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Kiribati
Issues and Options in the Energy Sector
Annex D

July 31, 1992

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

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CURRENCY EQUIVALENT

Kiribati's official currency is the Australian dollar
A$1.23 = US$1.00

FISCAL YEAR

July 1 to June 30

ACRONYMS

ADB	-	Asian Development Bank
AIDAB	-	Australian International Development Assistance Bureau
EC	-	European Community
EPU	-	Energy Planning Unit (Ministry of Works and Energy)
FSED	-	Forum Secretariat Energy Division
JICA	-	Japan International Cooperation Agency
KMK	-	Karikirakean Mwengaraoin Kiribati
KOIL	-	Kiribati Oil Company
MWE	-	Ministry of Works and Energy
PEDP	-	Pacific Energy Development Programme
PUB	-	Public Utilities Board
RPU	-	Forum Secretariat's Regional Petroleum Unit
SEC	-	Solar Energy Company
SCF	-	Save the Children Foundation
SOPAC	-	South Pacific Applied Geosciences Commission
SPIRE	-	South Pacific Institute for Renewable Energy
TSKL		Telecom Service Kiribati, Ltd. Also known as Telecoms.

ABBREVIATIONS

kgoe	-	kilograms of oil equivalent
LCT	-	local coastal tanker
MR	-	medium range
MT	-	metric ton
OTEC	-	Ocean thermal energy conversion
PV	-	photovoltaic
TOE	-	tons of oil equivalent

This report is based on the findings of an energy assessment mission which visited Kiribati in February 1991. The mission comprised Andres Liebenthal (mission leader - World Bank), Herbert Wade (rural and renewable energy specialist - consultant), Michael Charleson (power engineer - consultant), William Matthews (petroleum specialist - consultant), Douglas Macdonald (power economist - consultant) and Chuck Filiaga (assistant power planner - PEDP).

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KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

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ENERGY CONVERSIONS AND MEASUREMENTS

	Unit	Typical Density kg/litre	Typical Density l/tonne	Gross Energy MJ/kg	Gross Energy MJ/litre	Oil Equiv toe/unit (net)
Biomass Fuels						
Fuelwood (5% mcwb)	tonne			18.0		0.42
Coconut Residues (air dry) [1]						
Shell (15% mcwb)$_{harvested}$	tonne			14.6		0.34
Husk (30% mcwb)$_{harvested}$	tonne			12.0		0.28
Average (air dry$_{husk\ and\ shell}$) [2]	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	0.910	1100	38.4		0.90
LPG (propane)	tonne	0.510	1960	50.0	25.5	1.17
Ethanol	tonne			27.0		0.63
Gasoline (Super)	tonne	0.730	1370	46.5	34.0	1.09
Gasoline (Unleaded)	tonne	0.735	1360	46.5	34.2	1.09
Aviation Gasoline (Avgas)	tonne	0.695	1440	47.5	33.0	1.12
Lighting Kerosene	tonne	0.790	1270	46.4	36.7	1.09
Power Kerosene (Avtur, DPK)	tonne	0.795	1260	46.4	36.9	1.09
Automotive Diesel (ADO)	tonne	0.840	1190	46.0	38.6	1.08
High Sulphur Fuel Oil (IFO)	tonne	0.980	1020	42.9	42.0	1.01
Low Sulphur Fuel Oil (IFO)	tonne	0.900	1110	44.5	40.1	1.04
Electricity (MWh)						
Fuelwood [3]	MWh					0.93

Fuel Conversion Efficiency

Diesel: Text uses actual where known, otherwise:
Average efficiency for small (< 100 kW output) diesel engine 0.46 l/kWh (22%).
Average efficiency of large (>100 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).

Energy Measurements

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 = 3412 Btu = 0.086 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

Notes: (1) Average yield of 2.93 air dry tonnes residues/tonne copra produced (Average NCV 14.0 MJ/kg) mcwb = moisture content wet basis. NCV = net calorific value.
(2) Proportion: kernel 33%, shell 23%, husk 44% by dry weight.
(3) Assumes converson efficiency of 9% (biomass–fuelled boiler).

EXECUTIVE SUMMARY

1. The geographical fragmentation of the Kiribati islands, their remoteness, and their small size are fundamental constraints to Kiribati's development. During the 1980s, output in Kiribati followed a highly erratic pattern, reflecting the vagaries of weather and the vulnerability of the country's export commodities (copra and fish) to price and environmental shocks. Kiribati's per capita GDP is about US$500. Kiribati's trade balance has been negative for a number of years, and the deficit has been covered substantially by official transfers. Energy imports are approximately ten percent of total imports, and about 50% of total exports.

2. The Public Utilities Board (PUB) is responsible for electricity supply and water and sewage services to consumers on the southern islands of the Tarawa Atoll. Aside from Tarawa, there is a public electricity distribution system on Kiritimati, which is controlled by the Ministry of the Line and Phoenix Group. The import of petroleum products is through Mobil and BP. The Kiribati Oil Company (KOIL) operates the depot at the marine receiving terminal at Betio. The Solar Energy Company (SEC), wholly owned by the Government of Kiribati is responsible for rural electrification using photovoltaic systems.

Petroleum Products

3. The main issues that emerge from the assessment of this subsector relate to the need for improved distribution of petroleum products, a change in the price control formula, closer monitoring of petroleum prices, and a possible reduction in LPG prices.

4. In 1990, total inland consumption of petroleum products in Kiribati was approximately 9.9 thousand kl, including about 7.0 thousand kl in Tarawa, 1.4 thousand kl in Kiritimati, and about 1.4 thousand kl in the outer islands. There was an additional 2.3 thousand kl of aviation fuel, estimated for 1990 based on historical levels, for a total Kiribati trade of 12.2 thousand kl. ADO is the major product at 6.2 thousand kl, with the single biggest consumer being PUB, in South Tarawa, with 2.1 thousand kl in 1990. Total ADO consumption for the country grew at an average annual rate of 2.2% over 1986-90.

5. Forecast: The inland Tarawa consumption of petroleum products is projected to grow at 4.5% over 1990-2000, while the Kiritimati consumption is expected to remain unchanged. Motor spirit is projected to grow at an annual average rate of 3.0%, kerosene at 1.0%, and ADO at 5.5%.

6. Improved distribution. KOIL's efforts to improve the efficiency, safety and environmental aspects of the KOIL depot and distribution operation appear to be progressing well. Among KOIL's objectives are (i) reduction in KOIL's staffing from 35 to 21 on Tarawa, (ii) reduction or elimination of drum outlets with unsafe splash filling, (iii) reconstruction and modification of tank trucks to proper petroleum product standards, improving safety and efficiency, and (iv) acquisition of computer software and appropriate staff training for invoicing. It is recommended that the GOK work closely with KOIL to achieve these objectives.

7. Price Control Formula. GOK controls the retail price of motor spirit and kerosene in Kiribati. There are no controls on the ADO price. The GOK's price formula links distribution margins to CIF costs, which has, in the past, provided the petroleum distribution company with unintended windfall profits. To avoid the recurrence of such unintended windfalls, and the attendant cost to the consumers, it is recommended that the bulk of the distribution margin should be expressed as a flat, fixed value, to be adjusted periodically.

8. Price Monitoring. The surveillance of prices in Kiribati appears to be weak. The Ministry of Works and Energy is charged with the responsibility for reviewing the landed cost submissions provided by Mobil, but there is no evidence of any in-depth checks for the reasonability of the various components. It is recommended that the GOK develop an appropriate price monitoring capacity.

9. LPG Price. Approximately 30 tonnes per year of LPG are supplied to Tarawa by Kirigas in 50 kg bottles shipped from Fiji Gas, Suva. Kirigas and KOIL are considering the bulk supply of LPG to Kiribati in small tankers, combined with local bottling. This could significantly reduce the LPG price to consumers. It is recommended that the GOK support these proposals for bulk LPG supply by taxing LPG in the same manner as competing fuels such as kerosene.

10. Buffer Fund. KOIL has expressed the objective of establishing a Price Buffer Fund. Since the successful operation of buffer fund is highly unlikely, it is recommended that this fund not be pursued further.

Electricity Subsector

11. The main issues that emerge from the assessment of this subsector relate to the need for a better use of existing resources, a cautious expansion of capacity, and appropriate tariffs.

12. Sales. PUB's total electricity sales in 1989/90 were 6,502 MWh, which were supplied to a total of 3,021 consumers, of which 2,200 were classified as residential, 234 commercial, and 455 industrial, including Government facilities and offices. Over the last ten years, energy sales have grown at an average annual rate of 7.6%, while peak demand has gone up by only 4.3%, and the number of consumers by merely 3.7%. More than 60% of the consumers are concentrated in the Betio/Bairiki area, and they account for 70% of the total consumption. The two largest consumers are Telecom Service Kiribati, Ltd. (TSKL), also known as Telecoms, and Te Mautari Fishing Co., though Te Mautari has ceased operations, and its future is in considerable doubt.

13. Forecast. It is projected that overall energy sales will grow by 6.1% over 1989/90-1999/2000. It is assumed total system losses will be reduced from 17.4% to 16.4%, and that the system load factor will decline from about 68% to 64%.

14. Old Equipment. A substantial amount of PUB's equipment is so old that it is necessary to confirm its adequacy for satisfactory future service. PUB will require technical assistance for this purpose. Given the lack of spare parts and the limited reliability and age of the equipment, it is recommended

that the 300 kW diesel generating units in service at Betio be retired during the 1990s. Also, in view of the high level of system losses, it is recommended that PUB take necessary actions to reduce them.

15. Expansion Plan. Diesel generation is the only viable source of electricity generation in Tarawa, the main urban center in Kiribati, in the medium-term. The recommended expansion plan includes a 1 MW baseload unit at Betio in 1993, followed by a 700 kW peaking unit at Bikenibeu in 1995, the retirement of one 300 kW unit in 1994/95 and the other 300 kW unit in 1996/97. The total cost of the expansion plan to 2000 will be about US$1.8 million (1991 prices).

16. Rural Electrification. The extension of PUB's grid beyond Nabeina appears to be unviable. Hence, it is recommended that PUB focus on South Tarawa, leaving the SEC to service the lower density, largely residential loads in North Tarawa.

17. Institutional Capabilities. In spite of past efforts, PUB lacks adequately trained and experienced managers in the technical, administrative, and financial areas. Much more effort is required if Kiribati nationals are to effectively manage this important organization. It is recommended that PUB prepare long-term training plans with clear objectives, and ensure that those who receive training of any kind continue to work at PUB after the training is completed. In the short-term, PUB should continue to seek advisors to provide the assistance necessary to effectively manage the operations. Advisors in technical roles, and in accounting and administration should be sought.

Electricity Tariffs

18. Tariff Levels. In December, 1990, PUB's tariffs were increased; PUB's weighted average price is now almost A 37¢/kWh (approximately US 30¢/kWh). It appears that PUB's prices have approached the consumers' willingness to pay for electricity, and there is little room for further real tariff increases.

19. Agreement with TSKL. In October, 1990, GOK stipulated that TSKL's cost of electricity would fall to A$0.22/kWh by August, 1991, and by February, 1992, TSKL would pay the average tariff for the Pacific region, which, by the GOK's estimate, was A$0.18/kWh in October, 1990. If these favorable rates do not actually materialize, then TSKL would be permitted to generate its own electricity. Since TSKL is PUB's largest customer, the sale of electricity at greatly reduced rates will have an extremely detrimental effect upon PUB's financial position. Similarly, if TSKL decides to generate its own electric power, PUB will have to bear the fixed cost of power facilities in excess of its needs, without any revenue from TSKL. It is recommended that this issue be resolved in a manner that the viability of PUB's overall operations is not undermined.

20. Cross-subsidies. At present, revenue from electricity sales is used to subsidize PUB's water and sewage services. In view of the practical ceiling on power tariff increases, such cross-subsidization between services makes it difficult for PUB to meet its overall financial commitments, the covenants with international lending institutions, and the continued operation of the electric power system in a safe and effective manner. Rather than burdening the power

supply with such cross-subsidies, it is recommended that the GOK provide an explicit budgetary subsidy to PUB for its socially important water and sewerage services, and allow power to be priced at a level that is close to its economic cost of supply.

PUB's Financial Performance

21. PUB's overall financial performance has deteriorated in recent years. For electricity, PUB's Rate of Return (ROR) on net (revalued) fixed assets is only 3%, while an 8% ROR is required to meet PUB's existing loan covenants. Further, PUB may not be able to sustain even a 3% ROR. In the medium-run, it is likely that, in the absence of further tariff increases or significant cost reductions, PUB's financial position will become critical.

22. PUB's costs are high relative to other Pacific region utilities. One indication of the high costs is that PUB has one of the lowest values in the region of annual sales per employee. However, a detailed analysis of PUB's operating costs and profitability is difficult since the most recent audited accounts available are those for 1986/87. Hence, it is recommended that PUB improve its financial reporting procedures.

23. PUB has recently sought assistance from ADB to review its non-technical operations. To obtain full benefits from such a review, it is recommended that this review include PUB's financial accounting procedures, water and electricity tariff policies, and the present arrangements for subsidizing PUB's water and sewerage operations.

Renewable Sources of Energy

24. The main issues that emerge from the assessment of this subsector relate to the need for an expanded use of solar energy for household lighting and water heating, no change in the status of biomass and other renewable energy sources, and further training of field staff and administrative personnel.

25. Solar electrification of rural homes began in 1984 with the formation of the SEC. However, the photovoltaic (PV) systems were poorly installed and poorly maintained, and most of the systems have since failed. By 1989, sales of the PV units fell to a level that was too low to sustain the company. In 1990, the management was changed. Funds from JICA and the EC are expected to allow the placement of 150 home lighting units during 1992 and 1993. These installations will remain the property of SEC, which will now function as a rural PV utility company. Provided that the pilot projects prove satisfactory, donor assistance will be sought to continue funding the expansion of village electrification using photovoltaics at a rate of 300 to 500 units per year, until the market of about 5,000 units has been saturated.

26. The GOK's stated policy of not subsidizing rural electrification has been appropriate to encourage the transformation of the SEC into a financially autonomous, commercially managed PV utility. At present, the SEC's main source of revenue is from installation and maintenance contracts, mostly government or church based, though by the end of 1993, sufficient rural household installations should be in place to firmly establish the company as a rural electric utility.

27. Recycling lead. For solar PV applications, a system of reclaiming lead from spent lead acid batteries should be put into place to prevent possible environmental damage.

28. Solar water heating has been installed on the government hotel and a number of homes. Given the excellent record of solar water heaters in the Pacific and Kiribati's good solar environment, it is recommended that solar waters heaters be the first choice for water heating for all new construction.

Biomass

29. Kiribati's main biomass resource for energy use consists of the products of the coconut tree. South Tarawa's densely populated areas have insufficient biomass for household energy use but most of the households use kerosene for cooking, and a small number use LPG. The poorer families do not appear to have difficulty in obtaining fuel. Elsewhere in Kiribati, there is no foreseeable shortage of biomass fuel for household use.

30. The present rate of copra production does not provide sufficient husk and shell waste for commercial use. While senile coconut trees are potentially a commercial sources of energy, there are two problems associated with exploiting this source of energy. First, the operation of such a program is complex; for example, it requires a decades long program for plantation rehabilitation, with the schedule set by fuel needs, and not tree replacement needs. Second, atolls have a fragile ecosystem, which could be adversely affected by this program. Hence, it is recommended that no efforts be made to use senile coconut trees as an energy source.

Other Energy Resources

31. While OTEC and wave energy are potential sources of energy in Kiribati, is recommended that they not be considered for development until commercial systems have been in operation elsewhere for sufficient time to judge their economics and their effects on the environment. The combination of a poor wind regime and the difficulty of maintaining rotating mechanical and electrical equipment in Kiribati precludes the use of wind power for purposes other than non-critical water pumping.

Training

32. The SEC is capable of training PV field technicians with minimal external assistance. It is recommended that senior SEC staff be given further training in PV technology, both in the form of overseas courses, similar to those organized by PEDP/SPIRE, and local training provided on a periodic basis.

33. It is recommended that the Energy Division train its staff for monitoring and surveillance of petroleum prices. Further, it is recommended that the Tarawa Technical Institute be encouraged to re-establish its electrician training program, and to assist the Energy Division and the SEC in providing training to rural users and low-level technicians engaged in the maintenance of small diesel generators and PV systems.

I. THE ECONOMIC AND INSTITUTIONAL CONTEXT

Energy and the Economy

1.1 Kiribati consists of 33 islands located in the mid-Pacific, astride both the equator and the international date line, with three main groups--the Gilbert, Phoenix and Line Islands. The total land area amounts to only 725 km^2. The geographical fragmentation of the islands, their remoteness, and their small size represent fundamental constraints to Kiribati's development.

1.2 During the 1980s, output in Kiribati followed a highly erratic pattern, reflecting the vagaries of weather and the vulnerability of the country's export commodities (copra and fish) to price and environmental shocks. Kiribati's per capita GDP is about US$500. Stabilizing influences have been exerted over the years by a steady inflow of aid, budget grants and workers' remittances, together with revenues generated by the Revenue Equalization Reserve Fund.1/

1.3 Kiribati's trade balance has been negative for a number of years, and the deficit has been covered substantially by official transfers. Energy imports are approximately ten percent of total imports, and about 50% of total exports.

Institutional Framework

1.4 The Energy Planning Unit (EPU) is a division of the Ministry of Works and Energy (MWE). Its primary goal is a reduction in the magnitude of Kiribati's dependence on imported oil. For this purpose, it has programs in renewable energy. EPU also has oversight responsibility over the Kiribati Oil Company (KOIL), the Public Utilities Board (PUB), and the Solar Energy Company (SEC). The staff of EPU consists of two local and one expatriate officer (the solar energy technician); one additional position has been authorized, but remains vacant.

1.5 PUB generates and supplies electric power, water and sewage disposal services to consumers on the southern islands of the Tarawa Atoll. Its electrical service covers the main island of Betio, which is the most densely populated, and extends 3[illegible] km eastward to Tanaea. The population of South Tarawa is estimated to be about 23,000. PUB also has the authority to issue and control licenses for private electricity generation on South Tarawa.

1.6 Aside from Tarawa, the only other location where there is a public distribution system is Kiritimati Island in the remote Line Islands of Kiribati. On Kiritimati Island, power is provided from isolated diesel units at four locations; the amount of power distributed and the extent of the distribution systems is understood to be extremely limited. Power supply on Kiritimati comes under the responsibility of the Ministry of the Line and Phoenix Group.

1/ The RERF is managed in London, and it invests mainly in government bonds and cash in a variety of major world currencies.

1.7 The import of petroleum products is in the hands of Mobil and BP. The Kiribati Oil Company (KOIL) operates the Mobil-owned depot at the marine receiving terminal at Betio.

1.8 The Solar Energy Company (SEC), wholly owned by the Government of Kiribati, has the responsibility for rural electrification using photovoltaic systems.

II. ENERGY CONSUMPTION

Petroleum Products

2.1 In 1990, total inland consumption of petroleum products in Kiribati was approximately 9.9 thousand kl, including about 7.0 thousand kl for Tarawa, 1.4 thousand kl for Kiritimati, and about 1.4 thousand kl for the outer islands. Table 2.1 provides an estimated sectoral breakdown for 1990 inland petroleum consumption. There was an additional 2.3 kl of aviation fuel, estimated for 1990 based on historical levels, for a total Kiribati trade of 12.2 thousand kl. There was no reliable breakdown between Tarawa and Kiritimati aviation fuel consumption available for 1990.

Table 2.1: KIRIBATI CONSUMPTION OF PETROLEUM PRODUCTS - 1990

	Domestic	Transport	Power Generation Private	Power Generation Public	Non Energy	Total
	kl					
Inland (Tarawa and Kiritimati)						
Gasoline		2,358				2,358
Kerosene	1,168					1,168
ADO /a		3,310	827	2,090		6,227
Lubes					170	170
Total	1,168	5,668	827	2,090	170	9,923
Aviation (No bunkers)						
Avgas	n.a.	600	n.a.	n.a.	n.a.	600
Jet A1	n.a.	1,700	n.a.	n.a.	n.a.	1,700
Total	n.a.	2,300	n.a.	n.a.	n.a.	2,300

/a ADO used in public power generation is an actual figure, while ADO used in private power is a mission estimate.

Source: Mission estimates, based on discussions with KOIL.

2.2 ADO is the major product at 6.2 thousand kl, with the single biggest consumer being PUB, in South Tarawa, with 2.1 thousand kl in 1990. ADO is the only product which has major multi-sectoral use. Total ADO consumption for the country grew at an average annual rate of 2.2% over 1986-90. The data indicate high growth rates of 7.3% per annum for motor spirit, and 16.7% per annum for kerosene over 1986-90, but these growth rates need to be treated with caution. In particular, the data for kerosene could be in error because of classification

problems with Jet A1. Motor spirit consumption growth would have to be further analyzed with respect to such factors as "lumpy" effects of development projects and possible surge in use of small power generating sets.

2.3 Table 2.2 is a forecast summary of Kiribati consumption to the year 2000. Motor spirit has been projected to increase at an annual average rate of 3.0%, kerosene at 1.0%, and ADO "to others" at 4.0%. The forecast of ADO used by PUB is based on the projected demand for electricity. The aviation fuels have been held at their estimated 1990 consumption since no reliable forecasting basis is available in small Pacific Island countries such as Kiribati.

Table 2.2: KIRIBATI PETROLEUM PRODUCTS CONSUMPTION FORECAST

	Forecast Annual Growth Rate 1990-2000	1990	1995	2000
		---------- kl ----------		
INLAND (Tarawa)				
Gasoline	3.0%	2,058	2,386	2,766
Kerosene	1.0%	1,018	1,081	1,125
ADO	5.5%	5,327	7,048	9,112
Total	4.5%	8,403	10,504	13,002
INLAND (Kiritimati)				
Gasoline	0.0%	300	300	300
Kerosene	0.0%	150	150	150
ADO	0.0%	900	900	900
Total	0.0%	1,350	1,350	1,350
INLAND (Tarawa & Kiritimati)				
Gasoline		2,358	2,686	3,066
Kerosene		1,168	1,220	1,275
ADO		6,227	7,948	10,012
Lubes	4.0%	170	207	252
TOTAL INLAND		9,923	12,061	14,603
AVIATION (No Bunkers)				
Avgas	0.0%	600	600	600
Jet A1	0.0%	1,700	1,700	1,700
TOTAL AVIATION		2,300	2,300	2,300
TOTAL KIRIBATI TRADE		12,223	14,361	16,903

Source: Mission Estimates; Annex 1.

Electricity

2.4 PUB's total electricity sales in 1989/90 were 6,502 MWh, which were supplied to 3,021 consumers, of which 2,200 were classified as residential, 234

commercial, and 455 industrial, including Government facilities and offices.2/ Residential consumers used an average of about 65 kWh a month, while industrial consumers had an average use of about 470 kWh/month. In December 1990, the tariff was raised from A$0.29/kWh to A$0.32/kWh for residential consumers, and from A$0.33/kWh to A$0.39/kWh for commercial and industrial consumers.

2.5 Over the last ten years, energy sales have increased at an average annual rate cf 7.6%, while peak demand has increased by only 4.3%, and the number of consumers by merely 3.7% (Table 2.3).

Table 2.3: SUMMARY OF POWER SALES HISTORY (1981-90)

Year	Energy Sales (MWh)	Peak Demand (kW)	Number of Consumers
1980/81	3,366	910	2,179
1981/82	4,214	870	2,199
1982/83	4,103	950	2,218
1983/84	4,333	930	2,226
1984/85	4,554	1,080	2,405
1985/86	5,056	1,020	2,448
1986/87	5,342	1,200	2,483
1987/88	na	1,100	2,503
1988/89	5,965	1,210	2,521
1989/90	6,502	1,324	3,021
Average annual growth rate (%) 1980/81-1989/90	7.6	4.3	3.7

Source: PUB.

2.6 The percentage of consumers in each of the three classes has remained fairly stable since 1984/85, as has the share of consumption (Table 2.4). Historically, the industrial/Government class has accounted for about 63% of total sales, while commercial and residential consumers together accounted for about 37%.

2/ There are differing values available regarding the number of consumers. This confusion reflects PUB's deficiencies in institutional capabilities.

Table 2.4: CONSUMERS AND SALES BY CLASS, PERCENTAGE SHARES

Year	Residential		Commercial		Indust./Govt.	
	Consumers %	Sales %	Consumers %	Sales %	Consumers %	Sales %
1984/85	75	27	10	10	15	63
1987/88	80	25	10	12	10	63
1989/90	80	25	10	11	10	64

Source: PUB.

2.7 More than 60% of consumers are concentrated in the Betio/Bairiki area, and they account for 70%, or more, of total consumption.

2.8 The two largest consumers were Telecom Service Kiribati, Ltd. (TSKL), also known as Telecoms, and Te Mautari Fishing Co. The TSKL consumption is fairly stable at about 54 MWh/month (which is approximately 10% of total sales), while the Te Mautari consumption varied widely from month to month. While the Te Mautari consumption averaged 31 MWh/month (which is approximately 6% of total sales in 1990), Te Mautari ceased to operate in late 1990.

2.9 In October, 1990, TSKL signed an agreement with GOK, under which TSKL received written assurances from the Government that TSKL's cost of electricity would fall to A$0.22/kWh by August, 1991. Further, by February, 1992, TSKL would pay the average tariff for the Pacific region, which, by the GOK's estimate, was A$0.18/kWh in October, 1990. If these favorable rates do not actually materialize, then TSKL would be permitted to generate its own electricity. At present, TSKL has a 160 kW diesel generator to provide emergency power for essential services.

2.10 This arrangement raises a number of issues that need to be resolved promptly and judiciously. Firstly, while the Government can always take action that it considers appropriate, such action should not be detrimental to and undermine the institutions that the Government has established for specific purposes. In the case of agreements relating to electricity tariffs and private generation it would be more appropriate for any special arrangements to be made by PUB or at least in consultation with PUB.

2.11 Secondly, TSKL is by far the largest electric power consumer in Kiribati and the sale of electricity by PUB at greatly reduced rates to TSKL will have an extremely detrimental effect upon PUB's financial position, and its ability to subsidize the water and sewage services. Similarly, if TSKL decides to generate its own electric power, PUB will have to bear the fixed cost of power facilities in excess of their needs and with no revenue from TSKL.

2.12 Thirdly, the rates for electricity proposed by TSKL and apparently accepted by the Government, are understood to be the average electricity tariffs in the Pacific. However, the tariffs in the various countries of the Pacific

vary widely for many different reasons. The tariff levels in Kiribati must reflect the costs and situation in the country, not elsewhere.

2.13 It is recommended that this issue be resolved so that the viability of PUB's overall operations and its ability to meet its responsibilities under the Public Utilities Ordinance is not undermined.

2.14 The PUB system suffers from high system losses. In 1989/90, the total losses were 17.4% of gross generation, comprising station use of 1.1% and technical and non-technical distribution system losses of 16.3%. Distribution losses increased from 1981/82 to 1985/86, and have decreased a little since that time (Table 2.5). The expansion of the 11 kV distribution system, which now extends 35 km from the Betio Power Station, has also led to higher technical losses. Non-technical losses 3/ are also a problem for PUB, and a program has been started recently aimed at reducing the level of non-technical losses. It is recommended that PUB pursue this program consistently and with determination. The station use fell in 1987/88, when the new 1 MW diesel generator was commissioned, and the station use is not expected to exceed 1.0-1.5% in the future.

2.15 The system power factor appears to be satisfactory, averaging about 0.9, based upon spot readings that are recorded in the station log. Since low power factor is a source of losses, it is encouraging that poor power factor is not a problem on the PUB system.

Table 2.5: PUB SYSTEM LOSSES

	1981/82	1985/86	1989/90
	%		
Distribution system	12.9	18.5	16.3
Station use	3.8	2.1	1.1
Total	16.7	20.6	17.4

Source: PUB.

Load Forecast

2.16 The most recent load forecast for the PUB system was prepared in October, 1989 as part of a study, financed by the Asian Development Bank (ADB), entitled "Future Power System Expansion." Although this study developed forecasts for the entire PUB system, the primary focus was on the expansion of the 11 kV system into the less populated areas north of the existing system

3/ Non-technical losses are the result of a utility's inability to collect payments due for the services it provides.

termination, and accordingly much of the work entailed load forecasts for these new areas. In this study, for the existing consumers, the load forecast was based on past growth trends, and it was assumed that growth would take place at 7% a year prior to 1991/92, and at 6% after that. This forecast for the existing consumers was added to the projected consumption of new consumers to obtain an overall average annual growth rate of 7.5% to the year 2000.

2.17 This projected growth rate of 7.5% must be evaluated in the context of the Kiribati economy. In Kiribati, the principle sources of cash income are fish, copra and handicrafts, and from remittances of Kiribati workers overseas. The economy is heavily dependent upon external assistance for budgetary support and development. Given this background, the economy cannot sustain a continued growth in electricity demand at the historical rate of 7.5% a year indefinitely. Further, the aim of Government policy includes the restraining of public and private consumption, reducing population growth, curbing migration to South Tarawa, and promoting outer islands development. In this respect, it is noteworthy that Government departments and agencies, together with a few small industries, account for more than 60% of electricity consumption (Table 2.4). It is unlikely that the Government agencies will expand their electricity consumption at the projected 7.5% rate.

2.18 Recent developments may also make it difficult for the projected 7.5% growth rate to materialize. The closure of Te Mautari has significantly reduced the consumption of PUB's second largest consumer. Accordingly, it is projected that the growth in consumption by existing service areas after 1992 will be at 5% a year to 2000.

2.19 In part, this growth will be driven by a number of development projects, including a new hospital, completed in March 1991, the extensions to the airport and its facilities, including runway lighting, and a new prison. It is assumed that PUB will continue to provide power to TSKL, its largest consumer, at a mutually-acceptable tariff. It appears likely that Government electricity consumption will continue to form a considerable part of total usage. Other projects on the horizon include a new hotel, ice cream manufacturing and other light industrial projects in the private sector, but these appear to be some time away. Hence, they can be left out of the demand forecast until more solid evidence of their existence is provided to the PUB.

2.20 The data developed in the "Future Power System Expansion" study has been used to project the consumption of the new service areas. The reinforcement of the South Tarawa system has been accomplished earlier than anticipated, and some 300 new consumers in the Betio/Bairiki areas were connected during the last six months of 1990. However, the extension of the 11 kV system to Nabeina will be at least two years behind the original schedule, which will postpone the connection of new consumers. It is also to be noted that the load forecasts for this new service area assumes significant population relocation from South Tarawa, based upon the expectation that the Government would make significant investments in infrastructure and housing to encourage the relocation. No meaningful action appears to have been taken by Government, and no funds have so far been allocated. Notwithstanding, the projections have assumed the same additional consumers in the load forecast, although postponed for 2 years because of the delay in the system extension.

2.21 A summary of the overall sales growth projections is shown in Table 2.6, and provided in detail in Annex 4. The average annual growth in overall energy sal for 1989/90-1999/2000 is forecast to be 6.1%. This growth rate includes consumption for approximately 1,000 new residential consumers, 44 commercial, and 40 industrial/Government consumers, who are expected to be connected during the period of the projections.

2.22 Generation and peak demand projections have been made assuming that total losses will be 16.4% (15% for distribution system losses and 1.4% for station use) during the period to 2000. PUB should be able to reduce its losses to this level, from the present 17.4% level, if the loss reduction program, particularly for non-technical losses, is actively pursued. The system load factor is likely to decline over the period to 2000 because of the additional residential loading with its strong evening peak character without a proportionate increase in commercial and industrial load, which tends to have a greater daytime load. The load factor in 1989/90 was 67.9%; the load projections assume that this will decline to 65% in 1990/91 and very gradually thereafter reaching 64% in 1995/96 and remaining constant until 2000.

Table 2.6: SUMMARY OF PROJECTIONS OF SALES, GENERATION AND PEAK DEMAND

		1989/90 (Actual)	1991/92	1995/96	1999/2000	Av. Annual growth (%)
Sales	(MWh)	6,502	7,307	9,351	11,726	6.1
Generation	(MWh)	7,872	8,740	11,185	14,026	5.9
Peak Demand	(kW)	1,324	1,547	1,995	2,502	6.6

Source: Mission estimates.

Solar Energy

2.23 The use of solar energy for electricity production is increasing rapidly on the outer islands of Kiribati. Since 1984, nearly 200 solar lighting systems have been sold, but they have not been properly maintained, and most of them are inoperative. The Solar Energy Company (SEC) has been given the responsibility for rural electrification using photovoltaic systems. Funds from Japan International Cooperation Agency (JICA) and the EC are expected to allow the placement of 150 home lighting units during 1992 and 1993. These installations will remain the property of the SEC, which will function as a rural photovoltaic utility company. Provided that the pilot projects prove satisfactory, donor assistance will be sought to capitalize rural electrification using photovoltaics at a rate of 300 to 500 units per year, until the market of about 5,000 units has been saturated.

Biomass and Household Cooking

2.24 On Tarawa, kerosene has increasingly replaced wood fuel for cooking in many households. This trend is expected to continue with LPG also becoming an increasingly important cooking fuel. Since the change to kerosene and LPG is occurring at a more rapid rate than population increases on Tarawa, the pressures on the biomass supply on Tarawa are expected to decrease rather than increase, and there are unlikely to be problems with sustainability of this resource. On the outer islands, the average biomass fuel used for cooking in each household is likely to remain close to five tonnes per year, as found by two joint PEDP/MWE surveys in late 1985. The primary pressure on the biomass resource will be population increase rather than change in use patterns. However, it is expected that until well beyond 2000, the available resource will be sufficient to meet these needs on all the outer islands, without any need to undertake specific measures to increase wood use efficiency or to increase the supply. Since the fuel supply is abundant and readily available, no organized fuelwood markets exist in Kiribati.

2.25 During 1985-90, the Save the Children Foundation (SCF) conducted a project for the improvement of household cooking facilities, which included a concrete stove to replace the traditional open fire, and the construction of a metal roofed kitchen shelter which also serves as a rainwater collection surface. While SCF no longer serves Kiribati, a local organization, the Karikirakean Mwengaraoin Kiribati (KMK), has taken over this project. This project is intended primarily for convenience and comfort in cooking, and not for improved fuel efficiency.

III. ENERGY SUPPLY

Petroleum Products

3.1 The bulk supply and procurement of inland fuels for South Tarawa, and both inland and aviation fuels for Kiritimati, is provided by Mobil, Australia, out of their SW Pacific office in Suva, Fiji. Aviation fuels for South Tarawa are provided by BP SW Pacific, out of Suva, Fiji. The Mobil Supply Agreement, valid till October 1991 and "evergreen" thereafter based on three months mutual notice. Although the Agreement is based nominally on supply from Singapore, approximately 75% of the actual supply has been from Australia and New Zealand, and all of it passes through Mobil's Vuda terminal in Fiji. The local coastal tanker (LCT) has usually been the "Pacific Rover" about 1,600 DWT, which typically follows the three-port discharge circuits such as:

(a) Vuda (load) - Tarawa - Funafuti - Wallis
(b) Vuda (load) - Funafuti - Tarawa - Santo.

3.2 Parcels of about 700 to 800 tonnes are discharged at the Mobil depot in Betio every four to six weeks. Only three products are received in bulk - motor spirit, kerosene, and ADO. The terminal is situated near the jetty which has a draft of about five meters. The depot is owned by Mobil, but operated and maintained by the Kiribati Oil Company (KOIL). KOIL is 100% owned by GOK and is charged with the depot operations, as well as wholesale distribution of the three fuel products to consumers in Kiribati. It also re-sells Mobil lubricants supplied in packaged form. The Mobil depot has a capability of 1.7 thousand kl.

3.3 BP owns and operates a bulk receiving depot in Betio, near the dock adjacent to Mobil. Aviation fuels are received here and trans-shipped by road to the small aviation depot at Bonriki airport. The Betio terminal has a capacity of 810 kl, and Bonriki 77 kl, which together is sufficient for about half a year's consumption. The total storage for Tarawa with breakdown by product is summarized in Table 3.1.

Table 3.1: SOUTH TARAWA PETROLEUM PRODUCT STORAGE CAPACITY

	Mobil Betio	BP Betio	BP Airport	Total
	kl			
Avgas	-	270	26	296
Motor Spirit	405	-	-	405
Kerosene	155	-	-	155
Jet A1	-	540	51	591
ADO	1,097	-	-	1,097
Total	1,657	810	77	2,544

Source: KOIL.

3.4 Mobil owns all the depot facilities--tanks, lines, pumps, buildings, drum filling and truck loading rack. KOIL owns the four-inch transfer line from the jetty to the two storage depots and has a sharing arrangement with BP. There is a two-inch transfer line for ADO from the Mobil depot to the nearby PUB powerhouse, owned by Mobil. KOIL owns two tank trucks, which have capacities of 4 and 10 kl, as well as a garage/workshop. KOIL also owns a stock of 200 liter drums.

3.5 There are four formal retail pump outlets on Tarawa, run by private dealers. In addition, there are some 200 drum outlets where the fuels are dispensed to clients through splash-filling. These drum outlets, licensed by the MWE, are supposed to be inspected for safety, weights and measures, etc., but control is not exercised. Three additional pump outlets are proposed by KOIL with accompanied tightening of the policing of drum outlets.

3.6 The present staffing of KOIL is 54, with 23 at the depot, 12 in the administration office, and 19 on Kiritimati Island. This excludes a Mobil-assigned manager whose responsibility it is to develop work plans for, and begin implementation of, a program to improve the efficiency, safety and environmental aspects of staffing, procedures and infrastructure of the KOIL depot and distribution operation to bring it to acceptable international oil company standards. This program appears to be progressing well, with a coherent work plan prepared and significant improvements already made in accordance with the established objectives under the plan (5-year Work Plan 1990-95).

3.7 Among the KOIL work plan objectives are:

(a) reduction in total staffing of KOIL on Tarawa from 35 to 21;

(b) reduction or preferably elimination of drum outlets with unsafe splash filling through the construction of two more proper pump outlets for motor spirit and ADO dispensing, and acquisition of several 680 liter steel tanks for kerosene dispensing in shops;

(c) reconstruction and modification of tank trucks to improve safety and efficiency;

(d) acquisition of computer software and appropriate staff training to enable the reconciliation of depot liftings and associated invoicing by Mobil with the invoice to KOIL's customers. This could be done with simple spreadsheets, using standard software.

3.8 It is recommended that the GOK work closely with KOIL to ensure that these objectives are achieved. The need for co-operation is essential in areas such as downsizing of staff and upgrading of drum outlets.

LPG

3.9 Approximately 30 tonnes per year of LPG is presently supplied to Tarawa by a private company, Kirigas, in 50 kg bottles shipped from Fiji Gas, Suva. A small portion of this supply is redistributed directly in these bottles to larger consumers such as hotels and restaurants, but the greater portion is decanted into 13 kg cylinders for redistribution to approximately 350 smaller household consumers. The only use of LPG is cooking. The freight and handling costs for this bottled supply, combined with Kiribati customs duties, results in a high price in Tarawa and the market is unlikely to expand greatly to replace electricity and kerosene at the present price relationships.

3.10 Both Kirigas and KOIL (not presently in the LPG business) are considering the bulk supply of LPG to Kiribati in small tankers into pressurized bulk storage here, with local bottling. This has the potential to significantly reduce the price of this product to consumers in Tarawa, enhancing the commercial and household energy situation. One important aspect of this could be the replacement of electric cooking with LPG,4/ which would have a beneficial effect on Kiribati's overall energy costs through reduction in energy transformation losses.

Electricity

3.11 Diesel generation is the only viable source of electricity generation in Kiribati in the medium-term. Kiribati has no large energy resources that could replace diesel powered generation.

Present Power System - PUB

3.12 The PUB system comprises a single operating diesel powered generating station at Betio, at the extreme western end of the Tarawa Atoll. Power system statistics for 1990 are summarized in Table 3.2.

4/ There is already an FSED project financed through the EC to assist the Government in replacing electric stoves.

Table 3.2: SUMMARY OF PUB SYSTEM STATISTICS (1989/90)

Installed diesel generating capacity (operational)	(kW)	3,180
Generation capability (adjusted for derating)	(kW)	2,600
Peak Demand	(kW)	1,324
Energy Generation	(MWh)	7,872
Load Factor	(%)	67.9
Energy sales	(MWh)	6,502
Losses, incl. station use	(%)	17.4
Power Factor		0.9
No. of consumers		3,021

Source: PUB.

3.13 In 1967/68, three power stations were built, of which the largest was at Betio, and the other two at Bairiki and Bikenibeu. Second-hand units manufactured in 1953/54 were transferred from British military facilities on Canton Island in the Phoenix Group to these stations. Five 300 kW sets were installed at Betio, two of which are still operational. One set each, of the same type and size as at Betio, was installed at Bairiki and Bikenibeu. At Betio, two 750 kW diesel generating units were added in 1975/76, and in 1987/88 another unit of 1 MW capacity was installed. At present, there are five operational units at Betio (Table 3.3). The units at Bairiki and Bikenibeu are no longer operational.

Table 3.3: PUB OPERATIONAL GENERATING PLANT (February 1991)

Unit	Nameplate Rating (kW)	Capability Rating (kW)	Age (Years)	Operating Time (Hours)
1	300	240	37+	58,669
3	300	240	37+	47,794
6	750	600	15	61,235
7	750	600	15	63,607
8	1,080	920	3	20,040
Total	3,180	2,600		

Source: PUB.

3.14 The general condition of the electrical plant and auxiliaries in the station, and of the fuel storage tanks and delivery systems to the generating units is uncertain. Units 1 and 3 are close to 40 years old, and have long exceeded their economic life. Spare parts for these units are no longer available. The units have relatively low fuel efficiency and are no longer

reliable except for standby or emergency duty. The two 750 kW units, Units 6 and 7, are in relatively good condition and have reasonable fuel efficiency. Until 1987/88 these units were operated on base load, with the smaller units catering for the peak demand. The commissioning of Unit 8, with a capacity of 1 MW, in 1987/88 greatly improved the supply security and the fuel efficiency of the station. The two 750 MW units now handle peaking duty, and provide the reserve capacity in the event of maintenance or forced outage of the base load 1 MW unit. The two 300 kW units are used purely for standby purposes.

3.15 Within the PUB system, which was initially built in the late 1960s, much of the equipment has reached a stage at which it should be thoroughly checked to confirm the adequacy of the equipment for satisfactory future service. Hence, it is recommended that PUB check all of the equipment and correct the deficiencies before failure causes operational and safety problems. The equipment that should be included in such an assessment includes transformers, circuit-breakers and switchgear, metering equipment, generators and exciters, station auxiliary equipment (pumps, compressors, battery chargers, etc.), and fuel storage, handling and delivery systems.

3.16 At present, PUB lacks the resources and expertise for such inspections. Hence, it is recommended that technical assistance be provided for the inspection of most transformers and much of the switchgear, including the equipment and facilities at Betio Power Station. The proposed technical assistance would make detailed recommendations on any maintenance repair or replacement required so that the equipment can be placed in a condition that will ensure the provision of a high standard of reliable service, eliminate unsafe conditions and avoid unnecessary system failures. In connection with this work it is recommended that an inspection of the present system protective relays be carried out to ascertain if they are adjusted and are operating correctly. Some changes in the protective relaying may be required, particularly with the continued extension of the system and the increasing load and system complexity. Terms of reference for this work are included in Annex 6.

3.17 Given the lack of spare parts and the limited reliability and age of the equipment, it is recommended that the 300 kW diesel generating units in service at Betio be considered for retirement during the 1990s. If additional base load generating capacity is installed at Betio within the next few years, then these units could either be safely retired or, if they are in operational condition, they could be retained for emergency situations, until such time as major problems develop that would be costly to repair.

Expansion Plans

3.18 For the purposes of planning, and desirably for operations also, it is assumed that diesel units will normally be operated at a maximum of 85% of the nameplate rating. This is typically the loading at which maximum fuel efficiency is achieved, and loading at this level causes less stress on the engine and all auxiliary plant.

3.19 PUB's power development plan is based on the plan developed in the "Future Power System Expansion" ADB-financed study. This study focused primarily on the economic and technical viability of proposals to extend the 11 kV system to Nabiena, and possibly to the Islands of Northern Tarawa. The study

established that the extension to Nabiena, about 10 km beyond the present supply end point, was technically and economically viable, while extension beyond this point appeared to be non-viable.

3.20 The expansion study analyzed the operation of the system and determined that generation expansion should initially consist of a 700 kW peaking plant at Bikenibeu, followed by a 1 MW unit at Betio a few years later. The study's proposed peaking unit at Bikenibeu would cater for the evening peak demand in the eastern section of the system, and reduce losses and improve voltage regulation in that area. It would also provide standby service in the event of inadequate generating capacity being available at Betio, for any reason, or for trouble on the 11 kV distribution circuit from Betio.

3.21 Nevertheless, the expansion study did not clearly establish that the installation of the peaking unit was critical early in the planning period, and this timing does not appear to be justified. Most of the increase in demand in the eastern area of the system, resulting from the opening of the new hospital, the developments at the airport and the system extension to Nabiena, is still several years away. In contrast, demand, in absolute terms, is increasing more quickly in the western areas of Betio and Bairiki, particularly following the reinforcement of the system in South Tarawa and the additional consumers resulting therefrom. After considering these projected increases in demand, and recognizing that about 70-75% of energy consumption and peak demand is in the Betio/Bairiki area, it is recommended that the addition of a base load unit at Betio should precede the installation of a peaking unit at Bikenibeu. The peaking unit can be added at the appropriate time to meet the system conditions, as the load develops.

3.22 Given the above changes, the mission's recommended power development plan is shown in brief in Table 3.4, and in detail in Annex 5. The plan envisages the addition of a unit of 1 MW capacity in early 1993/94. One 300 kW unit, either Unit 1 or Unit 3, will be retired in 1994/95, and the other 300 kW unit will be retired in 1996/97. However, it is recognized that PUB may wish to retain one or both of these units for stand-by emergency purposes. The plan provides for a 700 kW peaking plant at Bikenibeu in 1995/96, but the actual timing will be determined more accurately as the system and the demand develops.

3.23 Apart from the costs of the generation additions, notional sums are included for the removal of Units 1 and 3. Notional sums are also included for limited reinforcement of the distribution system and for the repair/replacement of equipment that may be recommended in the proposed survey of power system equipment (see para 3.16).

Table 3.4: SUMMARY OF POWER DEVELOPMENT PLAN FOR PUB

Year	Item	Cost (constant 1991 US$ '000)
1992/93	Repair or replace deficient system plant and equipment as recommended in the Survey of Power System Equipment	100
1993/94	Install and commission a 1 MW diesel generator and associated equipment at Betio Power Station	200
1994/95	Retire and remove one 300 kW unit, either Unit 1 or Unit 3	10
1995/96	Install and commission one 700 kW high speed diesel generator unit, with all auxiliary equipment, electronic gear, including also possible remote control facilities at Bikenibeu	700
1996/97	Retire and remove the other 300 kW unit, either Unit 1 or Unit 3	10
1991/92-1999/2000	Distribution system (11 kV & LV) reinforcement and expansion to meet load growth /a	665

/a Refer to Annex 5 for breakdown by year.

Source: Mission estimates.

Rural Electrification

3.24 In addition to the recent ADB-funded extensions of the grid on Betio and Bairiki, PUB is also extending the grid to supply Buota, Abatao, Tabitauea and Nabeina. This project, also funded by an ADB loan and scheduled for completion in 1990/91, is expected to add a further 240 consumers by 1993/94. At present, PUB has no plans to extend the grid beyond Nabeina. In view of the fact that grid extension beyond Nabeina appears to be unviable (see para. 3.19), it is recommended that PUB continue to focus on providing a reliable and cost effective power supply in South Tarawa, leaving the Solar Energy Company (SEC) to service the lower density, largely residential loads in North Tarawa. This recommendation is consistent with the GOK's policy of developing rural electrification with solar photovoltaics (PV) where feasible, and pursuing diesel-based rural electrification only for sites with concentrated loads that cannot be economically met using PV systems.

Biomass

3.25 All of the islands of Kiribati are atolls or raised coral reefs, and the biomass resources available for energy use consist primarily of the products of the coconut tree. Other common trees include pandanus and breadfruit, but their use does not result in significant biomass being available for energy purposes. Mangroves are also common, but their ecological significance, e.g., for fish breeding, precludes their use for fuelwood on other than a minor, household basis.

3.26 The densely populated areas of South Tarawa have insufficient biomass for household energy use but the families are relatively affluent, and a high proportion of the families prefer to use kerosene for cooking. The poorer families do not appear to have difficulty in obtaining fuel, as shown by the lack of a wood fuel market supported from nearby North Tarawa, where there is a surplus of biomass. Elsewhere in Kiribati, there is no foreseeable shortage of biomass fuel for household use.

3.27 The present rate of copra production does not provide sufficient husk and shell waste to meet more than household fuel needs. With the present coconut product prices, only the planned cutting of senile coconut trees for plantation rejuvenation could provide the biomass fuel for energy use beyond the household level. On some of the larger islands, senile trees could provide sufficient biomass for a village steam electricity system. Since storage of cut trees for long periods is not practical, in order to use this resource, it would be necessary to cut the fuel trees shortly before they are needed for fuel. This requires a decades long program for plantation rehabilitation with the schedule set by fuel needs, and not tree replacement needs. Given the very fragmented land ownership system on most islands, and the conflicting needs of agriculture and energy, administering such a program would be very difficult.

3.28 Should the price of coconut products rise dramatically, sufficient waste might become available for small steam plant operation, but it is recommended that investment in such systems be made only if there is an assurance of at least ten years of adequate fuel supply. Such assurances are unlikely to become possible.

3.29 No planned development of biomass fuels has taken place in Kiribati. In 1982-84, biomass was considered for electricity generation on Kiritimati, and funding was sought under the EC Lomé II regional energy program. However, the proposal was withdrawn after feasibility studies showed that the project was not sustainable.

Solar Energy

3.30 Good quality solar radiation records are available only for Betio, South Tarawa. Rainfall data indicate slightly decreasing solar energy available, as one moves from south to north in the island chain of the Gilbert, Line and Phoenix groups. Using Betio records as a baseline, the solar resource appears good, though sometimes there are cloudy periods lasting more than a week, and solar designers need to take this into consideration. When the skies are clear, the clean air and equatorial sun angles result in high levels of solar radiation.

3.31 Solar electrification of rural homes began in 1984 with the formation of the Solar Energy Company (SEC) under the auspices of the Foundation for the Peoples of the South Pacific. The initial funds came from USAID, which gave the SEC sufficient equipment to begin the sale of solar lighting systems. Unfortunately, on-site service was provided only on demand and on a pay-as-you-go basis. To save money, purchased systems were usually installed by the owners rather than the SEC, and repairs were also attempted by owners to avoid the cost of an SEC technical visit. Poorly installed and poorly maintained, few of the systems functioned properly for more than a year, and the reputation of PV systems was badly damaged.

3.32 By 1989, sales of the PV units fell to a level that was too low to sustain the company. In 1990, the management was changed and, prompted by the expectation of a 50 to 70 household rural PV electrification pilot project from JICA, the company reorganized as a service company in the model of a rural utility. A proposal to install approximately 100 more two-panel household lighting systems is in the approval process for EC funding through the Lomé II regional program.

3.33 The GOK's stated policy of not subsidizing rural electrification has been appropriate to encourage the transformation of the SEC into a financially autonomous, commercially managed PV utility. At present, the SEC's main source of revenue is from installation and maintenance contracts, mostly government or church based, though by the end of 1993, sufficient rural household installations should be in place to firmly establish the company as a rural electric utility.

3.34 Solar water heating has been installed on the government hotel and a number of homes. There is no local capability to manufacture water heaters, though the PWD and private contractors can provide installation and service. Given the excellent record of solar water heaters in the Pacific and the good solar environment of Kiribati, it is recommended that solar waters heaters should be the first choice for water heating for all new construction.

Other Energy Resources

3.35 Wind. Winds are variable with no consistent, energy quality winds on South Tarawa, though Kiritimati Island has higher average wind speeds. The combination of a marginal wind regime and the problem of maintaining rotating mechanical and electrical equipment in the corrosive atoll environment makes it difficult to use wind power for purposes other than non-critical water pumping.

3.36 OTEC. Preliminary investigations by SOPAC indicate OTEC potential. Additionally, the higher temperature of the lagoons associated with many islands might be used to advantage with an OTEC system. However, OTEC systems have not yet been commercially proven anywhere. Given the limited land area and the fragile ecosystem of atoll islands, it is recommended that OTEC not be considered, even if offered on the basis of total external investment, until commercial systems have been in operation elsewhere for sufficient time to judge their economics and their affects on the environment.

3.37 Tidal Energy. A small tidal range and a lack of suitable sites precludes the use of tidal energy in Kiribati.

3.38 Wave Energy. From the limited available data, it appears that, in principle, wave energy might be a significant energy resource. Given the absence of any coastal features other than low lying reefs, wave energy will be difficult and expensive to tap, even when the equipment is commercially proven and generally available. Hence, it is recommended that wave energy not be considered until commercially operated systems have been in operation for sufficient time to judge their economic usefulness and environmental impact.

IV. POLICY AND INSTITUTIONAL ISSUES

Petroleum

4.1 GOK, through the Ministry of Trade, Industry and Labor, controls the retail price of motor spirit and kerosene in Kiribati. There are no controls on ADO price. For controlled products, the price is the same throughout Kiribati. The ceiling price is set at 25% above the landed cost. This means that the total wholesale cost and the retail margin varies directly in proportion with the level of landed cost. A summary of the level of controlled prices over the past year, as well as calculated landed cost (CIF) and total onshore distribution analysis is provided in Table 4.1.

Table 4.1: OFFICIAL RETAIL PRICES, LANDED COSTS AND DISTRIBUTION MARGINS OF PETROLEUM PRODUCTS

	Effective Price Dates			
	Mar. 1 1990	Oct. 24 1990	Dec. 31 1990	Jan. 29 1991
	----------A$ per liter----------			
Motor Spirit				
Retail Price	0.63	0.86	0.83	0.66
CIF cost /a	0.50	0.69	0.66	0.53
Margin /b	0.13	0.17	0.17	0.13
Kerosene				
Retail Price	0.50	0.71	0.76	0.72
CIF cost /a	0.40	0.57	0.61	0.58
Margin /b	0.10	0.14	0.15	0.14

/a Mission calculation.
/b Retail price less CIF cost.

Source: Mission estimates.

4.2 During the recent Gulf War, the total distribution margin would have increased in direct proportion to the increase in CIF. Motor spirit margins peaked at A$0.04 per liter higher than pre-war, and kerosene at A$0.05 per liter higher than pre-war. As a result, the price adjustments permitted under the existing ad valorem margin allowance appear to have provided the petroleum distribution companies with an unintended windfall profit, as there is no reason why distribution costs should have increased simply because the underlying costs of the product increased. There is a direct linkage, in percentage terms, between distribution costs and required margins due mainly to product losses and inventory financing charges. There may also be a few other small product value-related charges, such as insurance. However, the bulk of the margin should not be directly linked to the underlying product value. To avoid the recurrence of such unintended windfalls, and the attendant costs to the consumers, the

remainder of the margin should be expressed as a flat, fixed value, to be adjusted yearly as necessary, based on audited statements of unit costs, presented in a standardized format at a regular time each year. If the pre-Gulf-War margins are accepted as valid, for example, a preferable margin structure to the straight 25% of CIF would be:

- Motor spirit: 5% of CIF plus A$0.105 per liter
- Kerosene: 5% of CIF plus A$0.08 per liter

This calculation is intended only to be indicative of the preferred structure. To obtain a more complete determination, it is recommended that the exact percentage and flat values for each petroleum product should be based on an analysis of cost statements.

4.3 The surveillance of prices in general in Kiribati appears to be weak. The Ministry of Works and Energy is charged with the responsibility for reviewing the landed cost submissions provided by Mobil, but there is no evidence of any in-depth checks of the values of the various components. Although the components from Singapore FOB through the Vuda terminal should be analyzed and not simply accepted as given, the fact that they are verifiable with respect to international norms and are subject to the analysis of Fiji's Prices and Incomes Board (PIB) makes them more transparent and manageable. Of course, if Fiji abolishes the PIB, such controls would end, and Kiribati would have to establish its own price monitoring and surveillance capacity.

4.4 The tanker freight component for the shipping from Vuda to Tarawa is a large component, which could particularly bear some scrutiny. At a minimum, Mobil should assist the Ministry in establishing some sort of reference framework for the analysis of this component.

4.5 The Ministry of Trade, Transport, Industry and Labor is charged with administering the control of final retail price of motor spirit and kerosene. There is one (formal, paid) price control officer in the Ministry, and unpaid officers checking prices throughout the country. The paid officer seems to do little more than recalculate the 25% add-on when the CIF changes and administer the preparation and issuance of a new retail price order. The breakdown between wholesale and retail margin is left to KOIL to negotiate with the retail outlets or bulk clients such as PUB.

4.6 KOIL in its 1990-95 work plan has expressed the objective of establishing a Price Buffer Fund. A relatively small allotment of funds from KOIL's general revenues have already been designated for this fund. Their objective is to use the fund to maintain "normal prices" onshore in the face of fluctuating external prices. In spite of the fact that they have made a nominal allocation to a price buffer fund, neither KOIL nor GOK has any concept of the real workings of such a fund and their detailed objectives are not clearly defined. Even if such a fund were desirable for Kiribati, it is questionable whether KOIL as the operating oil company, should be administering what is a function of GOK central revenue authorities. As to desirability, unless KOIL can forecast the long-term average world oil price, as well as the extent and duration of fluctuations from the trend line, it is not possible to administer a buffer fund in a satisfactory manner. These parameters are required in order

to know what the "normal" buffered price level should be as well as the extent of the initial financing required to support it. Experience shows that buffer funds become, at best, variable taxes as the funds get used by general revenues when in surplus, and disappear altogether when in deficit. At worst, major surplus funds attract the attention of other dispositions - often inefficient, if not fraudulent uses of the consumer's money. Hence, it is recommended that the proposed buffer fund be not pursued further.

Power Subsector

Price and Cost of Supply

4.7 In December, 1990, PUB's tariff for domestic electricity consumers was increased from A 29¢/kWh to A 32¢/kWh, and for commercial/industrial consumers from A 33¢/kWh to A 39¢/kWh. It appears that PUB's prices have approached the consumers' willingness to pay for electricity. Indeed, TSKL's recent agreement with GOK (see para 2.9) suggests that PUB's larger consumers may have already realized that they can generate their own electricity for less than the PUB tariff. To an extent, this is to be expected, given the typically low levels of electricity usage per residential consumer and the fact that utilities such as PUB are often required to invest in costly projects such as rural electrification or grid extension that are not financially remunerative. Nevertheless, with PUB's weighted average price now almost A 38¢/kWh (approximately US 30¢/kWh), there is little room for further real tariff increases. This again points to the need for caution in regard to the financial viability of the further extension of the PUB's service beyond Nabeina in North Tarawa.

4.8 Analysis of PUB's provisional data for 1989/90 indicates an average cost per unit sold of A 34.9¢/kWh, an average revenue of A 38.4¢/kWh, for a net profit of A 3.5¢/kWh (Table 4.2).

Table 4.2: PUB COSTS AND REVENUES, 1989/90

	A¢/kWh
Revenues	
Electricity Sales	32.3
Interest plus Sundries	2.3
Administrative Charges /a	3.9
Total	38.4
Costs	
Fuel and Lube Oil	14.8
Wages and Salaries	7.6
Repairs and Maintenance	4.2
Misc. Office Expenses	1.6
Depreciation	5.2
New Connections	0.6
Other Expenses	1.0
Total	34.9
Net Profit	3.5

/a Internal Charges to Water and Sewerage Divisions.

Source: Mission calculations.

4.9 In comparison with the financial cost of A 34.9¢/kWh, the estimated long-run marginal cost of electricity supply 5/ is around A 21.5¢/kWh, based on:

(a) a marginal capacity cost of generation, including a 10% reserve margin, of A 2.0¢/kWh;

5/ The long-run marginal cost is the cost of an additional unit of electricity in the long-run, which is the period in which it is possible to change the power generating equipment in an optimal manner. The marginal costs, based on 1990 financial prices, have been calculated on the basis of:

(i) A$850,000 investment cost for 1 MW generator;
(ii) A$45/kW per year for transmission and distribution capacity costs;
(iii) PUB's actual fuel costs for 1989/90, and allowance for variable O&M costs of A 2.0¢/kWh; and
(iv) Mission estimates of cost of meters, meter reading, billing and money collection.

(b) a marginal capacity cost of transmission and distribution of A 1.75¢/kWh;

(c) a marginal energy cost, including operating and maintenance (O&M) costs and 17.5% losses, of A 17.25¢/kWh; and

(d) marginal customer costs, including meter purchase and installation, of A 0.5¢/kWh.

4.10 The long-run marginal cost of A 21.5¢/kWh is also a crude estimate of the marginal cost of supply for those large customers for whom self-generation is a practical alternative, assuming that the higher fuel costs associated with self-generation would be offset by the avoidance of transmission and distribution costs and energy losses.

4.11 These comparisons indicate that PUB's costs appear to be high; in particular, the labor costs and O&M expenditures appear high relative to other Pacific Island region utilities. For example, PUB has one of the lowest ratios of annual sales per employee at just 60 MWh per employee, which is substantially lower than the comparable figure of 150 MWh for the Solomon Island Electricity Authority, 325 MWh for Fiji Electric Authority, and 375 MWh for the American Samoa Power Authority.6/

PUB's Financial Performance

4.12 PUB's overall financial performance has deteriorated in recent years, with the budget for 1990/91 showing a net operating loss of almost A$550,000, following an estimated loss of A$380,000 in 1989/90. While it is only the water and sewerage divisions that are expected to record losses this year, the profits from electricity sales are low, representing a Rate of Return (ROR) on net (revalued) fixed assets of just 3%, which is substantially lower than the 8% ROR required to meet PUB's existing ADB loan covenants. In spite of the recent tariff increase, there are doubts whether PUB will sustain even a 3% level of profitability, given the loss of sales to Te Mautari. It is estimated that the loss of sales to Te Mautari will reduce PUB's 1990/91 revenues by almost A$80,000 and its net operating profit by around A$45,000.

4.13 In the medium-run, it is likely that, in the absence of further tariff increases or significant cost reductions, PUB's financial position will become critical over the next two to three years, as GOK subsidies to water and sewage are phased out and PUB's annual debt service costs for two ADB loans ($92,000 in 1990/91) increases to around $300,000. In addition, it is estimated that the A 17¢/kWh tariff reduction promised to TSKL from August, 1991 will reduce PUB projected revenue and profits by more than A$100,000 on an annual basis. Indeed, it is estimated that in order to offset the loss of revenues and profits resulting from the cessation of sales to Te Mautari and reduced tariff to TSKL, the average tariff to other PUB consumers would have to increase by A 3.5¢/kWh.

6/ To some extent, Kiribati's low ratio is a result of the fact that its electricity system is smaller than that of many other Pacific Island countries.

4.14 However, a detailed analysis of PUB's operating costs and profitability is difficult since the most recent audited accounts available are those for 1986/87. While acknowledging that PUB is short on qualified accounting staff, it is noted that PUB is required under the terms of its existing loan agreements to submit audited financial accounts within nine months of the close of each fiscal year. Quite apart from the need to meet existing loan covenants, however, PUB needs to improve its financial reporting procedures in order to facilitate future pricing and investment strategies.

4.15 PUB has recently sought assistance from ADB to review its non-technical operations. To obtain full benefits from such a review, it is recommended that this review include PUB's financial accounting procedures, water, sewage and electricity tariff policies, and the present arrangements for subsidizing PUB's water and sewerage operations.

4.16 The GOK has approved electricity tariffs and charges for water supply and sewage disposal such that revenue from electricity sales is used to subsidize the water and sewage services. In view of the practical market-imposed ceiling on power tariff increases, such cross-subsidization between services makes it difficult for PUB to meet its overall financial commitments, the covenants with international lending institutions, and that permit the continued operation of the electric power system in a safe and effective manner. Rather than burdening the power supply with such cross-subsidies, it is recommended that the GOK provide an explicit budgetary subsidy to PUB for its socially important water and sewerage services, and allow power to be priced at a level that is close to its economic cost of supply.

PUB's Institutional Capabilities

4.17 The PUB lacks adequately trained and experienced managers in the technical, administrative, and financial areas; for example, the billing and management information systems have been computerized, but it is unclear whether PUB has the capacity to operate and maintain these systems. In the past, efforts have been made to address the lack of skilled personnel, primarily through the provision of advisors in specific fields. The PUB has also supported training and education for staff, both at the Tarawa Technical Institute and at the University of the South Pacific, Fiji. Nevertheless, much more effort is required if Kiribati nationals are to effectively manage this important organization. Long-term training plans with clear objectives need to be prepared, and PUB should ensure that those who receive training of any kind, continue to work at PUB after the training is completed.

4.18 The PUB has received considerable assistance from various multilateral and bilateral sources, particularly from ADB and from Australia. An engineering advisor, under Australian (AIDAB) aid, has been assisting PUB during the last two years with the distribution expansion and rehabilitation program, and PUB is seeking an extension of his contract. A number of studies on technical and institutional matters have been financed from ADB technical assistance grants, the most recent being a study of future power system expansion in Tarawa, which was completed in March 1990.

4.19 In the short-term, PUB should continue to seek advisors to provide the assistance necessary to effectively manage the operations. Advisors in technical roles, and in accounting and administration should be sought.

Environmental Issues

4.20 Solar. For solar PV applications, a system of reclaiming lead from spent lead acid batteries should be put into place to prevent possible environmental damage, and also to make use of lead by recycling it.

4.21 Biomass. Atolls have a fragile ecosystem, and caution is urged to minimize the adverse environmental effects of biomass-based energy development. It is recommended that only developments based on sustainable agricultural waste should be contemplated. Fuel wood plantations are not appropriate in the limited space and fragile ecosystem of the atoll environment. It is recommended that the use of senile coconut trees for biomass be viewed with caution, because such use requires truck access, which has adverse environmental implications.

V. INVESTMENT AND TECHNICAL ASSISTANCE PRIORITIES

Petroleum

5.1 Subsector Focus. There is no need for Government investments in this subsector. The focus should be on price monitoring, and safety and environmental concerns.

5.2 Price Monitoring. There is weak price monitoring of petroleum products, both in terms of the CIF cost and the establishment of onshore margins. In order to strengthen this monitoring, it is recommended that the GOK request external specific training and ongoing technical support, particularly for:

(a) An analysis of the reasonableness of the freight component in the CIF price buildup.

(b) An analysis of onshore costs, with a view to establishing a more realistic margin adjustment basis, consisting of a flat rate component and a component linked to the landed cost. (See paragraphs 4.1-4.4)

5.3 Price Buffer Fund. In view of the difficulties of managing price buffer funds, it is recommended that the GOK does not pursue KOIL's proposed price buffer fund. (See paragraph 4.5)

5.4 KOIL's Goals. In order to ensure progress with the planning and implementation of major efficiency, safety and environmental improvements, it is recommended that GOK work closely with KOIL, particularly in areas such as staff downsizing and more stringent licensing of drum outlets. (See paragraphs 3.8-3.9).

LPG

5.5 It is recommended that the GOK support proposals for the bulk supply of LPG to Tarawa by taxing LPG in the same manner as competing fuels such as kerosene. (See paragraphs 3.9-3.10).

Power Subsector

5.6 Subsector Focus. PUB's total capital expenditures until 2000 will be about US$1.8 million, in constant 1991 prices. (See paragraphs 3.22-3.23). Apart from this, the focus should be on making better use of the existing assets, and on improving PUB's financial performance and institutional capabilities.

5.7 Existing Assets. In order to ensure that PUB's existing assets are used properly, it is recommended that technical assistance be provided for the inspection of PUB's existing equipment. (See paragraphs 3.15-3.16)

5.8 PUB's Financial Performance. While PUB's costs appear to be high and PUB's financial performance has deteriorated in the last three years, there are inadequate records for a detailed analysis of PUB's performance. Hence, it is recommended that technical assistance be provided for a review of PUB's accounting procedures, water and electricity tariff policies, and the present

arrangements for subsidizing PUB's water and sewerage operations (see paragraphs 4.11-4.15).

5.9 PUB's Institutional Capabilities. Since PUB lacks adequately trained and experienced managers in the technical, administrative, and financial areas, it is recommended that in the short-term, PUB should continue to seek advisors to assist in technical roles, and in accounting and administration. In the long-run, it is recommended that PUB provide appropriate training to its staff (see paragraphs 4.16-4.18).

Renewable Energy

5.10 The present institutional arrangements seem adequate for renewable energy development and for rural electrification, though technical assistance and external aid will be necessary for the feasibility stage of renewable energy projects, to optimize projects and to prevent inappropriate development.

5.11 It is recommended that the SEC train its staff for the management and design of renewable energy projects, with emphasis on solar and biomass technologies. The SEC is capable of training PV field technicians with minimal external assistance. It is recommended that senior SEC staff be given further training in PV technology, both in the form of overseas courses, such as those organized in the past by PEDP/SPIRE, and local training provided on a periodic basis.

5.12 It is recommended that the Tarawa Technical Institute be encouraged to re-establish its electrician training program, and to assist the SEC in providing training to low-level technicians engaged in the maintenance of small diesel generators and PV systems.

ANNEXES

1. MAP - Kiribati and South Tarawa Power System
2. PUB Historical Statistics (1981-90)
3. PUB Diesel Generating Plant
4. Projected PUB Sales, Generation and Peak Demand (1990-2000)
5. Power Development Plan
6. PUB Organization Chart
7. Survey of Power System Equipment - Terms of Reference

KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Kiribati Energy Assessment
Petroleum Products Consumption--Forecast

	Forecast 1990-2000 p.a.	Actuals 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
		kl										
Inland (Tarawa)												
Motor spirit	3.0%	2,058	2,120	2,183	2,249	2,316	2,386	2,457	2,531	2,607	2,685	2,766
Kerosene	1.0%	1,018	1,028	1,038	1,049	1,059	1,070	1,081	1,091	1,102	1,113	1,125
ADO to PUB	7.5%	2,090	2,230	2,510	2,700	2,900	3,110	3,320	3,550	3,790	4,050	4,320
ADO to others	4.0%	3,237	3,366	3,501	3,641	3,787	3,938	4,096	4,260	4,430	4,607	4,792
ADO Total	5.5%	5,327	5,596	6,011	6,341	6,687	7,048	7,416	7,810	8,220	8,657	9,112
	4.5%	8,403	8,744	9,233	9,639	10,062	10,504	10,954	11,432	11,929	12,456	13,002
Inland (Kiritimati)												
Motor spirit		300	300	300	300	300	300	300	300	300	300	300
Kerosene		150	150	150	150	150	150	150	150	150	150	150
ADO Total		900	900	900	900	900	900	900	900	900	900	900
Total Inland		1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350
Inalnd Total (Tarawa + Kiritimati)												
Motor spirit		2,358	2,420	2,483	2,549	2,616	2,686	2,757	2,831	2,907	2,985	3,066
Kerosene		1,168	1,178	1,188	1,199	1,209	1,220	1,231	1,241	1,252	1,263	1,275
ADO to PUB		2,090	2,230	2,510	2,700	2,900	3,110	3,320	3,550	3,790	4,050	4,320
ADO to others		4,137	4,266	4,401	4,541	4,687	4,838	4,996	5,160	5,330	5,507	5,692
ADO Total		6,227	6,496	6,911	7,241	7,587	7,948	8,316	8,710	9,120	9,557	10,012
Lubes	4.0%	170	177	184	191	199	207	215	224	233	242	252
Aviation (No Bunkers)												
Avgas		600	600	600	600	600	600	600	600	600	600	600
Jet A1		1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
		2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300
Total Kiribati Trade		12,223	12,571	13,057	13,480	13,911	14,361	14,819	15,306	15,812	16,348	16,903

Source: Kiribati Oil Company; Mission estimates.

KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Kirabati Energy Assessment
PUB Historical System Statistics
(1981-90)

Year to June 30	Number of Customers	Energy Sales (MWh)	Distribution Losses /a (MWh)	(%)	Station Use (MWh)	(%)	Energy Generation (MWh)	Load Factor (%)	Peak Demand (kV)
1981	2,179	3,366	1,644	32.1	116	2.3	5,126	64.3	910
1982	2,199	4,214	653	12.9	193	3.8	5,060	66.4	870
1983	2,218	4,103	955	18.5	103	2.0	5,161	62.0	950
1984	2,266	4,333	1,076	19.5	112	2.0	5,521	67.8	930
1985	2,405	4,554	1,269	21.2	167	2.8	5,990	63.3	1,080
1986	2,448	5,056	1,181	18.5	134	2.1	6,371	71.3	1,020
1987	2,483	5,342	1,046	16.0	148	2.3	6,536	62.2	1,200
1988	2,503	5,759	902	13.3	97	1.4	6,758	70.1	1,100
1989	2,521	6,026	1,102	15.2	105	1.5	7,233	73.3	1,260
1990	3,021	6,502	1,280	16.3	88	1.1	7,872	67.9	1,324
Av. annual growth (%)									
1981-90	3.3	6.8					4.4		3.8
1985-90	4.7	7.4					5.6		4.2

Source: PUB.

/a As a percentage of gross energy generation.

KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Kirabati Energy Assessment
PUB Diesel Generating Plant, South Tarawa
(As of February 15, 1991)

Unit No.	Location	Manufacturer	Type	Nameplate Rating (kW)	Available Capacity (kW) /a	Year Installed	Total Running Hours /c	Last Major Overhaul
1	Betio	English Electric	4SRK	300	240	1968	58,669	Feb. '89
3	Betio	English Electric	4SRK	300	240	1968	47,794	Dec. '84
6	Betio	English Electric	6RK3C	750	600	1976	61,235	Sept. '88
7	Betio	English Electric	6RK3C	750	600	1976	63,607	Mar. '87
8	Betio	Wartsila	F38	1,080	920	1988	20,040	Jan. '91
9 /c	Bairiki	English Electric	4SRK	300	240	1968	7,452	Jan. '88
10 /d	Bikenibeu	English Electric	4SRK	300	240	1968	15,730	n.a.

Source: PUB.

/a Based upon approximately 80-85% of nameplate rating.
/b As of January 31, 1991. Excludes operating hours of second-hand units prior to their installation in Tarawa in 1968.
/c Unit 9 at Bairiki has been decommissioned. It may be relocated to Betio.
/d Unit 10 at Bikenibeu is decommissioned. It may be reconditioned and moved to Betio.

KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Kirabati Energy Assessment
Projected PUB Sales, Generation and Peak Demand
(1990 - 2000)

Year	Energy Sales (MWh)	Total Losses (%)	Energy Generation (MWh)	Load Factor (%)	Peak Demand (kW)
1990 (Actual)	6,502	17.4	7,872	67.9	1,324
1991	6,912	16.4	8,268	65.0	1,452
1992	7,307	16.4	8,740	65.0	1,547
1993	7,763	16.4	9,286	64.8	1,636
1994	8,301	16.4	9,929	64.6	1,755
1995	8,811	16.4	10,539	64.4	1,868
1996	9,351	16.4	11,185	64.0	1,995
1997	9,924	16.4	11,871	64.0	2,117
1998	10,511	16.4	12,573	64.0	2,243
1999	11,127	16.4	13,310	64.0	2,374
2000	11,726	16.4	14,026	64.0	2,502
Av. annual growth (%)	6.1		5.9		6.6

Source: Mission estimates.

KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Power System Development Plan

Planning Criteria	
Reserve capacity	The largest generating unit not available. Note that all figures should be based on capability of the units, not nameplate rating.
Capability (for planning purposes)	The older generating units will have the derated levels in use. The new 1 MW unit and proposed new units would be deemed to have a capability equivalent to 85% of nameplate.
Firm energy	Based upon units operating at 65% load factor at capability level for one year.
Retirement	For the purpose of planning the timing of additional capacity it is assumed that the 300 kW units will be excluded from the determination of system capacity, even though they may be maintained in operation for standby operation. One unit retired in 1995, the other in 1997.

Power Development Plan - PUB Tarawa System
(Year ending June 30)

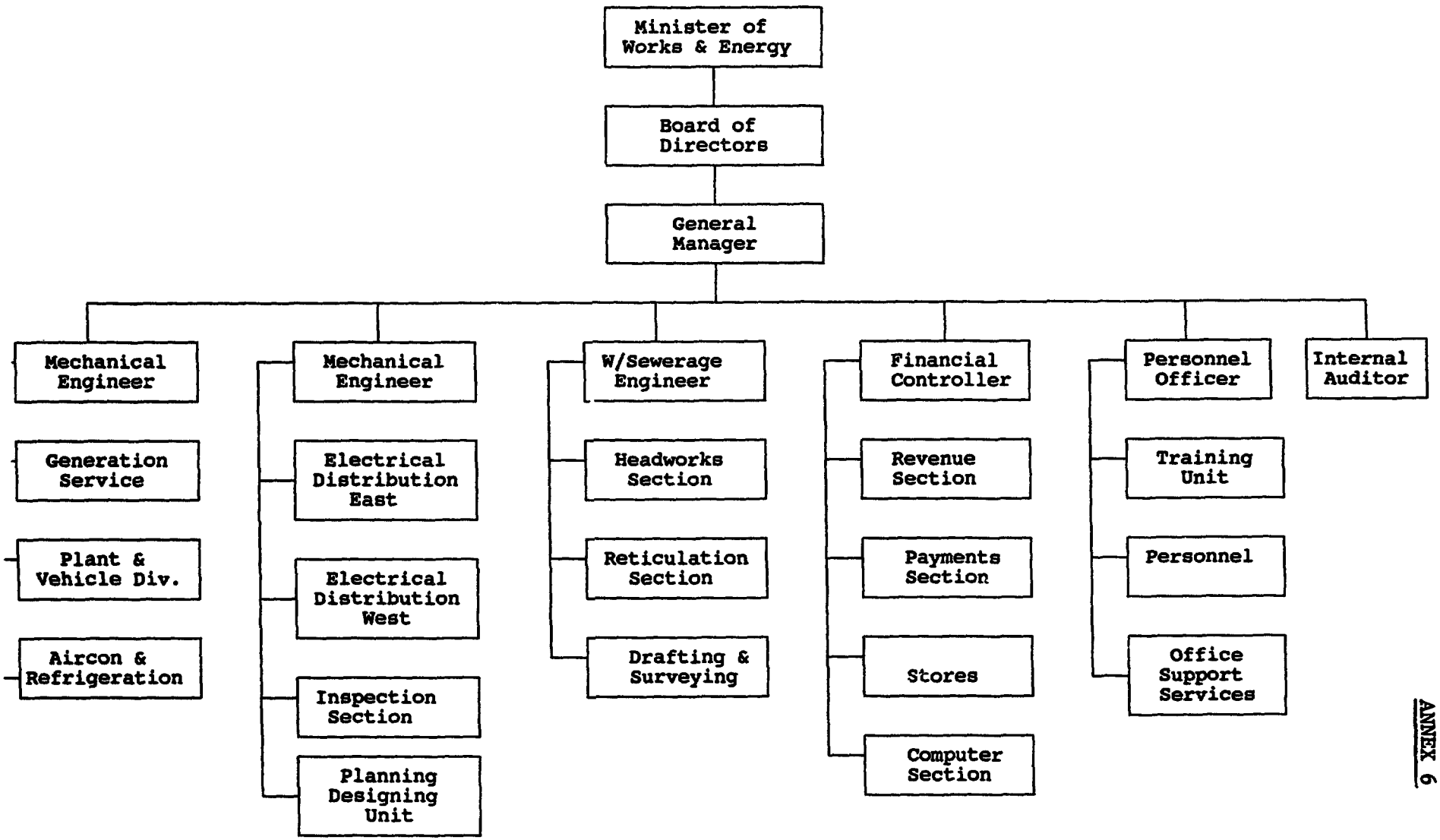
Description		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Projected generation	(MWh)	7,872	8,268	8,740	9,286	9,929	10,539	11,185	11,871	12,573	13,310	14,026
Projected peak demand	(kW)	1,324	1,452	1,547	1,636	1,755	1,868	1,995	2,117	2,243	2,374	2,502
Installed capability (start of year)	(kW)	2,600	2,600	2,600	2,600	2,600	3,520	3,280	3,875	3,635	3,635	3,635
New capability	(kW)					920		595				
Retired capability	(kW)						240		240			
Total capability	(kW)	2,600	2,600	2,600	2,600	3,520	3,280	3,875	3,635	3,635	3,635	3,635
Reserve capability	(kW)	920	920	920	920	920	920	920	920	920	920	920
Total System Firm Capacity	(kW)	1,680	1,680	1,680	1,680	2,600	2,360	2,955	2,716	2,715	2,715	2,715
COST STREAMS			---------- Constant US$ '000 (1991) ----------									
Generation												
Add 1.0 MW diesel generator						200						
Add 700 kW high speed peaking diesel generator								700				
Retire & remove 300 kW unit							10		10			
Distribution - 11 kV and LV												
Expansion, reinforcement as planned and as required				120	65	100	125	95	63	32	32	32
Repair and replacement of deficient power system equipment					100							
Total Investment				120	165	300	135	795	73	32	32	32

Source: Mission estimates.

KIRIBATI

COUNTRY ENERGY ASSESSMENT

PUP Organization Chart



KIRIBATI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

Survey of Power System Equipment

Objective

1. To ensure that the condition of the aging power system equipment and facilities is adequate to provide safe reliable service, and to assure that the power system protective relaying will effectively de-energize faulty and unsafe segments of the system under fault conditions.

Introduction

2. Electricity on the Tarawa Atoll of Kiribati is generated and distributed by the Public Utilities Board (PUB). The PUB power system was built starting in the late 1960s, and much of the equipment has had more than twenty years of service life in a harsh tropical marine environment. Very limited testing and inspection of the equipment, if any, may have been carried out from time to time. From the standpoints of safety and service reliability it is necessary to confirm the condition of the power system plant and equipment, and to correct any deficiencies, so as to avoid serious damage to equipment and serious power outages, and to ensure the safety of operating equipment.

3. The power system protective relaying was designed for a smaller simpler system than that which exists, and which is contemplated in the near future. The ability of the protective equipment to operate satisfactorily under all appropriate conditions must be confirmed to ensure the safety of life and property and to ensure satisfactory service reliability.

Power System Plant and Equipment

4. The survey will:

(a) Make an inventory of the power system plant and equipment, including details of the age and condition.

(b) Make a detailed examination of all plant and equipment that, because of age, or service, may require maintenance, repair, rehabilitation, or replacement.

(c) Determine the urgency ranking for the repair or replacement of equipment based upon considerations of safety, of life and property, and power system reliability.

(d) Prepare a report containing the record of the survey, the inventory of plant and equipment, and an assessment of the condition of the equipment and recommendations for maintenance, repair or replacement, together with a recommended program and schedule for such work, and cost estimates, broken down into local costs and foreign costs, for the recommended work.

Protective Relaying

5. Further, the survey will:

(a) Prepare an inventory of all protective relaying and single line diagrams showing all instrument transformers and relays, using international standard symbols.

(b) Determine the present relay settings, and the adequacy of the settings for all conditions on the present system.

(c) Based upon any deficiencies in the protective relaying, and taking into account planned extensions of the 11 kV system and the installation of generating capacity at Bikenibeu, prepare detailed recommendations for modifications and improvements to the protective relaying.

(d) Prepare a report detailing the findings and containing the inventory of protective equipment (e.g., circuit breakers, instrument transformers, transducers, relays, etc.).

Requirements

6. The survey will require an electrical engineer with practical experience of power distribution equipment, including transformers, switchgear, cables, etc., including the assessment of equipment condition and maintenance and rehabilitation requirements. An engineer with experience of diesel electric power stations will be required to assess the condition of the power station auxiliary plant, equipment and services, including fuel storage facilities and fuel handling/delivery systems.

7. An electrical engineer, possibly the same, if the appropriate knowledge and experience is evident, competent in the field of distribution and small power station protective relaying. The requirements include detailed recommendations for the upgrading of the protective relay system, including recommendations on the priority ranking of any work, and cost estimates, broken down into local and foreign expenditures, for the recommended improvements.

8. It is estimated that the complete survey and preparation of the report will require approximately 2½-3 work-months, of which about 2-2½ work-months will be in the field.

STATISTICAL APPENDIX

TABLE 1
KIRIBATI: SELECTED DEVELOPMENT INDICATORS

		1985	1986	1987	1988	1989	1990
GDP ('000 AU$)[1]		32,795	35,947	36,874	44,930	45,784	47,295
Per capita (AU$)		512	550	552	659	658	654
Total Imports ('000 AU$)[2]		21,548	21,456	17,980	24,130	28,143	34,446
Total Exports ('000 AU$)[3]		5,993	2,682	2,854	6,604	5,931	3,681
Inflation Rate[4]		4.5	6.5	6.5	3.1	3.9	na
Exchange Rate[5] (AUS$/US$)		1.43	1.49	1.43	1.27	1.26	1.28
Sea Area ('000 sq. km)[6]	3,550						
Land Area ('000 sq. km)	0.81						
Wage & Salary Employment[7]		6,769	na	na	na	na	na
Average Wage (AU$)		na	na	na	na	na	na
Total Population[8]		64,000	65,400	66,800	68,200	69,600	72,300
urban (%)		33	na	na	na	na	35

Overseas Development Assistance

Annual ODA ('000 AU$)[9]	17,124	19,966	12,689	15,187	17,027	na
Multilateral ('000 AU$)	na	na	1,784	1,566	2,556	na
Bilateral ('000 AU$)	na	na	10,905	13,622	14,470	na
% Bilateral	na	na	85.9	89.7	85.0	na
ODA as % of GDP	52.2	55.5	34.4	33.8	37.2	na
ODA as % of Current Government Income[10]	1.2	1.2	0.7	0.8	0.9	na
ODA/Capita (AU$)	268	305	190	223	245	na

Sources: Key Indicators of Developing Asian and Pacific Countries (ADB 1990).
Towards Higher Growth in Pacific Island Economies (World Bank 1990).
Kiribati Statistical Yearbook (1988).
Kiribati 1979–1987. A Compendium of Statistics (1989).
Kiribati 1991 Development Budget and Supplementaries (1991).
UNDP Development Co–operation Reports.
Mission Estimates.

Notes:
(1) For 1985–1988, at current market prices (Statistical Yearbook); for 1989, estimated growth at 1.9%; for 1990, estimated growth at 3.3%.
(2) For 1985–1988, CIF (Statistical Yearbook); 1989 from 1990 World Bank Report; 1990 from Statistics Office.
(3) For 1985–1988, FOB (Statistical Yearbook); 1989 from 1990 World Bank Report; 1990 from Statistics Office.
(4) Based on 1980 CPI=100.
(5) For 1985–1988, yearly averages (Statistical Yearbook); 1989 from 1990 World Bank Report.
(6) Sea and land areas taken from Compendium of Statistics.
(7) 1985 mid–year figure as reflected in 1985 census in Statistical Yearbook.
(8) 1985 figures from 1985 census. 1986–88 population from Statistical Yearbook. 1989 population estimated at growth rate of 2.1%. Urban population accounted as population of South Tarawa. 1990 from 1990 census.
(9) 1987–1989 from UNDP DCRs. 1990 from Kiribati Development Budget.
(10) Current Govt Income estimated from 1990 World Bank Report.

TABLE 2

KIRIBATI: SELECTED PROJECTIONS

	1990	1995	2000
Population[1]:			
urban	24,885	29,193	35,000
rural	46,215	49,707	52,500
Total	71,100	78,900	87,500
GDP ('000 AU$):			
high growth at 5%	47,295	60,362	77,039
med growth at 4%	47,295	57,542	70,008
low growth 3%	47,295	54,828	63,561
GDP/Capita (AU$)[2]:	665	729	800
Electricity Generation (MWh)[3]:	7,872	10,485	14,026
Peak demand (kW)	1,324	1,823	2,502
Fuel Consumption (kl)[4]:			
Gasoline	2,358	2,686	3,066
Kerosene	1,168	1,220	1,275
ADO	6,227	7,774	9,682
Lubes	170	247	524
Total Inland	9,923	11,927	14,547
Total Aviation	2,300	2,300	2,300
Total Kiribati Trade	12,223	14,227	16,847
Rural electricity consumers[5]:			
grid	121	128	136
isolated	675	716	758

Source: Mission Estimates.

Notes:
(1) Population growth rate of 2.1%; 37% urban in 1995, 40% urban in 2000.
(2) Medium growth scenario of 4.0%.
(3) Growth estimated at 5.9% with demand increasing at 6.6% assuming an additional 1000 residential, 44 commercial and 40 industrial consumers connected by 2000. Private power generation assumed constant at 350 kWh/yr.
(4) Gasoline: constant at 300 kl on Kiritimati, 3.0% elswhere; Kerosene: constant at 150 kl on Kiritimati, 1.0% elswhere; ADO to PUB at 7.5%, ADO to others at 4.0%, ADO on Kiritimati constant at 900 kl; Lubes: 7.8%.
(5) 1990: Approximately 5% of PUB's total number of residential consumers located in North Tarawa. Isolated consumers comprise approximately 250 on Kiritimati Island, 300 solar co-op customers and several independent diesel generator on outer islands. Assume growth rate of 6%.

TABLE 3a

KIRIBATI, ENERGY BALANCE, 1990
(Original units)

	Fuelwood (tonnes)	Coconut Residues (tonnes)	Total Biomass (tonnes)	Electricity (MWh)	Gasoline (kl)	Jet A1 (kl)	Kerosene (kl)	ADO (kl)	Avgas (kl)	Total Petroleum[5] (kl)
Primary Supplies:										
Production	15,084	26,816	41,900							0
Imports[1]			0		2,358	1,700	1,168	6,227	600	12,053
Bunkering/Exports			0			(1,700)			(600)	(2,300)
GROSS AVAILABLE	**15,084**	**26,816**	**41,900**	**0**	**2,358**	**0**	**1,168**	**6,227**	**0**	**9,753**
Conversion:										
Public Power Generation[2]			0	8,222				(2,251)		(2,251)
Station use			0	(99)						0
Transmission/Distribution Losses			0	(1,330)						0
NET SUPPLIED	**15,084**	**26,816**	**41,900**	**6,793**	**2,358**	**0**	**1,168**	**3,976**	**0**	**7,502**
Final Consumption:										
Households[3,4]	15,084	26,816	41,900	1,714			1,168			1,168
Transport			0		2,358			3,976		6,334
Government			0	4,163						0
Commercial			0	917						0
Agro-industries			0							0
Others			0							0
TOTAL	**15,084**	**26,816**	**41,900**	**6,793**	**2,358**	**0**	**1,168**	**3,976**	**0**	**7,502**

Sources: Mission Estimates (February 1991).

Notes:
(1) Jet A1 for international flights, Avgas used for Air Tungaru domestic flights.
(2) Private power generation estimated at 350 kWh with losses at 17.4% (3% station & 13.4% T/D). Fuel consumption for private power generation estimated at .46 L/kWh.
(3) Cooking and lighting. Population data as estimated from 1985 census (71,100, 35% urban). Biomass consumption based on Abaiang/Tarawa cooking patterns (1985 surveys). Assume 7.2 persons/urban HH with 91% of urban population using biomass and 5.7 persons/rural HH with 100% rural population using biomass. Rural consumption is estimated at 3,900 kg/HH/year (1.9 kg/cap/day), urban consumption is estimated at 3,100 kg/HH/year (1.2 kg/cap/day). Biomass consumption is therefore as follows:
Urban: 71,100 people x 35% x 1.2 kg/cap/day x 91% x 365 days/year/1000 kg/tonne = 9,900 tonnes
Rural: 71,100 people x 65% x 1.9 kg/cap/day x 100% x 365 days/year/1000 kg/tonne = 32,000 tonnes
Total Household Biomass consumption (assumed to be 64% coconut waste and 36 % fuelwood) = **41,900 tonnes**
(4) Household consumption of private electricity estimated at 25% of private generation: 350 kWh x 25% = 88 kWh; balance consumed by commercial sector.
(5) Energy Balance does not include consumption of Lubes (170 kl).

TABLE 3b

KIRIBATI, ENERGY BALANCE, 1990
(TOE)

	Fuelwood	Coconut Residues	Total Biomass	Electricity	Gasoline	Jet A1	Kerosene	ADO	Avgas	Petroleum[5]	Total Energy
Primary Supplies:											
Production	6,335	9,064	15,399							0	15,399
Imports[1]					1,904	1,469	1,009	5,599	470	10,451	10,451
Bunkering/Exports						(1,469)			(470)	(1,939)	(1,939)
GROSS AVAILABLE	**6,335**	**9,064**	**15,399**	**0**	**1,904**	**0**	**1,009**	**5,599**	**0**	**8,512**	**23,911**
Conversion:											
Public Power Generation[2]				2,024				(2,024)		(2,024)	0
Transformation Losses				(1,329)							(1,329)
Station use				(8)							(8)
Transmission/Distribution Losses				(112)							(112)
NET SUPPLIED	**6,335**	**9,064**	**15,399**	**574**	**1,904**	**0**	**1,009**	**3,575**	**0**	**6,488**	**22,461**
Final Consumption:											
Households[3,4]	6,335	9,064	15,399	145			1,009			1,009	16,553
Transport					1,904			3,575		5,479	5,479
Government				352							352
Commercial				77							77
Agro-industries											0
Others											0
TOTAL	**6,335**	**9,064**	**15,399**	**574**	**1,904**	**0**	**1,009**	**3,575**	**0**	**6,488**	**22,461**

Sources: Mission Estimates (February 1991).

Notes:
(1) Jet A1 for international flights, Avgas used for Air Tungaru domestic flights.
(2) Private power generation estimated at 350 kWh with losses at 17.4% (3% station & 13.4% T/D). Fuel consumption for private power generation estimated at .46 L/kWh. Transformation losses account for approximately 66% of energy in fuel.
(3) Cooking and lighting. Population data as estimated from 1985 census (71,100, 35% urban). Biomass consumption based on Abaiang/Tarawa cooking patterns (1985 surveys). Assume 7.2 persons/urban HH with 91% of urban population using biomass and 5.7 persons/rural HH with 100% rural population using biomass. Rural consumption is estimated at 3,900 kg/HH/year (1.9 kg/cap/day), urban consumption is estimated at 3,100 kg/HH/year (1.2 kg/cap/day). Biomass consumption is therefore as follows:
Urban: 71,100 people x 35% x 1.2 kg/cap/day x 91% x 365 days/year/1000 kg/tonne = 9,900 tonnes
Rural: 71,100 people x 65% x 1.9 kg/cap/day x 100% x 365 days/year/1000 kg/tonne = 32,000 tonnes
Total Household Biomass consumption (assumed to be 64% coconut waste and 36 % fuelwood) = **41,900 tonnes**
(4) Household consumption of private electricity estimated at 25% of private generation: 350 kWh x 25% = 88 kWh; balance consumed by commercial sector.
(5) Energy Balance does not include consumption of Lubes (170 kl).

TABLE 4a

KIRIBATI: ENERGY BALANCE, 2000
(Original units)

	Fuelwood (tonnes)	Coconut Residues (tonnes)	Total Biomass (tonnes)	Electricity (MWh)	Gasoline (kl)	Jet A1 (kl)	Kerosene (kl)	ADO (kl)	Avgas (kl)	Total Petroleum[10] (kl)
Primary Supplies:										
Production	16,212	28,820	45,032							0
Imports			0		3,066	1,700	1,275	9,619	600	16,260
Bunkering/Exports[1]			0			(1,700)			(600)	(2,300)
GROSS AVAILABLE	16,212	28,820	45,032	0	3,066	0	1,275	9,619	0	13,960
Conversion:										
Power Generation[2]			0	14,376				(4,088)		(4,088)
Station use[3]			0	(431)						0
Transmission/Distribution Losses[4]			0	(1,926)						0
NET SUPPLIED	16,212	28,820	45,032	12,018	3,066	0	1,275	5,531	0	9,872
Final Consumption:										
Households[5,6]	16,212	28,820	45,032	3,005			1,275			1,275
Transport			0		3,066			5,531		8,597
Government[7]			0	6,009						0
Commercial[8]			0	3,005						0
Agro-industries[9]			0							0
Others			0							0
TOTAL	16,212	28,820	45,032	12,018	3,066	0	1,275	5,531	0	9,872

Sources: Mission Estimates (February 1991).

Notes:
(1) Jet A1 for international flights, Avgas used for Air Tungaru domestic flights.
(2) Private power at 1990 estimate of 350 MWh. PUB growth at 5.9% to 14026 MWh. Fuel consumption: .46 L/kWh for small diesels and .28 litres/kWh for large diesels. Total losses at 16.4%.
(3) Station usage estimated at 3%.
(4) T&D losses estimated to be 13.4%.
(5) Cooking and lighting. Population for 2000 estimated using growth rate of 2.1% (87,500, 40% urban). Biomass consumption based on Abaiang/Tarawa cooking patterns(1985 surveys). Assumptions based on 7.2 persons/urban HH with 80% of urban population using biomass and 5.7 persons/rural HH with 90% rural population using biomass. Urban and rural consumptions at 3100 kg/HH/year (1.2 kg/cap/day) and 3900 kg/HH/year (1.9 kg/cap/day). Biomass consumption estimated as follows:
Urban: 87,500 people x 40% x 1.2 kg/cap/day x 80% x 365 days/year/1000 kg/tonne = 12,264 tonnes
Rural: 87,500 people x 60% x 1.9 kg/cap/day x 90% x 365 days/year/1000 kg/tonne = 32,768 tonnes
Total Household Biomass consumption (assumed to be 64% coconut waste and 36 % fuelwood) = **45,032 tonnes**
(6) Household electricity consumption estimated based on 1990 average of 25%.
(7) Government electricity consumption estimated at 50%.
(8) Commercial electricity consumption estimated at 25%.
(9) Copra drying done mainly with solar energy, thus Agro-industry biomass use negligible.
(10) Energy Balance does not include consumption of Lubes.

TABLE 4b

KIRIBATI: ENERGY BALANCE, 2000
(TOE)

	Fuelwood	Coconut Residues	Total Biomass	Electricity	Gasoline	Jet A1	Kerosene	ADO	Avgas	Petroleum[10]	Total Energy
Primary Supplies:											
Production	6,809	9,718	16,527							0	16,527
Imports					2,476	1,469	1,102	8,649	470	14,165	14,165
Bunkering/Exports[1]						(1,469)			(470)	(1,939)	(1,939)
GROSS AVAILABLE	**6,809**	**9,718**	**16,527**	**0**	**2,476**	**0**	**1,102**	**8,649**	**0**	**12,226**	**28,753**
Conversion:											
Public Power Generation[2]				3,676				(3,676)		(3,676)	0
Transformation Losses				(2,461)							(2,461)
Station use[3]				(36)							(36)
Transmission/Distribution Losses[4]				(163)							(163)
NET SUPPLIED	**6,809**	**9,718**	**16,527**	**1,016**	**2,476**	**0**	**1,102**	**4,973**	**0**	**8,550**	**26,093**
Final Consumption:											
Households[5,6]	6,809	9,718	16,527	254			1,102			1,102	17,883
Transport					2,476			4,973		7,449	7,449
Government[7]				508							508
Commercial[8]				254							254
Agro-industries[9]											0
Others								0		0	0
TOTAL	**6,809**	**9,718**	**16,527**	**1,016**	**2,476**	**0**	**1,102**	**4,973**	**0**	**8,550**	**26,093**

Source: Mission Estimates.

Notes:
(1) Jet A1 for international flights, Avgas used for Air Tungaru domestic flights.
(2) Private power at 1990 estimate of 350 MWh. PUB growth at 5.9% to 14026 MWh. Fuel consumption: .46 L/kWh for small diesels and .28 litres/kWh for large diesels. Total losses at 16.4%. Transformation losses account for approximately 66% of energy in fuel.
(3) Station usage estimated at 3%.
(4) T&D losses estimated to be 13.4%.
(5) Cooking and lighting. Population for 2000 estimated using growth rate of 2.1% (87,500, 40% urban). Biomass consumption based on Abaiang/Tarawa cooking patterns(1985 surveys). Assumptions based on 7.2 persons/urban HH with 80% of urban population using biomass and 5.7 persons/rural HH with 90% rural population using biomass. Urban and rural consumptions at 3100 kg/HH/year (1.2 kg/cap/day) and 3900 kg/HH/year (1.9 kg/cap/day). Biomass consumption estimated as follows:
Urban: 87,500 people x 40% x 1.2 kg/cap/day x 80% x 365 days/year/1000 kg/tonne = 12,264 tonnes
Rural: 87,500 people x 60% x 1.9 kg/cap/day x 90% x 365 days/year/1000 kg/tonne = 32,768 tonnes
Total Household Biomass consumption (assumed to be 64% coconut waste and 36 % fuelwood) = **45,032 tonnes**
(6) Household electricity consumption estimated based on 1990 average of 25%.
(7) Government electricity consumption estimated at 50%.
(8) Commercial electricity consumption estimated at 25%.
(9) Copra drying done mainly with solar energy, thus Agro-industry biomass use negligible.
(10) Energy Balance does not include consumption of Lubes.

TABLE 5

KIRIBATI: PETROLEUM CONSUMPTION (kl), 1986–1990

	1986	1987	1988	1989	1990
INLAND (Tarawa)					
Gasoline	1,456	1,418	1,712	2,069	2,058
Kerosene	621	713	733	813	1,018
ADO	4,078	4,409	4,612	4,835	5,327
PUB	na	na	na	na	2,090
OTHERS	na	na	na	na	3,237
TOTAL	6,155	6,540	7,057	7,717	8,403
INLAND (Kiritimati)[1]					
Gasoline	323	329	304	303	300
Kerosene	8	134	150	179	150
ADO	1,012	859	884	850	900
TOTAL	1,343	1,322	1,338	1,332	1,350
INLAND (Tarawa & Kiritimati)					
Gasoline	1,779	1,747	2,016	2,372	2,358
Kerosene	629	847	883	992	1,168
ADO	5,090	5,268	5,496	5,685	6,227
Lubes	126	144	150	161	170
TOTAL INLAND	7,624	8,006	8,545	9,210	9,923
AVIATION (No Bunkers)					
Avgas	295	263	na	636	600
Jet A1	1,036	1,474	na	1,698	1,700
TOTAL AVIATION	1,331	1,737	na	2,334	2,300
TOTAL KIRIBATI TRADE	**8,955**	**9,743**	**na**	**11,544**	**12,223**

Source: Mission Estimates based on discussions with with Kiribati Oil Company.

Note: (1) 1986–1988 actual figures. 1990 estimated.

TABLE 6

KIRIBATI: NATIONAL PUBLIC ELECTRIFICATION SYSTEM

	1985[1]	1986[1]	1987[1]	1988[1]	1989[1]	1990[1]
Consumers[2]:						
Residential	1,804	na	na	1,992	na	2,419
Commercial	248	na	na	252	na	290
Industrial/Government.	253	na	na	259	na	312
Total Consumers	2,305	2,448	2,483	2,503	2,521	3,021
Capacity (KW):						
Installed diesel[3]	2,700	2,700	2,700	3,780	3,780	3,780
Available diesel[4]	1,680	1,680	1,680	2,600	2,600	2,600
Max demand	1,080	1,020	1,200	1,100	1,260	1,324
Output (MWh):						
PUB Generation	5,990	6,371	6,536	6,758	7,233	7,872
Station usage	167	134	148	97	105	88
Total sent out	5,823	6,237	6,388	6,661	7,128	7,784
Distribution losses	1,269	1,181	1,046	902	1,102	1,280
Net consumption	4,554	5,056	5,342	5,759	6,026	6,504

Sources: Public Utilities Board generation and sales records.
Coopers & Lybrand Kiribati Power System Expansion Report.
Mission Estimates (February 1991).

Notes:
(1) Financial year begining 1 July and ending 30 June.
(2) Listed by PUB classification.
(3) Manufacturer nameplate rating. Installed equipment includes 2-300 KW non-operational at Bairiki and Bikenibeu.
(4) Total "de-rated" capacity based on 80-85 percent of nameplate rating of operational units

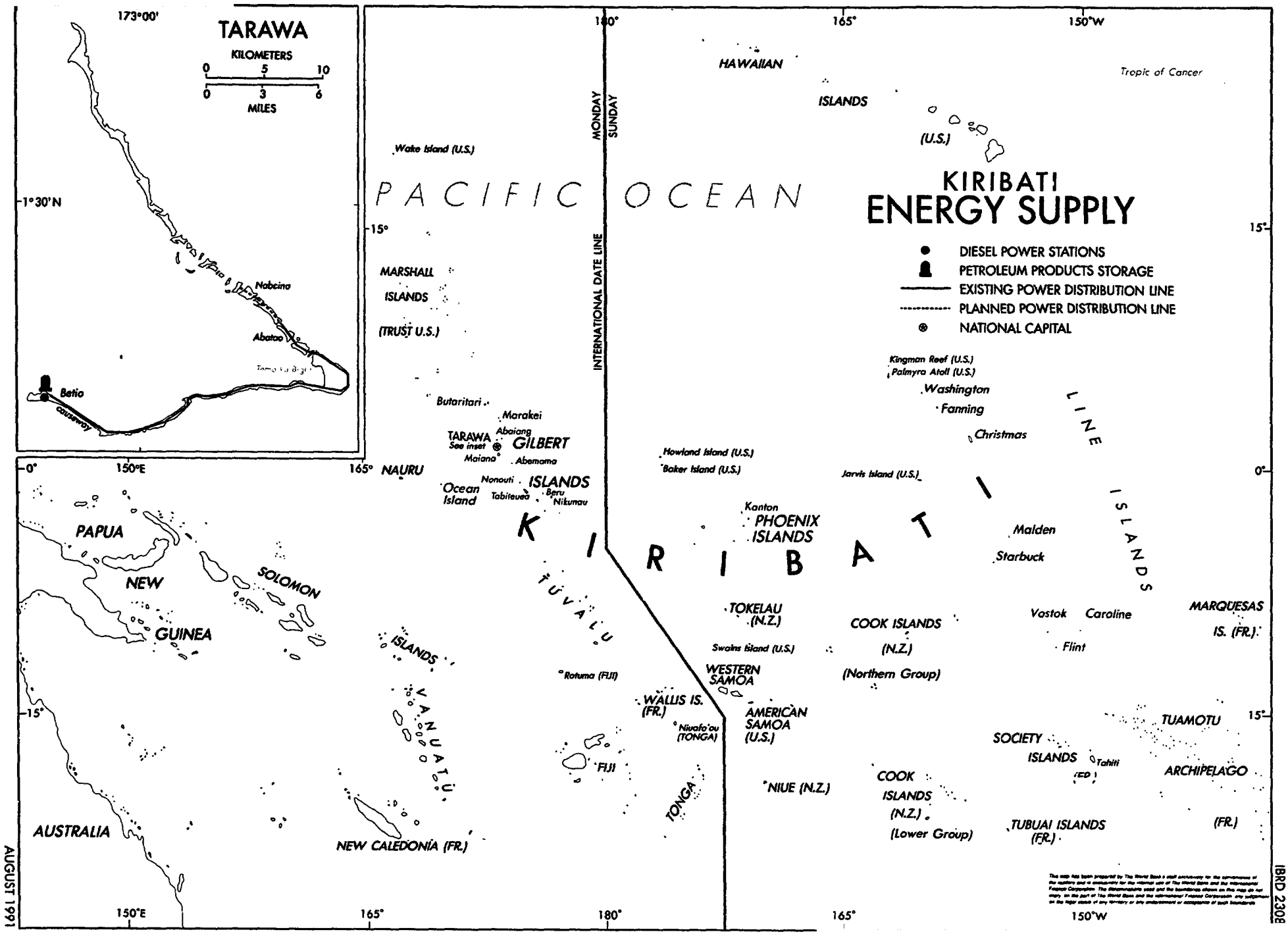
TABLE 7

KIRIBATI: ELECTRIFICATION PERFORMANCE INDICATORS, 1990 PUBLIC UTILITIES BOARD (PUB)

Fixed Assets ('000 AU$)	na
Average Revenue[1] (AU¢/kWh)	44.0
Average Cost (AU¢/kWh)	
Capital	na
Fuel	18.9
Other operating	25.7
Estimated ROI[2] (%)	3.0
Fuel Consumption[3] (l/kWh)	
Main system	0.27
Outer islands	0.46
% Households Electrified[4]	95.0
kWh/year/consumer	2,606
kWh/year/employee[5]	60,554
Employees/MW installed	34
Outages[7]	
Number	na
Ave. duration (hrs)	na
Customers affected (%)	na
Voltage drop/increase	na

Sources: Mission Estimates (February 1991).

Notes:
(1) Includes revenue from electricity sales, interest and sundries.
(2) Rate of Return based on (revalued) fixed assets.
(3) Outer islands fuel consumption estimated.
(4) Mission estimates complete electrification of South Tarawa. However, RE program in progress to electrify part of North Tarawa.
(5) PUB staff level of 130 not including 35 in Water/Wastewater divisions.



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