DRAFT NAURU NATIONAL REPORT

Prepared for:

GEF/ UNDP Pacific Islands Renewable Energy Programme (PIREP)

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1. COUNTRY CONTEXT

1.1 PHYSICAL

Located 41 km south of the Equator at longitude 166º 56´ East and about half way between Sydney and Honolulu, Nauru is a country consisting of a single, isolated, equatorial island. Although only 21 km^2 in land area, Nauru commands an Exclusive Economic Zone (EEZ) of 320,000 km^2. (No map of Nauru?)

Figure 1 – Nauru Coastal Area

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The fringing reef of 120-400 metres width falls rapidly at about a 40º angle to 4000 metres. The land has two separate plateau areas called "bottomside" or coconut land and "topside" or pandanus land. Virtually all the population lives on the bottomside plateau that is 100-300 metres wide all around the 19km of coast and is typically 1-15 metres above sea level. Topside is a central plateau typically 30 metres higher than bottomside with the tallest point 71 metres above sea level. Often the 30 metre difference between bottomside and topside is a sheer cliff although there is easy natural access with several roads leading to topside. Originally, topside consisted of pinnacles and outcrops of limestone with the spaces between filled with soil and high grade tricalcic phosphate rock that is the result of Nauru having been a resting place for Pacific migratory birds for thousands of years. This formation originally covered about 70% of the island and the 1888 discovery of the phosphate has resulted in phosphate mining being the primary economic activity since 1906. Unlike Niue, the only other Pacific country consisting of a single raised coral island, the lower plateau offers easy access to the sea typically with long white sand coral beaches leading down to a very rough reef area liberally studded with 1-4 meter tall limestone pinnacles and large rocks (Figure 1).

There are no natural harbours but deep water exists a short distance outside the reef, so large ships, in particular the freighter owned by Nauru that travels between Brisbane and Nauru via Port Vila and Honaria, can anchor less than 100 metres off shore and a small artificial harbour allows the safe movement of containers and other goods to shore. A second small artificial harbour was constructed by the Japanese Fisheries Department in 1998 at Anibare and provides protection for the unloading of fishing boats up to about 10

metres in length. Fuel can be offloaded from tankers using a flexible pipeline included in the offshore facilities used for loading phosphate ships.

A freshwater lens exists in the porous coral rock and most families tap it for washing and sanitation through wells and a small electric pump. The bottomside lens water is brackish and not suitable for drinking. Water obtained through boreholes topside is probably fresher but has not been significantly tapped as yet although there are plans to do so. Unfortunately there is evidence of both biological and chemical contamination of the freshwater lens so water withdrawn may require substantial treatment before it can be deemed safe for public use. Also there is little knowledge of either the extent of the freshwater lens or of the effect significant pumping may have on the remaining vegetation, particularly on bottomside. A somewhat brackish water lake exists 5 metres above seal level in the bottomside Buada residential area and a few smaller brackish ponds, including one in a cave underground, exist but do not solve the fresh water problem. Nearly all houses and commercial buildings have rainwater catchments but the volume of storage is insufficient for true drought conditions, maintenance is often poor and the production and loading of phosphate for export results in dust plumes that can contaminate water catchments in some areas of the island.

The Nauru Phosphate Corporation (NPC) is responsible for the public water supply. Due to drought conditions, several times in the past fresh water has had to be brought to Nauru by barge at high cost. Since 1994, a distillation type desalination unit operated by the NPC and powered by steam generated from the NPC power plant exhaust heat, has a capacity of 1200 tonnes of fresh water per day when it is working and when the power plant stationary engines are producing about 5.6 MW. The plant also requires an electrical input of around 240kW plus the power needed for pumping in the salt water. The fresh water is delivered by truck to users' storage tanks on demand for a charge of AU$8.00 for 6 tonnes of water. The desalination unit had not been functioning for about 30 months at the time of the April 2004 visit partly because of functional problems related to its age and state of maintenance and partly because NPC uses containerised rental generators that exhaust to the air and cannot provide exhaust heat to the desalination unit. For the desalination unit to function, 6 MW must be on line for starting the desalinator and at least 4.5 MW of generation must be on line feeding the heat to the desalination unit for continued operation. Presently only a single 1.5 MW engine is functioning in the power house; the rest of the 5.5 MW of operational capacity is provided by five containerised rented generators that exhaust their waste heat to the air.

A 125 tonne/day reverse osmosis desalinator unit is currently being used for potable water supply but it also has some functional problems and there is concern for its continued reliable operation. The cost of its operation is also considerably more than the AU$1.67/tonne charged for delivered fresh water. Fortunately, rainfall has been generally adequate to keep local catchments sufficient for needs and water delivery from the NPC has been modest. The 210 room, government owned Meneñ hotel, currently filled nearly to capacity by expatriate contract workers, has its own reverse osmosis desalinator, removing that demand from the NPC fresh water supply. NPC hopes that the waste heat powered desalinator can be back in operation before a drought period creates a major demand for fresh water.

1.2 HISTORICAL AND SOCIAL

Estimates vary but Nauru has probably been occupied for at least 3000 years. Although the people are considered Micronesians, the island was probably discovered by different ethnic groups at different times – there are indications of both Melanesian and Polynesian influences – and their descendents combined to form today's ethnic Nauruans. The language of Nauru is unique and gives few hints of its origins. Traditional Nauru society is matrilineal and is based on 12 tribal groupings.

Figure 1.1 – WWII Japanese fortification

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The first recorded European sighting of Nauru was by the British ship *Hunter* in 1798 when it was given the name 'Pleasant Island'.

Nauru was included in Germany's Marshall Island protectorate in 1888 but in November 1914 at the commencement of WWI, Australia took possession of the island. After Germany's defeat, the island was placed by the League of Nations under the trusteeship of Great Britain, Australia and New Zealand with Australia as administrator. Those countries then soon formed the British Phosphate Commission (BPC) and shared the revenues from phosphate mining.

Nauru was taken over by Japan in August 1942. The Pacific war years found Nauru drawn into the conflict with Japanese aerial attacks and occupation early in the war. In 1943, the Japanese built an airstrip on the island and deported 1200 Nauruans to the island of Chuuk, now a part of the Federated States of Micronesia. Some war relics remain: in 2004 an unexploded Japanese bomb was uncovered while excavating for building foundations and the coastal area has several concrete bunkers remaining as evidence of wartime activity. As a result of the war, phosphate was not exported from 1942 to 1947. At the end of World War II, Nauru was made a United Nations Trust Territory under Britain, New Zealand and Australia, again with Australia as administrator, and it became independent on January 31, 1968.

Table 1.1 – 1992-2002 Population Statistics (percentages)

Age	1992				2002			
	Nauruan		Non-Nauruan		Nauruan		Non-Nauruan	
	Males	Females	Males	Females	Males	Females	Males	Females
0-14	16.60	15.84	4.88	4.51	16.06	14.86	3.87	3.34
15-64	17.07	16.93	11.22	9.99	20.85	21.52	9.07	8.05

65+	0.40	0.68	0.13	0.17	0.44	0.59	0.14	0.12
N.S.	0.72	0.64	0.14	0.09	0.49	0.45	0.11	0.05
TOTAL	**34.79**	**34.08**	**16.37**	**14.76**	**37.83**	**37.42**	**13.19**	**11.56**

.Source: Nauru Bureau of Statistics, 2002 Census pre-release data

Although the 2002 census is not yet fully tabulated beyond basic population statistics, the those show a 2002 population of 10,065 persons of whom 75.25% are ethnic Nauruan. The 1992 census counted 9,919 persons on Nauru with about 68.87% ethnic Nauruan. This represents an overall annual growth of only 0.15%.

Table xxx – Nauru Population 1992-2002

	1992 population	**1992 households**	**2002 population**	**2002 households**	**Average HH Size**	**AAGR %**
Nauru Total	9919	1394	10065	1677	6.0	0.15

Source – 1992 and 2002 Census

The very low rate of increase is largely due to the decreasing number of expatriate contract worker households since 1992 as the rate of phosphate extraction has fallen. Nauru continues to have a very young population with 38.13% of the 2002 population 14 or younger as compared with 41.83% in 1992.

Health problems, particularly diabetes and associated degenerative diseases, are a major problem. Nauru maintains five kidney dialysis machines, more than any other Pacific Island Country (PIC), as they are needed to handle the unusual number of persons with renal failure on Nauru. In the late 1980s, around one-third of the adult population were diabetics. Foods intended for diabetics occupy significant shelf space in grocery shops. Nauru has consistently been low in Pacific rankings regarding life span and high in frequency of lifestyle related diseases. Health officials attribute these problems to a diet consisting almost entirely of imported processed foods, heavy use of soft drinks and alcohol, all combined with low levels of exercise.

Education facilities are available through high school and scholarships have been available for some students to attend secondary school in Fiji and other Pacific Islands. For example, the Hammer de Roburt Scholarship Scheme receives about A$250,000 annually from AusAID for five regional scholarships[1]. Until recently, many teachers have been foreign contract workers but problems with housing and with finances has reduced their numbers dramatically. The education system has had problems maintaining a good student/teacher ratio and in maintaining an acceptable standard of instruction.

USP has a centre in Nauru that could be used for short courses and focused technical training. There is a vocational-technical school on Nauru although its facilities were greatly reduced by a major fire in 2003. Most trades training in technical fields is through

[1] AusAID Country Brief, Nauru (2003)

informal apprenticeships at NPC and on-the-job training although some personnel receive overseas training, mostly in Fiji, Samoa, New Zealand and Australia.

1.3 ENVIRONMENTAL

Until quite recently, there has been no formal gathering of climate data on Nauru. Basic temperature and rainfall data has been collected by NPC since 1916, however, and provides a good picture of the general climate. Fortunately, in late 1998, the Atmospheric Radiation Measurement Programme (ARM) funded by the USA began taking detailed measurements of solar radiation, atmospheric radiation and primary meteorological data. Although the purpose of ARM is basic climatological research, as a by-product Nauru now has the highest quality solar radiation data in the Northern Pacific that includes not only data on global, but also direct and diffuse, radiation.

Figure 1.2 – Solar Instruments at ARM

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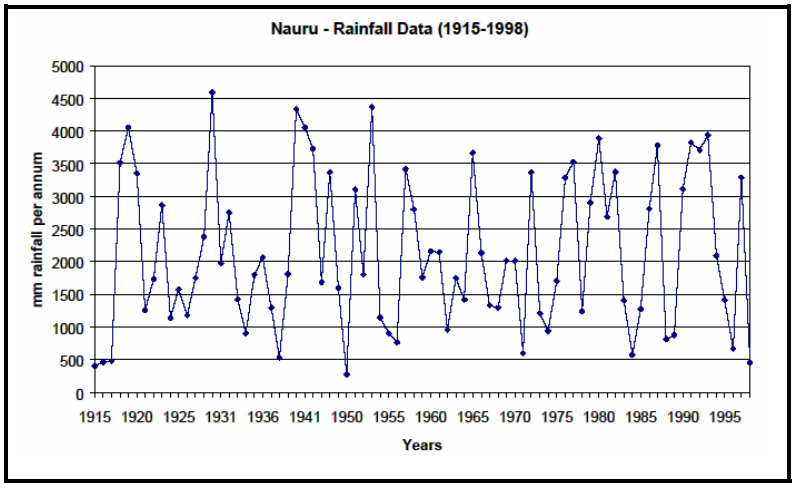
The Australia sponsored SEAFRAME sea level measurement program has had a station on Nauru since 1993 but many more years of data will need to be collected and analysed before genuine long term sea level trends can be determined.

Annual rainfall averages a relatively wet 2125 mm per year but over a 77 year period annual precipitation has ranged from severe drought at 280 mm to very wet at 4590 mm making water supply a particularly difficult problem. The occurrence of severe droughts also has resulted limited biodiversity making Nauru one of the poorest terrestrial ecologies in the world, much less diverse than most of the world's great deserts with only 60 species of indigenous vascular plants on record. Imported economic plants, particularly fruit trees such as breadfruit, often do not survive the severe drought periods. The rainfall cycles are related to the El Niño/El Niña cycle in the Pacific.Figure 1.3 **– Rainfall data for Nauru, 1915-1996**shows the rainfall variations from 1980-1998 indicating their clearly cyclic nature and the disturbing downward slope of the trend line.

Figure 1.3 – Rainfall data for Nauru, 1915-1996



Source – *Climate Change Response, Nauru – 1st National Communication 1999*

Not surprisingly considering its equatorial location and oceanic setting, temperatures remain quite constant the year around averaging about 28º with typically a ±3º diurnal variation.

Wind data has not been gathered with energy production in mind. However the data indicate that there is a low probability of the resource being economically useful for power production. May to November winds are typically easterly from 2.5-5 m/s. December to April winds are typically 5-9 m/s but westerly. Although higher winds are to be expected at some sites, their seasonal nature greatly reduces their economic importance and their seasonal reversal makes locating a suitable site more difficult. One advantage that Nauru has is that cyclones are not a hazard at the Equator although winds up to about 18 m/s can occur.

The interior mining has resulted in drainage of large quantities of silt and soil onto the reef following heavy rains. That has in turn resulted in a reef that is much less productive and diverse in life than the undisturbed reefs of other island countries. The processing and loading of the phosphate also results in plumes of phosphate dust that contaminates rain catchments causing the rain water resource to be reduced in value in some areas of the island.

Coastal erosion is an issue and significant costal change has been recorded as a result of the creation of boat channels and foreshore development.

Table 1.2 - Status of Ratification of Environmental Treaties and Conventions by Nauru

Status in Nauru	? ? (SPREP Convention)	Conservation of nature (Apia Convention)	Hazardous wastes (Waigani Convention)	Nuclear free Pacific (Rarotonga Treaty)	GHG reductions (Kyoto Protocol)	Ozone depleting substances (Montreal Protocol, et al.)
Signed Ratified Entered into force	15 Apr 87 28 Aug 95 22 Aug 90	? no no	16 Sep 95	17 Jul 86 13 Apr 87 13 Apr 87	– 16 Aug 01	Ac: 12 Nov 00

Notes: Treaties & conventions are briefly described in Volume 1, the PIREP Regional Overview report

* The Kyoto Protocol is in force from 15 February 2004 for European Union members only.

Sources: Websites for conventions, PIFS & SPREP (Jan. – March 2004).

Another coastal issue is that of sewage dumping. Household sewage is held in cesspools and septic tanks for pumping into tank trucks. The collected raw sewage is then dumped through a pipeline to a site just beyond the edge of the reef. While this avoids the contamination of the ground water by sewage, it does cause modification of the reef environment and is a potential health hazard.

1.4 POLITICAL

The primary political division of Nauru is into 14 districts. Independence was gained in 1968 forming a republic based on the Westminister parliamentary system. There is a single chamber parliament with 18 members elected for three year terms. The Parliament elects one of its members to be President who acts both as head of Government and Head of State. Elections are held every three years with all resident Nauru citizens 20 years and older required to vote. There are no permanent formal political parties but a loose multi-party system.

Nauru has had frequent changes in leadership brought about by election reversals, resignations, and votes of no confidence, usually following allegations of poor financial management.[2]

The government structure includes:

- President, Minister of Foreign Affairs, Public Service, Women's Affairs and Civil Aviation and Transport, Responsible for Nauru Phosphate Royalties Trust Hon. Ludwig Scotty
- Minister Assisting the President, Finance, Island Development and Industry Telecommunications
- Minister for Works, Housing, Fisheries and Marine Resources
- Minister for Justice and Good Governance
- Minister for Education, Youth Affairs, Culture and Tourism
- Minister for Sports, Health and Transport

Nauru is a member of the Pacific Islands Forum, Forum Fisheries Agency, SPREP, SOPAC and USP, the Pacific Community, the Asian Development Bank (ADB), ESCAP, ICAO, Intelsat (nonsignatory user), Interpol, IOC, ITU, OPCW, Sparteca, SPC, SPF, UNESCO, UPU, and the WHO. Nauru is also a member of the newly formed sub-regional group of Micronesian countries which formed to co-operate on transport and trade links. Nauru became a full member of both the Commonwealth and the United Nations in 1999.[3]

1.5 ECONOMIC

1.5.1 Phosphate

Nauru is one of the three islands of the Pacific having large quantities of phosphate left behind by migrating birds. The others are Banaba in Kiribati and Makatea in French Polynesia. Phosphate mining has been the mainstay of the Nauru economy throughout the 20th Century.

Phosphate was discovered on the island around 1900 and by 1906 mining operations had begun under an agreement signed by the Sydney-based Pacific Phosphate Company and the German government which administered Nauru as a protectorate.

After Independence, Nauru bought the phosphate industry from BPC for $21 million and formed the Nauru Phosphate Corporation (NPC) in 1970 although most of NPC management and technical personnel remained Australian. At the time of Independence about 30% of topside had been mined. In the ensuing years as much as $120 million a year in phosphate was exported. This high rate of export was maintained during the 1970s and through the mid-1980s but then began to decline.

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[2] *Nauru Country Report*, Commonwealth Business Council 2002.
[3] *Nauru Country Report*, New Zealand Ministry of Foreign Affairs and Trade, 2003

The Nauru Phosphate Royalties Trust (NPRT) was set up to invest the profits from the phosphate industry as a source of income for Nauru after the phosphate was depleted. However the NPRT has been a far from transparent operation. Numerous bad investments and unsecured borrowing by the Government to pay budgetary deficits has decimated (reduced by a tenth?) the fund. Ronwan payments are the returns to landowners on profits made by the NPRT. In recent years, there have been no Ronwan payments or if cheques were provided as payment, the Bank of Nauru sometimes has not had sufficient cash available to pay the amount.

Figure 1.5 – Phosphate Shipments 1996-2003

Fiscal Year	Tonnes Shipped	A$ value shipped	A$ per Tonne
1996	551,320	$38,003,000	$68.93
1997	541,050	$35,527,000	$65.66
1998	456,800	$30,302,000	$66.34
1999	648,500	$47,762,076	$73.65
2000	650,791	$48,298,191	$74.37
2001	449,190	$31,333,556	$69.76
2002	161,950	$11,007,445	$67.99
2003	112,900	$7,704,900	$68.25

Source – NPC 2004

Land tenure issues and land owner compensation has been a difficult problem in Nauru as in most of the Pacific. Land owners feel that they have been poorly compensated in the past and have retaliated by failing to renew government leases on properties and land that expired in the early 2000s. As a result government has lost access to housing for expatriate teachers, health workers and technical personnel causing their relocation to the Meneñ Hotel or non-renewal of contracts. Projects requiring land owner cooperation will not be likely to be easy to implement.

1.5.2 The 'Pacific Solution'

In 2001 a Memorandum of Understanding (MOU) between Australia and Nauru was signed allowing Australia to move up to 1,200 asylum seekers who had attempted illegal entry to Australia to camps in Nauru located topside. The MOU provided Nauru $10 million with promises to improve health care, education, waste management and other public infrastructure for Nauru. By 2004 about $20 million had been provided by Australia to Nauru for accommodating the two refugee camps.

Figure 1.4 – Phosphate Cantilevers for Ship Loading

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1.5.3 Other economic activity

Agriculture is limited by land availability and the high labour cost in Nauru. Also, imported insect pests, notably fruit flies and white flies, attack pandanus, guava, mango, papaya, breadfruit and other fruit bearing plants. Although an eradication programme assisted by Australia has apparently succeeded in eradicating three species of fruit fly, the eradication program has slowed and the quarantine procedures used to prevent reinfestation are considered inadequate by Australian experts. Presently there are no agricultural exports and production is almost purely for personal consumption. Attempts have been made to develop commercial egg production but production soon exceeded demand for what were perceived by the market as a low-quality product because of the pale yellow colour of the local egg yolks.

Table 1.3 - Nauru and Regional Economic Treaties

Status	SPARTECA	PACER	PICTA
Signed		18 Aug 2001	18 Aug 2001
Ratified	08 Aug 1982	14 Mar 2003	14 Mar 2003
Entered into force	07 Sept 1982	3 Oct 2002	13 Apr 2003

Source: Discussions with Pacific Islands Forum Secretariat (early 2004)

Coconuts are not a commercial crop and are only gathered for household use. There has been no census of coconut trees but given that the tree cover is very limited, their number is small by Pacific standards. Given the cyclic drought conditions, coconut production can be expected to also be cyclic. Many breadfruit trees died as a result of the 1997 drought and caution is needed in the selection of imported economic tree species due to the wide variation in annual rainfall seen in Nauru.

Figure 1.6 – The Japanese funded harbour at Anibare

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Trials for commercial fishing are now operating with one 18 metre catamaran and one 15 metre catamaran for long line fishing in the Nauru EEZ. Presently the 18 metre boat is undergoing major repairs. The strategy is to provide high quality sashimi grade tuna (big eye and yellow fin) to Japan at a premium price. Each boat has a crew of six with a three person support crew on shore. The small boat goes out on 3 day cruises and the larger boat can stay out about a week. The larger boat carries 7000 litres and the smaller boat has 6000 litres of diesel fuel to power their twin 210 hp Cummins engines. About 75% of the available fuel is used per trip. Trials thus far appear successful with around 1.5 tonnes of fish shipped to Japan per trip at a value of between AU$10,000 and AU$20,000 per shipment. Although the boats were purchased under local budgets, maintenance is assisted by Japan with on-the-job training for local staff since 1999. Increasing the number of operating boats is being considered but budgetary restrictions make it unlikely in the near future.

Except for the modest long line tuna fishing, there is no significant sea based economic activity. Many families have traditional canoes or small outboard powered boats that are used for subsistence fishing. The reef continues to provide households with a source of shellfish and other marine foods but damage due to silt and phosphate runoff keeps productivity low – some estimates put reef productivity at less than 40% of normal.

Although local fishing contributes little to the economy, licenses for fishing in the Nauru EEZ have provided substantial income. Bilateral fishing agreements exist with Japan, the Philippines and Vanuatu, In December 1999 the country signed a three year agreement with the Taiwan Tuna Fishing Association which allows up to 42 boats to enter Nauru waters at a fee of $28,000 per boat to fish in Nauru's EEZ.[4]

INSERT GDP TABLES WHEN PROVIDED

Although in the 1980s, Air Nauru was losing $20 million a year, in recent years the airline has had revenues higher than expenses. The trimming of the airline from 7 jets in the early 1980s to the single 737 now being operated plus operations only on routes where there is no competition or where there is reasonable passenger traffic has turned the finances around. The zero credit available to the airline hampers its operations and from 2000 – 2003 the plane was out of service a number of times due to insufficient cash to pay fuel and maintenance bills. To raise cash (and also to fend off creditors seeking to take possession of the aircraft) the 737 was sold, then leased back to Air Nauru. The airline is considering restoring the north-south Pacific link between Fiji and Majuro, an action that would make travel between the northern PICs and those in the south much more convenient and less costly.

In the hope of increasing income, offshore banking operations were undertaken in the 1990s. According to the 2003 Nauru Country Paper of the New Zealand Ministry of Foreign Affairs and Trade "Nauru has in recent times received criticism for its offshore banking arrangements. Problems are being worked through with the OECD's Financial Action Task Force on Money Laundering (FATF). FATF listed Nauru as one of the World's three most uncooperative money laundering jurisdictions. The recent passing of anti-money laundering legislation which closed Nauru's off-shore banks [2003] has eased the threat of further counter measures."

Nauru still maintains a foreign companies register acting as a tax haven and offers a "one stop shop" for foreign investors to establish and register companies in Nauru. Activities in this area appear to be secret and information could not be obtained regarding the number of companies or the value to Nauru of the maintenance of this registry.

1.5.4 Current fiscal problems

Starting in 1989, Nauru entered into an era of consistent budget deficits. Initially the NPRT was used as collateral for Government borrowing but those assets were largely mortgages. Soon massive borrowing from the Bank of Nauru began resulting in the 1995 collapse of the Bank. Huge debt servicing costs of over $13 million a year on the estimated $280 million government debt have caused a further spiral into debt and the loss of collateral to creditors. In 1998 the ADB began a technical assistance programme

[4] [4] *Nauru Country Report*, Commonwealth Business Council 2002.

focused on improving financial management in Government. The program got off to a good start with an across the board reduction in government budgets and a general restructuring of the civil service but the reforms soon lost headway and further progress has been minimal.

According to Asian Development Outlook 2003:

> *"Attempts to achieve sound economic management are severely hampered by poor-quality planning and budget systems. Budget planning and implementation are haphazard, basic administration is impeded by the breakdown in computing capacity and public accountability is extremely weak.*
>
> *Budget documents are usually treated as confidential and are not made available to the general public, while the accounts of public enterprises and trusts are typically out of date or nonexistent.*
>
> *Immediate priorities for the new government include (i) reducing the large budget deficits, principally be restructuring the public sector wage bill and containing the high cost of overseas representations; (ii) establishing a mechanism to reorganize the Nauru Phosphate Corporation, achieve the company's financial viability , and extract its remaining resources; (iii) improving management and restructuring the portfolio of the NPRT; (4) introducing appropriate legislation to encourage the operation of a reputable commercial bank and to restructure Air Nauru; and (v) repaying existing arrears to government suppliers and tenders"*

Nauru has no import tariffs except duties on imported alcoholic drinks and vehicles. There are no trade restrictions or foreign exchange controls. There is no income tax and no direct tax. After Independence, Government budgets were initially met by exports of phosphate but when phosphate shipments began to slow in the 1990s, government failed to control spending and began borrowing against the Phosphate Royalty Trust, the Bank of Nauru and other assets. By 2003, little was left in the way of liquid assets and Nauru had gone from a nation with huge per-capita cash surpluses to a debtor state dependent on AusAID for meeting basic infrastructure costs.

Since the late 1990s, Nauru has effectively had no credit. Shipping, NPC, Air Nauru and Nauru Telecom have seriously abused their credit and have had services curtailed as a result. The income from the 'Pacific Solution' – roughly $20 million in payments for maintaining refugee camps – has been helpful in meeting immediate cash requirements as has Australia's topside rehabilitation payments and other bilateral aid including financial support of public services.

The GoN and its businesses on Nauru, notably NPC, have not paid full salaries since July 2003. Every two weeks on 'payday' crowds form around the Bank of Nauru office in Aiwo, each person hoping to receive at least something in cash against their pay. To help offset this problem, public services such as water, sewage and electricity bills are not being collected by NPC but as few households have gardens, there remain significant household expenditures for food and transport. No one seems to be going hungry and the many air conditioners are still running, but the financial problems are great and are not going to go away without major structural changes that will strongly affect the life style of all Nauru citizens.

1.5.5 Donor assistance

In 2001-03 Australia provided around $3.0 million annually in bilateral assistance. Also in August 1993, after years of litigation in the International Court of Justice revolving around a suit brought by Nauru for the cost of rehabilitating mined out areas, an out-of-court settlement, the Compact of Settlement, totalling $107 million was signed between Australia and Nauru (of which $12 million comes from New Zealand and $12 million from the UK). In the settlement Australia provided a one time payment of $57 million into a trust fund for Nauru and is to provide a further $2.5 million a year (indexed for inflation) for 20 years to fund a Rehabilitation and Development Cooperation Program. That money is to be used for activities agreed in advance by both parties. A rehabilitation authority was established for the management of those funds. Information as to how those funds have been used for the past decade was requested but was not provided.

Additional funding totalling about $26 million has come from Australia in 2001-2003 for other bilateral activities largely associated with the refugee relocation scheme. Currently Australia has effectively taken over the cost of fuel for the electricity supply on Nauru and has many activities with NPC focused on the rehabilitation of power generators, refitting the fresh water distiller and other public infrastructure.

1.5.6 Rehabilitation

After the fiscal problems, the most pressing issue is rehabilitation of the mined out areas that comprise 80% of Nauru. Although the $107 million Compact of Settlement of 1993 was specifically to undertake rehabilitation of mined out areas, ten years later there is no visible evidence of rehabilitation topside. Numerous ideas have been proposed and studied but has been action minimal and the problem is very difficult. The limestone pinnacles left after the removal of the surrounding rock phosphate make it impossible to use the land unless either soil is imported to replace the phosphate or the pinnacles are removed. Both seem to be almost insurmountable problems and represent a mammoth investment.

Whatever is decided for rehabilitation, it will not be a quick solution. A century of concentrated commercial effort was needed to get topside into its present state and an equally concentrated effort will be needed for its rehabilitation. However the incentive of profits drove the mining; for rehabilitation huge amounts of money will have to be invested and where that will come from is not known.

1.6 INSTITUTIONAL CONTEXT FOR ENERGY

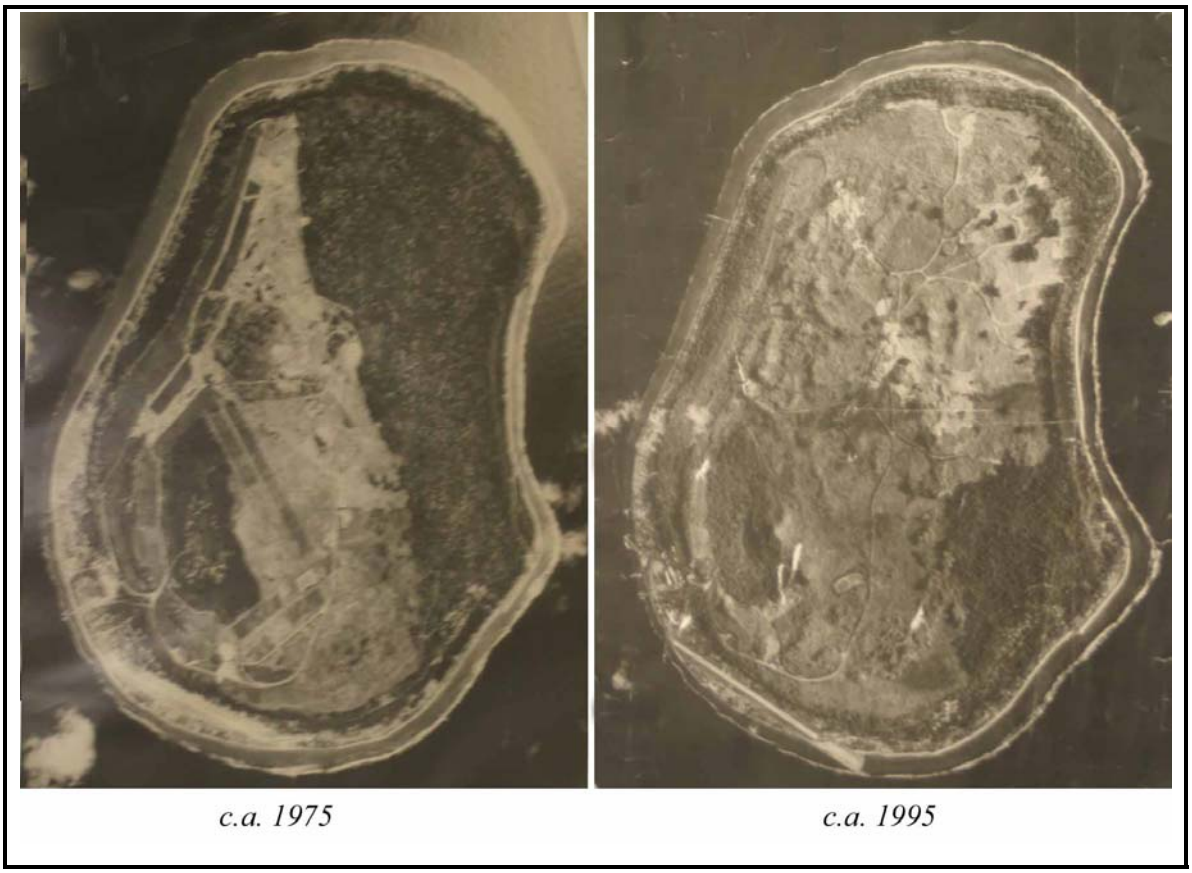
The NPC provides all energy for Nauru except for some liquid petroleum gas (LPG) that is privately imported. As a result the energy infrastructure is well integrated.

There is no Government energy office. Renewable energy is not designated as a responsibility for any government officers and departments interested in renewable energy operate independently. Except for the solar water heaters installed by PWD on new government housing in the 1980s and the Tokyo Electric Power Company (TEPCO) Ocean Thermal Energy Conversion (OTEC) pilot project in 1981, there has been no attempt to utilise renewable energy. A 2005 European Union (EU) project with a

renewable energy focus is being mainly handled by the environment division as the project is viewed within government as an aspect of climate change activities.

Nauru has no personnel with experience in renewable energy development and few with any training at all in either renewable energy or energy efficiency technologies.

Figure 1.7 - Progression of Phosphate mining from about 1975 to 1995



Source – Government of Nauru Aerial Photos (dates estimated)

2 ENERGY

2.1 ENERGY SUPPLY

2.1.1 Petroleum

Operational Structure

NPC remains the sole purchaser and wholesale distributor of petroleum products except for LPG and Jet fuel. LPG is imported privately and NPC has ceased providing Air Nauru with jet fuel due to payment collection problems. Air Nauru now does its own tendering and purchasing although delivery is coordinated with NPC for shipment and storage remains in NPC tanks. Due to prior problems with credit, Mobil and Shell are no longer willing to be contracted as providers to Nauru; all petroleum purchasing is tendered on a shipload basis and payment made as cash on delivery. Supplies come from several sources, although shipment from FSM is common. Ships deliver petroleum products on about a three month cycle. The phosphate ship loading system includes piping for fuel uptake and pumps deliver the fuel to the topside tank farm located about 30 metres above sea level. Due to the need for available cash and the relatively long period between ship arrivals, annual delivery amounts vary greatly.

Table 2.1 - Fuel Deliveries 1999-2003 (litres)

	1999	2000	2001	2002	2003	Average
Petrol	3,118,707	999,542	3,522,926	2,940,131	6,858,850	3,488,031
ADO	10,446,041	3,050,666	8,057,090	18,822,123	7,167,802	9,508,745
Jet Fuel	2,876,808	370,023	1,830,368	2,475,188	547,757	1,620,029
Heavy Oil	852,432	0	0	0	0	
Kerosene	635,142	0	0	0	0	
Waste Oil		877,004	59,132	0	0	

Source - NPC

Table 2.1 shows the fuel deliveries to Nauru for 1999-2003. The large variation from year to year makes it difficult to determine a trend. In general it appears that petrol use has a small increasing trend since 1999 but diesel and jet fuel use do not seem to be changing much over the long term. There is no clear reason to expect significant future growth in the use of petroleum and there is a likelihood of large reductions in the use of diesel fuel if in the future the cost of electricity provision is passed on to users.

Pricing

Pricing of petroleum products is based on CIF cost with a mark up sufficient to cover the cost of handling and storage. Retailers are not regulated as to price. It is not unusual for there to be a shortage of petrol between ship arrivals and retail outlets often voluntarily restrict the size of individual purchases of petrol when supplies are short. There have been times when diesel fuel supplies also were in danger of running out and NPC instituted rolling blackouts to stretch remaining fuel stocks until the next shipment.

Storage

The NPC tank farm is located above the main NPC processing facility. Although ageing, it appears well maintained and is operated under Australian standards. Australia sends a team for inspection several times a year and the storage meets the required standards. Table 2.2 shows the storage capacity available.

Table 2.2 - Storage Capacity

Product	Total tonnes
ADO	9508 (2 tanks)
Petrol	1624 (2 tanks)
Jet fuel	4030 (3 tanks)
Heavy oil	4862 (2 tanks)

Source – NPC 2004

Heavy oil and waste oil is used only in the phosphate drying kiln and with the presently low level of production, heavy oil is not shipped in as a separate product due to the high cost of shipping a relatively small quantity of that product. Currently the fuel requirement for firing the kiln is around 19 tonnes per week Used lubricating and engine oil is collected by NPC and delivered to the phosphate processing facility in 200 litre drums and when that is not sufficient, diesel fuel is used to make up the difference. Presently, waste oil represents about 20% of the fuel used. Shipping used engine oil from FSM in drums has been tried but the high shipping cost makes it cheaper to use diesel fuel.

Distribution

Distribution is directly from NPC storage by tanker truck. Retail sales of petrol and diesel for boats and vehicles is through private filling stations located in strategic places around the ring road.

2.1.2 Electricity

Institutional Structure

Electricity generation remains part of the NPC structure along with all other public services.

Generation, transmission and distribution system

Although there are thirteen generators at the NPC power plant, only five containerised Cummins diesel powered 800kW units and one Caterpillar 1.5 MW unit are operational. A second 1.5 MW Caterpillar unit is undergoing overhaul and the other units are awaiting parts for repairs. Table 2.3 shows the installed capacity, operational status and approximate age. AusAID is providing funding for the renovation of existing generation units.

AusAID has been paying all generation fuel costs for several years and is paying for the five containerised portable generator units that currently provide the bulk of the power. The 0.8 MW containerised Cummins diesel powered generators have an estimated rental cost of AU$15,000/month each. AusAID also has installed two 550 kVA Cummins generators at the Meneñ hotel, one 550 kVa Cummins generator at each of the two refugee camps and a 250 kVa Cummins generator at the storage warehouse that serves the refugee camps. All the AusAID generators external to NPC operate continuously providing 2.5 MVA of capacity that does not have to be provided by NPC.

Table 2.3 – Installed generators and their mid-2004 status.

Designation	Manufacturer	Nameplate capacity	Status
Engine 1	Ruston	2.5 MW	Out of service, waiting for parts
Engine 2	Paxman	2.MW	Out of service, waiting for parts
Engine 3	Caterpillar	1.6 MW	Out of service, waiting for parts
Engine 4	Ruston	1.8MW	Out of service, waiting for parts
Engine 5	Ruston	1.8MW	Out of service, waiting for parts
Engine 6	Ruston	1.6 MW	Out of service, waiting for parts
Engine 7	Paxman	2 MW	Out of service, waiting for parts
Engine 8	Caterpillar	1.6 MW	In service
AusAID rental	Cummins 1	0.8 MW	In service
AusAID rental	Cummins 2	0.8 MW	In service
AusAID rental	Cummins 3	0.8 MW	In service
AusAID rental	Cummins 4	0.8 MW	Out of service, waiting for parts
AusAID rental	Cummins 5	0.8 MW	In service

Source – *Brief Information on Electrical Power and Water Desalination in Nauru*, NPC 2004

The Cummins container units and the fixed Caterpillar engines average about 3.6 kWh/litre. The older slow speed diesels can go as high as 3.8 kWh/litre.

All transmission is through 11 kV in a ring main configuration. Some of the NPC industrial facilities are distributed at 3.3 kV but all domestic and commercial customers use 415V distribution lines.

Pricing and collection

Prior to about 1990, electricity was effectively provided at no cost in that meters were read but no collections made. The present tariff of AU$0.09 per kWh domestic and AU$0.13 for other users remains far lower than the real cost of production and distribution.

Due to the inability of the GoN and the NPC (who together employ 90% of the salaried persons in Nauru) to pay full salaries, the NPC has not attempted to collect domestic or

government electricity bills since July, 2003, although meter readings are still being taken monthly. Commercial users are expected to pay their bills.

Regulation

There is no formal regulation of the electricity sector although NPC as a government owned corporation must necessarily respond to the requirements of Government regarding pricing and service delivery.

2.1.3 Renewables

There currently is no renewable energy or energy efficiency activity in Nauru.

2.2 ENERGY DEMAND

2.2.1 Petroleum

Transport

There are no data separating land and marine transport fuel use but the great bulk of petrol use is for land transport and the great bulk of diesel fuel use is for electricity generation. No data could be provided regarding the number of vehicles until the 2002 census tabulation is complete.

Air Transport

Air Nauru currently operates one Boeing 737 for international flights. There is no domestic aviation.

Electricity Generation

All electricity generation is by diesel.

Industrial Thermal

During the years when phosphate processing was at a high level, heavy oil was used for firing the drying kiln. In recent years, waste oil supplemented by diesel fuel has been used to fire the kiln since that is lower in cost than the small scale delivery of heavy oil by ship. The requirement varies according to the quantity of phosphate being processed but in the first quarter of 2004 it averaged 19 tonnes a month.

Household Lighting and cooking

The majority of households cook with electricity although increasingly frequent power outages are driving a change to LPG. No domestic use of kerosene remains.

LPG

LPG is imported in filled cylinders, not in bulk so the cost is high relative to Kiribati and FSM where shipments are in container sized cylinders. LPG is imported by NPC and a private company. Usage is small, mainly confined to several Chinese restaurants on Nauru.

2.2.2 Electricity

The peak demand occurs when the calcination plant and the No. 2 cantilever are in operation at lunch and dinner time, typically 6.8 to 7.2 MW due to the heavy use of electric cookers plus the industrial load from NPC. The minimum demand has been around 5.6 MW, only a modest reduction from the peak due to the high percentage of air conditioning and refrigeration in the load. As the industrial load has fallen with falling phosphate production, peaks have dropped to around 6 MW and off-peak loads have dropped as low as 4.2 MW when the phosphate mining and processing plants are no operating. There is no obvious seasonal or weekly variation in load although weekend loading is perceived as slightly higher than week day loads since workers are home but office loads are left running. Although the percentage of the load that is air conditioning is not known, it is high and air conditioners are generally left on 24 hours a day in homes and offices. The 1992 census showed ownership of air conditioners in 65% of all households, of which about half had more than one installed (with one household claiming to have 8 air conditioners). Although 2002 census household data has not yet been tabulated, the number is expected to be even higher. The majority of households still cook with electricity. With the highly subsidised tariff 100% subsidised if no one pays?), electricity remains cheaper for cooking than LP gas but gas is increasing in use to some extent due to the fear of power outages interrupting meal preparation and also due to the perception of gas providing faster, more controlled cooking.

Domestic

In 2000-2001, domestic use of electricity amounted to 18.4 GW. With 1677 households enumerated in 2002, electricity use per household is one of the highest in the Pacific with an average use of 915 kWh/month. That high value is largely due to electric cooking and the heavy use of inefficient window type air-conditioners. Though the tariff is heavily subsidised at $0.09/kWh, the main reason for this high usage is because people have not been required to pay the bills even though a bill is presented every month. In the 1980s that was because there was the feeling that there was so much money available that there was no need to collect and today it is because there is so little money available that Government and NPC cannot pay full salaries so NPC could not collect if they wanted to. It is certain that this high level of usage will fall rapidly once fiscal responsibility is assumed by Government, customer payment discipline is imposed by NPC and electricity prices rise to be more in line with the real cost of production.

Commercial

A high percentage of commercial usage is for ice making for fish storage, for the two hotels, for the three larger stores and for the numerous Chinese restaurants on the island. The 2001-2002 demand totalled 5,848,607 kWh.

Industrial

The NPC phosphate production facilities represent the only industrial use of electricity in Nauru. In 2001-2002 the demand was 20,400,000 kWh. That changes with phosphate production so it is likely that the industrial energy use has fallen significantly since 2001.

2.3 GHG INVENTORY DUE TO ENERGY USE

2.3.1 Carbon Dioxide

Awaiting Electricity data for finalisation

2.3.2 Opportunities for Reduction

The primary opportunity for reduction is the implementation of a rational price for energy services and disciplined collection of power bills. Electricity generation can easily be cut by 50% through the elimination of unnecessary loads and the switching off of appliances when not actually in use. Until this is done, no renewable energy activity to replace petroleum imports makes any sense.

3 RENEWABLE ENERGY

3.1 RESOURCES

3.1.1 Solar Resource

As can be expected from an equatorial location, solar radiation is high. ARM measurements indicate an average of about 5.8 kWhr/m^2/day with only modest seasonal variation.

Due to a relatively high frequency of clouds, tracking the sun or concentrating the resource using reflectors or optics does not result in increases over the output from fixed photovoltaic panels that are sufficient to cover the added cost of purchase, installation and maintenance. As a result, only solar photovoltaic based electricity production appears to be technically appropriate; solar thermal systems cannot consistently achieve a high enough operating temperature to be economically effective.

3.1.2 Wind Resource

There has been no attempt to measure the energy content of wind on Nauru. Existing meteorological measurements indicate strong directional and speed seasonality with the period from May to November showing easterly winds in the 2.5-5 m/s category and December to April showing westerlies in the 5-9 m/s range. No data are available of either energy content or variability.

The absence of cyclones is a major advantage for the use of wind in Nauru but the seasonality of the wind speed makes it difficult to economically justify wind power although the very high cost of electrical energy on Nauru is in its favour. Additionally, the directional change from easterly to westerly makes it more difficult to choose a site for wind turbines that is optimal the year around. In any case, until measurements specifically for wind energy determination are taken and analysed, the actual economic value of wind energy for electric power generation remains in the realm of speculation.

3.1.3 Biomass Resource

Figure 1.7 shows the progressive loss of biomass due to mining. By 2004, virtually all but a small coastal area had been stripped of trees. Although it is conceivable that rehabilitation efforts could recover a major part of the biomass resource lost to mining, for the near term the resource is inadequate to form the basis of any significant energy producing effort. Less than 15% of the land area has not been mined or cleared for human habitation. This represents only about 3 km^2 of land available for biomass production, insufficient to provide much energy benefit and that land is much more valuable for economic trees such as breadfruit and coconut than for growing fuel.

Biofuels also are conceptually possible for future development with coconut plantations being possible as part of the topside development. However, the concept lies many years into the future and at present the coconut resource is only sufficient for household use.

Biogas generation in small quantities is also possible utilising the waste from the pigs and chickens on the island. However the numbers are small and the animals not concentrated sufficiently to make biogas an economically interesting energy resource.

3.1.4 Hydro Resource

Nauru has no hydro resource.

3.1.5 OTEC Resource

OTEC resources appear excellent. Not only is Nauru in a high surface temperature area of the ocean, the island has a rapid drop off from the edge of the reef to 4000 metres allowing a land based OTEC plant to be built, clearly a better economic option than a floating plant.

3.1.6 Geothermal Resource

No developable geothermal resource is known to exist nor is one likely.

3.1.7 Wave Energy Resource

In general, the wave energy resource is modest in comparison to higher latitude island countries. Although there has not been a wave energy resource assessment in Nauru, it is probably similar to that of Kiribati with wave power ranging from 10 kW/m to 15 kW/m, a relatively low energy level that is not very attractive for wave power generation.

3.2 APPROPRIATE TECHNOLOGIES FOR DEVELOPMENT

The renewable energy technologies that provide the most promise are solar and OTEC with wind a possibility that needs further resource study.

3.2.1 Solar Thermal

Although the climate is not appropriate for the use of solar thermal energy for electricity generation, it is appropriate for water heating using solar energy. Nauru has a significant percentage of housing that, from the type of system design and condition, appear to have installed solar water heaters in the late 1980s. An interview with the Director of Public Works confirmed this and he noted that the installations were included on new housing built by Government in that period. Most of the installed water heaters are of the thermosiphon type with a separate storage tank inside the building. By 1990, around 30% of the housing stock included solar water heating. Unfortunately, today the units appear poorly maintained and in several cases were installed improperly, so their present utility is questionable and interviews indicate that few still work.. Modern combined tank/collector units of the Solahart type are seen on Nauru homes but only rarely. Since solar water heaters quickly clog with calcium carbonate scale when Nauru ground water is circulated through them, they require frequent maintenance unless rain water or desalinated water is used for heated water use. Although the significant economic advantage of solar water heating over electric based water heating should be made known to households, the priority for hot water in Nauru homes needs to be evaluated and incentives developed only if it is known that there is significant electricity based water heating that can be replaced by solar heaters.

In theory, solar distillation is a possible means of producing fresh water and has been used in the past where fresh water availability was low. However, thousands of square metres of collection surface would be needed to produce the volume of fresh water needed by Nauru making the technology costly. The high cost of the facility combined with the problems of land tenure on Nauru makes solar distillation less attractive than other means of fresh water production.

3.2.2 Solar photovoltaics

The most common use of solar photovoltaics in the Pacific has been for the electrification of isolated, rural homes having energy requirements limited to lighting and entertainment appliances under 20kWh/month. Nauru is fully electrified by the grid and the average household use is over 1000 kWh/month making it unreasonable to replace the grid connection by a stand-alone, household solar power system.

Figure 3.1- Domestic solar water heater installation

Herb Wade 2004

However, the high cost of electricity supply does make the use of solar photovoltaic panels to supplement the diesel generation a possible application if a connection is directly made and no storage battery included in the system. In 2002, a French consultant, reporting on a pre-feasibility study for the upcoming €1.5 million EU project for Nauru, recommended that Nauru consider the installation of at least 100 peak kilowatts (kWp) of grid connected solar photovoltaics topside as part of rehabilitation efforts. Certainly the operating and maintenance cost for such a project would be modest and this could be economically reasonable if a donor organisation such as the EU were to provide the majority of the capital investment. Grid connected PV systems have been operational in the USA, Japan and Europe for nearly 20 years and a significant component of German and Japanese renewable energy investments in recent years have been for grid connected systems. In the Pacific, trials of a 10kW grid connected system in Fiji have been underway for almost 7 years and a feasibility study of a 1 MW PV installation is being considered by the Fiji Electricity Authority.

The approach recommended by the consultant, that of a single large 100 kWp array of solar panels, should be reviewed. World experience with grid connected solar photovoltaic systems has shown that distributed arrays in modules of from 3-10kWp each are not only more cost effective than a single large array, they also are practical for roof mounting on public buildings thereby totally avoiding the problem of land tenure faced by ground based arrays. Also by distributing the modules over a wide area, power swings on partly cloudy days are greatly reduced.

3.2.3 OTEC

OTEC shares with geothermal energy the significant advantage over solar, wind and wave power that it can provide continuous steady power indefinitely without fuel inputs. Solar, wind and wave power vary unpredictably according to weather conditions and cannot provide steady power without expensive batteries or other forms of energy storage.

Since about 1999, the University of Saga (Japan) has been promoting the OTEC design created by their President, Mr. Hauro Uehara, in the Pacific. Designs based on the Uehara thermal cycle are claimed to allow economically attractive construction of OTEC plants in the 3 MW power range, a power level considered too small to be cost effective with earlier designs. Trials of a floating 1 MW Uehara Cycle plant constructed on a barge off the coast of India were planned for 2003 but have been delayed due to serious engineering problems with the intake pipe, so the system remains essentially untested.

Hawaii based OTEC expert, Dr. Luis Vega, notes that "Technical and economic studies as well as experimental work have been conducted by numerous private and public entities in France, Japan and the USA. It was concluded that, for example, in Hawaii electricity production with OTEC technology is cost effective for 50 MW or larger plants. This conclusion is independent of the type of OTEC power cycle (i.e., Open, Closed, Kalina or Uehara) utilized. Moreover, it was concluded that commercialization ought to be preceded by the design, installation and operation of a pre-commercial plant sized at about 2 to 5 MW."

"The situation in some Pacific Island Nations is such that smaller OTEC plants (e.g., 1 to 10 MW) configured to produce desalinated water in addition to electricity could be cost effective. However, because the technology is presently not commercialized, proposed installations in independent island states must be implemented without any financial responsibility assumed by their governments."[5]

3.3 PROJECT EXPERIENCE

3.3.1 Past Projects

Although PWD included solar water heating on new government home construction in the 1980s and a few solar panels were imported more as a novelty than for technical trials, no other devices for renewable energy use have been installed in Nauru except for the first trial of an OTEC plant in the Pacific Islands.

In 1981 and 1982, the Tokyo Electric Power Company (TEPCO) in association with Toshiba installed and began technical trials of a mini-OTEC facility at the west coast of Nauru on the shore across from the Civic Centre in Aiwo. The facility had a gross power continuous rating of 100 kW and was expected to provide a net power of around 14.9 kW. The design was of the closed cycle low pressure turbine type and used Freon 22 as the working fluid. Very expensive titanium heat exchangers were used to provide high efficiency heat exchange at the low temperatures used in the plant.

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[5] Vega, Luis "Ocean Thermal Energy Conversion Primer" Marine Technology Society Journal, Vol. 36, No. 4, pp 25-35, Winter 2002/2003

The design was to use a 27.8 kW peak rated pump to bring 0.395 m^3/s of warm 29.8° surface water into the facility on the hot side. For the cold side, a 43.3 kW peak rated pump brought water at 7º from 580 metres deep through a 700 mm polyethylene inlet pipe 945 metres long at a flow rate of 0.382 m^3/s. A Freon pump rated at 15.3 kW peak circulated the working fluid at 74 tonnes/hour and a 2.5 kW pump provided high pressure oil for the bearings of the 3000 rpm axial flow turbine. Although intended for 100kW continuous operation, the system flows could be increased to provide a maximum of 120 kW gross which delivered a maximum net power of 31.5 kW.

At the time, the Nauru installation was the first land based OTEC plant in the world to produce net power, it was the highest power OTEC plant ever operational and the first to feed power to an operating commercial grid. It was known that it would not be a cost effective power supply for Nauru when it was installed and the system was not intended as a permanent installation but only a technical trial and it actually operated as a power generator feeding the Nauru grid for only 240 hours (a record for OTEC at the time, the 50 kW Hawaii mini-OTEC built about the same time ran only 110 hours). The actual cost is not available but estimates go higher than US$1 million, all paid by TEPCO and Toshiba.

Since that early installation, there have been significant improvements in high efficiency low temperature heat exchanger designs, eliminating the need for the use of very expensive titanium metal. Additionally, an open cycle OTEC system has been successfully operated in Hawaii. That design would be of particular interest to Nauru since a side benefit is the production of large amounts of fresh water. Also, the large volume of nutrient rich 7º water could be used for district air conditioning and aqua culture providing significant additional side benefits.

Shortly after tests were complete, a storm destroyed the inlet pipe and the facility was dismantled.

Lessons Learned for Nauru

- A land based, closed cycle OTEC plant can work in Nauru
- Solar water heaters require proper installation and maintenance if they are to work for the long term

3.3.2 Current Projects

None

3.3.3 Confirmed Future Projects

The European Union has allocated € 1.5 million for development of renewable energy and/or energy efficiency projects in Nauru. The pre-feasibility study proposed both energy efficiency measures and 100 kW of grid connected solar photovoltaics. The project start has been delayed until 2005 at which time it is expected that further project development and feasibility studies will take place before a final project design is accepted. The funds are specifically not to be directed toward experimental technologies, only those that have been commercially proven and preferably have had some prior success in the Pacific islands. Completion of the project is unlikely before 2008.

3.3.4 Proposed Projects

- A wind power resource study is proposed for topside sites
- Promotion of energy efficiency measures for domestic and commercial customers of NPC with emphasis on water heating, air conditioning and electric cooking. The project should includes audits, component selection, component import, component purchase finance and installation

3.4 BARRIERS TO DEVELOPMENT AND COMMERCIALIZATION

The following list of barriers was developed through interviews and situation analysis

- The financial situation in Nauru precludes any capital intensive activity not fully funded by donors
- The small population and its lack of adequate technical capacity is a major barrier to successful development of renewable energy and energy efficiency measures
- The country is too small to support the sufficiently large energy oriented private sector necessary to consistently provide high quality in design, installation and maintenance support of energy systems
- There is no government support for energy development through policy measures, manpower allocation or budget
- Public services operations remain massively subsidised making sustainable development difficult
- Public awareness of energy efficiency measures and renewable energy is very low
- The public sector financial crisis limits energy development options while preventing proper maintenance of existing energy systems
- There is no effective banking institution in Nauru that can provide finance for private enterprise development or personal purchases of renewable energy equipment such as solar water heaters

3.5 IMPLICATIONS OF LARGE SCALE RENEWABLE ENERGY USE

Since biomass does not represent an energy supply resource, only solar and wind technologies are practical for the near term use of renewable energy. Without energy storage, solar can only provide fuel saving during the day and cannot deliver more than about 20-25% of the electricity demand at any time without concern for the stability of the grid as the passage of clouds turns the solar power on and off. With a distributed system, land use issues can be avoided and power stability issues are reduced though the limit remains on the order of 25% of demand by PV. There is no capacity benefit for solar since there is no power at night and clouds can interrupt generation during the day so full capacity has to be retained in the diesel system.

Wind power also cannot provide more than about 20-25% of electricity demand but can provide power at night. Unfortunately wind resources are variable and there will be periods of calm, so there is no capacity benefit from the wind; there still needs to be full availability of power from diesel.

Energy storage in batteries and other forms is possible but at the scale needed to significantly impact the electric power system on Nauru it is prohibitively expensive. It is technically possible to use photovoltaics or wind to generate hydrogen as a storage medium and use fuel cells for power generation but the technology is not yet available to economically generate and store hydrogen or for electricity production from fuel cells that is comparable to the cost of diesel generation.

OTEC offers hope for renewable energy based generation that could provide a large scale reduction or even eliminate diesel generation but the technology remains decades from commercial application.

In the distant future, topside rehabilitation may have progressed to the point where biofuel plantations could be possible but today no firm plans for such development are in place.

4 ENERGY EFFICIENCY

4.1 PETROLEUM USE

The primary use of petroleum is for Air Nauru and for NPC power generation. Ground transport use is significant but about one-third the use of diesel and jet fuel. There is little opportunity at this time for improvement in marine use efficiency since usage appears quite low. Access to the reef and open ocean for fishing is easy and most subsistence fishing is done from traditional wooden canoes or through short trips using outboard equipped aluminium boats. Currently there are trials for a locally based commercial fishing but usage is low.

On a per-capita basis, vehicle ownership is high. In 1992, more than one vehicle per household was reported. 2002 numbers are reportedly similar although actual data could not be made available. Motorcycles are also a common means of transport with 1992 figures indicating that about half of the households owned at least one. There is reason to believe that the average fuel efficiency of the 2002 vehicles is better than those of 1992 but no specific data could be obtained. In any case, it is clear that personal transport could benefit from improved efficiency of fuel use since vehicle maintenance tends to be poor and vehicle occupancy low. There is no formal public transport although private vans and modified Land Rovers circulate the island carrying passengers for hire. There are some buses on island and when petrol is in short supply, government and NPC employees may receive free bus transport.

4.2 ELECTRICITY SUPPLY

The electricity supply system has been neglected for a decade or more and generation has become a hodge-podge of containerised, old and middle-aged fixed machines. Reliability of supply is poor with several hundred outages a year. Because of the poor reliability of power, the Meneñ Hotel, which is now mainly used for housing expatriate workers employed by government and the OIM (the operator of the refugee camps), has its own generation (provided by Australia) in the form of a pair of 550 kVA diesel generators and each of the two refugee camps also has its own power supply consisting of a 550 kVA diesel generator. The supply warehouse used by OIM to support the refugee camps is also continuously powered by a 240 kVA diesel generator.

The technical losses and fuel efficiencies for the engines are not known but it is known that there is room for significant improvement both in generation and in distribution efficiencies.

4.3 ELECTRICITY USE

Electricity use per household is more than double that of Palau, the second highest household electricity user in the Pacific. It is more than 30 times greater than household electricity use in urban Kiribati. Clearly this is a place where tremendous reductions in both demand and energy are possible. However, as long as electricity is provided at far below its real cost – effectively at zero cost to domestic and Government consumers in 2004 – it is unlikely that attempts to curb energy use through anything but unit price increases and disciplined collection of payments will have any effect.

5 IMPLEMENTATION AND CAPACITY DEVELOPMENT NEEDS

5.1 PETROLEUM

NPC has long experience in dealing with petroleum tenders and shipping costs and there is no clear need for capacity development in this area.

5.2 ELECTRICITY

Although there is a problem with the availability of skilled mechanics and electricians for the power sector, the problems with the power system are more basic and capacity development for staff is not likely to be of much immediate benefit. If the government finally faces its fiscal responsibilities and restructures its finances so that it possible to rehabilitate the power system in other than a crisis environment, capacity development will be important.

5.3 RENEWABLES

Capacity development will be required in association with the EU project. Although initial training of personnel responsible for project installation and maintenance will undoubtedly be provided under the EU project, continuing training after the project period ends will not. Therefore some process for maintaining a high level of competence for maintenance of the installed system will have to be developed for implementation by about 2008. It would be reasonable for the EU to co-finance a long term training programme with the GEF or other external agency with the EU developing the immediate training and the co-financing organisation developing the follow-on training development.