengthened. The mission recommends that:

(i) the role and work program of the DOE be developed and clearly defined;

(ii) the DOE play a lead role in monitoring and developing energy pricing policy in general and petroleum pricing policy in specific and work closely with the PIB;

(iii) the DOE closely liaise with FEA and CPO to help identify the growth areas where power will be needed or can be used and prepare a consistent and comprehensive energy development plan; and

(iv) DOE be assisted in the area of energy economics, petroleum supplies coordination and strengthen its technical capabilities.

The government has indicated that the petroleum supplies contracts with the oil companies will expire in 1984 and has requested for assistance in preparing a petroleum supplies strategy and negotiations.

4.02 Mineral Resources Department (MDR): As a result of technical assistance provided by the Australian government, 1/ a basic storage and retrieval system for petroleum data has been set up within the MRD in Fiji. This system allows access to past exploration data in an efficiently catalogued manner, and includes a comprehensive coding and indexing

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1/ Mr. C.S. Robertson of the Australian Bureau of Mineral Resources.

system. At this time, the only type of data outside the storage and retrieval system are the seismic tapes, which cannot be kept in Fiji because of the lack of permanent storage facilities. Most tapes are currently on loan to one of the license-holding oil companies, but the Australian government is apparently willing to provide temporary storage facilities until the Fiji Archives obtain appropriate tape storage.

4.03 Regarding technical personnel, the geological survey division of the MRD has several staff members with some petroleum background, although none of the staff spends full time on petroleum-related work. Once contracts have been signed and appropriate work programs agreed, Fiji should not have difficulties in recruiting technical personnel to monitor exploration activities.

4.04 Fiji Electricity Authority: FEA is a well-managed power utility and follows sound commercial principles in its operation. It has successfully accomplished two major tasks in the past few years:

(a) absorbing the Suva City Council Electricity Department which was twice the size FEA's size; and

(b) constructing the US$200 million Monasavu Project.

FEA has an adequate management information system which provides important technical, economic and financial information and is not overstaffed. FEA operates a comprehensive local and overseas training program.

4.05 FEA's organizational structure is basically sound, except for the planning. Planning activities are currently dispersed among several divisions and departments. FEA is in the comfortable position of having an adequate power system on Viti Levu to cope with the demand in the 1980s. Considering the lead time of future system additions, a master plan for further power system development will be required by 1985. FEA should make use of the available time and proceed with strengthening its in-house planning capability, with a view to establishing the data base required for the master plan and subsequently participating in its implementation.

4.06 Although FEA has most of the data, it is not always presented in a form readily available for planning work. Some important areas to be upgraded for the data base are:

(i) statistical data for load forecasting (electricity sales by consumer category and load center, substation loadings, new major loads, etc.);

(ii) survey of biomass resources (quantities available from FSC and FPC, other resources); and

(iii) rural electrification program (load surveys, price-elasticity of demand) and productive uses of electricity.

This data base will serve for: (i) load forecasts; (ii) planning of the optimum timing and mix of future generation facilities (hydro, biomass); and (iii) long-range transmission planning (grid configuration, voltage levels).

4.07 To complete these tasks, the mission recommends that the planning staff be reinforced, planning activities be separated from design and operation, and the position of the planning within FEA's overall organization be upgraded by: (i) transforming the present Hydro Department headed by Chief Engineer Hydro to Planning Department; (ii) transferring to the Planning Department planning staff from the existing Design and Planning Division; (iii) transferring to the Planning Department the Principal Power System Planner currently assigned to the Department of Energy; and (iv) appointing an engineer dealing with power generation, mainly from biomass resources.

External Assistance

4.08 GOF has received technical assistance from multilateral and bilateral sources in a broad range of energy fields. Proposed and ongoing multilateral projects include:

(i) UNDP Pacific Energy Program (RAS/81/092): This project has just become effective and will provide DOE and other energy organizations in the Pacific with short term consultant assistance to review issues such as oil industry pricing mechanisms, and also train local staff in energy planning methods. The project also incorporates demonstration/pilot projects on gasification;

(ii) UNDP Regional Energy Development Program for Asia (RAS/80/001): This project became effective in August 1982 and provides for consultancies, training courses, and information exchange on minihydro systems, community and family sized biogas systems, and training of local staff in charcoal production.

(iii) UNIDO: provided funding and technical assistance for the development and adaptation of wood and charcoal burning stoves. UNIDO may also provide a consultant to review the possible role of coconut oil as fuel;

(iv) European Development Fund: The EEC will provide funds, as part of the Pacific Energy Program for equipment and technical expertise, to demonstrate the diesel engine/gasifier retrofits, and for GOF's Energy Conservation Program.

4.09 The main source of bilateral assistance to Fiji has been the ADAB, which has financed technical experts, equipment and special tasks including energy audits and an urban energy survey of Lautoka. New

Zealand Aid included mini-hydro investigations on Taveuni. The International Development Research Center in Canada has funded a rural energy survey 1/ and an ongoing energy survey of the Greater Suva area. In the mission's view, DOE (MEMR) should be able to coordinate and manage these projects. However, DOE must first set priorities in its work program so that all internal agencies understand the framework for their activities.

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1/ Resulted in publication, Rural Energy in Fiji: A Survey of Domestic Energy Use and Potential IDRC Report No. 157e, 1981.

## Part 1. TECHNICAL ASSISTANCE FOR RURAL ELECTRIFICATION

### Terms of Reference for Rural Electrification Study

### A. Basic Objectives

The proposed study has the following basic objectives aiming at ensuring long-term technical, economic and financial viability of rural electrification:

(i) Formulation of a coherent rural electrification policy with respect to selection criteria, organization, financing and technical standards; and

(ii) Establishment of a country-wide electrification program showing communities suitable to receive electricity supply, assigning priorities among them and determining their optimum source of supply.

### B. Scope of Work

#### 1. Load Forecasts

1.1 Compile a list of communities without electricity supply, indicating their location, population, number of houses and major productive uses of energy, if any;

1.2 Analyze experience gained in already electrified communities with regard to the ratio of houses connected, initial load, end-use of electricity, type of appliances used, consumption patterns, load factor, load growth, etc.;

1.3 Derive average value of domestic load per consumer, load factor and annual growth rate of energy consumption;

1.4 Develop a simple BASIC language model for use on the FEA Apple II computer for load forecasting using the above average values coupled with the number of houses and requirements of individual major consumers as input;

1.5 Prepare a ten-year forecast for each community and province.

2. Optimum Source of Supply

2.1 Determine main technical parameters and costs of diesel sets for rural electrification schemes;

2.2 Determine main technical parameters and costs of grid extensions for rural electrification schemes;

2.3 Compile date on the availability of renewable energy resources, such as mini-hydro, solar energy (photovoltaics), biomass (wood, etc.) and wind energy;

2.4 Assess the viability of using these resources for rural electrification schemes;

2.5 Determine a least-cost solution for each community by comparing the unit cost of energy supply from the above alternative sources;

2.6 For communities to be connected to the grid, determine the routing of transmission lines, outline the final grid configuration including the main injection points and propose optimum voltage levels.

3. Service and Design Standards

3.1. Review the various design standards currently used in Fiji for rural electrification with a view to minimizing costs by avoiding unnecessarily high standards of service reliability, adopting appropriate construction technologies and using locally available materials;

3.2 Suggest uniform design standards to be used for small diesel power stations (type and size of units, type of powerhouse, etc.);

3.3 Suggest uniform design standards to be used for transmission lines and substations (voltage level, conductor size, type of poles, transformer rating, etc.);

3.4 Suggest uniform design standards to be used for distribution networks (size of feeders, size of service connections, type of poles, etc.);

3 5 Suggest uniform design standards to be used for in-house wiring (load, wiring rules, etc.);

3.6 Suggest least cost methods for initial survey, transport of equipment, installation and maintenance of isolated village systems using diesel and photovoltaic systems.

4. Economic and Financial Aspects

4.1 Define the main objectives regarding rural electrification in the light of Fiji's per capita income, promotion of balanced regional growth, social and political factors, etc.;

4.2 Based on sample household surveys, analyze the present tariff rates and capital contributions paid by rural consumers in the light of their income situation;

4.3 Suggest uniform levels of tariffs and capital contributions which rural population can afford to pay;

4.4 Propose methods of ensuring timely collection of the capital contributions so that the order of priorities, as determined by technical and economic considerations, can be followed;

4.5 Quantify and, where impossible, describe in qualitative terms, direct and indirect benefits to be expected from rural electrification such as revenues from electricity sales, displacement of other sources of energy (kerosene, etc.), opportunities for the establishment of small-scale industries, improvements in the productivity of agricultural operations, improvements in the quality of rural life, etc.;

4.6 Develop a simple model for use on the FEA Apple II computer for the calculation of economic and financial internal rates of return for each community, linked to the above load forecasting model and using as input the costs of the optimum source of supply on the one hand and the benefits of rural electrification on the other hand (properly distinguishing between economic and financial costs and benefits);

4.7 Develop criteria for the selection of individual rural electrification schemes, considering relevant technical, economic and financial aspects and constraints;

4.8 Propose a staged program of rural electrification using the above slection criteria to determine the order of priorities;

4.9 Prepare an estimate of capital requirements of the proposed staged program.

5. Institutional Aspects

5.1 Review the present institutional arrangements relative to the organization and administration of rural electrification;

5.2 Drawing on relevant examples, suggest modifications in the institutional arrangements required to ensure smooth and cost-effective implementations of rural electrification;

5.3 Propose guidelines with respect to the ownership, operation and maintenance of both individual and multi-village electrification schemes.

6. Rural Electrification Program

6.1 Based on discussions with the Government and ADB, determine the exact scope and time schedule of rural electrification;

6.2 Prepare a detailed construction program and capital expenditure schedule with costs broken down into foreign and local cost components;

6.3 Calculate the overall economic rate of return of the rural electrification program;

6.4 Outline a financing plan considering all possible sources of funds, such as loans, Government contributions and consumer's contributions;

6 5 Prepare a detailed financial cash flow for that part of the program which will be implemented by FEA comprising, on the one hand, all the capital input and revenues from electricity sales and, on the other hand, annual investments, operating expenses including the cost of grid energy and debt service;

6.6 Should the revenues turn out to be insufficient to recover that operating costs and debt service, indicate the level of tariffs and, alternatively, Government subsidies required to offset losses incurred in the rural electrification program;

6.7 Analyze and make recommendations regarding Government policy toward isolated electrification schemes operated by organizations other than FEA including subsidies, cost sharing, maintenance, and fuel costs.

Part 2. TECHNICAL ASSISTANCE FOR HYDROCARBON EXPLORATION

A. Petroleum Exploration Specialist:

A relatively senior petroleum exploration geologist and/or geophysicist is required for about six-man months to:

(i) prepare the technical part of the proposed "sales package" for presentation to oil companies;

(ii) assist the government in selecting areas to be offered to oil companies so as to maximize the attractiveness of the government's proposal;

(iii) prepare and organize the technical data relating to each area offered, for reproduction and sale to oil companies; and

(iv) assist the government in determining the appropriate exploration work program for each area being offered.

The assignment would extend over a period of 18 months, (beginning in 1983) and would cost about $90,000.

B. Promotion and Negotiation of Agreements:

Several officials of the Fiji Government, in the Ministry of Energy and Mineral Resources and in the Central Planning Office, have some experience in negotiating agreements with foreign investors in the resources sector. Thus, technical and financial assistance can be limited to a few specific tasks:

(i) preparation of the "sales package" for presentation to oil companies, including both geological/geophysical assistance and the assistance of a specialist in contract negotiations;

(ii) assistance in "sales meetings" in Houston, Singapore or elsewhere, both in financing and organizing such meetings to ensure good oil company attendance; and

(iii) assistance during actual negotiation of new contracts, analysis of company proposals and assistance in the development of government positions.

This assistance would cost about $45,000-$60,000. Additional time would be required if several negotiations were to take place.

C. Sales Meetings:

If the government decides to hold promotional meetings to familiarize oil companies with Fiji opportunities and the applicable terms, funds to cover the following would be needed:

(i) travel of Fiji officials;

(ii) preparation and reproduction of the "sales package";

(iii) rental of locations for the meetings and related hospitality expenses, and

(iv) retaining a public relations firm or other agency to make contacts with oil companies and promote attendance at the meetings.

Total costs for each meeting would be about $50,000 to $60,000.

Part 3. TECHNICAL ASSISTANCE FOR DEPARTMENT OF ENERGY

A. Resident Energy Economist:

2 man-years for a Resident Energy Economist to work with counterpart staff. Main tasks are related to a review of domestic energy pricing structures, pricing policy in relation to development of indigenous energy resources, and preparation of guidelines for economic analysis of public energy projects. Terms of reference cover:

(i) development of strategy and guidelines for monitoring and reviewing domestic energy prices;

(ii) economic evaluation of energy project proposals or options; and

(iii) training of local counterparts in energy economics and planning methods.

The Government has accepted the mission's recommendation and decided to recruit an energy economist.

B. Petroleum Supplies Specialist:

One man-year of advise and assistance to participating governments in setting-up joint petroleum procurement system. This assistance would depend on the regional government's accepting the mission's recommendations on pooling their petroleum purchases.

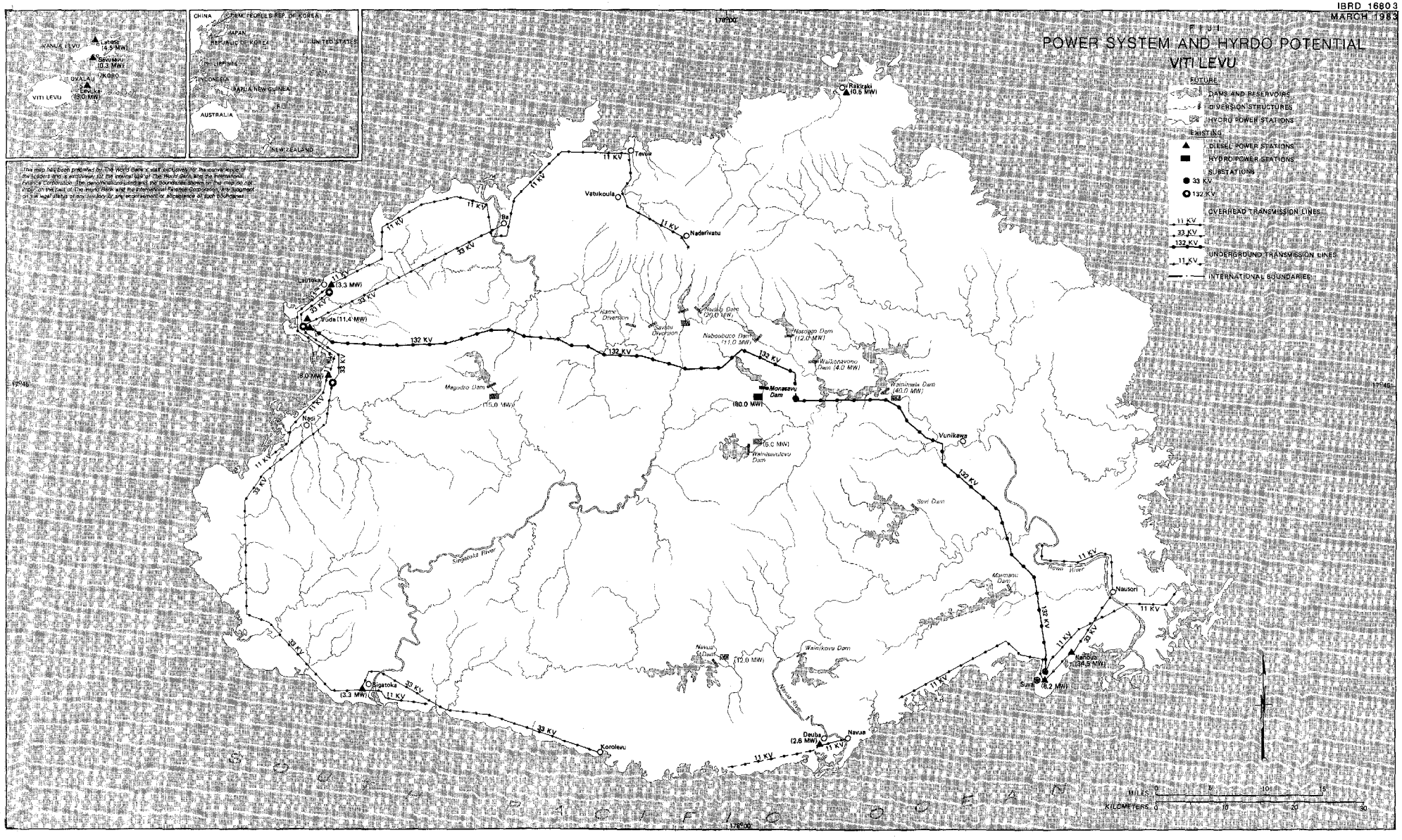
## ANNEX TABLE A.1 FIJI GDP COMPOSITION BY ECONOMIC SECTOR
(CONSTANT 1977 DOLLARS)

| ECONOMIC ACTIVITY | 1977 F$ Million | % | 1980 F$ Million | % | 1981 F$ MILLION | % | 1982 (p) F$ MILLION | % | GROWTH %/p.a 1/ | 1983 (e) F$ MILLION | % CHANGE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, Forestry and Fishing | 141.3 | 23.3 | 152.8 | 22.5 | 171.8 | 24.2 | 175.8 | 25.3 | 4.5 | 166.7 | (5.2) 3/ |
| Mining and Quarring | 0.7 | 0.1 | 0.3 | .. | 0.4 | 0.1 | 0.6 | 0.1 | (3.0) | 0.6 | - |
| Manufacturing | 69.4 | 11.5 | 80.7 | 11.9 | 88.9 | 12.5 | 86.4 | 12.4 | 4.5 | 85.2 | (1.4) |
| Electricity, Gas and Water | 6.0 | 1.0 | 6.5 | 1.0 | 6.8 | 1.0 | 7.0 | 1.0 | 3.1 | 7.3 | 4.3 |
| Construction | 49.2 | 8.1 | 59.7 | 8.8 | 53.8 | 7.6 | 47.2 | 6.8 | (0.8) | 43.0 | (8.9) |
| Wholesale/Retail, Rest. and Hotels | 104.6 | 17.3 | 117.3 | 17.3 | 123.9 | 17.5 | 110.8 | 15.9 | 1.2 | 116.3 | 5.0 |
| Transport and Communications | 54.6 | 9.0 | 66.8 | 9.8 | 70.6 | 9.9 | 73.0 | 10.5 | 6.0 | 76.2 | 4.4 |
| Others | 179.9 | 29.7 | 195.2 | 28.7 | 193.0 | 27.2 | 194.4 | 28.0 | 1.6 | 197.9 | 1.8 |
| Total GDP | 605.7 | 100.0 | 679.3 | 100.0 | 709.2 | 100.0 | 695.2 | 100.0 | 2.8 | 693.2 | (0.3) |
| GDP/Capita (F$) | 1,016 | | 1,072 | | 1,098 | | 1,057 | | | 1,033 | |
| GDP Growth % 2/ | | n.a. | | (1.7) | | 2.4 | | (3.7) | | | (0.3) |

1/ Average Growth between 1977 and 1982.
2/ Growth over previous year.
3/ Figures in parenthesis indicate negative numbers.

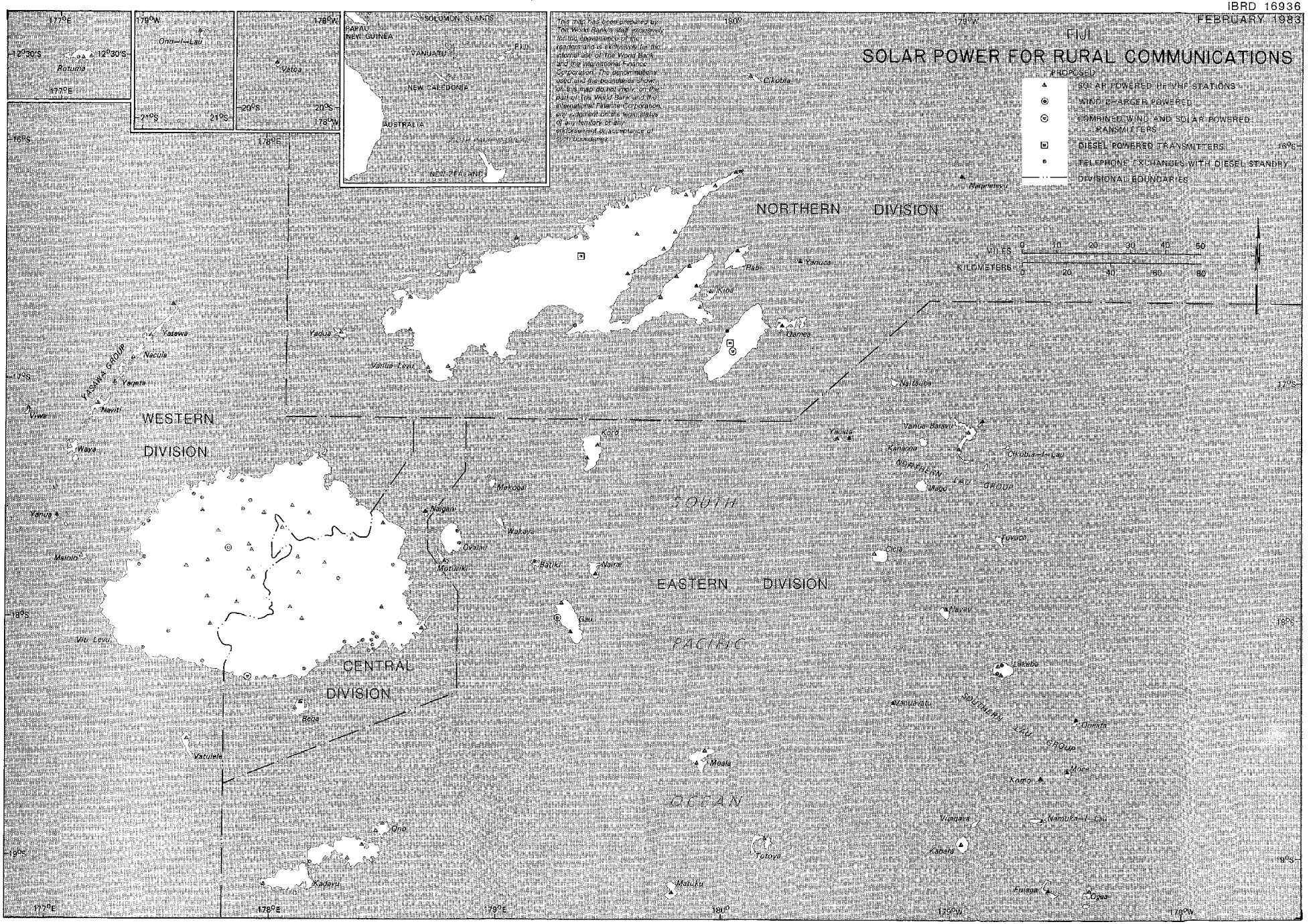
Source: Bureau of Statistics, Suva, Fiji.

IBRD 16803
MARCH 1983



IBRD 16936
FEBRUARY 1983

# Fiji
# SOLAR POWER FOR RURAL COMMUNICATIONS



IBRD 16897
JANUARY 1983