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Cook Islands

Issues and Options in the Energy Sector

Annex A

July 31, 1992

The World Bank in Cooperation with
The UNDP/ESCAP Pacific Energy Development Programme
The Asian Development Bank and the Forum Secretariat Energy Division

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CURRENCY EQUIVALENT

US\$1.00 = CKI\$1.65

(February 1991)

cents (¢) in the text refers to Cook Island cents (1CKI\$=100¢)

FISCAL YEAR

April 1 - March 31

(from 1991 fiscal year ends June 30)

ACRONYMS

ADB	- Asian Development Bank
EMP	- Environmental Management Plan
EPS	- Electric Power Supply
FSED	- Forum Secretariat Energy Division
MOPED	- Ministry of Planning and Economic Development
PEDP	- Pacific Energy Development Programme
PRI	- Pacific Resources Incorporated
PT	- Price Tribunal
RED	- Rural Energy Division
SPIRE	- South Pacific Institute for Renewable Energy
SPREP	- South Pacific Regional Environment Programme

ABBREVIATIONS

ADO	- automotive diesel oil
DWT	- dead weight tonne
FF	- French franc
kgoe	- kilograms of oil equivalent
LCT	- Local Coastal Tanker
LPG	- Liquefied Petroleum gas
LV	- low voltage
MT	- metric ton
MV	- medium voltage
PV	- photovoltaic
TOE	- tonnes of oil equivalent

This report is based on the findings of an energy assessment mission which visited Cook Islands in February 1991. The mission comprised Truls Holtedahl (mission leader - consultant), David Cleland (renewables specialist - Pacific Energy Development Programme), Peter Hunt (senior project engineer - Asian Development Bank) and June Morgan (petroleum officer - Forum Secretariat).

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ENERGY CONVERSION AND MEASUREMENTS

	Unit	Typical Density kg/liter	Typical Density 1/ton	Gross Energy MJ/kg	Gross Energy MJ/liter	Oil Equiv. toe/unit (net)
Biomass Fuels						
Fuelwood (5% mcwb)	tonne			18.0		0.42
Coconut Residues (air dry)/ <u>a</u>						
Shell (15% mcwb) ^{harvested}	tonne			14.6		0.34
Husk (30% mcwb) ^{harvested}	tonne			12.0		0.28
Average (air dry)/ <u>b</u>	tonne			14.0		0.33
Coconut Palm Wood (air dry)	tonne			11.5		0.27
Charcoal				30.0		0.70
Vegetable and Mineral Fuels						
Crude Oil	tonne			42.6		1.00
Coconut Oil	tonne	0.920	1,100	38.4		0.90
LPG (propane)	tonne	0.510	1,960	50.0	25.5	1.17
Ethanol	tonne			27.0		0.63
Gasoline (Super)	tonne	0.730	1,370	46.5	34.0	1.09
Gasoline (Unleaded)	tonne	0.735	1,360	46.5	34.2	1.09
Aviation Gasoline (Avgas)	tonne	0.695	1,440	47.5	33.0	1.12
Lighting Kerosene	tonne	0.790	1,270	46.4	36.7	1.09
Power Kerosene (Avtur, DPK)	tonne	0.795	1,260	46.4	36.9	1.09
Automotive Diesel (ADO)	tonne	0.840	1,190	46.0	38.6	1.08
High Sulphur Fuel Oil (IFO)	tonne	0.980	1,020	42.9	42.0	1.01
Low Sulphur Fuel Oil (IFO)	tonne	0.900	1,110	44.5	40.1	1.04
Electricity (MWh)						
Hydro / <u>c</u>	MWh					0.25
Fuelwood / <u>d</u>	MWh					0.93
Fuel Conversion Efficiency						
Diesel: Text uses actual where known, otherwise:						
Average efficiency for small (< 100 kW output) diesel engine 0.461/kWh (22%)						
Average efficiency of large (> 1000 kW output) modern diesel 0.284 l/kWh (36%)						
Average efficiency of low speed, base load diesel (Pacific region) 0.30 - 0.33 l/kWh (28% - 32% eff).						
Area: 1.0 km ² = 100 hectares = 0.386 mi ²						
1.0 acre = 0.41 hectares						
Mass: 1.0 long tons = 1.016 tonnes						
Energy: 1 kWh = 3.6 MJ = 860 kcal = 3,412 Btu = 0.86 kgoe						
1 toe = 11.83 MWh = 42.6 GJ = 10 million kcal = 39.68 million Btu						
1 MJ = 238.8 kcal = 947.8 Btu = 0.024 kgoe = 0.28 kWh.						

/a Average yield of 2.93 air dry tonnes residues/tonne copra produced (Average NCV 14.0 MJ/kg)

/b Proportion: kernel 33%, shell 23%, husk 44% by dry weight.

/c Assumes conversion efficiency of 30% (i.e., equivalent of diesel @ 30%).

/d Assumes conversion efficiency of 9% (biomass - fuelled boiler).

SUMMARY AND PRINCIPAL RECOMMENDATIONS

Energy and the Economy

1. The Cook Islands is one of the smallest self-governing countries in the Pacific region, composed of a number of highly dispersed islands, traditionally agriculture-based but relying increasingly on tourism, with an open economy, and completely dependent on oil imports for its commercial energy requirements. These characteristics are reflected in some of the country's main energy issues. The population (around 18,000) has not increased over the last decade due to emigration, particularly to New Zealand, with which the Cook Is. maintain a close association.

2. Tourism, remittances from emigrants and foreign assistance are the most important factors in determining the overall level of economic activity and compensate for a small and narrow commodity-export base, enabling the country to finance its oil imports. The Cook Islands has one of the highest GNP per capita in the region but, like many other island countries, suffers from a general scarcity of technical and management skills which hampers development in general and affects the ability to plan and implement energy projects and manage the energy sector. The economy is estimated to have grown by around 4-5% p.a. in real terms during the last few years and this rate is expected to continue in the 1990s. No large projects or other developments in the Cook Islands society are foreseen over the medium term that should in any major way affect present trends in energy demand.

3. More than most other countries in the region, the Cook Islands depend on imported energy. Only around 15% of the country's requirements are met by indigenous energy resources, virtually all of which are in the form of biomass. The latter, mainly coconut residues but also fuelwood, are the primary sources of energy of households on the outer islands where solar energy has a potential in certain uses. The bulk of energy demand is covered by petroleum products roughly a quarter of which is converted to electricity. The country has no hydroelectric potential of significance and power production is entirely diesel-based.

4. Final energy consumption totals 14,000 tons of oil equivalent (TOE) or close to 800 kgoe per capita which, with few exceptions, is higher than in all other Pacific Island countries. Electricity represents only 7% of final energy consumption, reflecting among other things the small industrial base. The predominant use of energy (more than 70%) is for transportation, illustrating the distant location, the dispersed geography, and the importance of tourism. The consumption of commercial energy is expected to increase by around 4% p.a. up to year 2000. With increasing dependence on imported oil to satisfy its energy needs, the country is vulnerable to external events. Such events may affect the price and availability of petroleum products, on the one hand, and tourism and foreign currency flows from remittances and aid, on the other.

Energy Issues and Recommendations

5. With very limited domestic energy resources and few substitution possibilities, management of supply and demand of commercial energy, and institution building in the energy sector takes on particular importance. In the case of the Cook Islands this implies:

- preparing and implementing least cost programs for diesel development, establishing institutional arrangements conducive to reliable and efficient electricity services, and pricing electricity to ensure well-founded investment decisions, efficiency in use and a financially sound utility,
- monitoring petroleum supply arrangements, ensuring adequate and reliable storage and distribution systems, and regularly reviewing pricing of petroleum products, and
- carefully assessing renewable energy options and establishing workable arrangements for their maintenance and operation.

6. These issues, together with direct conservation efforts, have to be dealt with within the tight constraints that apply to the Cook Islands financially and in terms of manpower, and imposed by small and dispersed energy markets.

Electricity Subsector

7. The electricity expansion program for Rarotonga being completed in 1991 will raise generating capacity sufficiently to cover requirements up to the year 2000 and possibly beyond, with sufficient security margins. The loan-financed investments undertaken now are substantial and appear not to be part of a least cost solution. On the other hand, the much-needed generation and distribution rehabilitation work being undertaken concurrently is strongly supported and should be continued beyond its present stage, as EPS (the Electric Power Supply) also plans.

8. The rehabilitation program should be extended to cover the outer island systems to bring losses down from levels of up to 20% and to increase reliability. On the other hand, it is strongly recommended that any further electricity expansion on the outer islands be preceded by a prioritized development plan that reflects what the users on the islands and the country can afford. In particular, the financial impact on the Government Budget of present and future level of power services to the Outer Islands should be carefully considered. The institutional restructuring and strengthening which is envisaged within the power subsector, and required in order to operate and maintain present systems in a satisfactory manner, should also have priority before further expansion. It is recommended that appropriate agencies, such as the Asian Development Bank (ADB) be approached for assistance in these matters.

9. The other salient issue currently confronting the Government in the power subsector is the reform of EPS, specifically the planned corporatization of the utility which is now a part of the Ministry of Energy. It is recommended that the reform be based on a concept emphasizing commercial operations, financial independence and accountability on the part of EPS which should have a board of directors answerable to the Minister of Energy. The new corporation would become responsible for considerably expanded management, accounting and financial functions; new procedures would have to be established and staff would have to be trained. The utility would require extensive technical assistance for institution building and the Government should approach suitable agencies in this regard. Assistance may also be required for drafting legislation.

10. Corporatization is more likely to succeed with an arrangement under which EPS remains responsible for services on Rarotonga, where the users are able to meet the full costs of supply, and a Rural Energy Division in the Ministry of Energy which will be responsible for the outer islands, where kWh costs overall are three times higher than main island generated electricity and services depend on substantial government subsidies. A split solution with separate Rarotonga and outer island responsibilities is therefore recommended, but for practical and economic reasons the Rural Energy Division should make use of EPS' capacity and purchase services from EPS to operate and maintain the systems.

11. The commercialization of EPS should be accompanied by tariff reform and a corporate financial structure (debt/equity) that ensures financial independence and viability. A recent New Zealand government-financed tariff study proposed an increase in the rates reflecting long-run marginal cost and financial considerations, together with the introduction of a fuel adjustment clause. It is recommended that the proposed rate increase be reviewed to take into account the capital structure and terms for EPS when these have been finalized and approved by the Government.

Petroleum Subsector

12. With its location and dispersed island geography, supply security and regularity with respect to petroleum products is a challenge, in particular to the outer islands. Based on the present system where private oil companies are responsible for supply, storage and distribution, it is recommended that the Government with the assistance of suitable agencies such as the Forum Secretariat, where needed:

- monitor the supply arrangements and landed prices for petroleum products, given the new situation created by the establishment of the Fiji National Petroleum Company, in order to ensure least-cost arrangements for the country;
- together with the oil companies evaluate the adequacy of the existing oil storage facilities on the main island and the justification for any further bulk storage on the outer islands, including the need for strategic reserves;
- monitor developments with respect to inter-island shipping frequency and regularity, of vital importance for the supply of oil products, and if necessary reconsider the incentives for private operators in order to secure reliable transport services under the new deregulated system; and
- carry out inspections and an evaluation of present landings and wharves, or the need for such, on the outer islands.

13. In order to reduce safety risks and environmental hazards related to petroleum related activities, it is recommended that the Government introduce physical standards for petroleum storage and distribution facilities in the country. These could be based on regional petroleum storage and handling standards under preparation by the Forum Secretariat, which could be requested also to assist with training and procedures for monitoring the standards.

Furthermore, procedures and facilities aimed at preventing or dealing with emergencies and spills need to be reviewed, and personnel require training. This also applies to current practices and arrangements for waste oil disposal, including waste oil from EPS' power plant in the capital. In the case of EPS, currently engaged consultants should be requested to look into the matter.

14. Quality control of petroleum products is assured only by the oil companies and the sulphur content of ADO is a matter of concern. The Government should consider introducing a Petroleum Standards Act and procedures for monitoring adherence to the standards, in order to ensure that petroleum imports meet international product quality requirements.

15. Due to limited competition in the small domestic market, prices of the most consumer-sensitive products (gasoline, ADO and kerosene) are regulated. A review of the price formulas of these products and that of LPG is recommended. With restricted domestic capacity for analyses, it is recommended that external assistance be requested to:

- examine the petroleum pricing formula and the basis for landed costs and to verify the oil companies' cost elements; the latter should also be audited annually;
- evaluate duties and taxes on petroleum products, with due regard to energy conservation, fiscal requirements, competitiveness and social considerations; in this connection, it is recommended that the Government discontinue the present tax and duty exemption for EPS on ADO which amounts to a subsidy of electricity consumers;
- assess fiscal controls to tighten collection of duties on petroleum products; and
- review public contracts, including that of EPS, for the purchase of petroleum products.

16. As part of the price review, it is recommended that the need for improvements with respect to product quality and certain other supply aspects be studied and the necessary changes made.

17. In order to initiate and coordinate the proposed measures in the petroleum subsector and to represent the Government in a dialogue with the oil companies, the Ministry of Energy needs to become involved in this area, as outlined below through the creation of a Policy and Planning Unit.

Renewable Energy

18. The present situation with respect to biomass supply for household energy purposes is, reportedly, generally satisfactory. However, in view of the dependence of households on the outer islands on woodfuels for cooking and the limited knowledge of the biomass resource situation on an island-by-island basis, it is recommended that the Government monitor the situation and consider localized initiatives in cooperation with the users as the situation may call for. As a first step, it is recommended that energy end-use surveys among

households on selected islands be carried out to determine the biomass usage pattern.

19. Renewable energy technologies should be applied selectively within a policy framework which focuses on the needs of the users and on technologies that can clearly be justified from a technical and economic point of view. Pilot projects and schemes utilizing unproven technologies with a limited impact on the energy situation should not be undertaken at the country's expense. This would at present apply to wind, wave and OTEC where any efforts should be at the full cost of donors. With the availability, cost and sustainability of biomass unknown, neither the Government nor EPS should pursue wood fired power generation.

20. Prior to the implementation of a planned ambitious Government program for photovoltaic systems on four islands, a study is strongly recommended to examine the options for establishing the necessary institutional arrangements, including responsibility for implementation and maintenance, and to determine manpower and financial requirements. The extent of user responsibility and participation must also be properly defined. Regional experience with PV systems and pilot projects in the Cook Islands clearly show the need for thorough preparations. The Government should approach regional institutions with a strong background in PV systems for assistance.

Conservation

21. In view of the country's high and increasing dependence on imported fuels, and the benefits of fuel saving in terms of economic return, opportunities to defer capital investments, and positive environmental consequences, the Government should emphasize energy conservation.

22. Correct energy pricing being the most important instrument of demand management, the Government should assure that electricity tariffs and petroleum prices fully reflect costs, through taxation and direct price stipulation. Public awareness campaigns should stress the benefits of fuel conservation and be followed up by an evaluation of the potential and incentives needed for further development of public transportation on the main island. The Government itself, as an owner of vehicles, can undertake fuel-saving measures. In addition to the direct benefits, the Government should recognize its role as a "model" for the public.

23. The power subsector can save diesel by reinforcing and extending its rehabilitation program where there are high electricity losses. EPS should take the initiative although the Ministry of Energy has overall responsibility for measures aimed at the general public and for initiating schemes targetting the Government's own energy use.

Sector Planning and Coordination

24. Apart from the fact that EPS operates as a department of the Ministry of Energy, the main institutional shortcoming in the energy sector is related to the narrow focus of the Ministry. Its scope should be broadened and its functions should be properly defined, followed by a reorganization and strengthening of the institution. Its role should basically be one of

formulating and overseeing the implementation of policies, providing advice and guidelines on energy matters to the Government and energy-related institutions, and ensuring overall coordination, gradually relinquishing its involvement in actual project implementation. One of the primary tasks of the Ministry in the short run will be to oversee and support the reorganization and development of EPS into a statutory authority.

25. It is recommended that the Ministry be organized as two divisions, a Rural Energy Division and a Policy and Planning Division reporting to the Executive Secretary.

26. The Rural Energy Division would:

- be given formal responsibility for electricity supply to the outer islands, with EPS providing services for engineering, operation and maintenance of the diesel power systems under a contract with the Ministry;
- plan the installation of alternative energy technologies on the outer islands, at present photovoltaics, and organize and supervise implementation and maintenance of the systems; and
- monitor development with respect to biomass supply and household energy consumption with data collection and analysis and take initiatives when required.

27. The Policy and Planning Division would:

- support the policy development responsibilities of the Executive Secretary through data collection and analysis;
- ensure that relevant energy options are considered prior to system expansions, that least cost development plans are formulated and adhered to, and carry out project evaluations;
- monitor energy prices and advise the Government on the need for changes;
- provide advice to the Government on petroleum matters (supply arrangements, storage, distribution, quality issues) and support to major users of petroleum products; and
- be the primary Government agency when it comes to taking energy conservation initiatives among users and producers.

28. As several of these tasks come up at infrequent intervals, require particular expertise, and may exceed local technical capability, the Ministry would rely on external agencies and donors for technical assistance and execution of studies.

29. In addition to the recently recruited Executive Secretary, other key positions that need to be created/filled in the reorganized Ministry are:

- for the Rural Energy Division:
 - * a division manager
 - * an energy project supervisor; and

- for the Policy and Planning Division:
 - * a division manager
 - * a petroleum officer
 - * a trainee.

30. This would require partly a reallocation of present staff and partly recruitment of additional personnel. Recruitment of Cook Islanders resident abroad or of expatriates to man some of the positions may be required. The Executive Secretary together with the two managers would be responsible for developing local capability in the respective fields by preparing and monitoring training programs for the staff of the Ministry. The Government, in return, would have to commit resources to fund local counterparts and provide suitable candidates for the positions.

I. ECONOMIC AND INSTITUTIONAL CONTEXT

Energy in the Economy

1.1 Cook Islands consist of 15 small islands forming two major groups: the Northern Group, comprising seven widely dispersed islands, and the Southern Group which includes the island of Rarotonga, with the capital, Avarua. Its territorial waters and exclusive economic zone covers an area of nearly 2 million km² compared to a total land mass of only 240 km².

1.2 The total population is estimated at slightly less than 18,000 ^{1/} in 1990, of which close to 90% live in the Southern Group and more than 50% on Rarotonga alone. The country's population has declined since the early 1970s due to emigration, in particular to New Zealand. The country is self-governing in free association with New Zealand. Economic cooperation between the two countries is close: New Zealand's monetary system extends to the Cook Islands, capital and trade flows are largely unrestricted, and the Government's budget has received substantial support from New Zealand.

1.3 The Cook Islands has a limited resource base other than the potential of its sizable economic zone. Fishery resources are large but have not been much developed for want of appropriate technology, management and facilities. Agriculture is important for subsistence and commodity exports but has performed poorly in recent years. Based on provisional figures for 1989, ^{2/} agriculture accounted for around 12% of GDP and close to 40% of commodity export earnings, the latter mainly from fruit and vegetables. The manufacturing sector's contribution to GDP lies around a modest 5%. The economic base of the outer islands is particularly fragile and is linked to costly inter-island shipping services. A small domestic market and geographical remoteness lead to high internal and external transport and administrative costs. Infrastructure outlays per capita are high, with virtually no economies of scale.

1.4 The most important factors in determining the overall level of economic activity have been foreign aid (about 25% of estimated GDP), tourism, and remittances from Cook Islanders living abroad. Aid from New Zealand has been large, crucial for the development needs of the country and a steadying influence on the economy. There will, however, be a gradual phasing out of budgetary support and the Cook Islands is seeking to diversify its sources of assistance. The Government's ability to prepare and implement sound proposals for projects and programs is a significant constraint on the capacity to absorb additional external assistance and on development in general. This is related to the small number of qualified indigenous personnel and to the country's widely dispersed islands and population.

1.5 Tourism has grown from virtually nothing in the early 1970s to become the main driving force of the Cook Islands economy and the principal source of foreign exchange and employment (directly and indirectly). With appropriate

^{1/} The latest census (1986) estimated the population at 17,460.

^{2/} Statistical Bulletin 1990. Statistics Office, Rarotonga.

policies there is a potential for continued development of this sector but competition with other tourist destinations in the region is strong. The requirements of tourism for basic infrastructure have been one of the determinants in the Government's emphasis on electricity in recent years. Gross receipts from tourism amount to 4-5 times the value of the narrow range of commodity exports. Imports are some 10 times the value of commodity exports and some 75% of GDP and underline the open nature and vulnerability of the economy to external forces (including natural disasters).

1.6 The economy grew at an annual rate of around 7% per annum in real terms between 1982 and 1987. Official figures are not available for subsequent years but estimates put economic growth at 4-5% per annum since 1987. With a virtually constant population, GNP per capita has increased rapidly and is higher than in almost all other Pacific Island countries. It is estimated to exceed US\$2,000 per year, an average that conceals wide disparity in distribution of income among islands. With tourist arrivals anticipated to increase at the same rate as in the recent past and assuming that the Government succeeds in revitalizing agriculture and fishing, it is expected that the economy will grow at a rate of 4-5% p.a. during the 1990s. Except for a fairly large hotel complex, no major new development projects or industrial schemes are planned that should change past trends in economic output or energy demand.

1.7 Indigenous energy resources are limited. There is no significant hydroelectric potential. Wind and wave energy will not become significant sources of energy in the foreseeable future. No exploration for hydrocarbons has been carried out due to apparently poor prospects. The country's only immediately available resources are its abundant coconut residues, its probably limited wood stock, and its solar energy. Indigenous energy sources are important particularly on the outer islands, whereas imported petroleum products and electricity are the main options for meeting commercial and domestic energy needs on Rarotonga.

1.8 Imported oil accounts for the bulk of energy supply (some 85%) for the country overall, and the value of oil imports (expressed in CKI\$) grew by around 35% between 1985 and 1989 to CKI\$8.6 million.^{3/} Table 1.1 illustrates the extent of petroleum import dependence of this open economy. Whereas the value of petroleum imports as a share of total imports has been stable and relatively modest, it is of an equal order of magnitude to the country's total merchandise exports. The petroleum bill is of considerable concern to the Government, and the trade balance demonstrates the need for sound policies and measures regarding the energy sector.

^{3/} In US\$ terms, the value increased by around 65%, compared to an increase in volume by only 34% over the same period. The result of this comparison is surprising since, with the development in international oil prices, the opposite should have been expected, i.e. volumes increasing more than values. The value figures from the Statistics Office in Rarotonga are listed as "provisional" and the comparison may be an indication of weak statistics.

Table 1.1: PETROLEUM PRODUCTS AND THE COMMERCIAL BALANCE 1985-89 /a

	1985	1987	1989
Imports of mineral fuels, etc. (CKIS million)	6.3	6.5	8.6
As % of total imports	15	11	12
As % of total exports	103	54	183

/a Years refer to fiscal year ending March 31.

Source: Quarterly Statistical Bulletin.

1.9 Despite a very narrow energy resource base, the Cook Islands has been able to maintain a reasonably secure and uninterrupted supply of energy at prices which are in line with other island countries in the region. In the case of petroleum products, the underlying costs are high as a consequence of the small market, transshipment and long transport from the supply points but, with relatively moderate taxation, prices to consumers are probably not a major constraint with respect to consumption.^{4/} The complete dependence on petroleum products for power generation and other commercial energy needs, however, makes the economy in general and the energy sector in particular vulnerable to supply and price fluctuations. In the past, Rarotonga and the outer islands have experienced petroleum product stockouts due to irregular shipping connections. The main island which, together with the island of Aitutaki, has the only system providing 24-hour electricity service, has experienced periodic power shedding and blackouts. These issues are discussed in Chapter III.

1.10 Energy development in the Cook Islands is subject to constraints, common to other island countries in the Pacific and resulting from the stage of development and the geographical situation of the countries. These limitations, which have to be taken into consideration by the Government and donors involved in the sector, are related to (i) very restricted domestic financial resources, (ii) a dearth of managerial and technical skills, and (iii) small and widely scattered energy markets.

1.11 Although external financial assistance may, to a large extent, offset limited domestic financial resources for investment purposes, donors normally do not provide funding for recurrent costs. Due to lack of domestic funds, the

^{4/} A qualification may be necessary with respect to the outer islands where official retail prices on some of them are more than 40% higher than on Rarotonga.

Government tends to underbudget operating and maintenance expenses which leads to investment projects with shortened economic life, and malfunctioning or even total abandonment of energy schemes. As a consequence, it is recommended that the selection of energy projects, their design and the choice of technologies, should as a general principle emphasize schemes with low recurrent manpower and financial resource requirements. The Ministry of Energy, in its capacity as a policy-formulating body and adviser to other institutions, has an important role to play in this respect. In addition, it is recommended that the Ministry stress to the Government the obvious but easily overseen need to allocate funds and create arrangements to secure regular maintenance for every project.

1.12 Similarly, the Ministry of Energy should address the general problem of shortage of managerial and technical skills, which affects the capacity to plan, implement and monitor complex energy schemes. Shortcomings in this respect can lead to choice of energy alternatives or technologies that are ill-adapted to the country's needs, time and cost overruns during project construction, and shortened project life due lack of proper maintenance. From an energy point of view, there are two main approaches for dealing with limited domestic institutional and technical capacity:^{5/} (i) training and transfer of skills through technical assistance as a continual and persistent effort on the part of all institutions involved in energy development and operations; and (ii) a realistic assessment of the number and types of energy options that the country should be actively pursuing with or without external donor assistance. The Ministry of Energy should emphasize proper management of existing energy alternatives and resources and not spread limited institutional capacity too thinly. It is recommended that the number of new options that are being pursued be restricted to those that are proven technologically and economically for Pacific Island circumstances and which can have a significant impact on the energy situation of the country. More esoteric technologies and options should be considered only if the complete lifetime costs are borne by a donor who will guarantee the results.

1.13 As a consequence of the island nature of the country and a small and widely dispersed population, markets for energy in the Cook Islands are small and scattered. The results of this are (i) uncertain and costly distribution of petroleum products, in particular to distant outer islands dependent on irregular shipping services involving transshipment and drum handling; (ii) costly power supply due to expensive generating equipment, distribution systems with small loads, and generation based on expensive diesel at the outstations; and (iii) problems in creating an adequate infrastructure for maintenance and other support services of grid-supplied electricity or photovoltaic installations on the outer islands. While it is difficult to overcome these problems as indicated later in the report, it is possible to improve the distribution and storage of petroleum products. Problems of infrastructure and maintenance of energy systems in remote areas point to the need for robust energy alternatives that can largely be serviced locally.

^{5/} Beyond the scope of the present report but affecting energy sector management is the complex issue of institutional shortcomings in government and the public sector in general, such as the availability of qualified national candidates for public sector positions, salary levels, management skills, motivation, staff turnover, and institutional memory.

Institutional Framework

1.14 With the establishment of the Ministry of Energy in 1989 by a Cabinet decision,^{6/} the Government created the framework for further development and coordination in the energy sector. At that time, the Energy Division was transferred from the Ministry of Planning and Economic Development (MOPED) to the newly constituted Ministry of Energy. The latter has so far adopted a quite narrow view of energy, focussing mainly on the supply of electricity to Rarotonga and the outer islands through EPS and, to some extent, on solar energy. As the initial step in its development, the Ministry of Energy has recruited an expatriate Executive Secretary, who reports to the Minister.

1.15 EPS is an integral part of the Ministry, and financial control is exercised by the Treasury. Some 180 persons of the Ministry's staff are assigned to EPS functions, around 100 of these covering Rarotonga and the balance serving the outer islands. Some of the senior positions are held by expatriates financed from multilateral sources.

1.16 In addition to EPS, the Ministry has an Energy Division which plays an active role in the utilization of solar energy for lighting through photovoltaic installations on outer islands. These activities rely heavily on the assistance of regional bodies [Forum Secretariat Energy Division (FSED) and the South Pacific Institute for Renewable Energy (SPIRE)] for funding and implementation.

1.17 Besides the Ministry of Energy, several other government bodies and the private sector are engaged in energy and energy-related matters:

- The Price Tribunal (PT) in the Ministry of Trade, Labor and Transport controls prices of petroleum products. In addition, the Ministry issues licenses to shipping companies involved in the transportation of petroleum products to the outer islands.
- The Ministry of Planning and Economic Development handles issues related to petroleum storage. This ministry has authority regarding overall coordination of the Government's internal project cycle, including the evaluation and presentation to the Cabinet of projects proposed by the line ministries and the submission of proposals to foreign donors for possible funding.
- The Ministry of Internal Affairs has organized some pilot projects aimed at energy conservation or substitution, such as wood stoves through women's groups.
- The Ministry of Agriculture and Forestry is responsible for forest resource development and management.
- Private companies, Mobil, Triad Petroleum Ltd. and British Petroleum/Shell (joint venture) handle imports, storage and distribution of petroleum fuels.

^{6/} The Ministry was formally constituted by an Act of Parliament in July 1991.

1.18 The present allocation of responsibilities within the energy sector appears in broad terms to be justified. The different organizations perform functionally diverse and partly self-contained energy-oriented activities. There is, however, a clear need to (i) consider the organization of the supply of electricity, (ii) broaden the scope and policy functions of the Ministry of Energy, and (iii) restructure the Ministry accordingly. This should be done within a realistic framework that takes account of the available manpower and financial resources. Institutional proposals are discussed in Chapter V.

II. ENERGY CONSUMPTION

The Structure of Energy Consumption

2.1 The estimated 1989 energy balance for the Cook Islands is presented in Annex 2.1. While data quality and reliability vary to a significant extent, particularly for biomass which is the major source of household energy, the balance shows in broad terms the movement of energy through the economy, the role of the various forms of energy, and orders of magnitude.

2.2 Final consumption of energy from all sources is estimated at 14,000 tonnes of oil equivalent (TOE) or close to 800 kgoe per capita. The latter figure is among the highest for Pacific Island countries. The bulk of energy use in the Cook Islands is for transportation reflecting, in part, the country's distant location, dispersed geography and tourism as an important element in the economy. Due to this and to diesel-based power generation, petroleum products dominate and provide as much as 35% of gross energy supplied and more than 75% of final energy consumption. A quarter of the petroleum is converted to electricity which accounts for 7% of final energy consumption. Around 16% of energy used is in the form of biomass, virtually all of which is consumed by households for cooking.

2.3 A projection of energy end use in year 2000 is presented in Table 2.1 and shows an increase in total energy consumption of around 40% compared to the present level, or an annual increase of slightly more than 3%. The basis for the forecast for the individual types of energy is given in the respective subsector sections later in the report. The main general factors underlying the projections are a continued low rate of population growth (0.5% p.a.), no energy supply constraints, certain upward adjustments of energy prices in real terms, economic growth at the same rate as in recent years, and no new major industrial or commercial activities except for some expansion in hotel capacity.

2.4 By the year 2000, the predominance of petroleum products as the main provider of energy will be even more pronounced. Diesel generation will remain the dominant option for electric power production of any significant quantities and is likely to increase its share of total petroleum use. Air, land and sea transportation combined will, in absolute terms, be the primary force behind the increase in petroleum consumption. The use of biomass, still the major outer island household fuel, is expected to decline slightly in absolute, and more so in relative, terms, as commercial forms of energy, particularly kerosene and LPG for cooking and electricity, gain ground outside Rarotonga.

Table 2.1: FINAL ENERGY CONSUMPTION 1989 AND 2000

Source of Energy	1989		2000		Growth Rate % p.a.
	1,000 TOE	Share %	1,000 TOE	Share %	
Biomass	2.30	16	2.20	11	0.4
Petroleum Products	10.77	77	15.97	81	3.7
Electricity	1.03	7	1.67	8	4.5
<u>Total</u>	<u>14.10</u>	<u>100</u>	<u>19.84</u>	<u>100</u>	<u>3.2</u>

Source: Mission estimates.

Energy Conservation

2.5 The increasing dependence on imported energy decreases the importance of energy conservation. The benefits of higher energy efficiency should not, however, be considered only in terms of a reduction in the country's vulnerability to forces outside its control, such as high costs of petroleum products, drain on the reserves of foreign currencies, or supply constraints. Energy efficiency projects and programs often yield financial and economic returns that are higher than schemes undertaken to increase supply. Furthermore, improved efficiency will, in many cases, provide an opportunity for postponing capital investments. Finally, conservation has positive environmental consequences that are becoming increasingly important.

2.6 The low priority often accorded energy conservation and efficiency measures is partly due to the fact that conservation projects are difficult to define, implement and monitor. Moreover, they get less attention because their results are often less visible than a new power project or supply extensions. Finally, the most effective instrument of demand management, correct energy pricing reflecting the economic cost of supply, may be problematic to apply for political reasons.

2.7 In the case of Cook Islands, fuel uses in land transportation and power generation account for more than 50% of petroleum consumption and lend themselves to a combination of general conservation measures (pricing and influencing attitudes among users) and specific interventions (improved efficiency in energy production and use). Proposals aimed at curtailing the increase in fuel use by motor vehicles would target, on the one hand, the general public through pricing of gasoline and ADO, public awareness campaigns emphasizing the benefits of reduced fuel consumption, and development of public transportation and, on the other, the Government itself as an owner of a pool of vehicles. In the latter case, limiting the use of official vehicles to designated purposes and annual tune-ups of the engines are some of the measures that should be considered and followed up. In addition to the direct savings that would be achieved, the Government should recognize its role as a "model" for the population. It is

important to keep under observation the country's petroleum procurement and supply arrangements to ensure that the least cost alternatives are pursued, and to monitor the oil companies' costs and cost components under the regulated price formula (discussed later in the report).

2.8 The other main area amenable to direct intervention is the electricity subsector. Transmission and distribution losses in the different diesel-based power systems vary significantly but are high (14-20%) for the small systems involved and quite significant reductions are achievable. EPS should give high priority to loss reductions as part of its present rehabilitation program. Pricing electricity correctly (at present considerably below cost of supply) is also important since past experience with tariff increases on Rarotonga in the early 1980s indicates that price increases will lead to reductions in consumption through energy saving measures.^{7/}

2.9 In all the areas of commercial energy use and production mentioned, the Government, through the Ministry of Energy, should demonstrate its concern for conservation by itself initiating or pressing other bodies for relevant measures. In order to identify, plan and assist with the execution of specific proposals, it is recommended that the Government, through the Ministry of Energy, approach suitable agencies for assistance. Implementation should mainly be left to users and beneficiaries, once the costs and benefits have been identified.

The Consumption of Petroleum Products

2.10 Overall consumption of petroleum products increased at an annual rate of some 6% p.a. between 1984 and 1989 (see Annex 2.2). The largest demand growth has been in automotive diesel oil (ADO) and in aviation fuels. The latter (jet fuel and avgas) make up almost 40% of total consumption of petroleum products. For both ADO and aviation fuels, demand growth in the 1990s is expected to be somewhat lower than in the previous decade; for ADO this is related to an expected reduced growth in power generation whereas imports of aviation fuels could be affected by uncertainty regarding tourist arrivals (increasing competition in the region). Gasoline consumption is expected to continue to show a modest rise over the decade.

2.11 In total, demand for petroleum products is projected to increase by approximately 4% p.a. during the 1990s or by more than 55%, from around 17,000 kl in 1989 to 26,000 kl in year 2000, as summarized in Table 2.2. The potential for substitution of imported energy is insignificant.

^{7/} From 1980 to 1983 domestic and commercial electricity tariffs through several adjustments were more than doubled and trebled, respectively (in nominal terms). Aggregate sales fell in each of the fiscal years 1981/82-1983/84 by an average of almost 6% p.a. Other factors may also have played a role but the indications of energy saving behavior are nevertheless quite strong. Since then, nominal tariffs have been moderately increased or even slightly reduced whilst energy sales have show'd a "normal" growth pattern.

Table 2.2: PETROLEUM PRODUCT SALES, 1989 AND 2000

Product	1989		2000 kl	Growth % p.a.
	kl	Share (%)		
Gasoline	3,200	19	4,000	2.0
Jet fuel	5,937	35	9,100	4.0
Kerosene	100	1	140	3.1
ADO	6,107	36	9,900	4.5
Avgas	837	5	2,000	8.2
LPG	591	3	1,000	4.9
Other (lubes, solvent)	136	1	170	2.0
Total	16,908	100	26,310	4.1

Source: 1989 figures: PEDP, Fiji;
projections: Mission estimates.

2.12 Although the private sector has a major role in petroleum acquisition, storage and supply, the Government needs to monitor the development and requirements in the petroleum subsector and to be an informed partner on the energy scene. A more active involvement than at present requires, in part, more reliable and readily available petroleum information and data than is the case today. It is recommended that the Ministry of Energy take steps to create a petroleum data base covering quantities, prices, storage capacities and demand forecasts, together with the oil companies.

The Consumption of Electricity

2.13 EPS provides electricity on Rarotonga and nine other of the country's twelve inhabited islands. In the course of 1991 an eleventh island, Nassau in the Northern Group, will be added by EPS.

2.14 In the Rarotonga electric power system, peak load reached 2,300 kW in FY 1989/90 and energy generation totalled 13.12 GWh. In contrast, for the second largest system, on Aitutaki, the corresponding figures were 290 kW and 1.12 GWh. Major performance indicators in selected years for the two systems are summarized in Table 2.3 and details for Rarotonga for a ten year period are provided in Annex 2.3. Total EPS energy sales were 12.93 GWh, of which 88% were in Rarotonga. Domestic consumers and hotels are the largest user categories accounting for some 60% of total sales. Preliminary estimates for FY 1990/91 indicate sales growth in the order of only 1-2% due to generating capacity shortages. For the previous eight year period, the Rarotonga system exhibited an annual average growth of 5.5% (6% for all systems combined). Energy generation for all ten islands covering the 1980s is shown in Annex 2.4. Loss aspects are discussed in Chapter III.

Table 2.3: PERFORMANCE OF RAROTONGA AND AITUTAKI SYSTEMS

Year	Peak Load (kW)	Energy Generation (GWh)	Energy Losses (%)	Energy Sales (GWh)
<u>Rarotonga System</u>				
1982/83	1.710	9.05	13.7	7.81
1989/90	2.300	13.12	13.3	11.38
<u>Aitutaki System</u>				
1982/83	200	0.86	26.4	0.63
1989/90	290	1.12	19.6	0.90

Source: EPS.

2.15 The most recent load forecast was submitted early in 1991 through assistance from New Zealand in preparing for the commercialization of EPS. High and low projections were prepared, taking into account both regional and local factors. The high projection appears to be more realistic based on expected developments on Rarotonga including a new large hotel complex, power system augmentations comprising two new large French generators (2 x 2,000 kW) and the recently commissioned New Zealand unit (1,600 kW) which will remove plant capacity constraints, ongoing and planned transmission/distribution system rehabilitation and expansion, and port, airport and township developments. The high forecast for Rarotonga has been adopted in the present report, with slight adjustments for recent developments. Thus, an annual average growth rate of 4.7% up to year 2000 has been assumed, down somewhat from the past 5.5% noted above since future projections should be tempered by recommended tariff increases expected to be applied in the years to come. For the outer islands, overall growth in power sales is expected to be of the same order of magnitude as on Rarotonga, although the aggregate figure masks substantial differences from island to island. The projections for Rarotonga and for the outer islands in aggregate are summarized in Table 2.4 and the details are provided in Annexes 2.5 and 2.6.8/

8/ The slightly higher growth rate in generation than for sales for Rarotonga implies an increase in losses over the projection period as a whole (as shown in Annex 2.5). This assumption has been made in order to provide a conservative forecast as a basis for the generation development program, in recognition that losses tend to increase some years after the completion of a rehabilitation program, due to new connections and loads being added without a concurrent strengthening of the distribution system.

Table 2.4: SUMMARY OF LOAD PROJECTIONS FOR EPS

FY	Rarotonga			Outer Islands	
	Energy		Peak Load (kW)	Energy	
	Sales (GWh)	Generation (GWh)		Sales (GWh)	Generation (GWh)
1990/91	11.38	13.08	2,300	1.59	1.98
1995/96	14.78	16.61	2,920	2.12	2.48
2000/01	17.98	20.91	3,670	2.53	2.98
AAGR <u>/a</u> (%):	4.7	4.8	4.8	4.8	4.2

/a Average annual growth rate.

Source: EPS; Draft Government of New Zealand Report (1991); mission.

Biomass and Household Energy Consumption

2.16 Households use locally available woody biomass resources (forest timber, ironwood, Hibiscus) and coconut residues (husk, shell and frond) to meet domestic woodfuel needs. Where household incomes and availability permit, LPG and kerosene are generally preferred alternatives. No survey data are available for the Cook Islands to provide indications of biomass consumption, and broad estimates are therefore based on data from comparable areas elsewhere in the Pacific region.

2.17 While woodfuel continues to be used for the traditional Sunday meal, LPG and kerosene appear to have displaced indigenous biomass as the principal domestic cooking fuels on the main island (55% of the total population). It is assumed, however, that 60% of households on Rarotonga use woodfuel for some of their cooking,^{9/} implying a consumption of 0.4 kg/person/day (air-dried) over the entire population and a total domestic biomass use of 1,450 MT/year on Rarotonga (Table 2.5).

^{9/} Urban biomass consumption data are based on a household energy survey carried out within the peri-urban/rural area of Nadi/Lautoka in Fiji.

Table 2.5: ESTIMATED BIOMASS CONSUMPTION 1989

Area	MT	%
Rarotonga	1,450	23
Other islands in Southern Group	3,000	49
Northern Group	1,700	28
<u>Total</u>	<u>6,150</u>	<u>100</u>

Source: Mission estimates.

2.18 For the remainder of the islands in the Southern Group, an overall rate of biomass usage of 1.5 kg/person/day is assumed.^{10/} Total annual demand for these islands is thus about 3,000 MT. Households in the Northern Group use almost exclusively coconut residues for cooking. Fuelwood is generally not available. Coconut palms are not cut for fuelwood as they provide other products essential for living in these remote islands. Moreover, the resistance of coconut stemwood to "chipping" renders it unsuitable for household energy purposes. It is therefore assumed that consumption of biomass is similar to other atoll environments in the region where households use an average of approximately 2.0 kg/person/day. Total annual consumption is on this basis 1,700 MT for the Northern Group.

2.19 The total consumption of biomass of about 6,200 MT per annum amounts to around 70% of present estimated total household energy needs, a share that is expected to continue to fall as increased use is made of more convenient fuels, LPG in particular (Table 2.2). Whereas coconut production is vital for domestic consumption, exports of copra and other coconut products like oil have ceased in recent years due to low prices on the international market. The demand for coconut residues for copra drying has therefore diminished and there is no significant use of biomass in agroindustries or in the commercial sector. Biomass use in institutions is assumed to be negligible.

2.20 Commercial energy in the form of electricity, LPG and kerosene, provides close to 30% of the energy requirements of households, a figure that is considerably higher than in many other Pacific island countries. Consumption of LPG is concentrated to Rarotonga and four of the other islands with LPG depots, which indicates a scope for future market penetration for this fuel.

^{10/} Based on assuming the same level of consumption as in rural areas of Fiji, where 80% of the households use woodfuels.

III. ENERGY SUPPLY

Petroleum Products

3.1 Petroleum is supplied to the Cook Islands by four international oil companies: Mobil--all products; Triad 11/--all products; and BP and Shell--aviation fuels. LPG is supplied and distributed by Boral Gas, Australia, in cooperation with a local agent. The companies maintain bulk facilities on Rarotonga 12/ for major products (gasoline, ADO and aviation fuels) plus for LPG. Minor products to Rarotonga and all liquid fuels to the outer islands (except ADO for power generation) are supplied in drums.

3.2 Mobil, BP and Shell ship their products from refineries in New Zealand, Australia or, occasionally, Singapore via Fiji, based on regional optimization schedules, to their bulk tanks on Rarotonga in local coastal tankers (LCTs, 650-5,000 DWT). Products for the outer islands are transhipped through Rarotonga due to limited demand and facilities on the islands. Triad currently makes its purchases in New Zealand and delivers in local coastal tankers (LCTs) to Rarotonga or directly to EPS' ADO tanks on outer islands. Small quantities, long transportation routes and transshipment increase costs of petroleum products above those of several neighboring island countries.

3.3 Some apprehension is being expressed regarding the quality of petroleum products being supplied by Triad on account of their purchase and shipping procedures. Since inferior quality fuel can have serious consequences for EPS and other users, the present arrangement needs to be looked into to determine the scope of necessary improvements. Product pricing and Government subsidies related to freight arrangements should also be considered in the same context. It is recommended that these matters be reviewed as part of the evaluation of petroleum prices proposed in Chapter IV.

3.4 Distribution to the outer islands raises three interrelated issues: (i) inter-island shipping; (ii) wharves and landing facilities on these islands; and (iii) distribution in drums.

3.5 Transportation and communication difficulties between the different islands are major constraints on development of the country in general and on the distribution of petroleum and other products in particular. Stockouts occur on the outer islands, especially in the Northern Group, due to infrequent and irregular sea transport. None of the suppliers owns or operates local shipping. The Government has in the last couple of years had to charter a vessel from Fiji

11/ Until recently affiliated with Pacific Resources Incorporated (PRI), Hawaii, a subsidiary of Broken Hill Proprietary (BHP), Australia. Triad no longer has regular supply contracts and purchases products on the spot market.

12/ BP and Shell own a joint user hydrant installation for the aviation fuels.

to secure supplies of ADO for EPS.^{13/} The Government has decided to deregulate inter-island transportation and will in the course of 1991 issue licenses to shipping companies fulfilling minimum requirements. Although the problems regarding local shipping, according to the Ministry of Trade, Labor and Transport, are in the process of being resolved, the Government needs to monitor their development closely and, if necessary, reconsider the incentives for private operators in order to secure a reliable inter-island sea transport network.

3.6 An assessment of landings and wharves on outer areas is required. Due to encircling reefs, most fuel cargoes have to be unloaded into lighters or floated ashore, with inherent risks and potential loss of cargo. It is recommended that the Government request appropriate agencies such as the Forum Secretariat for assistance to carry out inspection and evaluation of present facilities (or lack of such) on the outer islands.

3.7 Distribution in drums is more expensive than bulk distribution and costs are compounded by the fuel losses (of up to 15%) through evaporation, leakage and drum decanting. A synthetic rubber bag (500 US gallons) is an alternative to the traditional 200 liter steel drum and has been evaluated by Mobil Oil Fiji. The assessment has reportedly established that the use of the rubber bag can lower freight cost for fuel supply to outer islands and rural locations where demand does not warrant bulk storage facilities. It is recommended that the Government keep this alternative under observation with a view to employing the bags when they have proven their efficiency in terms of handling and cost.

3.8 Although stockouts have not been reported on Rarotonga recently, and storage and distribution are carried out by the private sector, the present situation on the outer islands ^{14/} and the question of future supply security in the country in general warrant some degree of Government involvement in key issues in the subsector, such as the capacity and location of petroleum storage facilities. It is recommended that the adequacy of the existing facilities on Rarotonga and the justification of bulk storage on outer islands be studied, in cooperation with the petroleum companies.^{15/16/} Such a study should also consider the need for strategic reserves. A review of the private sector

^{13/} Even a major Southern Group island (Aitutaki) was without gasoline for four months in 1990 due to shipping difficulties.

^{14/} In addition to the problems created on outer islands due to irregular shipping, the lack of means of refuelling in the Northern Group has other consequences such as effectively preventing the recently acquired patrol boat from reaching all islands due to insufficient range.

^{15/} In the immediate future, the Government and Mobil need to address outstanding issues regarding the possible construction of bulk tanks on the island of Aitutaki.

^{16/} The establishment of oil storage on four islands, Mangeia, Atiu, Mauke and Penrhyn, has been proposed under an Asian Development Bank (ADB) Multiloan Project for the Cook Islands. This project has been evaluated by an ADB team in September 1991 and a decision by the Bank is expected shortly.

investment incentives, including the petroleum product pricing structure, may be necessary in this connection.

3.9 EPC and other Government agencies have fuel supply contracts with the suppliers. The purchase agreements in their present form, however, require a review as they resemble a quarterly price list according to which EPS and the other Government bodies benefit from tax and duty free purchases. They do not appear to be negotiated contracts or tenders for supply. It is recommended that the Government request assistance to establish proper contractual arrangements considering the quantities and potential savings involved. It is also recommended that the Government withdraw EPS tax exemptions for two reasons: first, EPS is soon to be commercialized and should operate on such terms in all respects and, second, the tax exemption is an indirect way of subsidizing electricity consumers, for which there is no economic or social justification.

3.10 With the Fiji National Petroleum Company (Finapeco) due to start operations in late 1991, both the routing and the cost of landed products, Rarotonga, may be affected. It is recommended that the Government make its concerns on this matter known and that it introduce dual price monitoring to record landed costs according to the existing pricing formula and landed costs as they develop under a new supply arrangement. The assistance of suitable agencies such as the Forum Secretariat should be requested should cost increases or supply disruptions occur.

Electricity

Present Systems

3.11 EPS's generation facilities are all diesel based. Although Rarotonga is quite mountainous, hydropower has not been developed because river flows are not substantial due to the porous soil and short river lengths. Rarotonga is the largest of EPS's generation and distribution systems with a load and a capacity eight to nine times the size of the power authority's next largest system, on Aitutaki (Annex 3.1 lists the installations of all ten systems).

3.12 The Avatiu Valley power station on Rarotonga was built under New Zealand aid in the early 1970s, followed by the development of an 11 kV primary distributions system. At the end of 1990, total installed generating capacity at Avatiu was about 4,000 kW, downgraded to 3,000 kW due to age or other operational limitations, compared to a peak load of 2,300 kW.

3.13 Since mid-1987, three of the six diesel units at Avatiu have been irreparably damaged and shortfalls in capacity have been partly met by hiring a unit and lately (1990) by installing a new 1,600 kW diesel set financed by the New Zealand Government. Recognizing the need to further augment EPS's generating capacity with reliable units, the Government commissioned consultants to design and specify an upgraded power supply system for Rarotonga. The Government subsequently negotiated with bilateral sources for additional generating sets and an order was placed in April 1990 for two 2,000 kW French diesel generators.

3.14 Due to the shortage of reliable generating capacity, EPS' power supply has been inadequate in the past two to three years. This situation has been compounded by inadequate distribution line capacity and overloading of lines and

transformers. The result has been high losses in the Rarotonga system which are reportedly more serious (up to 20%) than available statistics indicate (13% see Table 2.3).^{17/} Outer island systems also tend to be unreliable due to old generating sets, irregular maintenance and a lack of regular shipping services which makes the supply of fuel and maintenance services erratic. Although EPS in Rarotonga has indicated no derating of the individual outer islands diesel sets, this may not be the actual case since capacity deficiencies are reported to exist on several islands.

3.15 For Rarotonga, energy losses are expected to be progressively reduced in the early 1990s as a result of ongoing distribution system upgrading being financed from the French Franc 36.3 million loan ^{18/} (US\$7 million) for the two diesel sets. The upgrading will consist of renovation of the Avatiu power station, partial refurbishment of the medium voltage (MV) and low voltage (LV) network, construction of a cross-island MV link, and operational assistance and training for EPS staff. The work, which will be completed in 1991, will provide only for the partial upgrading of the system and it is understood that the Government intends to seek additional loan funds in the order of CKI\$2.8 million (US\$1.7 million) to complete the program. It is recommended that this effort to increase reliability and reduce losses be continued.

3.16 Australian assistance was obtained to study the expansion and upgrading requirements for Aitutaki (completed in March 1988) and it is understood that EPS will seek further assistance in 1991 to finance similar studies for the other islands. It is recommended that the ongoing and planned work to improve the systems, which should bring present losses of up to 20% on some of the outer islands to reasonable (15% or less) levels in the mid-1990s, be continued and that the Government seek donor funding for the implementation.

System Expansion

3.17 As indicated above, an expansion program for Rarotonga is well in progress. With the commissioning of the two new French-financed sets by in 1991, in addition to the unit financed by New Zealand, Rarotonga has adequate generating capacity for the foreseeable future. The situation will be further improved if the New Zealand government provides additional assistance to rehabilitate the old diesel sets, which is likely.

3.18 Projected Rarotonga system capacity and peak loads are shown in Annex 3.2 for the period up to FY 2000/01. Utilizing an outage allowance corresponding to the capacity of the largest sized generating unit (2,000 kW), it is seen that there is a reserve margin of over 1,000 kW to 1998 and over 700 kW to the year 2000. In relative terms, in 1995 there will be a reserve margin equal to 50% of the peak load. In 1998 it will still be around 30%. These figures are

^{17/} After the completion of the partial upgrading of power supply for Rarotonga in July 1991, the transmission and distribution losses have reportedly been reduced to around 10%.

^{18/} Obtained from a French commercial bank at terms, 6% p.a. and a repayment period of 3 years' grace period, plus 15 years repayment period, that are partly subsidized by the French Government.

indicative of excess generating capacity in the system. With the installation of new units of 2,000 kW each, a further problem arises due to the large size of these units compared to the existing sets. Failure of one of two large sets in operation with the third out of service (say on maintenance) requires a fourth large unit as reserve to take up the load. However, EPS will not have this additional unit. Hence, it would not be desirable to remove the 1,200 kW sets from the station. With suitable rehabilitation, which is planned for the smaller and older 600 kW sets, the 1,200 kW units would have been much more useful as standby sets than the 600 kW machines. It is recommended that EPS reconsider this matter and, if necessary, obtain further advice.

3.19 Thus, it appears that the recent generation augmentations have not been least cost solutions. A technical assistance grant requested by the Government and approved by ADB in February 1989 to provide consulting services to EPS to ascertain the next optimum generation expansion for the Rarotonga system was canceled at the Government's request in December 1989, just prior to the placing of the order for the French generators. It appears that no feasibility study or least-cost study was carried out to justify these units. New Zealand authorities had reportedly previously rejected a request from the Government for a 2,000 kW unit in 1988, favoring instead a set of about 1,400 kW. The actually installed 1,600 kW unit was the result of a compromise.

3.20 A power system is presently being constructed on the island of Nassau which will result in power for the eleventh of twelve populated islands. Government plans to further expand the outer islands systems. However, it is strongly recommended that priority be given to enhancing the institutional and technical capacity to maintain and operate present systems, and to creating a rural energy unit in the Ministry of Energy (see Chapter V). The latter should devote its attention to establishing a well-founded and prioritized expansion plan for the outer island prior to any implementation. The assistance of a suitable agency, such as the ADB, should be considered. It is, furthermore, recommended that the Government give careful consideration to the financial requirements for the operation and maintenance of outer island power supply at its present level and, in particular, the impact on the Government budget of any future expansion on the outer islands.

Biomass

Resources and Supply

3.21 Little is known about the forest resources in the Cook Islands. The New Zealand Government has proposed funding forestry programs on Rarotonga, Mangaia and Atiu where the only significant stands of natural or planted forest exist. Some rough indications of biomass supply may be inferred or calculated indirectly.

3.22 The coconut palm is an integral part of traditional agricultural practices and its sustainability does not appear to be threatened. It is used to supply food (both human and animal), drink, fuel, building materials, medicines and materials for decoration and for making kitchen utensils. Most new land is being planted to coconuts, together with other crops, early in the farming cycle.

3.23 Coconut residues available on Rarotonga are estimated to average 0.5 kg/person/day.^{19/} Distribution across the population is not uniform, however. Slightly less than three quarters of the households use coconut for human consumption and half as animal feed supplement from which biomass residues are available. For households that do not consume coconut, it is reported that other forms of biomass (fuelwood and shrubs) or commercial fuels are used to meet cooking energy requirements. There is no established woodfuel market on the island and households gather biomass from household lots and nearby wooded areas.

3.24 On the other islands in the Southern Group, almost all of the households use coconut for both human and animal food, with available residues estimated at 2.7 kg/person/day. Other biomass resources (Hibiscus) are also available and used, although the extent is not known. In the Northern Group, coconut consumption is recorded among all households, with an average of 2.1 kg/person/day of residues as by-product. Little other biomass for energy through the future rural energy unit, purposes is available there.

3.25 Total residue supply in the country associated with household coconut consumption is presented in Table 3.1 and shows, for the geographical groupings, varying surpluses or figures that are comparable to estimated woodfuel requirements presented in Chapter II.^{20/} In addition, other forms of biomass like fuelwood and shrubs are used, confirming the general impression that there is no overall biomass shortage at present. With low population growth and a continued shift towards commercial fuels it is expected that biomass demand will gradually decrease and that the biomass fuel situation will be manageable in the future.

3.26 However, in view of the continued dependence of households on biomass, particularly on the outer islands, and the possibility that local woodfuel shortages may develop despite an overall surplus, the Government should, through the future rural energy unit, monitor the situation and consider localized initiatives in cooperation with the users as the situation may call for. It is recommended that, as a first step, energy end-use surveys among households on the outer islands be carried out to determine more accurately the biomass usage pattern.

^{19/} "Cook Islands: Census of Agriculture 1988". Ministry of Agriculture and Statistics Office, 1989.

^{20/} The same conclusion can be drawn from residue assessments derived from estimates of areas on the island groups planted with coconut trees and assumed coconut yields.

Table 3.1: BIOMASS SUPPLY ESTIMATE AMONG HOUSEHOLDS, 1989

Area	MT
Rarotonga	1,850
Other islands in the Southern Group	5,300
Northern Group	1,750
<u>Total</u>	<u>8,900</u>

Source: Mission estimates.

Biomass Schemes

3.27 The use of charcoal and smokeless stoves has been promoted by the Ministry of Internal Affairs in rural areas in the past in order to improve fuel efficiency and reduce the inconvenience associated with the use of biomass for cooking. Production of the stoves has reportedly been discontinued, however, due to the costs and skills involved in their manufacture and maintenance. As quite significant resources are required for implementation and measurable benefits remain to be identified, it is recommended that further initiatives should be given low priority.

3.28 Several schemes have been proposed in the past to generate electricity using indigenous biomass resources as a means of replacing imported fuel. In 1984, a French company proposed the installation of a 1,700 kW wood-fired power station on Rarotonga together with the establishment of a fuelwood plantation. Various appraisals found the proposal to be flawed in many areas, including the estimation of future woodfuel requirements, long-term availability of fuel, cost of fuel, and land availability. In 1987, the installation of a 150 kW wood-fired steam generation plant was proposed on the island of Atiu. Because of difficulties in securing fuel supply the project was shelved. A similar project on Mauke (50 kW rated output) originally proposed in 1983, was deferred following the fall in oil prices. Efforts were reportedly made in 1988 to revitalize the project but without success. A very small dual fuel gasifier was installed on Atiu in March 1983. Scrap wood from a nearby sawmill was used. Operation ceased, however, due to lack of operating skills and plant maintenance.

3.29 It is recommended that the biomass technologies mentioned above not be pursued at government or EPS expense. Apart from high investment costs, the operation and maintenance required by these technologies represent a particular challenge, as does a reliable and inexpensive supply of wood over the lifetime of the project. Apart from transportation costs, the question of dedicated energy plantations raises the issue of availability of land in competition with cultivation of higher value crops. Land is held under customary ownership and there appears to be very little of it owned by the Government that could be made available. It also appears doubtful that there are sufficient stands of senile coconut palms that could provide the required quantities of fuelwood.

New and Renewable Energy Technologies

Solar Energy

3.30 The Government places high priority on providing lighting, water pumping and refrigeration on the outer islands and prefers indigenous alternative energy sources. This applies in particular to islands in the Northern Group where the population does not have access to grid supplied electricity. Petroleum-based fuel supplies to these islands are unreliable and expensive due to erratic shipping schedules and long distances. Photovoltaic (PV) technology is therefore being promoted by the Ministry of Energy. The country has abundant sunshine and, based on neighboring countries, most parts of the Cook Islands should be receiving a daily average insolation exceeding 5 kWh/m².

3.31 In 1983/84, PV systems were installed in 50 households on Mitiaro with assistance from the South Pacific Commission. Despite a revolving fund being established to finance maintenance work and spare parts, revenue collection was difficult and maintenance work disorganized and ineffective. A survey in 1989 showed only 5 systems remaining in operation. In 1989, 63 systems were installed in private homes and in community buildings on Nassau. In 1990, three community systems were completed on Pukapuka. The projects were designed as demonstrations and as precursors to a comprehensive program to provide solar lighting systems for all private homes, community buildings and government centers in the Northern Group. In addition to PV systems, solar water heaters appear to be widely used throughout Rarotonga in domestic, commercial and government installations. However, there are no records showing the extent of use.

3.32 There are plans to install PV lighting systems on the northern islands of Manihiki, Rakahanga, Palmerston and Pukapuka. Financing is likely to be obtained through French sources. Phase 1 of the project, involving surveys and project formulation for two of the islands, has been completed and phase 2 will cover implementation. The Government recognizes some of the difficulties in providing such services to rural areas and the need for subsidies. Present government policy is to donate the equipment to the households with its responsibility ceasing following installation. However, provisions for loan repayments or for future maintenance work and parts replacement have not been made and it is unclear what commitment, involvement and responsibility will and can be expected from the recipients of the systems.

3.33 Experience elsewhere in the Pacific indicates that the viability of PV systems is critically dependent on, among other things, the continuing availability of good technical support services within the country. Some training courses have been held in the Cook Islands covering design and maintenance of PV systems but follow-up training is needed. More fundamentally, the existing domestic infrastructure and institutional arrangements for managing the implementation and maintenance of projects of the size envisaged are inadequate. It is therefore recommended that a study be carried out to examine the institutional framework necessary for implementation and maintenance of PV systems as well as the manpower and funding requirements, and also to clearly define the extent of user responsibility and participation. The involvement of potential users in the study is strongly advised. The Government could approach a suitable agency such as SPIRE (South Pacific Institute for Renewable Energy) for assistance.

Other Renewable Energy Technologies

3.34 Hydro resources. A preliminary survey of hydro resources was carried out on Rarotonga in 1981.^{21/} The principal conclusion was that the hydroelectric potential on Rarotonga is very limited, the study identifying five sites with capacities between 10 and 30 kW. Installation costs would be high. The study requires verification and updating. It is unlikely, however, that the sites can be developed to provide electricity at a lower cost than the existing diesel system and no further action seems justified.

3.35 Wind technology. Practical application of wind technology in the Cook Islands has been limited to small wind generators to supply power for communications and lighting (Rarotonga, Palmerston, Pukapuka, Atiu), and water pumping (Mauke, Aitutaki). It is reported, however, that the systems are no longer operating. Based on the experience in the country and more generally in the Pacific region, commercial wind systems do not appear to be appropriate for the Cook Islands' environment. Apart from indications that unit costs of electricity will be high due to operating conditions and the need for support infrastructure, the Cook Islands is also subject to hurricanes that would affect system design and costs.

3.36 Seawave energy. The monitoring of seawave potential in the Cook Islands has been carried out since 1986 with funding provided through the Norwegian Government in collaboration with the South Pacific Applied Geoscience Commission (SOPAC) based in Fiji. The technical and economic viability of the technology has yet to be demonstrated. The application of wave power in the country, even if the seawave potential were established, is therefore not recommended at this time. Only in the case where the foreign developer provides all the funding, manages the operation and undertakes the training of local personnel for an extended period of time should the country devote attention to a new technology such as wave power. The country's limited financial and manpower resources dictate that it concentrate on existing and well-proven energy technologies.

3.37 Biogas. Five biogas plants have been built on Rarotonga, of which only two are now in operation. In 1989, a system using pig manure was installed at a college with New Zealand funds, as demonstration for the students. The financing of the construction of a large biogas digester on a chicken farm (10,000 birds) has recently been approved by the Forum Secretariat. Although such systems provide methane gas for local consumption, their contribution to total energy supply is very limited and further application should be at private or local initiatives. Their merit is primarily related to the resolution of environmental and public health problems associated with chicken farms and piggeries.

^{21/} "An Assessment of the Potential for Micro-hydro Development on Rarotonga, Cook Islands". The Ministry of Works and Development, 1982.

IV. POLICY ISSUES AND PRIORITIES

Pricing Issues

4.1 Commercial energy prices 22/ are administered by different government agencies. Petroleum product prices are set by the Price Tribunal (PT) of the Ministry of Trade, Labor and Transport, and power tariffs are established by the Ministry of Energy. In real terms these prices have fallen since the early 1980s. Biomass is not traded.

4.2 Energy pricing is the most important instrument of demand management and the Government needs to use it to promote energy-use efficiency and conservation. Since the Government controls commercial energy prices through taxation and direct price stipulation, it has the means to apply the principle whereby the users are required to pay the full cost of the energy they consume. The implication of this is that commercial energy prices should cover all operating costs, adequate maintenance of the supply facilities, as well as capital replacement or expansion. Energy should as a general principle not be subsidized. Where clearly warranted to certain users on social grounds, however, subsidies should be made explicit with separate allocations in the Government budget for social service.

Petroleum Product Pricing

4.3 Ground products are supplied by two companies, Mobil and Triad, and their respective market shares depend, among other things, on which company is the supplier to EPS for ADO for the current quarter. BP and Shell, through their joint user agreement for installations, are the sole suppliers to the aviation market. Other companies can only market here via an into-plane contract negotiated with the partners. For LPG, Boral is sole supplier. The Cook Island market is very small and isolated and competition among the suppliers of petroleum is limited. It is not likely (nor possibly desirable due to small size and minimum operating costs) to expect more companies to enter the national petroleum market, but at the same time it is important that the existing principals remain in the market.

4.4 With limited competition, prices of the three most consumer-sensitive products, gasoline, ADO, and kerosene, are controlled by the Government through the Price Tribunal (PT), a section of the Ministry of Trade, Labor and Transport. The role of the PT is restricted to checking the build-up of each company's landed and distribution costs which, together with previously established profit margins, form the basis for the approved price for each company. In practice, market prices are determined by the company with the lowest costs. It is recommended that the proposed Policy and Planning Division in the Ministry of Energy (see below), which will be responsible for petroleum matters, generally be consulted on the issue of petroleum prices and in particular when prices are to be revised.

4.5 Price variations in the international market for petroleum products are, under the present system, reflected in the domestic market prices. Higher

22/ The term commercial energy here denotes petroleum products and electricity.

distribution costs for consumers outside Rarotonga are, furthermore, reflected in higher wholesale and retail prices for the outer islands. (Annex 4.1 presents the price build-up of gasoline, diesel and kerosene.) This policy is appropriate. Limited competition in the national market and the restricted capacity of the PT to examine the cost basis of the oil companies imply, however, that there may be scope for reducing present prices. It is therefore recommended that a full price review be carried out, including the basis for landed cost, the price formula itself, a verification of the oil companies' cost elements (which also should be audited on a regular (annual) basis), and an assessment of the level of government charges (para. 4.6).^{23/} This should also include an examination of LPG prices. The Government should approach a suitable agency such as the Forum Secretariat for assistance.

4.6 Import duty and taxes on gasoline, diesel and kerosene are expressed as ¢/liter and make up 20%, 13% and 7%, respectively, of retail prices. When setting these charges, the Government should strike a balance between fiscal needs, conservation, competitiveness of the Cook Islands economy and social concerns. The first two considerations would suggest higher taxation and prices whereas the last ones work in the opposite direction. Since industry and households are minor users of petroleum products compared to transport and power generation, there is a case for relatively high taxation and prices of gasoline and ADO based on conservation and fiscal considerations. As discussed earlier (paras. 3.8-3.9), it is recommended that the indirect subsidization of EPS, i.e., its tax and duty exemption on ADO, be discontinued. The level of Government charges should be part of the evaluation carried out under the price review.

4.7 Finally, fiscal controls need to be improved, as evidenced by the fact that (i) the price for LPG is not controlled, (ii) Triad often does not make price submissions, and (iii) the collection of duty can be slow and/or difficult since the bulk tanks on Rarotonga are bonded stores and some imports reportedly are being delivered directly to outer islands. It is recommended that the collection policy and procedures be reassessed as part of the proposed price review. In particular, it is recommended that duties be paid when the product is offloaded from ship instead of when it leaves the depots.

Power Tariffs and Utility Finance

4.8 Domestic tariff charge is set at 20¢/kWh for the first 120 kWh and 25¢/kWh for quantities beyond that. The commercial tariff is fixed at 39¢/kWh. The present tariff, in force since 1986, as well as changes since 1970 are shown in Annex 4.2. EPS maintains a uniform tariff structure across its ten supply systems.

4.9 Operations on Rarotonga have usually shown an operating cash flow surplus which has been inadequate, however, to cover losses on the outer islands. Due to small size, distant location and low tariffs, costs of outer island services can exceed revenues by three times or more and overall are three times

^{23/} The cost elements covering distribution costs and return on investments, as well as the retail margins for the outer islands, are high. This may reflect small quantities and long distances but at the same time seems to confirm the need for a review of the cost structure.

higher per kWh than main island generated electricity, according to EPS accounts. The Government has therefore regularly subsidized the operations of EPS. For FY 1989/90, the subsidy amounted to more than 20% of EPS' revenue and constituted as much as 1.4% of total government expenditure. These figures do not include depreciation on capital equipment in the power sector, as depreciation is not charged to EPS' accounts. For FY 1990/91, it is expected that EPS' Rarotonga operations will show a loss on a cash flow basis of some CKI\$230,000 (US\$140,000) before depreciation, due to oil price rises following the Gulf crisis. With the inclusion of capital subsidies (for which data is not available), real losses would be several times this amount. Regardless of a return of fuel prices to pre-crisis levels, EPS's Rarotonga operations will show significant negative cash flows in the coming years due to servicing of the debt incurred in connection with the Rarotonga diesel and distribution program.

4.10 Unprofitable operations, lack of planning capabilities, inadequate maintenance and the new debt situation led the Government to reassess present institutional arrangement in the power subsector and to decide to corporatize EPS.^{24/} Two studies have recently been undertaken in this respect. A preliminary study was carried out in early 1990 by Pacific Energy Development Programme (PEDP), followed by a New Zealand government financed consultancy to review EPS's financial situation and tariff requirements, and to make general recommendations on the commercialization arrangements. The latter study was substantially completed in March 1991.

4.11 One of the objectives of the commercialization of EPS is to eliminate the reliance on Government subsidies as far as Rarotonga operations are concerned. The 1991 commercialization study reviewed the adequacy of EPS' tariffs in the context of separating the Rarotonga operations from those on the outer islands and forming a statutory power authority for Rarotonga. The need to provide for the full cost of power supply, including system expansion and for long term debt servicing was emphasized. On the basis of an appropriate corporate capital structure reflecting the ongoing and impending capital investments, a proposal was made for new tariffs to be introduced with the commercialized EPS.

4.12 Retaining the present structure, new tariff levels were recommended as follows: (i) the rate for the first step of domestic consumers (lifeline rate for up to 60 kWh/month) to be maintained at 20¢/kWh; (ii) the rate for the second step to be increased to 35¢/kWh; (iii) the commercial tariff to be increased to 45¢/kWh; and (iv) the introduction of an automatic fuel cost adjustment clause. Although a tariff increase and the introduction of the automatic fuel cost provision are desirable, it is recommended that the adequacy of the tariff levels be reviewed after the Government has decided on the financial structure, terms and performance targets of the future EPS.^{25/} To

^{24/} An act of Parliament for the establishment of a corporate authority (for Rarotonga) was passed in July 1991.

^{25/} Since the large investments on Rarotonga are not part of a least-cost development plan, the size and structure of the debt for which the future EPS will be responsible should be tailored to reflect a "normal" expansion plan and the balance be serviced by the Government.

enable the Government to make these decisions, an asset valuation was carried out as part of the commercialization study, establishing the current performance of the organization 26/ and proposing targets under the corporatization plan.

4.13 In view of the clearly unprofitable power operations in general and on the outer islands in particular, there has been a growing awareness of the need to create two separate enterprises, one to be responsible for operations on Rarotonga where the users can carry the full costs of electricity supply and the other for operations on the outer islands which will depend on substantial government subsidies. This division of responsibilities as part of the proposal to commercialize EPS is appropriate. The organization of outer island services is outlined in Chapter V.

4.14 The other broad implication of a commercialization of EPS is that the utility becomes accountable for short-term operations, long-term investment decisions and debt servicing within the framework of government policies, placing responsibility with a board of directors answerable to the Minister of Energy. The corporation will, furthermore, be responsible for considerably expanded management and planning functions compared to the present situation, including budgeting and accounting, billing and revenue collection, tariff proposals and staffing (functions which today are partly covered by, for example, the Treasury). It will also imply changes from past procedures and the establishment of entirely new systems (e.g. management information systems with the associated computer hardware and software). It is recommended that this process be continued and that the Government emphasize commercial operations, financial independence and accountability for EPS. The utility will require considerable technical assistance for institution building and should approach appropriate agencies such as the New Zealand Government which has provided assistance to the subsector in the past and the Asian Development Bank (ADB) with its wide power sector experience in the Pacific region.

Regulatory Issues

Petroleum Subsector

4.15 The regulation of the petroleum industry can be improved in several areas. In order to make sure that all imported products meet internationally acceptable standards, legislation or regulations are required. At present, the sulphur content of ADO is a matter of concern. Quality control is carried out only by the oil companies, as neither the Government nor EPS addresses this issue. It is recommended that the Government consider introducing a Petroleum Standards Act together with procedures for monitoring the adherence to the standards. EPS should consider developing its own fuel testing facilities (para. 3.3). There are savings to be made by the country by avoiding importing gasoline of a quality that is in excess of the country's needs. Thus, it is possible that present gasoline octane rating in the Cook Islands is too high. The Forum Secretariat, which is carrying out a regional review of this issue, should be approached for assistance with this and the preceding matter.

26/ According to the study, EPS will show a rate of return on total equity for 1990/91 of the order of minus 60%.

4.16 Petroleum storage and distribution facilities in the Cook Islands are not required to meet any minimum standards of safety. Even though existing installations seem to be in fair condition, it is recommended that the Government consider introducing standards together with procedures for monitoring them in order to reduce the risk of accidents with consequences for people and the environment. The Forum Secretariat is preparing draft regional petroleum storage and handling standards. It is recommended that the Government urge the Secretariat to complete this work and itself make the necessary preparations for the enforcement of such standards. Monitoring of physical standards should be carried out by the Public Works Department in consultation with the Ministry of Energy.

Electricity Subsector

4.17 The salient issue currently confronting the Government in the power subsector is the reform of EPS, specifically the corporatization of the utility, which will require new legislation. EPS should be established in law as a statutory authority with its legal existence, powers, and obligations defined, and the Treasury should formally relinquish control over EPS. Assistance should be sought from suitable agencies for this purpose.

Environmental Issues

4.18 The Cook Islands Conservation Service is a corporation under the direction of a council headed by the Minister for Conservation. The Service covers Rarotonga and Aitutaki only, the other islands being responsible for environment policy development and planning on an island by island basis. Environmental impact assessment is not yet considered part of the routine planning of development projects. It is recommended that the Conservation Service be given the responsibility for developing and implementing an Environmental Management Plan (EMP) to form the basis for the assessment and monitoring of environmental aspects of projects and programs within the energy (and other) subsectors. The South Pacific Regional Environment Programme (SPREP) could be approached for assistance in this respect.^{27/}

4.19 With the EMP as a framework, the Conservation Service would assess the environmental aspects of energy projects, if necessary with donor assistance should there be doubts about the quality or coverage of the environmental impact assessment. The involvement of the Conservation Service should cover both the design and the implementation phases of an energy project, to ensure that actions and precautions proposed in the environmental assessment are carried out.

Petroleum Subsector

4.20 A Marine Pollution Contingency Plan was adopted in May 1990 but no department appears to have accepted responsibility for implementing the plan and the Government lacks staff to enforce environmental legislation. Procedures and facilities to prevent or cope with emergencies, oil spills and product contamination on land and sea require strengthening. Current indiscriminate and

^{27/} From 1990, SPREP has increased staff, budget and capacity to assist member countries with environmental issues.

hazardous practices of disposal of waste oil need to be rectified. Training in the detection, clean-up and monitoring of environmental hazards is also required. It is recommended that SPREP be requested to assist the Government with environmental issues, reviewing national emergency plans and advising on implementation.

Electricity Subsector

4.21 At the Avatiu Valley Power Station on Rarotonga there is a problem with respect to the handling of waste and spilled oil. The storm water system is inadequate as the contents of the oil sump are flushed into the adjacent Avatiu stream. The stream discharges into the harbor in the center of the Rarotonga commercial and tourist area. It is recommended that the consultants currently engaged in the power station rehabilitation be requested by EPS to investigate remedial measures which may be financed and implemented under the current French loan.^{28/}

4.22 A related matter is the amount of water in the Avatiu stream. As the power station is located quite far up the course of the stream, flows are not reliable in the dry periods. The power station requirements for machine cooling purposes therefore reduces flows even further which, together with the oil spillage problem, exacerbates the conditions in the stream. It is recommended that additional water storage and treatment facilities also be investigated under the ongoing works.

^{28/} A plan was prepared in 1991 for the prevention of spill of used oil into the Avatiu stream. Sources of financing (about CKI\$20,000) are being explored.

V. INVESTMENT AND TECHNICAL ASSISTANCE PRIORITIES

Sectoral Planning and Coordination

5.1 The Ministry of Energy in principle has overall sector responsibility but in practice its focus is on electricity supply. Its involvement in petroleum issues, energy pricing and conservation, project evaluation and screening, and data collection and analysis, is limited or non-existent. To enable the Government to play a meaningful role in the management and coordination of the energy sector, the scope of the Ministry has to be broadened and its functions properly defined. In addition, EPS needs to be set up as an autonomous statutory authority and both the Ministry and EPS should consequently be reorganized.

5.2 The basic task of the Ministry of Energy should be to provide a framework within which the subsector institutions operate, by (i) formulating policies on energy- and energy-related matters, (ii) overseeing the implementation of adopted policies and measures, (iii) providing guidelines, advice, information and certain other types of service to the subsector- and other energy-related institutions, and (iv) ensuring coordination within the sector. The Ministry should minimize its direct involvement in the implementation of energy projects and programs, given the nature of such tasks, the need for distinguishing between design and execution of programs and projects, and the institutional background and staffing of a ministry.

5.3 On this background, changes are proposed and recommendations made with respect to institutional matters in the energy sector, as outlined in the following paragraphs.^{29/}

Role and Functions of the Ministry of Energy

5.4 One of the primary tasks in the near term of the Ministry will be to oversee and support the reorganization and development of EPS into a Statutory Authority and, in that respect, be responsible for drafting relevant legislation.

5.5 To support EPS and carry out its other responsibilities in the energy sector, the Ministry itself needs to be reorganized. It is proposed that two units reporting to the Executive Secretary be created: (i) a Rural Energy Division; and (ii) a Policy and Planning Division (see Annex 5.1).

5.6 Rural Energy Division. There are many ways to organize electricity supply on the outer islands and finance the services. However, in order to emphasize the commercial character of the reorganized EPS, take into account the high cost of supply and the capacity to pay off the users on the outer islands, and at the same time take advantage of the fact that EPS has an organization and staff already operating on most of the outer islands, it is recommended that: (i) formal responsibility for supply on these islands be transferred to the Rural Energy Division (RED) (once it is established), and (ii) the commercialized EPS provide services for engineering, operation and maintenance of the diesel power

^{29/} See also "Organization and Man-ower Requirements of the Cook Islands Energy Ministry and Electric Power Supply". PEDP, Fiji, 1990.

systems on these islands under a contract between EPS and the Government (the Ministry of Energy). EPS would be paid for its services by the Government.

5.7 The Rural Energy Division would plan and manage, but not implement nor operate, outer islands electrification programs which, in addition to diesel-supplied electricity, would include electrification based on renewable energy sources, principally photovoltaics. As proposed in Chapter III, a study should be carried out to determine the infrastructural requirements and the financial framework for the future PV development program, as well as responsibility for the actual implementation and operation of the systems.

5.8 The Division would oversee development with respect to biomass and household energy in general. It should therefore be responsible for commissioning the proposed energy end-use survey among households on the outer islands.

5.9 Policy and Planning Division. The division would support the policy development responsibilities of the Executive Secretary through data collection and analysis, carry out project evaluations, monitor energy prices and propose changes, advise the Government and large consumers on petroleum matters, support EPS and RED in power system planning, and take energy conservation initiatives.

5.10 Although EPS and RED would be responsible for planning and operation in the electricity subsector, including the identification and screening of non-conventional alternatives to thermal power generation, the Policy and Planning Division would (i) ensure that expansion is carried out according to a least-cost development program and review expansion proposals before submission to the Minister of Energy, (ii) review the financial position of the utility and its ability to carry out the development program, and (iii) monitor adherence to technical standards. As part of the overall coordination of energy prices, EPS would consult with the Policy and Planning Division prior to tariff changes. The Division would, however, in many cases, have to commission consultancy studies or advice on these matters due to their scope and complexity. With scarce local manpower resources having the necessary qualifications and the relative infrequency of larger energy projects requiring special competence, it would be necessary to hire short-term external expertise.

5.11 In addition to petroleum price monitoring--offering advice to the Price Tribunal--the adequacy of storage and distribution facilities, security stocks, and assistance in relation to public fuel purchases are areas where the Division would be involved. It would support the Executive Secretary in maintaining, on behalf of the Government, a dialogue with the oil companies on the possible need for storage expansion and security stocks, and it would assist in organizing the study recommended in this respect. It is finally recommended that the Division be responsible for establishing a petroleum data base and that its staff be given training to enable it to provide information and advice on petroleum matters in general to other government entities.

5.12 In the area of energy conservation, the Policy and Planning Division should have the overall responsibility for organizing initiatives among energy producers and users. The Division should be assigned the task of initiating campaigns to raise public awareness and, with outside assistance, undertake energy audits, thereby identifying measures and costs and presenting findings to

the beneficiaries for subsequent implementation by the latter. It should evaluate the potential for energy savings in government buildings and vehicles, as well as the efforts by EPS to reduce energy losses and specific fuel consumption.

Staffing of the Ministry of Energy

5.13 In addition to the recently recruited and externally funded Executive Secretary, other key positions that need to be created/filled in the reorganized Ministry of Energy are (see Annex 5.1):

- for the Rural Energy Division:
 - * a division manager responsible to the Executive Secretary for overall power system planning and monitoring for the outer islands and for management of renewable energy programs;
 - * an energy projects supervisor responsible to the manager for overseeing the administration of renewable energy projects and for assisting the manager in administering the contract with EPS for operation and maintenance of the diesel-based power systems on the outer islands; and

- for the Policy and Planning Division:
 - * a division manager responsible to the Executive Secretary for policy development, project evaluation, energy pricing proposals, and energy conservation;
 - * a petroleum officer responsible to the manager for analysis of petroleum issues, development of petroleum policy, contracts and advisory services to large consumers;
 - * a trainee assisting the manager with data collection, and energy conservation initiatives.

A reallocation of present positions to reflect the new organization will be required.

5.14 It will be the responsibility of the Executive Secretary and the respective managers to develop local capability in the respective fields, in particular if overseas experts or volunteers are required to staff some of the positions. One of the main tasks will be to prepare and monitor training programs for the local staff of the Ministry. The Government, in return, will have to commit resources to fund local counterparts and provide suitable candidates for the positions.

Power Subsector

5.15 Given the substantial ongoing investment program in Rarotonga, additional capital needs should not be significant in the next five to ten years. The present program, however, provides only for the partial upgrading of the Rarotonga distribution system, pending more detailed studies by consultants.

These will be completed by mid-1991 and it is understood that the Government will seek extra loan funds, in the order of CKI\$2 million (US\$1.2 million) from the same French sources as for the present program.

5.16 Additional technical assistance is needed as follows:

- assistance to EPS and the Ministry for the preparation of legislation for the corporatization of EPS, and for the reorganization of the utility and the Ministry, including the establishment of a Rural Energy Division. In connection with the commercialization of EPS advice will be needed on aspects of planning, financial management, accounting systems, audit functions, information systems, staffing and training. Procurement of computer equipment and software; and
- assistance to the Ministry of Energy in preparing projects for the rehabilitation of generating and distribution facilities on the outer islands. Subsequently, funding for project implementation will be needed.

Petroleum Subsector

5.17 The major investment requirements will be covered by the private oil companies.

5.18 Priority technical assistance requirements in the subsector are as follows:

- institutional support to the Ministry of Energy to develop capabilities with respect to petroleum pricing issues, negotiations and contracts, monitoring of supply arrangements, and data collection and analyses;
- an evaluation of the price formula for petroleum products, a verification of the costs of the oil companies, and a review of government duty and taxes; improvement of fiscal control;
- an evaluation of present landings, wharves and storage facilities on the outer islands;
- the introduction of engineering standards for storage facilities and quality standards for petroleum products; training of staff in monitoring adherence to standards;
- an assessment of the capacity of existing storage facilities against present and future requirements and the need for strategic reserves; and
- a review of the present contingency plans for dealing with oil spills and accidents; procedures for dealing with waste oil; training of personnel in detection, monitoring and clean-up of spills.

5.19 A request for the above assistance should be made to the Forum Secretariat which will either have the resources to carry out the outlined tasks or be able to contact relevant institutions and donors for support.

Biomass and Renewable Energy

5.20 Technical assistance requirements are:

- energy end-use survey among households on the outer islands, particularly biomass usage patterns; request for assistance could be made to the New Zealand Government; and
- study of the infrastructure requirements, manpower and financial needs, and user contributions related to PV system expansion on the outer islands; SPIRE could be approached for assistance. Such a study and the creation of a Rural Energy Division should precede the implementation of government plans for PV investments on islands in the Northern Group.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Energy Balance for the Cook Islands
(1,000 TOE)

	Fuelwood	Coconut residues	Total Biomass	Electricity	Gasoline	ADO	JetA1	Kerosene	Avgas	LPG	Total Petroleum	Total Energy
Primary Supplies												
Production	1.29	1.01	2.30	-	-	-	-	-	-	-	-	2.30
Imports	-	-	-	-	2.58	5.44	5.21	0.09	0.65	0.35	14.32	14.32
Gross Available	<u>1.29</u>	<u>1.01</u>	<u>2.30</u>		<u>2.58</u>	<u>5.44</u>	<u>5.21</u>	<u>0.09</u>	<u>0.65</u>	<u>0.35</u>	<u>14.32</u>	<u>16.62</u>
Conversions/Losses												
Public Power Generation	-	-	-	3.55	-	(3.55)	-	-	-	-	(3.55)	0.00
Transformation Losses/Station Use	-	-	-	(2.35)	-	-	-	-	-	-	0.00	(2.35)
Trans/Distribution Losses	-	-	-	(0.17)	-	-	-	-	-	-	0.00	(0.17)
Net Supplied	<u>1.29</u>	<u>1.01</u>	<u>2.30</u>	<u>1.03</u>	<u>2.58</u>	<u>1.89</u>	<u>5.21</u>	<u>0.09</u>	<u>0.65</u>	<u>0.35</u>	<u>10.77</u>	<u>14.10</u>
Final Consumption												
Domestic	1.29	1.01	2.30	0.44	-	-	-	0.09	-	0.35	0.44	3.18
Transport	-	-	-	-	2.58	1.89	5.21	-	0.65	-	10.33	10.33
Manufacturing/Commercial/Gvt.	-	-	-	0.59	-	-	-	-	-	-	-	0.59
Total	<u>1.29</u>	<u>1.01</u>	<u>2.30</u>	<u>1.03</u>	<u>2.58</u>	<u>1.89</u>	<u>5.21/a</u>	<u>0.09</u>	<u>0.65</u>	<u>0.35</u>	<u>10.77</u>	<u>14.10</u>

Source: Mission estimates.

^{/a} The large share (37%) of jet fuel heavily influences the total balance and the relative share of other fuels and user categories. From one point of view, jet fuel could be deducted as exports but, to the extent it is mainly related to the transportation of tourists, other visitors and Cook Islanders to and from the country, its place in the balance under final consumption is justified.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Cook Islands Petroleum Market
1984-89 Sales Volumes
(kl)

annual Product	1984	1985	1986	1987	1988	1989	1984-89 average
							% increase
Gasoline	3,073	3,029	2,535	2,568	3,610	3,200	0.8
Jet Fuel	4,277	5,454	5,116	5,628	6,767	5,937	6.8
Kerosene	152	52	78	76	100	100	-8.0
ADO	4,070	3,133	4,036	5,050	5,313	6,107	8.4
Lubes	0	40	46	54	156	121	-
Avgas	518	579	329	714	784	837	10.1
Solvent	8	6	6	10	15	15	13.4
LPG	354	392	430	487	505	591	10.8
<u>Total</u>	<u>12,452</u>	<u>12,658</u>	<u>12,576</u>	<u>14,587</u>	<u>17,250</u>	<u>16,908</u>	<u>6.3</u>

Source: PEDP.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Rarotonga Power System Performance

Year	Maximum Demand (kW)	Energy Generation (GWh)	Energy Losses (GWh) (%)		Energy Sales (GWh)	Energy Sales Growth p.a. (%)	Load Factor (%)
1980/81	-	10.32	-	-	-/a	-	-
1981/82	-	9.59	-	-	-/a	-	-
1982/83	1,710	9.05	1.24	13.7	7.81	-	60.4
1983/84	1,850	8.61	0.60	6.9	8.01	2.6	53.1
1984/85	-/b	10.33	1.51	14.6	8.82	10.1	-
1985/86	-/b	10.91	1.82	16.7	9.09	3.1	-
1986/87	-/b	10.81	0.97	9.0	9.84	8.3	-
1987/88	2,200	11.66	1.54	13.2	10.12	2.8	60.5
1988/89	2,200	12.49	1.73	13.9	10.76	6.3	64.8
1989/90	2,300	13.12	1.74	13.3	11.38	5.8	65.1
Average growth rates, 1980/81 to 1989/90 (%):							
	-	2.7	-	-	-	-	-
1982/83 to 1989/90 (%):							
	4.3	5.5	-	-	5.5	-	-

/a Generation only figures available.

/b Maximum demands not available.

Source: EPS.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Energy Generated
(kWh)

Year	Raratonga	Aitutaki	Atiu	Mauke	Mitiaro	Mangaia	Penrhyn	Manihiki	Palmerston	Rakahanga	Outer Is. Total	Cook Is. Total
1980/81	10,318,060	-	-	-	-	-	-	-	-	-	-	-
1981/82	9,597,660	-	-	-	-	-	-	-	-	-	-	-
1982/83	9,051,625	856,272	32,106	52,298	637	-	5,114	9,313	-	3,659	959,399	10,011,024
1983/84	8,610,110	741,459	101,613	62,775	703	28,743	23,176	24,967	6,903	32,061	1,022,430	9,632,540
1984/85	10,332,420	923,888	104,456	55,997	2,878	62,657	32,197	36,555	9,722	27,553	1,255,903	11,588,323
1985/86	10,909,089	1,020,560	123,564	67,576	4,938	171,644	58,894	41,772	7,045	34,810	1,530,803	12,439,892
1986/87	10,812,290	1,049,988	147,205	76,300	6,947	136,728	57,898	48,040	6,623	10,739	1,540,468	12,352,758
1987/88	11,662,540	1,006,431	181,779	80,500	16,772	130,785	74,207	59,823	-	33,640	1,583,937	13,246,477
1988/89	12,491,840	1,078,608	191,347	99,200	28,682	148,631	77,803	74,614	3,213	20,123	1,722,221	14,214,061
1989/90	13,121,012	1,118,716	193,797	115,600	35,063	208,791	83,486	69,131	17,585	27,889	1,870,058	14,991,070
1990/91	7,719,550	703,692	102,288	76,060	22,077	121,717	23,418	32,950	3,152	13,905	1,099,259	8,818,809

Note: 1990/91 figures up to October 31.

Source: EPS.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Rarotonga Power System Load Projections

Year	Maximum Demand (kW)	Energy Generation (GWh)	Energy Losses (GWh) (%)		Energy Sales (GWh)	Energy Sales Growth p.a. (%)	Load Factor (%)
1990/91	2300	13.08	1.7	13.0	11.38	1.0	65
1991/92	2300	13.06	1.6	12.0	11.49	3.0	65
1992/93	2380	13.53	1.4	10.0	12.18	6.0	65
1993/94	2580	14.69	1.5	10.0	13.22	8.5	65
1994/95	2780	15.82	1.7	11.0	14.08	6.5	65
1995/96	2920	16.61	1.8	11.0	14.78	5.0	65
1996/97	3070	17.47	2.1	12.0	15.37	4.0	65
1997/98	3230	18.38	2.4	13.0	15.99	4.0	65
1998/99	3400	19.34	2.7	14.0	16.63	4.0	65
1999/00	3530	20.10	2.8	14.0	17.29	4.0	65
2000/01	3670	20.91	2.9	14.0	17.98	4.0	65

Source: EPS; Draft Government of New Zealand Report (1991); Mission estimates.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Energy Generation Projections for all Systems

(in kWh)

M

FY	Rarotonga	Aitutaki	Atiu	Mauke	Mitiaro	Mangaia	Penrhyn	Manihiki	Palmerston	Rakahanga	Nassau	Outer Islands Total	EPS Total
1989/90	13,120	1,120	200	-	35	202		78	10	26	-	1,763	14,566
1990/91	13,080	1,214	168	146	48	227	50	101	6	22	1	1,983	15,063
1991/92	13,060	1,316	171	148	48	231	74	107	9	22	1	2,127	15,187
1992/93	13,530	1,468	178	154	50	238	77	114	9	23	2	2,313	15,843
1993/94	14,690	1,519	181	170	57	243	78	113	9	23	4	2,397	17,087
1994/95	15,820	1,539	203	182	55	251	78	113	9	24	5	2,459	18,279
1995/96	16,610	1,540	209	185	53	256	80	116	9	24	7	2,479	19,089
1996/97	17,470	1,579	213	189	52	260	82	122	9	24	8	2,538	20,008
1997/98	18,380	1,680	218	193	57	266	83	131	9	25	10	2,672	21,052
1998/99	19,340	1,771	222	197	57	271	85	138	9	25	12	2,787	22,127
1999/2000	20,100	1,824	240	200	59	277	86	146	9	26	12	2,879	22,979
2000/01	20,910	1,879	258	208	60	283	87	154	10	26	13	2,978	23,888

ENERGY SALES PROJECTIONS FOR ALL SYSTEMS

1989/90	11,380	897	163	115	27	180	65	64	12	23	-	1,546	12,926
1990/91	11,380	953	151	124	33	195	42	74	5	19	1	1,597	12,977
1991/92	11,490	1,033	154	126	33	199	62	78	7	19	1	1,712	13,202
1992/93	12,180	1,152	160	131	34	205	65	83	7	20	2	1,859	14,039
1993/94	13,220	1,215	163	148	40	209	66	88	7	20	3	1,959	15,179
1994/95	14,080	1,277	183	158	41	216	68	93	8	21	4	2,069	16,149
1995/96	14,780	1,309	188	161	42	220	70	99	8	21	6	2,124	16,904
1996/97	15,370	1,342	192	164	43	224	71	104	8	21	7	2,176	17,546
1997/98	15,990	1,428	196	168	47	229	72	111	8	22	9	2,290	18,280
1998/99	16,630	1,505	200	171	47	233	74	117	8	22	10	2,387	19,017
1999/2000	17,290	1,550	216	174	48	238	75	124	8	23	11	2,467	19,757
2000/01	17,980	1,597	233	177	49	243	76	131	9	23	11	2,531	20,511

Source: EPS; Draft Government of New Zealand Report (1991); Mission estimates.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Existing Generating Units in EPS' Systems
(February 1991)

Power Station	Unit No.	Manufacturer	Model	Speed	Year Installed	Nameplate Rating	Available Capacity	No. of Consumers	No. of EPS Staf
<u>SOUTHERN GROUP</u>									
<u>Rarotonga System</u>									
Avatiu Valley	1	English Electric	12SVA	750	1985	1,200	600	2709/472	103
	2	Duvant Crepelle	12V26N	750	1991	2,000	2,000		
	3	Mirlees Blackstone	MB275-8	750	1990	1,600	1,600		
	4	Mirlees Blackstone	ETSL8671	750	1971	600	400		
	5	Mirlees Blackstone	ETSL8669	750	1969	600	400		
	6	Mirlees Blackstone	ETSL8669	750	1969	600	400		
<u>Aitutaki System</u>									
itutaki	1	Lister Blackstone	EV 6	600	1955	150	150	498/69	20
	2	Lister Blackstone	EV 6	600	1956	185	185		
	3	Lister Blackstone	EV 603	600	1956	185	185		
	4	Lister Blackstone	EV 6	600	1955	185	185		
<u>Atiu System</u>									
tiu	1	Lister	HR6	1,500	1979	44	44	245/33	10
	2	Lister	HR6	1,500	1979	54	54		
	3	Lister	JA6	1,500	1985	68	68		
<u>Mauke System</u>									
Mauke	1	Lister	HRW4	1,500	1972	28	28	156/22	10
	2	Lister	JA6	1,500	1988	84	84		
<u>Mitiaro System</u>									
Mitiaro	1	Lister	HR4	1,500	1989	30	30	60/5	5
	2	Lister	HR3	1,500	1988	20	20		
<u>Mangaia System</u>									
Onero	1	Deutz Detroit	SSF6L	1,500	1982	100	100	220/23	11
	2	Deutz Detroit	SSF6L	1,500	1982	100	100		
	3	Deutz Detroit	SSF5L	1,500	1988	40	40		
	4	Deutz Detroit	SSF5L	1,500	1988	40	40		
Ivirua	1	Lister	HR4	1,500	1985	26	26		
Tamarua	1	Lister	HR3	1,500	1988	26	26		

Domestic/Commercial (August 1990 figures).
To be decommissioned when the new unit No. 2 is commissioned.
Commissioning due April 1991. Similar unit to be installed in No.1 position in July 1991.

Power Station	Unit No.	Manufacturer	Model	Speed	Year Installed	Nameplate Rating	Available Capacity	No. of /a Consumers	No. of EPS Staff
<u>NORTHERN GROUP</u>									
<u>Penrhyn System</u>									
Omoka	1	Lister	HR3	1,500	1982	20	20	168/12	7
	2	Lister	HR4	1,500	1990	30	30		
Tetautua	1	Lister	HR3	1,500	1982	20	20		
<u>Manihiki System</u>									
Tauhunu	1	Perkins	T4	1,500	1990	54	54	111/17	8
Tukao	1	Lister	HR3	1,500	1982	20	20		
<u>Palmerston System</u>									
Palmerston	1	Lister	HR3	1,500	1982	20	20	15/4	3
	2	Lister	HR2	1,500	1990	16	16		
	3	Lister	ST1	1,500	N/A	2.8	2.8		
<u>Rakahanga System</u>									
Rakahanga	1	Lister	HR4	1,500	1982	30	30	64/8	4

Source: EPS.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

EPS Generation Development Program, 1991-2000
(in kW)

FY	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
<u>Rarotonga System</u>										
Existing capacity:	3,600	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400
Capacity added:	2x2,000	-	-	-	-	-	-	-	-	-
Capacity retired:	1,200	-	-	-	-	-	-	-	-	-
Available capacity:	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400
Peak load:	2,300	2,380	2,580	2,780	2,920	3,060	3,230	3,400	3,530	3,670
Margin: /a	4,100	4,020	3,820	3,620	3,480	3,340	3,170	3,000	2,870	2,640
Outage allowance: /b	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Firm capacity: /c	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400
Security margin: /d	2,100	2,020	1,820	1,620	1,480	1,340	1,170	1,000	870	730
<u>Aitutaki System</u>										
Existing capacity /e	400	400	400	630	630	630	630	630	630	760
Capacity added /e	-	-	3x150	-	-	-	-	-	1x200	-
Capacity retired	-	-	2x110	-	-	-	-	-	1x 70	-
Available capacity	400	400	630	630	630	630	630	630	760	760
Peak load	320	336	353	370	389	408	429	450	472	496
Margin	80	64	277	277	241	22	201	180	288	264
Outage allowance /f	110	110	150	150	150	150	150	150	200	200
Firm capacity	290	290	480	480	480	480	480	480	560	560
Security margin	-30	-46	127	110	91	72	51	30	88	64

/a Margin between total capacity available and peak load.

/b Capacity of largest unit.

/c Total capacity available minus outage allowance.

/d Margin between firm capacity and peak load.

/e Mission estimates.

/f Capacity (derated) of largest unit.

Source: EPS, Mission

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Petroleum Products: Price Build-Up /a

	<u>Gasoline</u>		<u>Diesel</u>		<u>Kerosene</u>	
	<u>US¢/l</u>	<u>%</u>	<u>US¢/l</u>	<u>%</u>	<u>US¢/l</u>	<u>%</u>
<u>Rarotonga</u>						
FOB	20	33	23	38	24	40
Freight	6	10	7	12	7	12
Transshipment	2	3	2	3	2	3
Distribution and ROI /b	10	17	10	17	11	18
Government Charges	12	20	8	13	4	7
Wholesale Price	49	82	49	82	49	82
Retail Price	60	100	60	100	60	100
<u>Other Southern Group Islands</u>						
Retail Price	84		81		84	
<u>Northern Group Islands</u>						
Retail Price	86		82		85	

/a Lowest-cost supplies, February 1991.

/b Return on investment.

Source: The Price Tribunal.

COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Electricity Tariffs (1970-1990)

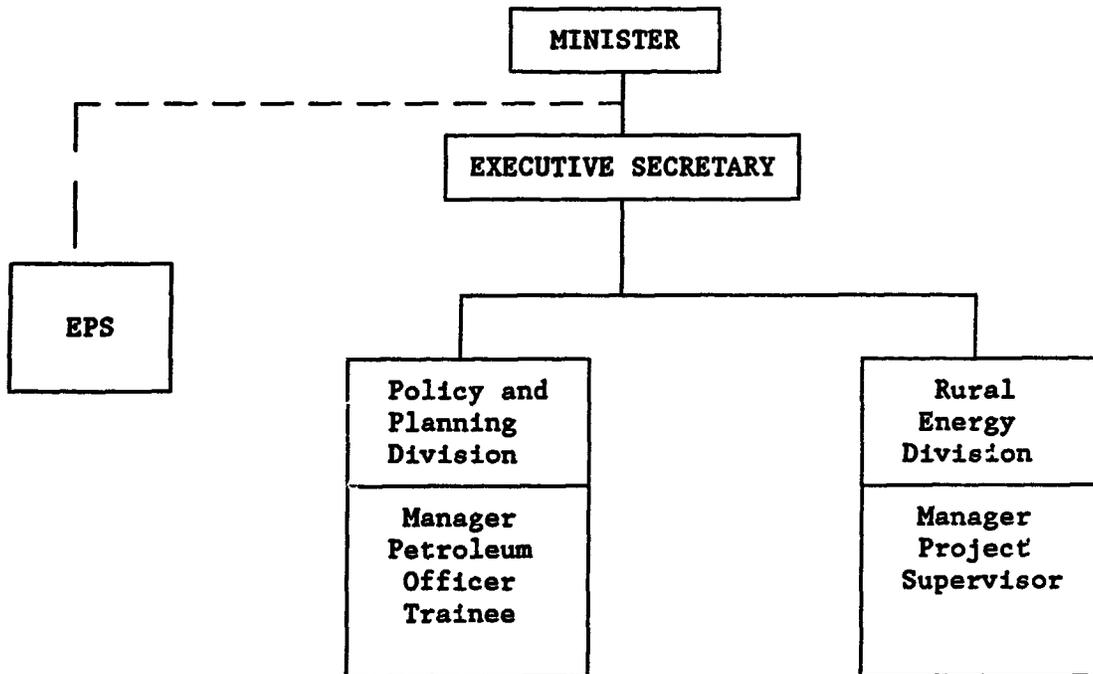
Year		Domestic		Commercial
1970-76	1st 20 kWh Over	@ 10¢ @ 5¢	1st 20 kWh Over	@ 10¢ @ 8¢
1973-75	Hot Water System Plus Elec. Oven	@ 3¢ 10% disc.		
1977-79	1st 20 kWh Over Over	@ 10¢ @ 7¢ @ 9¢	1st 60 kWh Next 240 kWh	@ 12¢ @ 10¢
1980	1st 3 months Remaining months	@ 15¢ @ 16¢	All	@ 27¢ @ 29¢
1981	1st Quarter 2nd Quarter 3rd Quarter	@ 18¢ @ 19¢ @ 20¢	All	@ 33¢ @ 35¢ @ 36¢
1982-83	All	@ 22¢	All	@ 38¢
1984	All	@ 25¢	All	@ 40¢
1985	All	@ 27¢	All	@ 42¢/a
1986-90	1st 120 kWh Over	@ 20¢ @ 25¢	All	@ 39¢

/a 42¢ up to August '86

Source: EPS.

COOK ISLANDS
ISSUES AND OPTIONS IN THE ENERGY SECTOR

Ministry of Energy
Proposed Organization



COOK ISLANDS

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Statistical Appendix

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Table 1: COOK ISLANDS: SELECTED DEVELOPMENT INDICATORS

	1985	1986	1987	1988	1989	1990
GDP (current prices <u>/a</u> (US\$ mil))	25.6	33.1	45.7	n.a.	n.a.	n.a.
Total imports (c.i.f. US\$ mil)	21.5	26.3	33.7	42.4	43.8	49.7 (est)
Total exports (f.o.b. US\$ mil)	3.0	4.8	7.1	4.3	2.8	3.4 (est)
Inflation rate (%)	10.8	9.8	10.8	8.3	4.9	6.3
Exchange rate (CKI\$/US\$)	2.01	1.91	1.69	1.52	1.67	1.68
Land area (km ²)	240					
Wage & salary employment (No.)					4,778	
Average wage/salary (CKI\$/hr skilled)						2.6
Economically active (No.)		6,722				
Position						
Total		17,600				17,900 (est)
Urban		9,826				
Aid						
Annual ODA (US\$ Mil)	9.5	9.8	11.1	10.8	n.a.	n.a.
ODA (% GDP)	37	30	24			
ODA (% Govt. current income)				29		
% Bilateral				n.a.		
ODA/Capita (US\$)				607		

/a Source: Cook Islands Statistical Bulletin (Third Quarter, 1990).

Table 2: COOK ISLANDS: SELECTED PROJECTIONS 1990 - 2000

	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1995/96	1999/2000
Population								
Total		17,605				17,900	18,400	18,900
Urban		9,826				9,960		
Projections @ 0.5% p.a.								
GDP Growth Rate <u>/b/d</u> p.a. (real)	8.8%	8.2%	n.a.	n.a.	n.a.	n.a.	5.0%	4.0%
Agriculture	17.1	4.1	n.a.	n.a.	n.a.	n.a.		
Manufacturing	0.0	18.4	n.a.	n.a.	n.a.	n.a.		
Others	8.0	8.3	n.a.	n.a.	n.a.	n.a.		
GDP/capita (US\$ 1987)	n.a.	n.a.	2,550	n.a.	n.a.	n.a.		
Imports (NZ\$ mil c.i.f.)	n.a.	50.3	57.0	64.5	73.1	83.5		
Petroleum	n.a.	5.0	6.5	7.8	8.6	9.9		
Exports (NZ\$ mil f.o.b.)	n.a.	9.1	12.0	6.6	4.7	5.7		
External assistance (US\$)	9.5	9.8	11.1	10.8	n.a.	n.a.		
Budgetary support (NZ)	54%	56%	52%	49%	n.a.	n.a.		
Exchange rate (avg. NZ\$/US\$) (Report: NZ\$1.65/US\$)	2.00	1.91	1.69	1.52	1.67	1.68		
Inflation rate (c.p.i.)	n.a.	9.8%	10.8%	8.3%	4.9%	6.2%		
Electricity generation <u>/a</u> (GWh)								
Consolidated	12.6	12.3	13.1	14.1	15.0	15.7	19.9	24.1
Urban								
Rural								
Rural electricity consumers								
Consolidated	4,217	4,320	4,512	4,612	4,841			
Urban grid	2,716	2,803	2,955	3,047	3,181			
Rural grid	1,501	1,517	1,557	1,565	1,660			
Isolated	n.a.	n.a.	n.a.	n.a.	n.a.			
Fuel consumption (kL)								
Gasoline			2,568	3,299	3,567	3,549		
Jet A1			5,628	7,652	4,283	6,051		
Kerosene			76	100	56	73		
ADO			5,050	6,310	6,079	5,198		
IDO								
IFO								
Lubes			54	156	115	159		
Avgas			714	784	875	386		
Solvents			10	15	15	10		
LPG			487	505	591	545		
White Benzine				13	16			
Total Inland			14,587	18,834	15,597	15,971		
Bunkers								
Total			14,587	18,834	15,597	15,971		

/a Public/national utility.

/b Estimated 1982-87 annual average GDP growth: 7.3% p.a.

/c Fiscal year ends March 31. From 1991 fiscal year ends June 30.

/d A growth rate of 5.0% and 5.0% p.a. is projected for the economy for the first and second half of the decade, respectively is based growth over last 2-3 years, linked to an increase in tourist arrivals of the same magnitude and that no factors are apparent that would change this trend. Aid and remittance levels are expected to remain at the same level and no large projects are foreseen.

Table 3: ENERGY BALANCE ESTIMATE FOR THE COOK ISLANDS, 1989
(^{'000 TOE})

	Fuelwood	Cocunut residues	Cocunut stemwood	Agricultural residues	Total biomass	Electricity	Gasoline	ADO	Jet A1	Kerosene	White Benzine	Avgas	LPG	Petroleum	Total energy
Primary supplies															
Production	1.01	1.28	-	-	-	-	-	-	-	-	-	-	-	-	2.29
Imports	-	-	-	-	-	-	2.58	5.45	5.21	0.09	0.01	0.65	0.35	14.34	14.34
Bunkering	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gross Available	<u>1.01</u>	<u>1.28</u>	<u>0.00</u>	<u>0.00</u>	<u>2.29</u>	<u>0.00</u>	<u>2.58</u>	<u>5.45</u>	<u>5.21</u>	<u>0.09</u>	<u>0.01</u>	<u>0.65</u>	<u>0.35</u>	<u>14.34</u>	<u>16.63</u>
Conversions															
Public power generation	-	-	-	-	-	3.76	-	(3.76)	-	-	-	-	-	(3.76)	0.00
Transformation Losses/Station use	-	-	-	-	-	(2.49)	-	-	-	-	-	-	-	0.00	(2.49)
Trans/Distribution losses	-	-	-	-	-	(0.18)	-	-	-	-	-	-	-	0.00	(0.18)
Net Supplied	<u>1.01</u>	<u>1.28</u>	<u>0.00</u>	<u>0.00</u>	<u>2.29</u>	<u>1.09</u>	<u>2.58</u>	<u>1.69</u>	<u>5.21</u>	<u>0.09</u>	<u>0.01</u>	<u>0.65</u>	<u>0.35</u>	<u>10.58</u>	<u>13.96</u>
Final Consumption															
Domestic	1.01	1.28	-	-	2.29	0.47	-	-	-	0.09	0.01	-	0.35	0.45	3.21
Transport	-	-	-	-	-	-	2.58	1.69	5.21	-	-	0.65	-	10.13	10.13
Manufacturing/Commercial	-	-	-	-	-	0.62	-	-	-	-	-	-	-	-	0.62
Agroindustries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	<u>1.01</u>	<u>1.28</u>	<u>0.00</u>	<u>0.00</u>	<u>2.29</u>	<u>1.09</u>	<u>2.58</u>	<u>1.69</u>	<u>5.21</u>	<u>0.09</u>	<u>0.01</u>	<u>0.65</u>	<u>0.35</u>	<u>10.58</u>	<u>12.96</u>

Source: Mission Estimates, 1990.

Table 3a: ENERGY BALANCE ESTIMATE FOR THE COOK ISLANDS, 1989
(Original Units)

	Fuelwood	Cocunut residues	Cocunut stemwood (tonnes)	Agricultural residues	Total biomas	Electricity (GWh)	Gasoline	ADO	Jet A1	Kerosene	White Benzine	Avgas	LFB	Total petroleum
Primary supplies														
Production	3,050	3,050	-	-	6,100	-	-	-	-	-	-	-	-	-
Imports	-	-	-	-	-	-	3,200	6,107	5,937	100	16	837	591	16,788
Bunkering														
Gross Available	<u>3,050</u>	<u>3,050</u>	=	=	<u>6,100</u>	=	<u>3,200</u>	<u>6,107</u>	<u>5,937</u>	<u>100</u>	<u>16</u>	<u>837</u>	<u>591</u>	<u>16,788</u>
Conversions														
Public power generation	-	-	-	-	-	14.99	-	(4,663)	-	-	-	-	-	(4,663)
Transformation losses/station use	-	-	-	-	-	(2.09)	-	-	-	-	-	-	-	-
Transmission/distribution losses	-	-	-	-	-									
Net Supplied	<u>3,050</u>	<u>3,050</u>	=	=	<u>6,100</u>	<u>12.93</u>	<u>3,200</u>	<u>1,444</u>	<u>5,937</u>	<u>100</u>	<u>16</u>	<u>837</u>	<u>591</u>	<u>12,125</u>
Final consumptions														
Domestic	3,050	3,050	-	-	6,100	5.56	-	-	-	100	16	-	591	707
Transport	-	-	-	-	-	-	3,200	1,444	5,937	-	-	837	-	11,418
Manufacturing/commercial	-	-	-	-	-	7.37	-	-	-	-	-	-	-	-
Agroindustries														
Others														
Total	<u>3,050</u>	<u>3,050</u>	=	=	<u>6,100</u>	<u>12.93</u>	<u>3,200</u>	<u>1,444</u>	<u>5,937</u>	<u>100</u>	=	<u>837</u>	<u>591</u>	<u>12,125</u>

Source: Mission Estimates, 1990.

Table 4: ENERGY BALANCE ESTIMATE FOR THE COOK ISLANDS, 2000
('000 TOE)

	Fuelwood	Coconut residues	Total biomass	Electricity	Gasoline	ADO	Jet A1	Kerosene	White Benzine	Avgas	LPG	Petroleum	Total energy
Primary supplies													
Production	0.97	1.24	2.21	-	-	-	-	-	-	-	-	-	2.21
Imports	-	-	-	-	3.39	9.81	7.02	0.06	0.02	1.17	0.59	22.06	22.06
Bunkering													
Gross Available	<u>0.97</u>	<u>1.24</u>	<u>2.21</u>	<u>0.00</u>	<u>3.39</u>	<u>9.81</u>	<u>7.02</u>	<u>0.06</u>	<u>0.02</u>	<u>1.17</u>	<u>0.59</u>	<u>22.06</u>	<u>24.27</u>
Conversions													
Public power generation	-	-	-	6.04	-	(6.04)	-	-	-	-	-	(6.04)	0.00
Transformation losses/station use	-	-	-	(4.00)	-	-	-	-	-	-	-	0.00	(4.00)
Transmission/distribution losses	-	-	-	(0.28)	-	-	-	-	-	-	-	0.00	(0.28)
Net Supplied	<u>0.97</u>	<u>1.24</u>	<u>2.21</u>	<u>1.76</u>	<u>3.39</u>	<u>3.77</u>	<u>7.02</u>	<u>0.06</u>	<u>0.02</u>	<u>1.17</u>	<u>0.59</u>	<u>16.02</u>	<u>19.99</u>
Final consumptions													
Domestic	0.97	1.24	2.21	0.76	-	-	-	0.06	0.02	-	0.59	0.67	3.63
Transport	-	-	-	-	3.39	3.77	7.02	-	-	1.17	-	15.36	15.36
Manufacturing/commercial	-	-	-	1.00	-	-	-	-	-	-	-	-	1.00
Agroindustries	-	-	-	-	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	<u>0.97</u>	<u>1.24</u>	<u>2.21</u>	<u>1.76</u>	<u>3.39</u>	<u>3.77</u>	<u>7.02</u>	<u>0.06</u>	<u>0.02</u>	<u>1.17</u>	<u>0.59</u>	<u>16.02</u>	<u>19.99</u>

Source: Mission Estimates, 1990.

Table 4a: ENERGY BALANCE ESTIMATE FOR THE COOK ISLANDS, 2000
(Original Units)

	Fuelwood	Coconut residues	Coconut stemwood	Agricultural residues	Total Biomass	Electricity (GWh)	Gasoline	ADO	Jet A1	Kerosene	White Benzine	Avgas	LPG	Total petroleum
	----- (tonnes) -----						----- (kl) -----							
Primary supplies														
Production	2,950	2,950	0	0	5,900	-	-	-	-	-	-	-	-	-
Imports	-	-	-	-	-	-	4,200	11,000	8,000	80	20	1,500	1,000	25,800
Bunkering														
Gross Available	<u>2,950</u>	<u>2,950</u>	<u>0</u>	<u>0</u>	<u>5,900</u>	=	<u>4,200</u>	<u>11,000</u>	<u>8,000</u>	<u>80</u>	<u>20</u>	<u>1,500</u>	<u>1,000</u>	<u>25,800</u>
Conversions														
Public power generation	-	-	-	-	-	24.14	-	(7,416)	-	-	-	-	-	(7,416)
Transmission losses														
Station/Trans/Dist. Losses	-	-	-	-	-	3.32	-	-	-	-	-	-	-	-
Net Supplied	<u>2,950</u>	<u>2,950</u>	<u>0</u>	<u>0</u>	<u>5,900</u>	<u>20.81</u>	<u>4,200</u>	<u>3,584</u>	<u>8,000</u>	<u>80</u>	<u>20</u>	<u>1,500</u>	<u>1,000</u>	<u>18,384</u>
Final consumption														
Domestic	2,950	2,950	-	-	5,900	8.84	-	-	-	80	20	-	1,000	1,100
Transport	-	-	-	-	-	-	4,200	3,584	8,000	-	-	1,500	-	17,284
Manufacturing/commercial	-	-	-	-	-	11.97	-	-	-	-	-	-	-	-
Agroindustries														
Others														
Total	<u>2,950</u>	<u>2,950</u>	<u>0</u>	<u>0</u>	<u>5,900</u>	<u>20.81</u>	<u>4,200</u>	<u>3,584</u>	<u>8,000</u>	<u>80</u>	<u>20</u>	<u>1,500</u>	<u>1,000</u>	<u>18,384</u>

Source: Mission Estimates, 1990.

Table 5: COOK ISLANDS: PETROLEUM MARKET, 1985 - 1989
(kl/'000 US\$)

Product	1985		1986		1987		1988		1989		1990	
	Volume	Value	Volume	Value								
Gasoline	3,029		2,535		2,568		3,299		3,567		3,103	
Jet Al	5,454		5,116		5,628		7,652		4,283		4,213	
Kerosene	52		78		76		100		56		73	
ADO	3,133		4,036		5,050		6,310		6,079		6,983	
IDO												
IFO												
Lubes	40		46		54		156		115		159	
Avgas	579		329		714		784		865		386	
Solvents	6		6		10		15		15		10	
White Benzine	-		-		-		13		16		-	
LPG	392		430		487		505		591		545	
Total Inland Trade	12,685	3,145	12,576	3,466	14,587	3,840	18,834	5,099	15,587	5,156	15,472	
Bunkers												
ADO												
IDO												
IFO												
Total Bunkers	0		0									
Total Trade	12,685	3,145	12,576	3,466	14,587	3,840	18,834	5,099	15,587	5,156	15,472	

/a Butane.

Table 6: COOK ISLANDS: NATIONAL PUBLIC ELECTRIFICATION SYSTEM

	1985	1986	1987	1988	1989	1990
No. of Consumers						
Urban						
Domestic	-	-	-	-	2,709	
Commercial	-	-	-	-	472	
Rural						
Domestic	-	-	-	-	4,264	
Commercial	-	-	-	-	653	
<u>Total</u>	<u>4,217</u>	<u>4,320</u>	<u>4,512</u>	<u>4,612</u>	<u>4,917</u>	
Installed Diesel Capacity (MW)						
Urban	-	-	-	-	3.00	
Rural	-	-	-	-	1.56	
<u>Total</u>	<u>=</u>	<u>=</u>	<u>=</u>	<u>=</u>	<u>4.56</u>	
Firm Capacity						
Urban						
Rural						
<u>Total</u>					<u>n.a.</u>	
Maximum Demand (MW)						
Urban	-	-	-	-	2.34	
Rural	-	-	-	-	0.82	
<u>Total</u>	<u>=</u>	<u>=</u>	<u>=</u>	<u>=</u>	<u>3.16</u>	
Output (GWh)						
Urban	10.91	10.81	11.66	12.49	13.12	
Rural	1.67	1.45	1.48	1.62	1.87	
<u>Gross Generation</u>	<u>12.58</u>	<u>12.26</u>	<u>13.14</u>	<u>14.11</u>	<u>14.99</u>	
Losses (% generated)						
Urban	20.0	9.9	15.4	16.1	15.5	
Rural	23.7	22.3	14.8	8.9	20.9	
Consumption						
Urban	9.09	9.84	10.11	10.76	11.36	
Rural	1.35	1.19	1.29	1.49	1.55	
<u>Net Sales</u>	<u>10.44</u>	<u>11.03</u>	<u>11.40</u>	<u>12.24</u>	<u>12.90</u>	

Table 7: COOK ISLANDS: ELECTRICITY TARIFF STRUCTURE

Commercial: CKI\$0.45/kWh plus 10% fuel adjustment surcharge

Domestic: CKI\$0.23/kWh for first 120 kWh
CKI\$0.29/kWh for balance plus 10% fuel adjustment surcharge

Table 8: COOK ISLANDS: RURAL ELECTRIFICATION /a (1989)

No. of Rural Grids	9
Consumers supplied by grid	1,660
Rural kWh consumed	
Total generated	1.870 GWh/year
Recorded sales	1.547 GWh/year
kWh per consumer	1.127 kWh/year
% rural consumers metered	
Isolated rural consumers not electrified	
No. of villages	n.a.
No. of consumers	n.a.
Estimated consumption (kWh) /a	
Estimated load (kWh) /a	

/a Basic services only (lighting).

Table 9: COOK ISLANDS: HOUSEHOLD ENERGY PRICES/CONSUMPTION

Community	Average Annual Consumption per Household /a								
	HH Energy (GJ)	Kerosene (lts)	W. Spirit /a (lts)	LPG (kgs)	Gasoline (lts)	Diesel (lts)	Fuelwood (kg _{w.b.})	Electricity (MWh)	Batteries No.
Rarotonga	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Southern group	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Norther group	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Retail prices (USC/unit) /b		75.76	n.a.	173.3	63.64	60.61	n.a.	(Table 8)	n.a.

/a Unleaded gasoline (used in pressure lamps and irons).

/b As at February 17, 1991.

Table 10: COOK ISLANDS: NON-CONVENTIONAL ENERGY RESOURCES AND USE

Systems Installed

Photovoltaics <u>/a</u>		
Number	118	
kW _{peak}	17.7 kW	
Micro-hydro <u>/b</u>		
Number	0	
kW _{peak}	0	
Biomass <u>/c</u>		
Number	0	
kW _{peak}	0	
Solar Thermal Units Applications		
Resources		
OTEC (delT) <u>/d</u>	21-21 °C	
Distance from shore (km)	1-10 km	
Tidal range <u>/e</u>	0.7 m	(Rarotonga)
Solar <u>/f</u>	n.a.	
Monitoring site	n.a.	

/a Systems installed by end December 1990.

/b 100 kW and less.

/c Power gasifiers, steam, heat gasifiers.

/d 0-1,000 m.

/e Indicate location.

/f Outer islands, indicate monitoring site (Average daily kW/m²/day).

Table 11: COOK ISLANDS: BIOMASS RESOURCES

Resource	1985	1990	Projections	
			1995	2000
Forest cover (ha) <u>/a</u>				
Primary		n.a.		
Plantation		n.a.		
Secondary <u>/b</u>		n.a.		
<u>Total</u>				
Agricultural Wastes (tonnes/year) <u>/c</u>		8,900		
Mangroves		n.a.		
Agricultural plantations (ha)				
Coconut <u>/d</u>		772		
Other		n.a.		
<u>Total</u>				

/a Include estimate of % on steep land, inaccessible to harvest.

/b Disturbed forest by logging, shifting agriculture.

/c Coconut wastes from household consumption

/d Single Crop Equivalent Area of total individual holdings.

COOK ISLANDS ENERGY SUPPLY RAROTONGA

