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Pacific Islands Renewable Energy Project

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The Secretariat of the Pacific Regional Environment Programme

Pacific Regional Energy Assessment 2004

An Assessment of the Key Energy Issues, Barriers to the Development of Renewable Energy to Mitigate Climate Change, and Capacity Development Needs for Removing the Barriers

VANUATU National Report Volume 16

SPREP IRC Cataloguing-in-Publication Data

Johnston, Peter
Pacific Regional Energy Assessment 2004 :
an assessment of the key energy issues, barriers
to the development of renewable energy to
mitigate climate change, and capacity development
needs to removing the barriers : Vanuatu National
Report / Peter Johnston; John Vos. – Apia, Samoa : SPREP, 2005.

xvi, 75 p. : figs., tables ; 29 cm. – (Pacific Islands
Renewable Energy Project. Technical report ; no.16)

"This report is based on data gathered by a
PIREP team consisting of Ruben Bakeo, Anare Matakiviti,
John Vos and Peter Johnston".

ISBN: 982-04-0301-4

1. Energy development – Vanuatu. 2. Energy sources,
Renewable – Vanuatu. 3. Energy research – Vanuatu
4. Conservation of energy resources – Vanuatu. 5.
Conservation of natural resources – Vanuatu. 6.Energy
consumption - Climate factors – Vanuatu. I. Bakeo,
Ruben. II. Matakiviti, Anare. III. Vos, John. IV. Pacific
Islands Renewable Energy Project (PIREP). V. Secretariat
of the Pacific Regional Environment Programme - (SPREP).
VI. Title. VII. Series.

333.794159595

Currency Equivalent:	US$ 1.00 = Vatu (Vt) 110 in March 2004 (but highly variable around the time)
Fiscal Year:	1 January – 31 December
Time Zone:	GMT/UTC +11 hours

This report is based on data gathered by a PIREP team consisting of:

Mr Ruben Bakeo	National PIREP Coordinator
Mr Anare Matakiviti	SOPAC Energy Adviser / National PIREP Consultant
Mr Peter Johnston	International PIREP Consultant; and
Mr John Vos	International PIREP Consultant

The consultants visited Vanuatu in January and early February 2004. Because a suitable national consultant was unavailable at that time, SOPAC provided the services of its Energy Adviser. In addition to discussions in Port Vila, there were field trips to visit renewable energy projects (and potential project sites) on the islands of Efate and Espiritu Santo. Unfortunately the head of Government Energy Unit and several other key staff were unavailable for discussions during the mission's visit. The local offices of the international oil companies were unwilling to provide any information on their product sales, an omission that has hindered some analysis. This report reviews the status of energy sector activities in Vanuatu through February 2004.

An earlier draft of this report was reviewed by the Vanuatu National PIREP Committee (the National Advisory Committee on Climate Change), which provided thoughtful, useful and substantive feedback, and by Secretariat Pacific Regional Environment Programme (SPREP), United Nations Development Programme and others. However, the contents are the responsibility of the undersigned and do not necessarily represent the views of the Government of Vanuatu, SPREP, UNDP, the Global Environment Facility, the NACCC/PIREP committee or the many helpful individuals who provided the information on which the study is based.

Peter Johnston

John Vos

October 2004

ACRONYMS

AAGR	Average Annual Growth Rate
AC	Alternating Current
ACP	African, Caribbean, Pacific countries
ADB	Asian Development Bank
ADO	Automotive Diesel Oil
BP	British Petroleum
CCA	Common Country Assessment (UN)
CIF	Cost+insurance+freight
CPI	Consumer Price Index
CROP	Council of Regional Organisations of the Pacific
DC	Direct Current
DESP	Department of Economic and Sector Planning
DPK	Dual Purpose Kerosene
DSM	Demand Side Management for efficient electricity use
EC	European Community
EDF	European Development Fund
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ENSO	El Niño/El Niña oceanic climate cycle
EPC	Electric Power Corporation
ESCAP	Economic and Social Commission for Asia and the Pacific (UN)
EU	Energy Unit (of the Government of Vanuatu)
E.U.	European Union
EWG	Energy Working Group of CROP
FY	Fiscal Year
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GMT/UTC	Greenwich Mean Time/Universal Time Coordinate
GNP	Gross National Product
GTZ	Deutsche Gesellschaft für Technische Zusamenarbeit (German Tech. Cooperation)
HF	High Frequency
JICA	Japan International Cooperation Agency
kV	Kilo-Volts (thousands of volts)
kVA	Kilo-Volt-Amperes (Thousands of Volt Amperes of power)
kW	Kilo-Watt (Thousands of Watts of power)
kWh	Kilo-Watt-Hour (Thousands of Watt Hours of energy)
kWp	Kilo-Watts peak power (at standard conditions) from PV panels
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goals

MOU	Memorandum of Understanding
NASA	US National Aeronautics and Space Administration
NCCP	National Climate Change Policy
NEC	National Energy Corporation (proposed)
NORAD	Norwegian Agency for International Development
OPEC	Organisation of Petroleum Exporting Countries
OTEC	Ocean Thermal Energy Conversion
PACER	Pacific Agreement on Close Economic Relations
PEDP	Pacific Energy Development Programme (UN 1982-1993)
PIC	Pacific Island Country
PICCAP	Pacific Islands Climate Change Assistance Programme (GEF/UNDP)
PICTA	Pacific Island Countries Trade Agreement
PIEPSAP	Pacific Islands Energy Policies and Strategic Action Planning
PIFS	Pacific Islands Forum Secretariat
PIREP	Pacific Island Renewable Energy Project (GEF/UNDP)
PPA	Pacific Power Association
PREA	Pacific Regional Energy Assessment (1992)
PREFACE	Pacific Rural Renewable Energy France-Australia Common Endeavour (SPC)
PREGA	Promotion of Renewable Energy, Energy Efficiency and GHG Abatement (ADB)
PV	Photovoltaic
RE	Renewable Energy (not 'rural electrification')
RET	Renewable Energy Technology
SHS	Solar Home Systems
SOPAC	South Pacific Applied Geoscience Commission
SPC	Secretariat of the Pacific Communities
SPREP	Secretariat of the Pacific Regional Environment Programme
SSRF	Sarakata Special Reserve Fund
SWH	Solar water heater
SWOT	Strengths, Weaknesses, Opportunities and Threats
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States
USGIC	United States Geothermal Industries Corporation
USP	University of the South Pacific
V	Volts
WB	World Bank
Wh	Watt hours of energy
WSSD	World Summit on Sustainable Development

Energy Conversions, CO_2 Emissions and Measurements

The following conventions are used in all volumes of the PIREP country reports unless otherwise noted.

Fuel	Unit	Typical Density kg / litre	Typical Density l / tonne	Gross Energy MJ / kg	Gross Energy MJ / litre	Oil Equiv.: toe / unit (net)	Kg CO_2 equivalent [e]	
							per GJ	per litre
Biomass Fuels:								
Fuelwood (5% mcwb)	tonne			18.0		0.42	94.0	
Coconut residues (air dry) [a]								
Shell (15% mcwb) harvested	tonne			14.6		0.34		
Husk (30% mcwb harvested	tonne			12.0		0.28		
Average (air dry) [b]	tonne			14.0		0.33		
Coconut palm (air dry)	tonne			11.5		0.27		
Charcoal	tonne			30.0		0.70		
Bagasse	tonne			9.6			96.8	
Vegetable & Mineral Fuels:								
Crude oil	tonne			42.6		1.00		
Coconut oil	tonne	0.920	1,100	38.4		0.90		
LPG	tonne	0.510	1,960	49.6	25.5	1.17	59.4	1.6
Ethanol	tonne			27.0		0.63		
Gasoline (super)	tonne	0.730	1,370	46.5	34.0	1.09	73.9	2.5
Gasoline (unleaded)	tonne	0.735	1,360	46.5	34.2	1.09	73.9	2.5
Aviation gasoline (Avgas)	tonne	0.695	1,440	47.5	33.0	1.12	69.5	2.3
Lighting Kerosene	tonne	0.790	1,270	46.4	36.6	1.09	77.4	2.8
Aviation turbine fuel (jet fuel)	tonne	0.795	1,260	46.4	36.9	1.09	70.4	2.6
Automotive diesel (ADO)	tonne	0.840	1,190	46.0	38.6	1.08	70.4	2.7
High sulphur fuel oil (IFO)	tonne	0.980	1,020	42.9	42.0	1.01	81.5	3.4
Low sulphur fuel oil (IFO)	tonne	0.900	1,110	44.5	40.1	1.04	81.5	3.4

Diesel Conversion Efficiency:

Actual efficiencies are used where known. Otherwise:	litres / kWh:	Efficiency:
Average efficiency for small diesel engine (< 100kW output)	0.46	22%
Average efficiency of large modern diesel engine(> 1000 kW output)	0.284	36%
Average efficiency of low speed, base load diesel (Pacific region)	0.30 - 0.33	28% - 32%

Area:	1.0 km^2 = 100 hectares = 0.386 $mile^2$	1.0 acre = 0.41 hectares
Volume	1 US gallon = 0.833 Imperial (UK) gallons = 3.785 litres	1.0 Imperial gallon = 4.546 litres
Mass:	1.0 long tons = 1.016 tonnes	
Energy:	1 kWh = 3.6 MJ = 860 kcal = 3,412 Btu = 0.86 kgoe (kg of oil equivalent)	
	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	
GHGs	1 Gg (one gigagramme) = 1000 million grammes (10^9 grammes) = one million kg = 1,000 tonnes	
CO_2 equiv	CH_4 has 21 times the GHG warming potential of the same amount of CO_2; N_2O 310 times	

Notes: a) Average yield of 2.93 air dry tonnes residues per tonne of copra produced (Average NCV 14.0 MJ/kg)
b) Proportion: kernel 33%, shell 23%, husk 44% (by dry weight).
c) Assumes conversion efficiency of 30% (i.e., equivalent of diesel at 30%).
d) Assumes conversion efficiency of 9% (biomass - fuelled boiler).
e) Point source emissions

Sources:
1) Petroleum values from Australian Institute of Petroleum (undated) except bagasse from AGO below
2) CO_2 emissions from AGO Factors and Methods Workbook version 3 (Australian Greenhouse Office; March 2003)
3) Diesel conversion efficiencies are mission estimates.
` 4) CO_2 greenhouse equivalent for CH_4 and N_2O from CO_2 Calculator (Natural Resources Canada,

EXECUTIVE SUMMARY

1. COUNTRY CONTEXT

Physical. The Republic of Vanuatu, formerly the New Hebrides, is located about three-quarters from Hawaii to Australia, centred near 16^{o} degrees south latitude and 167 ^{o} east longitude. Vanuatu is mostly mountainous, of volcanic origin with narrow coastal plains. About 41% of all land is cultivable with 14% utilised. Total land area is 12,200 km^2 with 65 islands populated of 80 total. It is hot and wet from November through April, and cooler and drier from May - October. In the capital Port Vila, the average temperature is 26^{o}C and the annual rainfall 2300 mm. Natural hazards include tropical cyclones, volcanism and occasional tsunamis.

Population. Between the 1989 and 1999 censuses, population grew at 2.6% per year reaching 212,000 in 2004, of whom about 27% lived in the urban centres of Port Vila and Luganville, and 80% on seven islands. 98% are indigenous Melanesians. The current development plan identifies population as a key development issue; the young population structure and rapid growth indicate the need for strong investments in health, education and environment.

Environment. Traditional land tenure and customary land and sea are enshrined in the constitution. Because of poor coordination among ministries, the Department of Environment is drafting a comprehensive national environmental policy incorporating various stand-alone environmental policies, linked with the Millennium Development Goals (MDGs). The Department of Meteorological Services is responsible for national climate change policies, which include GHG emissions.

Politics. Vanuatu, then a joint Anglo-French 'condominium', became independent in 1980 following an independence struggle. There is a unicameral 52- member parliament elected through universal adult suffrage. Following an initial period of political stability, the 1990s were less stable, with various coalitions governing Vanuatu. There were frequent changes in policies, disruptions in government services, a lack of good governance, corruption and nepotism resulting in a comprehensive reform programme in 1997 designed to renew and rehabilitate the institutions of governance, redefine the public sectors' key roles, and improve public sector efficiency. Due in part to poor data and social indicators, it has been difficult to reliably assess progress.

Economy. Vanuatu has a classic dual economy: a small, high-cost modern sector and subsistence/small-scale agriculture and fishing with most ni-Vanuatu largely outside the cash economy. Nearly 80% of the population engage in subsistence agriculture contributing only 10% to GDP. The Asian Development Bank states that that progress in meeting MDGs has been slow or stagnant, with wide differences between urban and rural areas in delivery of basic services. Real growth in gross domestic product (GDP) from 1990- 2000 averaged 3%, but capita GDP increased only slightly. The government anticipates growth of 2.6 - 2.8% per year for the next few years, nearly static in per capita terms. The national *Priorities and Action Agenda* hopes to raise the welfare of ni-Vanuatu through better macroeconomic stability to create a stable investment climate, higher economic growth, and improved health, education and transport in rural areas. Within the energy sector, priorities are an effective regulatory framework to induce competition; transparency in cross-subsidises for rural electrification, solar energy through hydropower fuel savings, and minimal direct government involvement in providing energy services.

Institutional and Legal Context for Energy. An Energy Unit within the Ministry of Lands, Geology, Mines, Energy, Environment and Water Resources formulates energy policies.

However, it has very limited financial resources and deals mainly with small-scale renewable energy technologies (RETs). A privately owned utility, UNELCO, has provided electricity to Port Vila and Luganville for several decades, recently extended to parts of the islands of Malekula and Tanna. The high cost of electricity, and its limited geographical coverage, have concerned the government for some years. Except for areas served by UNELCO, the EU is responsible for rural electrification (overseeing design, installation, finance, operation and maintenance, often through contractors) using solar photovoltaics (PV) and small hydro. Communities are supposed to establish rural development committees, with households paying fees that cover operational and maintenance costs. However, arrangements have not been effective. The EU is expected to be restructured when a proposed government-owned National Energy Corporation (NEC) is established to plan and implement commercial urban and rural electrification.

The EU's renewable energy (RE) activities are financed primarily through the Sarakata Special Reserve Fund (SSRF), using savings from a Japanese-funded UNELCO-operated hydroelectric system near Luganvuille. Some UNELCO charges for operating the system are unclear, there is weak budgetary control and ineffective government accounting. The World Bank (WB) has advised the GoV on establishing a regulatory framework for utilities, covering water, electric power and telecommunications.

Shell, British Petroleum and Mobil import petroleum products from New Caledonia and sometimes Fiji. The government has the legal power to control fuel prices but these have not been used since 1989. The government has considered tendering for supply of petroleum fuel products, similar to Samoa's approach.

There have been numerous draft national energy policies and plans, national and rural, but none formally adopted by government. In 2000, the Council of Ministers endorsed a 'Vision for a 100% Renewable Energy Economy' by 2010 but there have been no follow-up activities or a budget. The Department of Economic and Sector Planning is apparently working with others to draft a new national energy policy.

There are no effective regulations, laws, standards or codes governing the power sector. Concession agreements between UNELCO and the government include provision for a weak regulator, the Electricity Commissioner, which has been unfilled for years. There are apparently no legal standards for petroleum fuel or its transport, storage or disposal. There are several acts or proposals that deal to some extent with energy issues: i) a proposed *Electricity Supply Act*, revised seven times since 1998; ii) an *Environmental Management and Conservation Act* which requires environmental impact assessments for projects with significant impacts; and iii) the proposed NEC, which will require new legislation.

A national energy committee was established in 2002 but seems to be defunct. The National Advisory Committee on Climate Change functions as a *de facto* national energy committee but there is no effective overall coordination mechanism dealing with power sector regulation, electricity pricing, rural electrification policies, or petroleum supply and pricing issues.

2. Energy Supply, Demand and the GHG Inventory

Energy Supply and Pricing. Vanuatu is overwhelmingly dependent on imported petroleum for commercial energy. Biomass probably provides over 50% of gross national energy production, and solar and hydro together less than one percent.

Petroleum imports vary considerably year-by-year but were about 47 million litres in 2003, growing at 4% annually over the previous decade. Almost all liquid petroleum gas is used in Port Vila and Luganville with sales static at 1300 tonnes for the past five years. Between 1999 and 2002, petroleum imports were equivalent to between 56-86% of domestic exports,

considerably more than the early 1980s (30-60%) when oil prices were of serious concern to the government. Recent Port Vila wholesale prices of gasoline and distillate (excluding taxes and duties) are slightly higher than average for the PIC region. The wholesale and retail prices of LPG are roughly double the prices for other PICs for which data are available.

In 2002, UNELCO had a peak demand of 8.2 MW, generated 40 GWh, and sold 34 GWh in Port Vila, which accounts for 85% of demand and 70% of customers. Diesel accounted for 93% of generation, and hydro the rest. The average tariff was Vt 34.23 (US$0.25) per kWh. The ADB describes Vanuatu's electricity charges as among the highest in the world, although they are comparable to those of other smaller Pacific Island Countries.

Energy Demand. It is estimated that transport accounts for about 64% of petroleum fuel use (including jet fuel), electricity generation nearly 30%, and direct household use four percent.. Overall, 61% of urban households are electrified, 36% use kerosene for lighting and 53% cook mainly with LPG. Only about 7% of rural households are electrified, 86% light with kerosene, and over 95% cook with wood. About 106 kilotonnes of fuel wood are consumed per annum for cooking.

Future Commercial Energy Demand and GHG Emissions. For estimating growth in energy use and GHG emissions, it is assumed that population will grow 2.6% annually, real GDP about 2.8% and petroleum fuel use 3.5% percent GHG emissions from petroleum fuels would increase from about 110 gigagrammes in 2003 to 156 Gg in 2013, a 41% increase. In principle, by 2013 Vanuatu could reduce annual emissions by about 94 Gg per year, about 85% of current emissions from energy use, ignoring some practical economic, financial, political, social, technical, and environmental constraints. Achievable reductions if barriers to RE were removed would be considerably less. The bulk of potential reductions are from biofuels, with very little from PV or wind energy, even if these were pursued on a large scale.

3. The Potential for Renewable Energy Technologies in Vanuatu

Geothermal. Twelve islands have thermal springs and possible geothermal potential, the best probably on Efate where two prospective sites have been identified and deep drilling has been recommended. A 2.5 MW power plant (with later 2.5 MW expansion) could probably be developed on Efate, possibly producing power at less than UNELCO's avoided cost. Although a development license has been awarded, no agreement has been reached with UNELCO, which disputes costs.

Hydro. Vanuatu has some hydro potential for supplying urban grids and small rural demands. Studies suggest a technical potential on Efate (e.g. 1.2 MW at Teouma) but with prohibitively high development costs. There is potential to expand Sarakata (Santo) hydro from 0.6 MW to 1.2 MW. The government has developed no other small hydro schemes but a 75 kW project on Maewo, designed by APACE of Australia, may be built in 2005. The EU has investigated micro-hydro potential for 13 sites on six islands with about 1,500 kW of available power. Four sites are promising (Lowanau in Tanna, Mbe Tapren in Vanua Lava, Waterfall in Pentecost and Anivo in South Santo) and may be studied further.

Ocean. In the early 1990s, Oceanor of Norway monitored Vanuatu's sea wave potential. Data from buoys suggest an average of 14.4 kW per metre of wavefront off Efate. Satellite data suggest 9-20 kW/m at various sites. If seawave energy were commercially available, Vanuatu could produce much of its demand (22 MW) from a few small plants. There have apparently been no measurements of deep sea versus surface ocean temperatures to enable estimates of near-shore ocean thermal energy potential.

Wind. There is very limited data on wind energy potential. A Pacific Islands Forum Secretariat project monitored wind speeds at an Efate site in the mid 1990s, indicating 5.0 m/s average speed in 1995 and 4.2 m/s in 1996, well below the 6 m/s generally considered to

be necessary for economic electricity production. However, only 63% of data was recovered in 1996 so results are suspect. UNELCO is monitoring wind at Devil's Point north of Port Vila but preliminary results show average speeds of only 4.2 m/s.

Solar. Solar energy offers substantial technical potential in Vanuatu. Annual sunshine hours range from 2000 to 2300, averaging 6 kWh/m^2/day.

Biomass. Vanuatu is heavily forested. Some 36-41 thousand m^3 of timber was cut annually from 1996-1999, dropping considerably since then as the highly accessible eastern part of Santo has little remaining resource. Two large companies and a few dozen portable saw millers harvest logs. At the larger companies, wood recovery is about 40-45% so the volume of residue potentially available for energy is at least equal to the volume of timber produced. However, a significant portion is already used for energy, as compost or sold as fuelwood. The potential for significant wood-based power generation by sawmills, where residues are widely dispersed, does not appear to be promising. There is very limited practical potential for biogas (methane from animal wastes) or energy from municipal wastes at landfills. There is considerable experience in Vanuatu with the use of coconut oil as 'biofuel' replacing diesel fuel for electricity and transport. In some recent years, copra output has exceeded 40,000 tonnes, sufficient to produce about 27,000 tonnes of coconut oil, equivalent in energy to 28 million litres of diesel, in principle enough to replace all diesel fuel imports.

4. Experiences with Renewable Energy Technologies in Vanuatu

Geothermal. There has been some study of the geothermal resource but no geothermal power has been developed in Vanuatu.

Hydro. The government's only hydro plant is the 600 kW Sarakata system, which could be increased to 1,200 kW.

Ocean Based. There has been no Vanuatu experience with sea wave, tidal or other ocean-based energy.

Wind. There have apparently been no wind energy systems in Vanuatu, but monitoring is continuing.

Solar. A hundred or so solar water heating systems have been imported for home and hotel use since 1999. Since 1992, the EU has been involved in at least eight rural PV projects with a total of about 63 peak kilowatts of output. There have been problems due to poor choice of regulators and controllers (not suitable for tropical conditions) and poor battery maintenance. For early projects, support from the service company was poor and there were no technicians near the site. Although recipients are supposed to pay a monthly fee for service, this has often been in arrears. The PIREP mission visited two villages that were solar electrified in 2000 with Suncard pre-payment systems, which never functioned well. Fifteen PV systems of 81 installed were removed due to non-payment of the monthly fee. At least one PV project has been implemented through a local NGO, which installed 20 systems at aid posts in Tafea Province. Telecom has installed 283 PV systems for telecommunications power. Overall, donors have provided approximately US$1 million for PV equipment and installation between 1992 and 2002.

Biomass. A 25 KW_e wood fuelled biomass gasifier was installed at Onesua Presbyterian College in the 1980s. It functioned well for eight years with nearly 10,000 operating hours, was later refurbished and operated again, but has not been used for some years. Two companies on Efate have produced coconut oil on a small scale as a substitute for diesel fuel for power generation and transport. In 2002, about 200 mini-buses used it daily with no serious technical difficulties. Government legislation and regulation in 2003 dramatically reduced the use of coconut oil as a diesel fuel substitute. A change in tax laws (or their

interpretation) raised the price of fuel blends and new rules made it illegal to blend fuels without a license. It appears as if coconut oil sold duty free (i.e. free of the equivalent of the import duty on distillate for transport) would undersell diesel fuel by a considerable margin.

5. Barriers Identified in the Development and Commercialisation of RETs

Fiscal. Fiscal barriers to RETs include those for which government fiscal policies (import duties, taxes, charges) raised for public finance are biased in favour of conventional energy or biased against renewable energy. The following are fiscal issues in Vanuatu: i) there is no fiscal incentive to import RETs rather than conventional systems as duties and taxes do not differentiate; ii) a new license fee, and cumbersome inspection and bonding procedures, have contributed to drastically reduced sales of biofuel; iii) there are allegations that decisions on exemptions to import duties are not transparent and negatively affect prospects for biofuel; iv) UNELCO pays no import duty on fuel for electricity generation in Port Vila, effectively a disincentive for local biofuels; and v) there are no 'green' interest rates, or access to foreign capital for RET through government support.

Financial. A key financial barrier is the low level of resources allocated to the EU for RET implementation. Others include: i) the small percentage of net Sarakata reserve fund income used for RE (under nine percent) with most subsidising electricity supply on Santo; ii) the government's weak financial position suggesting that it may be unable or unwilling to substantially increase funding for rural electrification or RETs; iii) UNELCO apparently has no financial incentive to adopt RETs as the agreements allow fuel price increases to be fully passed on to the consumer; and iv) commercial banks charge high interest rates and feel that land tenure acts as a financial barrier, as owners cannot use land as equity for loans.

Legislative, Regulatory and Policy. The lack of any energy legislation, approved national energy policies, guidelines, regulations or a regulatory mechanism for electric power all form significant barriers to RET development.

Institutional. There is no overall coordination of energy sector activities in Vanuatu, the EU having little authority, limited finances, and few staff. Other key institutional issues include: i) UNELCO, perhaps the only institution in Vanuatu which can make RE work on a meaningful scale, is not regulated at all and has no incentive to further develop RE; ii) there is no effective organisation for operating and maintaining rural energy systems and services; iii) there are allegations of continued abuses by the political elite and inertia, widely believed to be threats to progress of all sorts, including RET development; and iv) donors, whose support is much appreciated, nonetheless tend to have a shifting focus for RETs with no long term momentum needed for sound development of specific RETs.

Technical. There are no national standards or certifications to assure that imported RETs are suitable for local conditions. Unscrupulous or poorly informed foreign experts advocating unsuitable RETs are bigger barriers than the technologies themselves. Other technical barriers are: i) a very small manufacturing sector which cannot develop the capacity to manufacture or assemble RETs, except possibly for biofuels; ii) almost no local knowledge of RETs except PV and small-scale biofuels; iii) very little knowledge of local RE resources, except solar and coconut palms; iv) the lack of an affordable suitable biofuel for petrol-fuelled outboard engines, a substantial barrier considering the importance of transport by boat; and vi) no proven, commercially available technologies exist to exploit Vanuatu's abundant ocean energy resources.

Market. Although the market for RE technologies and services is small and many ni-Vanuatu live outside the market economy, market barriers were not identified as serious constraints. However, there are no incentives for local people to establish businesses to provide RE services.

Information and Public Awareness. There was no evidence of public awareness campaigns on energy or climate change. Issues include: i) information on RETs is largely restricted to a few urban English-speaking people; and ii) government ministers and many officials are unaware of the practical problems in implementing RETs.

Other. Two miscellaneous barriers identified were: i) Vanuatu's susceptibility to natural disasters, particularly cyclones, which can damage RET equipment and biomass resources required for producing energy; and ii) limited access to traditional land over a long period of time.

6. Implications of Large Scale Use of Renewable Energy

The employment effects of major investment in RETs are likely to be significant. If half of distillate were replaced by biofuel and 60% of rural families had electricity though small-scale RETs, the rural income would be increased by a factor of four or more over present levels. Hydro and geothermal would create little employment after construction. The biggest impacts for reducing GHG emissions and increasing energy from RETs would be from biofuels followed by geothermal and hydro. Any, if poorly planned, could have significant environmental impacts.

Biodiesel. It is assumed that copra production need not increase to produce sufficient coconut oil to displace most distillate, so the impact should be no worse than current coconut cultivation practices. Biofuels are very low in emissions and in case of spillage, they biodegrade readily.

Geothermal. Geothermal is considered to be a relatively environmentally friendly energy technology, producing almost no CO_2 emissions, no NO_x, and very little SO_2. Drilling deep wells can have a negative impact on the land, reduced considerably by slant drilling.

Small hydro. Hydro development under 10 MW can, if responsibly implemented, be environmentally and socially low-impact. Small hydro schemes that are not run-of-river should be planned, built and operated in line with the recommendations of the World Commission on Dams.

7. Capacity Development Needs for Removing the Barriers

Fiscal. Barriers in Vanuatu include anomalies in import duties, lack of knowledge of the fiscal (and development) impact of producing coconut oil biofuels, non transparent mechanisms for decisions on duty exemptions, and lack of 'green' interest rates or incentives. Identified needs are: i) developing capacity for analysing the effects of biofuel production on government revenue and rural development and for developing the logistics required for large-scale production and delivery of biofuels to urban centres; and ii) developing capacity within government for analysing the effects of interest rates, import duties, energy prices and taxes on RET and EET measures.

Financial. Although access to finance does not appear to be a major barrier to RET development, effectively using finance is a constraint. Capacity development needs include: i) ability to effectively use and develop the Sarakata reserve fund for RE; and ii) better capacity to develop and document suitable RE projects.

Legislative, Regulatory and Policy. The lack of legislation, energy policies, guidelines and regulations form a significant barrier to the development of RE. Development needs include the capacity to develop practical and effective energy policies, energy legislation, supporting regulations and regulatory mechanisms.

Institutional. Capacity development needs include: i) RET development and project management within the EU (or the proposed NEC if it is created); ii) electric power sector

oversight and regulatory capacity; and iii) development of regional organisational ability to better provide energy sector assistance to Vanuatu and other PICs.

Technical. Some key technical barriers require capacity development: i) developing easily understandable publicly available reference materials on RETs; and ii) developing capacity to assess Vanuatu's renewable energy resources, especially wind, biomass and small hydro. In the long term, it is in Vanuatu's interests to develop commercial technology to tap ocean energy resources but this cannot, and should not, be addressed locally.

Market. Although market barriers were not identified as serious constraints, there is a need to develop incentives for local people to establish businesses to provide RE services through special interest rates, loan guaranty funds, and tax reform. There is little experience within the private sector regarding technical, institutional, financial and management issues relating to RET development and a demand in both the private and public sectors for relevant and practical training in designing, marketing, installing, operating, maintaining, and repairing RETs.

Information and Public Awareness. It would be appropriate to develop materials on energy efficiency and RE in school curriculums. For any RET installed in rural areas, there should be materials (training, operations, maintenance) available to technical and operational staff in Bislama or the appropriate local language; skills need to be developed to prepare these.

Other. Those who advocate particular RETs and develop design specifications need to be aware of cyclonic and other natural risks, and assure that design considerations adequately take them into account. Land tenure and the attitudes of traditional landowners are sometimes seen by public servants as barriers to the development of RE. A study with follow-up recommendations for action should be carried out on options and opportunities to involve landowners as potential partners rather than opponents in the development of RETs.

8. Implementation of Capacity Development Needs and Co-Financing Opportunities

Studies and co-financing opportunities. The following are recommended as specific studies and co-financing opportunities for capacity development.

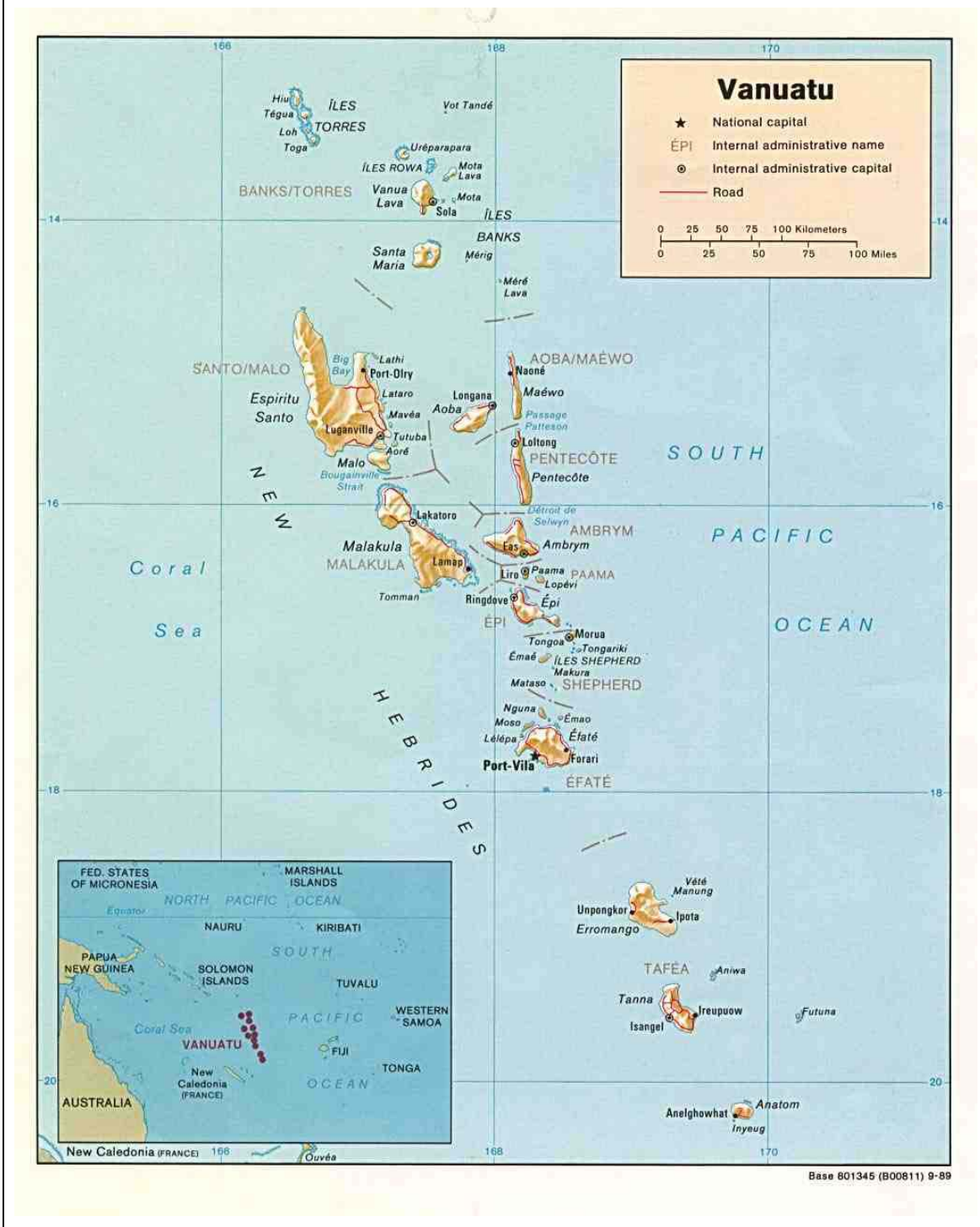
- **Biofuels.** A study of coconut oil biofuel should be carried out for replacing distillate imports for power generation and transport at a scale of 5-30 ML per year; and at community scale for remote areas. It should estimate the effects of biofuel on government revenue, rural incomes and employment.
- **Import duties and taxes.** A study should be undertaken of import duties and taxes to determine any bias for or against the development and use of RETs. It should assess duties and taxes for petroleum fuels and electricity production and recommend changes to encourage use of RETs.
- **Development of capacity for effective RET project document creation for donor funding**. The capacity of both the private sector and government to develop clear, logical and adequate project documents should be improved to assure continued access to donor RET funding.
- **Green interest rates.** An assessment should be made of lower interest rates for locally-owned businesses for the establishment of RE services. If "green" rates would be a useful incentive, a special fund or loan arrangements for private RET development should then be developed.
- **Sarakata fund operational improvement.** There should be an independent management and financial audit of the reserve fund and recommendations for changes so it can be used to accelerate RET development.
- **Energy policy development.** Advisers should assist Vanuatu to review its draft energy policies and prepare practical policy documents for consideration by Cabinet.
- **Utilities regulation**. Financial support should be provided for the establishment of a utilities regulatory framework that includes the electric power sector.
- **Energy legislation.** A range of legislative tools are required: for electricity supply and regulation, fuel quality and handling, fuel pricing and RET institutional development (such as Renewable Energy Service Companies).

- **EU**. The functions, authority, and responsibility of the EU should be clarified and revised as needed, particularly as a national energy corporation may soon be formed.
- **Development of power sector oversight capacity**. An effective mechanism needs to be developed to oversee and regulate the electric power sector in Vanuatu.
- **Development of a public information resource for RETs and EETs**. Financing is needed to develop a library of RET/EE information materials specifically for the government, NGOs and private users.
- **Assistance in resource assessment capacity development.** A programme to assist the EU and other appropriate agencies to develop the capacity to locally carry out wind, biomass and solar resource assessments is needed.
- **Development of a local capacity to prepare RET operation and maintenance training and manuals in the local language.** Developing the capacity of rural technicians is needed to effectively install, operate and maintain RET systems.
- **Land Access.** A study with follow-up recommendations for action should be carried out on options and opportunities to involve landowners as potential partners rather than opponents in the development of RETs.
- **Preparation of guidelines for village scale hydro development**. Finance is needed to develop guidelines for hydro technical assessment, environmental impact assessment, economic analysis, technical design, institutional possibilities, operational requirements and maintenance requirements.

Hardware Investments for Co-financing. The highest short-to-medium term potential for reducing GHG emissions from petroleum energy use in Vanuatu: would be from biofuel, followed by geothermal and hydro. If finance is available, all should be seriously considered for support. However, RET should not be developed solely on the basis of GHG emissions. The development impacts of large-scale village solar PV is likely to be far greater than geothermal or hydro. A major PV programme should be seriously considered if donor funding is available.

TABLE OF CONTENTS

Map of Vanuatu and its location in the Pacific



Source: Source: www.lib.utexas.edu/maps

1 THE COUNTRY CONTEXT

1.1 Physical

The Republic of Vanuatu, formerly known as the New Hebrides, is located in the South Pacific, about three-quarters of the way from Hawaii to Australia, about 2500 km east of Sydney. It is centred (Figure 1-1) near 16 degrees south latitude and 167 degrees east longitude, extending about 1300 kilometres from north to south and 500 km from east to west. Vanuatu's terrain (Table 1-1 and Figure 1-2) is mostly mountainous, of volcanic origin with narrow coastal plains. About 41% of land is classified as cultivable although only 14 % is utilised (Marte, 1998).

Table 1.1 – Land Types and Islands by Province

Province	Number of principal islands	Island types
Torba	13	Volcanic and Raised Atolls
Sanma	6	
Malampa	9	
Shefa	13	
Penama	3	Volcanic
Tafea	45	Volcanic

Source: 1999 Vanuatu National Population and Housing census, Main Report

The highest point is Tabwemasana at 1877 metres. Total land area is 12,200 square kilometres (km^2) spread over more than 80 islands, of which 65 are populated, with a maritime exclusive economic zone (EEZ) of 680,000 km^2. Administratively, it is divided into six provinces from north to south respectively as follows with provincial headquarters indicated in parentheses: Torba (VanuaLava), Sanma (Luganville), Penama (Ambae), Malampa (Malekula), Shefa (provincial and national capital Port Vila) and Tafea (Tanna).

Figure 1.2 – Image of Efate from NASA

Note: White portion is cloud cover
Source: www.vanuatugovernment.gov.vu

The tropical climate is moderated by southeast trade winds. There are two main seasons, hot and wet from November through April, and cooler and drier from May through October. In Port Vila the long-term average annual temperature is 26°C and the average annual rainfall is about 2300 mm. Table 1-2 shows rainfall and temperatures for Port Vila and two other sites with weather stations, Analguat (on Aneityum) and Pekoa (on Santo).

Table 1-2 – Annual Rainfall and Temperatures in Vanuatu

Year	Average Annual Rainfall (mm)			Average Annual Temperature (°C)		
	Aneityum	Port Vila	Pekoa	Aneityum	Port Vila	Pekoa
1994	1570.4	1908.4	2676.8	22.3	24.7	25.4
1995	1632.6	2230.6	2705.4	23.5	25.3	25.4
1996	2815.1	4104.4	3467.8	23.6	25.3	25.4
1997	1459.9	3229.0	2485.6	23.7	24.9	25.1
1998	2349.8	2608.9	2508.7	24.6	25.8	25.4
1999	2806.2	3081.7	2490.7	24.5	25.7	25.5
2000	3487.9	3229.0	3467.8	23.9	25.7	25.6
2001	2645.8	2608.9	2485.6	24.2	25.3	25.8
2002	2278.5	3081.7	2508.7	24.2	25.4	25.8
2003	2507.5	1553.3	2490.7	23.9	25.2	25.6

Source: Anare Matakiviti from Vanuatu Meteorological Service, 2004

The frequency and severity of natural disasters is an important consideration for investments in renewable energy. Natural hazards affecting Vanuatu include tropical cyclones (usually between November -April), volcanism which causes earthquakes, and occasional tsunamis. From 1990 through 1999, Vanuatu experienced more cyclones than any other Pacific Island Country (PIC), and more geophysical hazards than any PIC except Papua New Guinea. Shortly after the PIREP mission left Vanuatu in March 2004, a cyclone struck. The estimated financial impact of the worst of the 1990s disasters is shown in Table 1-3 below.

Table 1-3 – Disasters in Vanuatu (1991-2001)

Event	Date	Provinces and/or Islands Most Affected	Estimated Damage US$
Cyclone Tia	Nov 1991	Not known	Not known
Cyclone Betsy	Jan 1992	Pentecost, Ambrym, and Efate	Two million
Cyclone Fran	Mar 1992	Efate	Not known
Cyclone Prema	Apr 1993	Ambrym, Paama, Epi, Shepherds, and Efate	60 million
Cyclone Sarah	Jan 1994	Not known	0.5 million
Torba Earthquake	Apr 1997	Malekula, Pentecost, Ambrym, andEpi	Not known
Cyclone Yali	Mar 1998	Erromango, Tanna, and Aniwa	Six million
Cyclone Zuman	Apr 1998	Torba and Sanma Provinces	Six million
Cyclone Dani	Feb 1999	Sanma Province	Seven million
Penama Earthquake	Nov 1999	Pentecost, Paama, Ambrym and Epi	Nine million
Landslides	Dec 1999	Paama	Not known
Cyclone Paula	Feb-Mar 2001	Malampa and Shefa Provinces	Not known
Cyclone Sose	Apr 2001	Santo, Malampa, Shefa and Tafea Provinces	Not known
Lopevi Eruption	Jun 2001	Paama and SE Ambrym	Not known

Source: *Common Country Assessment for Vanuatu* (Office of United Nations Resident Coordinator; Fiji; 2002)

1.2 Population

In early 2004, Vanuatu had a population of about 212,000 people. At the time of the 1999 national census, the population was 186,678 of whom 27% lived in the two urban centres of Port Vila and Luganville, and 73% lived in rural areas. Between 1989 and 1999 (see Table 1-4), the national population grew at an average annual growth rate (AAGR) of 2.6%, with an urban AAGR of 4.2% and rural of 2.2 percent. 98% of the total are indigenous Melanesians. There are also about 3000 residents who are French, Vietnamese, Chinese, or other Pacific Islanders. About 80% of the population live on seven islands: Efate (where the capital Port Vila is located), Santo (the largest island and with the second urban centre Luganville), Tanna, Malekula, Pentecost, Ambae and Ambrym. Forty two percent of the population is below 15 years of age and those below 25 years constitute 59.3 percent. On the majority of islands, the population is concentrated along narrow coastal strips or small offshore islands. However, the interiors of Pentecost, Tongoa, Tanna and Santo in particular are all quite densely populated (1999 Census).

Table 1-4 – Population and Growth Rate, 1989 - 99

Location	1989	1999	AAGR
Vanuatu total:	142,419	186,678	2.6 %
of which, urban	25,870	40,094	4.2 %
of which, rural	116,549	146,584	2.2 %
Rural by Province:			
Malampa	28,174	32,705	1.4 %
Penama	22,281	26,646	1.7 %
Sanma *	18,577	25,346	3.0 %
Shefa **	19,118	25,083	2.6 %
Tafea	24,414	29,047	2.5 %
Torba	5,985	7,757	2.5 %

Notes: * Sanma excludes Luganville; ** Shefa excl Port Vila

Source: *1999 National Population and Housing Census* (Dec '00)

The current medium-term development plan (*Priorities and Action Agenda: Supporting and Sustaining Development*, Government of Vanuatu (GoV), 2002) identifies population as a key cross-cutting development issue; the young population structure and rapid growth indicate the need for strong investments in health, education and environment. Although there

are no formal population projections by the GoV, the plan notes that, at current rates, population will double between 1999 and 2024 and Port Vila will double by 2014. Reducing the high rate of rural to urban migration is a key objective of the plan. Various studies have emphasised the need for Vanuatu to address population growth and distribution:

- the Australian National University argued a decade ago (ANU, 1994) that fast growth will place substantial additional pressures on urban services and infrastructure that are already inadequate: *"the problems faced by the municipal government in Port Vila is as severe as anywhere else in the world."*;
- according to the UN's *Common Country Assessment for Vanuatu* (CCA, UN, 2002), *the "alarming acceleration in the number and the size of squatter settlements in Port Vila has brought a corresponding decrease in the capacity of health and sanitation facilities to provide even minimal facilities for these families. ... Up to eight people share one room, and the rents for one room without water and electricity, but with access to a shared pit latrine, are frequently equivalent to 50% of the family income."*
- the Asian Development Bank (ADB, 1999) reports that Port Vila needs 3000 additional houses, 100 primary school classrooms, and a further 3400 jobs in the next ten years; and
- the World Bank (WB,2000) reports that income inequalities are growing, and poverty and vulnerability are evident in an increasing underclass of landless urban poor.

The population distribution, and the ability to afford energy services, will affect the demand for energy and energy policy and planning needs.

1.3 Environmental

Article 7(d) of Vanuatu's Constitution states that *"every person has the following fundamental duties to himself and his descendants and to others… to protect Vanuatu and to safeguard the national wealth, resources and environment in the interests of the present and of future generations."* Traditional land tenure and customary rights to use the land and sea are also enshrined in the constitution. Vanuatu is party to various treaties and conventions related to environmental protection, including Antarctic-Marine Living Resources, Biodiversity, Climate Change, the Kyoto Protocol, Desertification, Endangered Species, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Tropical Timber 94.

Table 1-5 – Status of Ratification of Environmental Treaties and Conventions by Vanuatu

Status in Vanuatu	Environment Protection (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	No	No	16 Sep 95	16 Sep 95	–	
Ratified	No	No	No	09 Feb 96	Ac: 17 Jul 01	Ac: 21 Nov 94
Entered into force	22 Aug 90	26 Jun 90	22 Oct 91	09 Feb 96	n/a *	

Notes: Treaties and conventions are briefly described in Volume 1, the PIREP Regional Overview report; Ac = acceded
* The Kyoto protocol is in force from 15 February 2004 for European Union members only.
Sources: websites for conventions, Forum Secretariat and SPREP (January – March 2004)

An initial national communication to the United Nations Framework Convention on Climate Change (UNFCCC), indicating greenhouse gas (GHG) emissions, and vulnerability and adaptation to climate change, was submitted in 1999. Vanuatu has focussed on several issues including: i) institutional arrangements to implement the UNFCCC and Kyoto Protocol, ii) understanding and responding to the impacts of climate change, and iii) training, public

awareness and education. A *National Strategy for the Implementation of the UNFCCC* has been completed as has a *Community Vulnerability and Adaptation Assessment and Action Report 200*3. Table 1-5 summarises the status and date of signing of some key environmental conventions.

Among the constraints to implementation of environmental policies has been a lack of coordination among line ministries, with relevant policies not incorporated into the mainstream policy framework of GoV. The Department of Environment (DoE) is therefore drafting a single comprehensive policy document encompassing the aims of various stand-alone policies, linked with the Millennium Development Goals (MDGs), which are discussed in Section 1.5.

The Department of Meteorological Services (DMS) is responsible for national climate change policies, which include GHG emissions. The DMS Climate Change Section provides the secretariat for a National Advisory Committee on Climate Change (NACCC), membership of which is drawn from government ministries (including the Energy Unit of the Ministry of Lands, Geology, Mines, Energy, Environment and Water Resources (MLGMEEWR), non-governmental organisations (NGOs) and invited private sector participants

1.4 Political

The British and French, who settled the New Hebrides in the 19th century, agreed in 1906 to an Anglo-French Condominium, which administered the islands until 30 July 1980 when, following a struggle for independence, Father Walter Lini became the nation's first prime minister. Following an initial period of relative political stability, the 1990s were plagued by instability with a number of different coalitions governing Vanuatu.

Vanuatu has a unicameral 52 member parliament, elected (in May 2002) to a five-year term by universal adult suffrage. The President of the Republic and Head of State is Kalkot Matas Kelekele, elected for a five-year term through secret ballot by an electoral college comprising the Vanuatu Parliament, President of the National Council of Chiefs, and the Presidents of Vanuatu's six provincial governments. The Hon. Edward Natapei, Prime Minister since 13 April 2001, is the leader of the Vanua'aku Pati (VP), and heads a coalition with the Union of Moderate Parties (UMP) led by Serge Vohor. A Council of Ministers (i.e. Cabinet) of thirteen is appointed by the Prime Minister, and is responsible to Parliament. There is also a National Council of Chiefs, which advises on matters of custom and land. The Minister responsible for energy (at the time of the mission in early 2004) was the Hon Jacklyn Reuben Titek, Minister for MLGMEEWR, who replaced the Hon. Sela Molisa.

Over the years, political changes have led to frequent changes in policy, disruptions in government services and a general lack of application of good governance principles (Vuti, 2001). Corruption and nepotism also became more common, with the Ombudsman's Office investigating activities of many of Vanuatu's political elite. A deteriorating economic situation led to a request for ADB and other donor assistance. However, the GoV recognised that to solve the economic and financial problems, it would be necessary to first address governance issues. Accordingly, a Comprehensive Reform Programme (CRP) was approved in 1997, supported by the ADB through a US$25 million loan, and integrated into assistance provided by a number of donors, most notably Australia and New Zealand. Key elements of the CRP are: i) renewal and rehabilitation of the institutions of good governance including the offices of the Ombudsman, Attorney General, Auditor General and Judiciary; ii) a redefined role for the publics sector revolving around the core functions of law, policy design and regulation; and iii) improvements in public sector efficiency. Progress in implementing the CRP has been monitored by the ADB as part of the loan process but (ADB, 2001) the scarcity

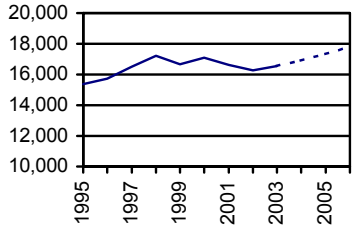
of data and social indicators at the beginning of the process makes it difficult to assess achievements.

1.5 Economic

The Vanuatu economy is based on subsistence and small-scale agriculture, fishing, offshore financial services, and tourism. Mineral deposits are negligible and the country has no known petroleum deposits. A small light industry sector caters to the local market. Vanuatu has a classic dual economy, with a small, very high cost modern sector (prices being higher than anywhere in the Pacific except new Caledonia and Tahiti) with most ni-Vanuatu largely outside the cash economy. For most people, there is poor access to basic services. In September 2000, Vanuatu was among 147 countries that adopted the Millennium Development Goals (MDGs), a set of targets with quantifiable indicators, to assess development progress. In 2003, the ADB reported on the progress of PICs toward meeting MDGs. For Vanuatu, the ADB concluded that progress has been slow or stagnant, with significant discrepancies between urban and rural areas regarding delivery of all basic services. Only half the population had access to safe water and sanitation facilities, with large urban-rural differences. According to a Household Income and Expenditure Survey (HIES) conducted in 1999, the average monthly income of all households in the country was Vt 52,900 of which salaries and wages accounted for Vt 34,200, the remainder made up of income from home grown food. Port Vila households had an average monthly income of Vt 102,200 compared with Vt 19,300 for rural households. Despite considerable progress with the CRP, economic prospects are not good (ADB, various reports).

Annual growth in real (constant dollar; inflation adjusted) GDP for the decade to 2000 averaged 3%, 0.4 percentage points above the corresponding growth in population (ADB, 2001); accordingly per capita GDP has increased only marginally. As indicated in Figure 1-3, national economic growth has been uneven. Slow growth of GDP during the second half of the 1980s improved from 1989 onwards but declined considerably by the end of 1990s. According to the Department of Economic and Sector Planning (DESP), this continued in 2001 and 2002, with real GDP decreases of 2.1% and 2.8% respectively (GoV Budget Policy Statement, 2004). However, the Reserve Bank of Vanuatu has estimated real growth of 1.5% for 2003 and has projected growth of 2.1% for 2004 (RBV, Sept. 2003). DESP expects economic growth to continue at 2.6 to 2.8% for the next few years, i.e. nearly static per capita GDP in real terms.

Figure 1-3 –
GDP in Million Vatu (1983 prices)



Sources: National Statistics Office and Reserve Bank
Note: Solid line actual; dashed line estimated or projected.

Table 1-6 provides actual and forecast GDP by sector for 2002 through 2006. External grant aid accounted for a substantial part of foreign exchange receipts in the mid 1990s, representing 32% and 21% of current account receipts and GDP, respectively (ADB, 1997). Slow economic development can be attributed in part to dependence on a narrow range of agricultural exports, distance from world markets, limited capacity to utilise natural resources, the high cost of infrastructure, and Vanuatu's vulnerability to natural disasters. Contrary to expectations of private sector dynamism as a result of the CRP, with reduction in public sector employment by 10% and corporatisation of some services, little change is evident in business activities. The economy remains highly dualistic with nearly 80% of the population engaged in subsistence agriculture that contributes only 10% to GDP. As the UN

notes (CCA, 2002), the disparity in incomes between rural and urban sectors is a factor of 16 or more; but may in part reflect the poor quality of data on rural incomes. The structure of production has changed over the last two decades: in 1983 the primary sector contributed 25% of GDP but by 1999 this had fallen to 18% (ADB, 2001), while services increased to 70% by 2000 (WB, 2001). Domestic exports remain consistently low.

The national *Priorities and Action Agenda* (PAA), apparently but not explicitly covering 2003 through 2005, lists three main objectives to raise the welfare of ni-Vanuatu: i) ensuring macroeconomic stability to create a stable investment climate; ii) higher levels of economic growth to raise income earning opportunities while conserving natural resources; and iii) raising standards of service delivery, particularly health, education and transport to rural and outer island regions.

Specific PAA priorities for the energy sector include: i) the introduction of an effective regulatory framework to induce competition; ii) greater transparency in arrangements used to cross-subsidise rural electrification and provision of solar energy through fuel savings from hydropower; and iii) minimum direct involvement of government in providing energy services. The government's goals are to reduce the cost of electricity and extend rural electrification by the most cost effective means. Priorities within environmental management include 'cleaner production and renewable energy.' Within transport, priorities include seeking "solutions to reduce the high fuel costs in the country." Each of these issues is discussed further in this report.

Table 1-6 – Real GDP by Sector, Million Vatu (2002 – 2006)

Sector	2002	2003e	2004p	2005p	2006p
AGRICULTURE, FISHING AND FORESTRY	3,157	3,433	3,556	3,670	3,764
Copra	520	556	579	605	617
Cattle	242	448	477	505	521
Cocoa	72	174	180	193	199
Kava	451	259	268	274	281
Other commercial	79	84	85	86	90
Subsistence agriculture	1,630	1,672	1,714	1,757	1,801
Forestry and logging	97	161	163	167	172
INDUSTRY	1,487	1,470	1,475	1,494	1,525
Manufacturing	569	563	563	569	580
Electricity	414	406	413	420	433
Construction	413	408	404	407	412
Subsistence construction	91	93	95	97	99
SERVICES	11,641	11,649	11,878	12,170	12,525
Wholesale / retail trade	5,219	5,271	5,377	5,538	5,759
Hotels / restaurants	897	870	914	929	945
Transport / communications	1,539	1,448	1,477	1,506	1,536
Finance and insurance	1,205	1,229	1,260	1,285	1,311
Real estate and other services	1,039	1,091	1,113	1,135	1,158
Government services	2,216	2,216	2,216	2,260	2,306
Personal services	128	123	121	120	119
Domestic Services	137	140	144	148	152
Less imputed bank charges	*739*	*740*	*742*	*751*	*760*
TOTAL GDP (1983 PRICES)	16,285	16,551	16,899	17,333	17,814
GDP growth rate (% / year)	*-2.8*	*1.6*	*2.1*	*2.6*	*2.8*
Per capita GDP (Vatu)	80,778	80,000	79,620	79,600	79,700

Notes: e = estimate based on quarters 1-3; p = projected
Source: Budget Policy Statement, DESP, Ministry of Finance (2004)

As shown in Table 1-7, Vanuatu is signatory to all three Pacific regional trade and economic trade agreements, but has yet to ratify the Pacific Island Countries Trade Agreement (PICTA) and the Pacific Agreement on Closer Economic Relations (PACER; between PICTA signatories and Australia and New Zealand). The GoV has signed the Cotonou Agreement, providing membership in the African Caribbean Pacific (ACP) group of countries, and thus access to further development assistance from the European Union (E.U.).

Table 1-7 – Vanuatu and Regional Economic Treaties

Status	SPARTECA	PACER	PICTA
Signed	No	18 Aug 2001	18 Aug 2001
Ratified	18 Nov 1981	No	No
Entered into force	18 Dec 1981	3 Oct 2002	13 April 2003

Source: Pacific Islands Forum Secretariat, January 2004

A bill giving greater powers to the Vanuatu Investment Promotion Authority (VIPA), to promote Vanuatu as a favourable investment destination was passed by parliament in June 2001. However, this has not overcome various investment barriers including low productivity, high effective labour costs, and a widely held perception that vested interests among the local elite lead to decisions that are not necessarily in the national interest. There are efforts underway to promote ni-Vanuatu business development through a Ni-Vanuatu Business Development Centre. Poor access to loan finance and the inability to use land as collateral for business loans are seen by the government (PAA, 2002) as major obstacles to local business development. There have been no loans by commercial banks or the National Bank specifically for developing energy projects or services. For small business loans in general, the interest rates are about 14% per annum or 16-17% for unsecured loans. Some credit union loans have reportedly been provided to individuals for solar PV systems but no details are available. There were some discussions between the Credit Union and the Energy Unit for solar PV loans but this has not materialised.

1.6 Institutional and Legal Context for Energy

An Energy Unit (EU) in the Ministry of Lands, Geology, Mines, Energy, Environment and Water Resources (MLGMEEWR) is responsible for formulating and implementing policies relating to the development of the energy sector (*Corporate Plan for Period 2003-2005*, MLGMEEWR, GoV, 2002) including *"energy planning and management, promoting energy programs, assessment of alternative energy, and review of electricity contracts."* According to the *Business Plan for Period 2000-2004 for Energy Unit* (GoV; November 1999), the Unit's aim *"is to raise the national prosperity and quality of life through the development of renewable and non-renewable sources of energy. Efficient and cost effective measures which enhance energy efficiency, reduce the environmental impacts of energy supply and use, with an enhanced focus on the development of competitive sources of renewable energy, is also a key priority."* The Business Plan lists the following specific Energy Unit responsibilities: i) studies and surveys on indigenous energy resources; ii) rural and urban energy demand surveys; iii) government petroleum products supply; iv) energy conservation; v) rural electrification by solar and hydro systems; vi) extension of urban electrification networks; and vii) energy policies and legislation.

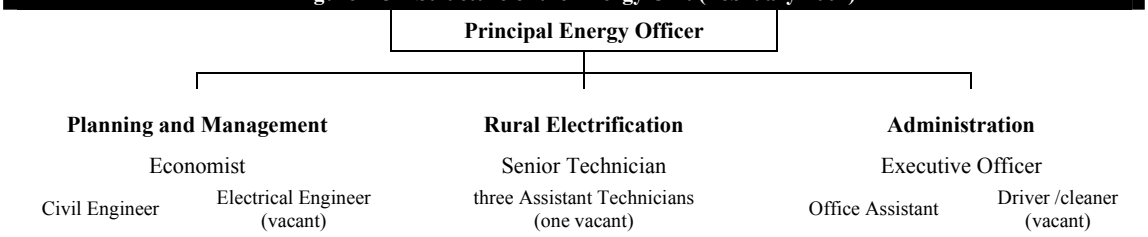
However, some of these responsibilities are shared with other departments or ministries. The Energy Unit has very limited financial resources and its actual powers are unclear but limited. It tends to focus primarily on small-scale renewable energy technologies (RETs). *De facto* departmental responsibilities for various aspects of energy are indicated in Figure 1-4. The structure of the Energy Unit is shown in Figure 1-5.

Figure 1-4 – *De Facto* Responsibilities for Energy Matters in Vanuatu (February 2004)

Ministry of Finance	**Ministry of Lands etc. (MLGMEEWR)**		**Office of Prime Minister**	**Meteorological Services**
(including DESP)	**Energy Unit**	**Environment Unit**	**Dept of Strategic Management**	
• Proposed utilities regulation • Aid coordination and allocation • National planning	• Energy studies, legislation and policies • Rural electrification through RETs • Reviewing fuel and electricity pricing • Proposed National Energy Company	• Environmental Impact Assessments (including energy sector) • Consolidated national environmental policy	• Overall policy coordination • Vetting proposed laws and regulations • Comprehensive Reform Programme	• Climate change policy (including GHG emissions)

Source: mission discussions in Vanuatu

Figure 1-5 – Structure of the Energy Unit (February 2004)



Note: There are drafts of proposed new structures but this is the structure as approved by the Public Service Commission.

It is understood that the Energy Unit is expected to be restructured, reduced in size, and have newly defined roles as several anticipated institutional initiatives, discussed later in this report, are finalised and implemented. These include a new framework for utilities regulation being developed with World Bank assistance, and a National Energy Corporation, both of which could reportedly be finalised before the end of 2004.

1.6.1 Urban electricity supply

For some years, electricity supply through grids in Vanuatu has been restricted to the urban areas of Port Vila and Luganville by a privately owned utility, Union Electrique de Vanuatu Ltd (UNELCO) owned by Lyonnaise des Eaux of France. Until 2000, the GoV had a 14% shareholding and it still retains a seat on the board of directors. UNELCO has operated in Vanuatu since 1939 through a series of long-term concession agreements, which were recently extended to parts of the islands of Malekula and Tanna. As discussed under energy legislation below, there is in effect no regulation, legislation, or standards governing electric power operations. For Port Vila and Luganville, the concession areas extend 15 km from the towns' boundaries. The others are defined on concession maps. The high cost of electricity, and its limited geographical coverage, have long been matters of concern to the public and the GoV. As Table 1-8 indicates, UNELCO operates two very small urban power systems. The two new supply areas cover several small communities and surrounding areas; these are essentially rural electrification grids.

Table 1-8 – UNELCO Concession Areas for Electric Power

Location	Consumers (Dec 2002)	UNELCO service began	Current concession ends
Port Vila, Efate	6,016	1939	31 Dec. 2031
Luganville, Santo	1,654	January 1990	31 Dec. 2010
Tanna	451	April 2002	31 Dec. 2020
Malekula	425	Nov 2002	31 Dec. 2020

Source: UNELCO / GoV concession documents, 1997 and 1999; UNELCO 2002

1.6.2 Rural electrification

Except for the areas defined within UNELCO supply concessions, the Energy Unit is responsible for rural electrification through solar photovoltaics (PV) and small hydroelectric systems. The Public Works Department presumably retains responsibility for operating and maintaining any small diesel generators at rural government facilities. Details of the Energy Unit's PV programme and hydro site investigations are discussed in later sections of this report and its annexes. Institutionally, the Energy Unit is currently responsible for overseeing the programme overall including approval of design, installation, finance, operation and maintenance. Most systems have been donor financed but the GoV has financed a few. In most cases, contractors were responsible to the Energy Unit for detailed designs, installation and initial operations. For some PV projects installed on behalf of other ministries (e.g. the Ministry of Health), the ministry concerned is in principle responsible for maintenance for an agreed period. For solar home systems (SHS), experts provided through the Japan

International Cooperation Agency (JICA) helped the Energy Unit prepare a set of guidelines for installation, management and maintenance. Communities that receive SHSs from the Energy Unit are supposed to establish a Rural Development Committee and households are meant to contribute a monthly fee sufficient to cover operational and maintenance costs, although not the replacement of batteries or major components. However (JICA, 2001 and others), these arrangements have been ineffective due to poor community management and practical skills. According to the Energy Unit, this has been exacerbated by a decline in rural economies (as kava and copra prices dropped) and natural disasters, causing difficulties for the communities to pay for the system usage and for the Energy Unit to collect funds from the communities.

The Energy Unit's renewable energy (RE) activities have been financed primarily through the Sarakata Special Reserve Fund (SSRF), using savings (relative to diesel generation) from a hydroelectric system installed in early 1995 at Sarakata, Espiritu Santo. From 1995-2002, the fund provided about Vatu 34 million (US$330,000) to the GoV through the Treasury for solar RE.[1] The Finance Department then divides the SSRF to two accounts, Rural Energy Development (30% of the total) and Urban Energy Development (70%). The 70% urban allocation can only be used with the approval of the Minister of Energy through the recommendation of a Sarakata Hydropower Technical Committee, established in 1995 with the endorsement of JICA. The committee meets annually to recommend funds for specific urban electrification activities. The 30% rural allocation is used by the Energy Unit for rural energy development.

Reportedly (JICA 2003), some UNELCO charges for operating the hydro system are unclear, there is very weak, opaque and ambiguous budgetary control, and there is no effective accounting system.[2]

1.6.3 Proposed institutional changes for electricity

To establish a clear, transparent and financially more sound framework for both urban and rural electrification through diesel generation and renewable resources, the GoV has proposed establishing a government-owned National Energy Corporation (NEC) which is to encourage "suppliers to operate and distribute power to unelectrified areas" and to "facilitate and or supply stable and affordable electricity to consumers in the whole country." It was expected that the NEC would require an operating budget of Vatu 30-50 million annually (roughly US$0.3-0.5m), own the Sarakata hydro facilities, develop electrification projects for implementation outside of UNELCO's current electricity concessions, monitor and analyse electricity tariffs and prepare power sector assessments. The Energy Unit would continue to be responsible for implementing non-commercial energy projects and would evolve toward a policy and regulatory body. Although the NEC concept was approved by the Council of Ministers in 2003, the bill has not yet been forwarded to parliament for its approval. The GoV has also approached the World Bank for assistance. Since 1998, four WB missions, the most recent (at the time of writing), in April 2004, have advised the GoV on establishing a regulatory framework for utilities covering telecommunications, water and electric power. These have included advice on appropriate timing, legislation and regulations.

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[1] The 0.6 MW Sarakata system, financed by Japan, is owned by the GoV and is operated by UNELCO. The gross savings during the eight-year period were about Vatu 624 million. After accounting for UNELCO's operation, management and maintenance costs, the net savings were Vatu 389 million. Most of this was used for subsidising Luganville tariffs, connections, streetlights and extensions. Less than 9% of net savings were available for financing solar PV.

[2] The EU uses the funds but accounting is controlled by the Finance Department, which makes all payments. Due to budget and staffing limitations, Finance reportedly requested, and received approval from JICA to use some of the 30% allocation to pay salaries and administrative costs of implementing the urban and rural energy development programmes.

1.6.4 Petroleum supply and pricing

Three companies import and distribute petroleum fuels in Vanuatu: Shell, British Petroleum and Mobil Oil (Australia). Shell does not own any storage facilities in Vanuatu and uses those of Mobil. Petroleum products are usually imported from New Caledonia and to a lesser extent Fiji. Liquefied petroleum gas (LPG) is imported by Origin Energy of Australia with distribution outlets in urban and rural areas, generally at service stations or retail shops.

Petroleum products were under price control until 1989, when the Price Control Unit ceased to perform its duties and was transferred from the Ministry of Finance to the Ministry of Internal Affairs. Later it was transferred to the Ministry of Trade and Industries, and eventually abolished. The oil companies are expected to provide changes in wholesale and retail prices to the Energy Unit, which monitors petroleum supply and pricing for the government, although not for the general public. Monitoring of petroleum imports is carried out by the Customs Department for import duty collection but the information is not analysed for policy purposes.

The GoV has considered establishing a mechanism to regularly tender for the supply of Vanuatu's petroleum fuel products, similar to Samoa's approach. This was reportedly discussed by the Council of Ministers in late 2003 and may be considered further.

1.6.5 Energy policies and plans

Over the past two decades, there have been numerous drafts of national energy policies and plans prepared by consultants, advisers and GoV officials. In the mid-1980s, a comprehensive *Energy Development Plan for Vanuatu: 1987-1996* was prepared with ADB assistance (ADB 1986) but never adopted. A decade later, the Forum Secretariat (now Pacific Islands Forum Secretariat, PIFS) developed a *National Energy Policy* (NEP) for Vanuatu covering energy sector planning, coordination and management; petroleum; transport; electricity; rural electrification; new and renewable sources of energy; environment; and energy conservation and efficiency. The NEP was never formally endorsed by the GoV but to some extent still guides the Energy Unit in formulating plans and programmes.

The first rural electrification policy was adopted in 1993. It was revised in 2000 with assistance from the South Pacific Applied Geoscience Commission (SOPAC). The overall objective of the *Revised Rural Electrification Policy*, a draft guideline rather than formal policy, is provision of electricity to all rural people in Vanuatu. No compensation is to be given for land acquired for rural energy projects. The top priority is energy for medical facilities (health centres) followed in order by education (schools and rural training centres), village/community halls (including churches and households) and commercial/industrial. The primary emphasis is on renewable energy (solar, hydro, biomass, etc.) based on a least-cost strategy and technically proven approaches. The paper proposed a Rural Electrification Office (with manager, engineer, technical officer and secretary) within the Energy Unit *to "manage and implement the national rural electrification programme."* According to the draft policy, rural electrification for health centres, clinics, aid posts, and education institutions "will be fully subsidised by the government" but for community halls there is to be a minor local contribution of three percent of capital cost with all operating and maintenance costs met by consumers. For stand-alone systems, the consumer is to pay a maximum maintenance fee of Vt 1500 (U$15) and a users' fee of Vt 500 per month *"depending on the level and service provided by each system."* After seven years, ownership was to be transferred to the user. For the initial seven years, the Energy Unit was to be responsible for all maintenance. To pay for the RE Office, the paper proposed 'temporary' taxes as follows: electricity 0.3 Vt/kWh sold (which would yield about Vt 9 million per year),

oil products 1.0 Vt/litre (Vt 4 m/year), and Sarakata savings (Vt 60 m/year, to increase with the proposed third hydro turbine). This 'revised policy' was a discussion paper which was implemented in part (e.g. expectation of consumer payments for energy services) but has been superseded by the proposed NEC.

The only recent policy statement on energy which has clearly been formally endorsed by the Council of Ministers is Vanuatu's *Vision for a 100% Renewable Energy Economy* (GoV, September 2000), which seeks special assistance from donors, resolves to stop importation of petroleum fuels, and become a hydrogen-based economy by 2010, with all renewable energy and hydrogen technology equipment accorded the same tax exemptions as other development programmes during a 20 year period. There has been no apparent progress in implementing this ambitious goal or developing serious plans to shift in the directions sought by cabinet. The DESP is reportedly working with other departments to draft a new national energy policy.

1.6.6 Energy legislation

As noted, there is no effective legislation or regulations, standards and codes governing the power sector. Although the concession agreements between UNELCO and the government have provided for the post of an Electricity Commissioner to regulate power sector matters, the post has been vacant for some years, due at least in part to the absence of relevant legislation providing powers so the commissioner can perform his or her duties effectively. There are apparently no legal standards for petroleum fuel or its transport, storage or disposal. There are, however, several acts of Vanuatu law or proposed legislation that deal directly or indirectly with energy issues:

- a proposed *Electricity Supply Act* (Chapter 65 of the Laws of Vanuatu) has gone through seven revisions since 1998. The final revised version is currently (early 2004) with the State Law Office for editorial polishing before submission to Parliament;
- the *Environmental Management and Conservation Act* (2003) requires environmental impact assessments (EIAs) of projects with potentially significant impacts. Public input is also required. There are apparently no specific requirements for the energy sector; and
- establishment of the National Energy Corporation has been approved by the Council of Ministers and its required legislation is with the State Law Office. The NEC will be established under its owned legislation.

1.6.7 Inter-ministerial energy committees

A national energy committee was established in 2002, with membership from a number of ministries and departments. This is one of several temporary *ad-hoc* committees that the GoV established to tackle specific issues. Examples are the VAT Committee on Electricity, Refinery Committee, Fuel Supply Committee, and Committee on Utility Regime**.** Currently, the National Advisory Committee on Climate Change (NAACC) functions as a *de facto* national energy committee and has served as the national coordination/consultation committee for PIREP. There is no permanent overall coordination mechanism to consider overall power sector regulation, electricity pricing, rural electrification policies, or petroleum supply and pricing issues. However, the Sarakata Hydropower Technical Committee established in 1995 has been an effective mechanism for proposing urban electrification projects, providing cost quotations for projects and making recommendations to the Minister responsible for energy on expenditures.

2 ENERGY SUPPLY, DEMAND AND THE GHG INVENTORY

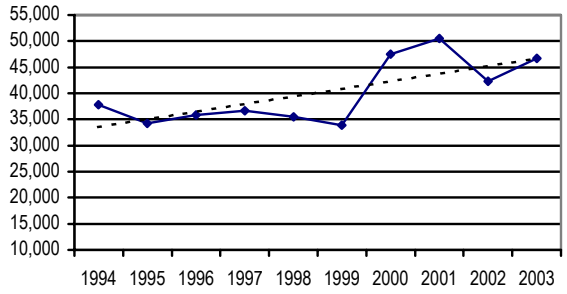
2.1 Energy Supply and Pricing

Vanuatu is highly dependent on imported refined petroleum fuels for its commercial energy needs for electricity generation, for transport by land, sea and air and for lighting. It is likely that biomass provides more than 50% of gross national energy production. Solar and hydro together account for less than one percent.

2.1.1 Petroleum

Figure 2-1 and Table 2-1 show the volume of petroleum fuel imports into Vanuatu over the past decade. For a small market, oil imports in any year do not generally match consumption (i.e. sales) during the year. Because the petroleum companies were unwilling to provide sales data, growth in consumption has been estimated from an import trend line. For petroleum fuels overall, the average annual growth rate (AAGR) has been 4.0% per year with distillate erratic, consumption of most products static, and jet fuel increasing at an AAGR of 17 percent. The *Pacific Regional Energy Assessment* (WB et. al. 1992) predicted that petroleum fuel sales would grow at an AAGR of 3.6% per annum. However, the PREA estimated jet fuel growth to be only 4% per year, distillate 5% and other products including liquid petroleum gas (LPG) to be 2.2-2.5%, consistent with the WB's estimate of growth in real GDP, which was somewhat lower than the actual AAGR of 3 percent. (*Additional information, attached as Annex F, was received after this section was revised in October 2004. The new information has been considered in the analysis of Section 2.3 on the likely future growth of petroleum use.*)

Figure 2-1 – Petroleum Fuel Imports (KL), 1994-2003



Note: Dashed line is linear trend line

Table 2-1 – Petroleum Imports into Vanuatu, 1994 – 2003 (thousand litres)

Product	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Motor spirit	5,512	4,648	5,125	5,028	5,411	3,894	5,164	5,539	4,836	5,809
Aviation gasoline	125	191	190	159	105	148	227	1,015	151	427
Jet fuel	2,200	1,796	2,028	2,334	2,535	3,206	5,032	7,594	5,084	9,745
Other kerosene	981	871	975	1,065	862	670	1,088	707	786	514
Distillate fuels	22,969	20,750	21,512	22,070	20,343	19,404	29,450	29,131	24,940	23,799
Other petroleum oils	8	6	9	12	237	573	548	544	467	437
Total	*37,787*	*34,255*	*35,833*	*36,663*	*35,489*	*33,892*	*47,507*	*50,529*	*42,264*	*46,732*

Source: Vanuatu National Statistics Office, 2004

Almost all LPG is consumed in Port Vila and Luganville (Santo) for household cooking and commercial use, largely hotels and restaurants. As shown in Table 2-2, sales have been static for the past five years for both the residential and commercial sectors.

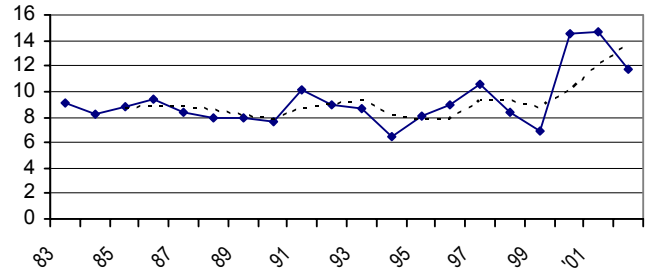
Table 2-2 – LPG Sales in Port Vila and Santo, 1998 - 2003 (tonnes)

Location	Customer category	1998	1999	2000	2001	2002	2003
Port Vila	Commercial	576	595	586	599	581	610
Port Vila	Residential	566	553	532	559	510	563
Santo	Residential	167	172	188	171	164	154
Total	*All*	*1309*	*1320*	*1306*	*1329*	*1255*	*1327*

Source: Anare Matakiviti from Origin Energy Vanuatu Limited, February 2004

In the early-mid 1980s, there was considerable concern within the GoV regarding the high cost of petroleum fuel and the growing percentage of imports accounted for by petroleum products. A joint WBUNDP study noted with concern that petroleum fuels accounted for 30-60% of the value of domestic exports in the early 1980s (WB/UNDP 1985). By 1999-2002, the corresponding percentage had increased considerably to 56 - 86%. The PREA (WB 1992) also identified high petroleum fuel prices, and the lack of effective price monitoring, as key energy sector issues. Figure 2-2 indicates that petroleum imports as a percentage of total imports by value are even higher now than those of the early 1980s.

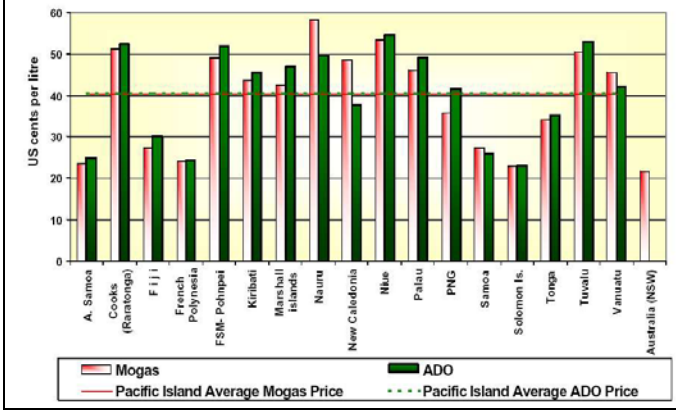
Figure 2-2 –
Petroleum as Percentage of Total Imports: 1983 - 2002



Note: The dashed line is a two year moving average
Sources: 1983-2000 (ADB, 2003); 2001-2002 (Statistics Office, 2004)

As noted earlier, petroleum fuels are supplied by Mobil, Shell and British Petroleum. Except for distillate for power generation on larger islands, fuels are shipped to the outer islands in drums. Recent[3] wholesale prices of gasoline and distillate (excluding taxes and duties) are shown in Figure 2-3. Prices in Port Vila are slightly higher than average for the PIC region and considerably higher than the nearby Solomon Islands with a similar level of demand.

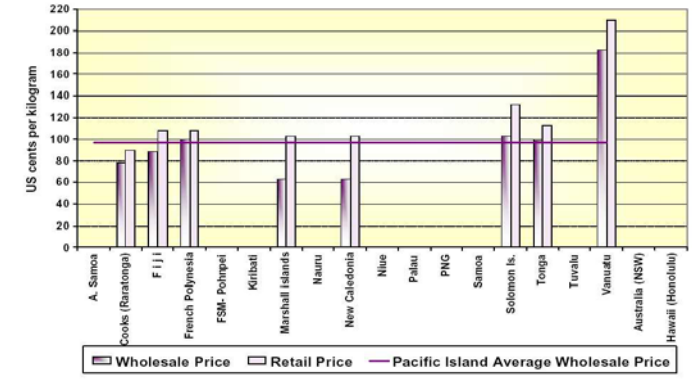
Figure 2-3 – PIC Wholesale Petroleum Fuel Prices
(excluding import duties and taxes; August 2003)



Source: Pacific Fuel Price Monitor, Edition 5 (PIFS; 12 Nov. 2003)

Vanuatu is a relatively low per capita consumer of LPG, which is imported and distributed by Origin Energy. As illustrated in Figure 2-4, the wholesale and retail prices in Port Vila (also excluding import levies and taxes), are roughly double the average prices for those PICs for which comparative data are available.

Figure 2-4 – PIC Wholesale LPG Prices
(excluding import duties and taxes; August 2003)



Source: Pacific Fuel Price Monitor, Edition 5 (PIFS; 12 Nov. 2003)

[3] The Pacific Islands Forum Secretariat has prepared a more recent price monitor but updated prices were unavailable for Vanuatu so the previous edition has been used in this report.

2.1.2 Electricity

In 2002, UNELCO's Port Vila system had a peak demand of 8.2 MW, generated nearly 40 GWh, and sold 34 GWh to its consumers. From 1992-2002, as shown in Table 2-3, Port Vila peak demand grew at an AAGR of 3.4%, generation at 3.9%, and sales at 2.8 percent. Growth has been considerably less than PREA projections (WB 1992), based largely on earlier UNELCO expectations: an AAGR of 7% for demand and 6.6% for sales from 1991-2000. The Vila system (Table 2-4) accounts for 86% of UNELCO's peak demand, 84% of generation, 83% of sales, and 70% of customers. In 2002, diesel accounted for 93% of total generation and 54% of Santo generation, the remainder being from the government-owned, UNELCO operated Sarakata hydroelectric system. The average UNELCO selling price per kWh in 2002 was Vt 34.23, or about US$ 0.25 (based on an average 2002 exchange rate of Vt 120/U$). In Port Vila and Santo, consumers are categorised as low voltage (LV) or high voltage (HV), the former accounting in 2002 for 99% of all customers but only 56% of sales.

Table 2-3 – UNELCO Generation and Distribution: Port Vila (1992 – 2002)

Year	Energy (GWh)				Peak MW
	Gross	Supplied	Distrib.	Sold	
1992	27.06	26.37	n/a	25.60	5.88
1993	28.18	27.43	26.61	26.32	6.80
1994	29.98	29.14	28.18	26.01	7.08
1995	31.84	31.02	30.19	28.04	7.28
1996	33.87	32.95	32.07	29.88	7.24
1997	32.26	32.36	31.28	29.07	7.30
1998	35.34	34.41	33.39	31.25	7.65
1999	36.49	35.29	33.81	31.63	8.07
2000	38.64	37.15	36.08	33.76	8.20
2001	39.46	37.93	36.13	33.73	8.20
2002	39.54	37.81	36.22	33.81	8.20

Note: GWH = 1 million 'units' or kWh.
Source: UNELCO Annual Tech Report Electricity, 2002

Table 2-4 – Electricity Statistics: UNELCO (2002)

Statistic	Port Vila	Santo	Male kula	Tanna	Total
Installed capacity (MW)	17.1	3.7	0.4	0.4	21.6
Peak demand (MW)	8.2	1.3	-	-	9.5
Gross energy (MWh) of which, hydro	39,537 none	7,006 3,200	443 none	162 none	47,148 3,200
Generation efficiency (%)	95.6	98.1	-	-	96.1
Fuel consumption (KL)	9,818	1,070	156	67	11,111
Fuel consumption (l / kWh)	0.248	0.282	0.374	0.433-	0.253
Planned interruption (hrs/customer)	0	0	-	-	.02
Unplanned gen. interruption (hours / customer)	4.78	0.9	-	-	4.17
HV network length (km)	126.7	69.2	11.5	9.3	216.8
LV network length (km)	149.9	50.6	11.4	14.9	226.8
Customers *	6,016	1,654	425	452	8,546
Energy sold (MWh)	33,809	6,452	402	121	40,784
Turnover (million Vt)	1,160	217	15	4	1396
Ave. selling price Vt/kWh	34.3	33.68	36.2	36.99	34.23
Employees *	116	34	4	5	159

Notes: HV = high voltage; LV = low voltage * 31 December 2002
Source: As for Table 2-3

In the much smaller systems of Malekula and Tanna, 90% of all customers use pre-paid meters; the rest are LV customers who are billed monthly. Table 2-5 summarises these average sales per month by UNELCO's customer category. For the Port Vila system, the top seventeen customers (Table 2-6) consumed 7.8 GWh in 2002 or 23% of total Port Vila sales. The ADB (2004) describes Vanuatu's electricity charges as among the highest in the world although charges are similar to those of other small PICs. The UNELCO electricity tariff is the same for customers in Port Vila and Santo.[4] There is a pricing formula based on a reference price of Vt 32.63 per kWh with quarterly adjustments depending on changes in diesel fuel price, Port Vila public service wage levels, a New Caledonia index of material costs, and exchange rate variations for the Pacific franc.

[4] Electricity supply costs, however, are higher for diesel-based power in the smaller Santo system. Most of the savings in operating costs accruing from the Sarakata hydro system are used to subsidise Santo operating costs including connections, extensions and street lighting.

Table 2-5 – UNELCO's Average Sales by Customer Category: 2001 and 2002											
	Customer category	Port Vila		Santo		Malekula		Tanna		Total	
		2002	2001	2002	2001	2002	2001	2002	2001	2002	2001
Customers (31 December)	LV	5,961	5,689	1,640	1,466	44	-	44	-	7,689	7,155
	Prepaid	0	0	0	0	381	-	407	-	788	0
	HV	55	56	14	16	-	-	-	-	69	72
	Total	6,016	5,745	1654	1482	425	-	451	-	8,546	7,227
Average Consumption (kWh/month)	LV	272	278	169	181	713	-	214	-	252	259
	Prepaid	0	0	0	0	23	-	26	-	20	-
	HV	21,786	22,602	19,310	28,280	-	-	-	-	21,290	22,892
	Total	22,057	22,880	19,479	28,461	735	-	240	-	21,562	23,150
Note: LV = low voltage; HV = high voltage Source: As for Table 2-3											

The Port Vila / Santo tariff schedule for the first quarter of 2004 is shown in Table 2-7. For domestic consumers, there is a 'lifeline' rate for the first 60 kWh per month, which in effect subsidises low-income households. For Malekula and Tanna (Table 2-4), charges are slightly higher.

Table 2-6 – Major UNELCO Consumers (2002)	
Customer	**Sales (MWh)**
Le Meridien Hotel	1,495.5
Hebrida	846.1
Melanesian Hotel	710.4
Iririki Island	557.1
TVL City Centre	414.1
Au Bon Marche, Nambatu	394.1
Club Vanuatu	385.0
ANZ	360.6
Au Bon Marche, Town	357.6
Hospital	352.6
TVL International	338.7
Au Bon Marche, Manples	304.4
Int'l Terminal, Airport	275.1
Vanuatu Beverage	268.7
Westpac Bank	267.5
Government Building	255.0
Switi	254.8
Total: Top 17 customers	*7,837*
Source: John Chaniel (UNELCO, 2004)	

Table 2-7 – Vila / Santo Electricity Tariff (Q1; 2004)		
Category	**Consumption charge:** Vt / kWh	**Demand charge:** Vt / KVA
Domestic:		
0-60 kWh/m	21.29	
61-120 kWh/m	31.94	
over 120 kWh/m	58.38	
Other low voltage	32.97	652.4
Government	18.54	
Sports stadium	34.34	
High voltage	29.88	686.8
Source: Tarification de L'Energie Electrique (UNELCO; 2004)		

2.2 Commercial Energy Demand

Table 2-8 provides an estimate in tonnes of oil equivalent (toe) based on the import data of section 2.1. [5]

[5] The sales data shown in Annex F were considered. However, the most recent three years available (2000-2002) are clearly atypical. Neither the data nor the trend line appear to be appropriate for projecting future petroleum product demand. If the trend line of Annex F were used (adjusting for LPG sales and extrapolating to 2003)), the 2003 GHG emissions would be about 7% lower in 2003 than those shown in Table 2–10. However, the magnitude of potential GHG reductions shown in Tables 2–11 and 2–12 would change insignificantly, if at all.

Table 2-8 – Consumption of Petroleum Products by Sector (toe; 2003)						
Product	Imports (tonnes)	--------- Consumption by Sector in Tonnes of Oil Equivalent ---------				
		Transport	Electricity	Households	Commercial & industry	Total
Motor spirit	4,240	4,622				4,622
Aviation gasoline	297	333				333
Jet fuel	7,734	8,430				8,430
Other kerosene	405			441		441
LPG	1,327			854	699	1,553
Distillate	19,999	10,400	10,600		599	21,599
Total	*34,002*	*10,400*	*10,600*	*1,295*	*1,298*	*57,595*
% of total toe	*n/a*	*64%*	*29%*	*4%*	*4%*	*100%*
Notes: toe calculated from energy conversions table of page iv; Totals rounded; n/a = not applicable						
Source: Imports are from GoV as reported in Table 2-1 (omitting 'other petroleum oils') and Table 2-2						

Transport accounts for about 64% of petroleum product use in Vanuatu. Jet fuel is often considered an export or bunker but was included by the 1992 PREA as local consumption because it is mainly used for transportation of tourists, a mainstay of the economy. This report retains the PREA convention. There are no available records of fuel sold specifically for ground or marine transport. There are no accurate records of vehicles on the road (from which fuel use could be estimated). It is assumed that all motor gasoline (petrol) and most ADO not used for public electricity generation are for ground and marine transport.

Electricity generation accounts for nearly 30% of petroleum fuel use. Distillate used by UNELCO is calculated from the data of Table 2-4. It is crudely estimated that an additional 5% above UNELCO usage is consumed for private diesel generation. *Household* petroleum use accounts for only about 4% of the total. LPG for household consumption was calculated from the data of Table 2-2 provided by the importer. It is assumed that most kerosene is used for household lighting and cooking. Direct use of fuel for *business or commercial use* is quite small, also about four percent. Distillate use s estimated; LPG is from the data of Table 2-2.

Information from the 1999 census on the main source of energy for household cooking and lighting is summarised in Table 2-9. The total number of households is 36,415 of which 8,258 are urban and 28,157 are rural. Overall, 61% of urban households are electrified but only 7% of rural households. Nearly 86% of rural households (and 74% of all households) use kerosene as their main lighting source. Over 95% of rural households (and 86% of all households) cook with wood or other biomass.

Table 2-9 – Households by Main Energy Source for Cooking and Lighting, 1999								
Energy Source	Lighting:				Cooking:			
	Urban	Rural	Total	% of total	Urban	Rural	Total	% of total
Electricity	5024	1927	6951	19	197	46	243	< 1
Kerosene	2941	23969	26910	74	67	107	174	< 1
LP Gas	82	82	164	< 1	4271	1126	4397	13
Wood/Coconut	57	1638	1695	< 5	3450	26811	30261	86
Torch	4	128	132	< 1				
Other	53	254	307	~1	9	16	25	<< 1
Total	*8,161*	*27,998*	*36,159*	*100*	*7,994*	*28,106*	*35,100*	*100*
Source: *1999 Vanuatu National Population and Housing Census* (Dec 2000)								
Notes: Does not add up to 36,415 households as some questions unanswered. < = 'less than'; ~ = 'approximately'								

2.3 Future Commercial Energy Demand and GHG Emissions

Vanuatu has had variable economic growth since Independence in 1980 but has on average grown slightly faster than population. It is assumed that population will continue to grow about 2.6% annually and GDP about 2.8 percent. Assuming no major technological changes, or major investments in energy efficiency or indigenous energy sources, petroleum fuel is estimated to grow at an AAGR of about 3.5%, similar to growth in both fuel use and electricity production in the past decade. For individual fuels, the 1992 PREA, with far more resources than PIREP, was unable to accurately predict growth and this exercise is unlikely to be more accurate.[6] It is assumed that the AAGR in consumption of all petroleum fuels will be the same: 3.5 percent. Although this is unlikely, projections of greenhouse gas (GHG) emissions are not very sensitive to the petroleum fuel mix used in Vanuatu so this assumption has little effect on GHG projections.

Table 2-10 shows petroleum imports and GHG emissions (CO_2 equivalent). In 2003, emissions were about 110,400 tonnes or 110.4 Gigagrammes (Gg), the standard measure. Vanuatu's communication to the UNFCCC (GoV, 1999) estimated 1994 emissions from petroleum fuels as 56.7 Gg including bunkers or about 66 Gg including the CO_2 equivalent of CH_4 and N_2O.[7] It is not clear why the 1994 estimate is only 60% of the 2003 level as 1994 fuel imports were about 78% of those in 2003. If PIREP assumptions are valid, GHG emissions from petroleum fuels will increase by about 41% over the next decade.

Table 2-10 – Petroleum Demand and GHG Emissions in 2003 and Projections for 2013

Product	2003			2013			
	Imports (KL; actual)	Share (%)	GHGs (Gg)	Imports (KL; projected)	Share (%)	AAGR (%)	GHGs (Gg)
Motor spirit (petrol)	5,809	14	14.2	8,191	14	3.5	20.1
Aviation gasoline	427	1	1.0	602	1	3.5	1.4
Jet fuel	9,745	23	25.3	13,741	23	3.5	35.7
Other kerosene	514	1	1.4	725	1	3.5	2.0
ADO	23,799	55	64.3	33,571	55	3.5	90.6
LPG	2,602	6	4.2	3,669	6	3.5	5.9
Total	*42,896*	*100*	*110.4*	*60,499*	*100*	*3.5*	*155.7*

Notes: CO_2-equivalent emissions for various fuels and conversion of LPG from T to KL from data of page iv.
GHG emissions assume that all fuels imported during 2003 were consumed during the year.
Source: 2003 imports from Vanuatu Statistics Office (2004); 2013 imports are mission estimates

As discussed in the chapter 3, Vanuatu has significant potential for commercial energy production from renewable indigenous resources, even ignoring promising technologies that are unlikely to be commercialised in the next decade, such as seawave or ocean thermal energy. Table 2-11 provides a summary of indicative estimates of the potential and their associated GHG reductions.

[6] A comment in an early draft of this report suggested that the higher resources of PREA (roughly ten times the funds available for the PIREP national studies) should not be used to justify difficulties in projecting future energy growth. However, two of the three international consultants were part of the PREA exercise and the third was involved to a lesser extent. It is clear that the PREA resources did allow the team to obtain far more petroleum import data and resolve discrepancies in that data, which eased the task of preparing projected future commercial energy use.

[7] Vanuatu's communication to the UNFCCC indicates 56.71 Gg of CO_2 emissions in 1994 plus 0.0026 Gg of methane (CH_4) and 0.029 Gg of nitrous oxide (N_20). CH_4 has 21 times the GHG effect as CO_2 and N_20 310 times so their combined contribution is 9.07 Gg of CO_2 equivalent. The CO_2 equivalent impact of Vanuatu's petroleum-related NO_x and CO emissions were not calculated.

Table 2–11 – Indicative GHG Savings from Renewable Energy and Energy Efficiency in 2013				
Technology	**Potential fuel, energy or power savings**	**GHG reductions** (Gg) [1]	**% of total**	**Comments**
Mini hydro [2]	At least 3 x 300 KW	5	5	Based on JICA calculations from Sarakata
Micro hydro [3]	At least 1,500 kW	9	8	Assumes 1/2 of Sarakata savings per kW
Geothermal	3 MW minimum	17	16	GHG reductions calculated by WB's IFC
Other biomass [4]	Assume 500 kW	< 1	< 1	Displacing UNELCO supply at Santo sawmill
Biofuel	28 ML+ of ADO equiv.	75.6	69	Displacement of distillate by coconut oil
Solar PV [5]	15,000 SHS; 500 others	< 2	< 2	Generally good solar resource
Wind [6]	1 x 250 kW minimum	<< 1	0	Wind speeds appear to be very low in Vanuatu
Efficiency (electricity) [7]	823 KL of ADO	0	0	5% of all ADO used for electricity
Efficiency (transport) [8]	410 KL of petrol; 500 of ADO	1	1	5% of fuel used for ground transport. Most would save fuel but not reduce GHG emissions
Total		*~ 109*	*100*	

Notes:

1) **General**. 1 Gg of GHG emissions = 1,000 tonnes. < = 'less than' << = 'much less than' ~ = approximately

2) **Mini-hydro**. 4.5 GWh/yr from 600 kW, long-term Sarakata average, at base load, displacing 1.27 ML of distillate/year or 3.4 Gg.

3) **Micro-hydro**. Assumes half of Sarakata's energy output per installed kW for small systems

4) **Biomass**. Assumes (Annex 2), 0.93 kg CO_2 / MWh. At 1,000 MWh/yr, this is 0.93 t of CO_2 equiv. UNELCO produces 764 t CO_2 equiv/MWh or 0.764 Gg./MWh. Nearly all, over 0.76 Gg is CO_2 reduction.

5) **PV**. About 25,000 rural households. Assume 15,000 systems of 100 Wp and 0.25 kWh/day plus 500 larger (school, health, etc.) systems at 1.0 kWh/day. Assume 300 days/yr operation = 1.275 million kWh/year. At 0.5 l/kWh for small diesel systems, this would displace 0.64 ML of fuel, equivalent to only 1.7 Gg per year.

6) **Wind**. Assume average output of 50 kW for 2,000 hour/year or 100,000 kWh. If this replaced small diesel system (0.5 l/kWh), fuel savings are 50,000 l/year or 135 tonnes of CO_2 displacement, less than 0.14 Gg per year.

7) **Efficiency (electricity).** UNELCO is efficiently run but there are relatively demand-side (end-user) improvements. Electricity accounts for 49% of ADO use (Table 2-8) or 0.49 x 33,571 = 16,450 KL. 5% savings is 823 KL. However, not all of this will reduce GHGs because most ADO for power generation is already displaced by renewable energy. Hydro, geothermal, biomass and wind account for 32 Gg or 72% of all electricity production even if no biodiesel is used for electricity. Assuming that biodiesel replaces the other 28%, then fuel would be saved but there were be no additional GHG savings.

8) **Efficiency (transport).** 5% of petrol saved is 410 KL or 1.0 Gg. Transport accounts for 48% of transport or 16,100 KL. Assume that 10,000 KL is for ground transport. The 5% is 500 KL. However, 28% of electricity production is from biofuel would require about 4,600 KL of ADO-equivalent biofuel, leaving 23.4 ML for transport fuel, which is more than the total projected ADO consumption of 16.1 ML for transport. Therefore, efficiency measures would only save fuel, not GHG emissions.

Table 2–11 suggests that in principle, Vanuatu could reduce CO_2 equivalent GHG emissions by over 110 Gg per year by 2013, about the same magnitude as total 2003 emissions from petroleum fuels. However, if all the above measures were carried out, they would displace about 40.6 ML of distillate compared to a projected demand of only 33.6 ML, about 21% too high. Table 2–12 adjusts the totals by reducing biofuel production by 6 ML[8] but the results would be the same if the reduction were from another renewable energy source.

Table 2–12 – Adjusted Indicative GHG Savings in 2013			
Technology	**Potential savings**	**Potential GHG reductions** (Gg)	**% of total reductions**
Biofuel	22 ML of ADO equiv.	59.6	64
Hydro, geothermal, wind and biomass for electricity	As in Table 2-11	31.0	33
Solar and wind	As in Table 2-11	~ 2	2
Transport efficiency	As in Table 2-11	1	1
Total		*93.6*	*100*

Source: Mission estimates

[8] Table 2-10 suggest 7 ML but about 1 ML is used for industrial / commercial purposes in addition to ADO used for transport and electricity. It is assumed that this add ional 1 ML would be replaced by biofuel.

The indicative estimate of Table 2–12 is based on proven technologies and known resources but does not consider economic, financial, political, social, technical, environmental or other practical constraints. Although actual achievable reductions would be considerably less, the table suggests the order of magnitude of the reductions in emissions that is approachable if the barriers to renewable energy, and to a lesser extent, energy efficiency, were removed. The bulk of the potential reductions would come from biofuels, with very little from even a large solar PV or wind energy programme. The basis for the above estimates is discussed in the following chapter.

3 THE POTENTIAL FOR RENEWABLE ENERGY TECHNOLOGIES IN VANUATU

The technical potential for energy production from renewable energy technologies (RETs) from local renewable resources in Vanuatu is considerable. However, in practice most of this potential cannot be exploited and much has not been accurately assessed. Indications of technical potential are nearly meaningless as estimates of short-term practical options. Nonetheless, there is considerable value in estimating the potential resources and associated technologies for geothermal, hydro, ocean based energy, wind, solar and biomass for liquid fuels (coconut oil) and combustion (forest resources). These are discussed below.

3.1 Geothermal

Twelve islands of the Vanuatu archipelago have thermal springs. Because of the volcanic origin of Efate, there apparently exists a substantial geothermal resource, which could be exploited to replace a significant proportion of imported fuels for power generation. Efate's geothermal potential has been studied for the last three decades (Chaniel, 2004). Various studies by the Department of Geology and Mines (DG&M) and others from the mid-1970s to early 1990s have strongly indicated and delineated the probable geothermal resource base (IFC, 2001). According to SOPAC, exploration has identified two prospective sites on Efate: Takara Springs in the north at 17^0 32' south / 168^0 25' east, and Teouma Graben springs northeast of Port Vila at $17^0$48' south / 168^0 23' east, both of which have temperatures higher than required for electricity generation (SOPAC, 2002).

Although sufficient surface investigations have been undertaken at the two Efate sites, further studies are needed to establish their technical and economic viability (PREA, WB 1992). A 1991 consultancy study recommended two production-size wells at a total cost of approximately US$4 million (GENZL/KRTA, 1991). According to UNEP (2002), development of the Efate potential would provide the following benefits:

- long-term decrease in energy cost (in the post-debt period);
- less dependence on imported fuel;
- economic benefits (such as employment) during construction; and
- system development due to a new transmission line across Efate.

Following exploration drilling based on the GENZL/KRTA report, the government (GoV, 1996) concluded that geothermal development on Efate should be based on a structured three-phase approach.

- Phase 1: Drill two deep exploration boreholes to depths between 1000-1500 feet to determine temperatures and prove the thermal models. A go no-go decision would depend on whether temperatures are high enough to warrant further investigation.
- Phase 2: Drill additional boreholes and finalise analysis of geothermal potential and design of geothermal borehole array and station. Go no-go decision: Is the geothermal resource capable of producing economic power?
- Phase 3: Complete drilling of boreholes and construction of station and transmission distribution.

In line with the 1992 PREA recommendations, the GoV sought private financing and assistance of multilateral institutions to finance exploration costs. In July 1999, the government signed an agreement with the Efate Geothermal Joint Venture (EGJV) to initiate private sector geothermal development. EGJV is a joint venture between Layman Energy Associates, Inc. (USA) and Rawson Resources (Australia). The agreement granted EJGV

exclusive rights for one year to prepare a comprehensive feasibility study for development of the geothermal project (Conolly et al, 2000).

The United Nations Environment Programme (UNEP) provided US$37,000 from a Global Environment Facility (GEF)/UNEP financed Renewable Energy/Energy Efficiency Investment Advisory Facility to engage a geothermal consultant to advise the equity investor and development banks (UNEP, 2004). The study was to determine costs of the proposed development and determine if it could deliver electricity at lower rates than the existing diesel system, assuming an initial 2.5 MW geothermal plant plus another 2.5 MW unit when needed to meet growth in demand. The study concluded that the following key elements – necessary for successful commercial development of geothermal power – exist at Efate:

- excellent geothermal resource potential;
- high retail power prices;
- sufficient power demand to justify construction of an initial 3 MW geothermal power plant, followed by subsequent units (initially 1 MW) to satisfy a rapidly growing power demand into the indefinite future;
- strong government support for the project;
- a long history of private sector involvement in the power industry;
- a utility willing to consider purchase of the geothermal power; and
- significant greenhouse gas and pollutant emissions reductions achieved by displacement of diesel generation by geothermal.

Following the study, EJGV concluded that the project was viable based on the resource, its calculations of UNELCO's avoided costs, estimated project development costs and the likelihood of some donor assistance. Although the average cost of energy from the initial geothermal plant would be slightly higher than the costs from diesel-based plants, the investment was economically justified. As the system demand grows and more geothermal units are added, incremental cost would fall sharply below the costs from alternative diesel power plants. In the long run according to the WB's private sector lending arm, the International Finance Corporation (IFC, 2001), the average geothermal power costs would be significantly lower than those from diesel plants.

Subsequently, the GEF partially financed[9] a power purchase agreement (PPA) between geothermal plant developer (EGJV) and the power utility (UNELCO). A substantive private project developer reportedly made a commitment to join the Joint Venture as the senior partner once the PPA negotiations were successfully completed. Commercial financing, possibly including IFC, would then be sought to finance the remaining US$9 million of plant and transmission line capital costs (IFC, 2001). If developed, the result is expected to be:

- green field development of a new, renewable and environmentally benign energy resource for power production on Efate;
- permanent conversion of possible future power plant developments from hydrocarbon-based technology to geothermal;
- long-term and permanent reduction in the real costs of electricity generation; and

[9] GEF provided a US$25,000 Project Development Facility (PDF) 'Block A' grant. Once a satisfactory PPA was signed, a GEF PDF 'Block B' grant of up to US$350,000 could be requested by the GoV to support an estimated US$ 745,000 programme for initial thin-hole exploration and development drilling. If this were successful, a GEF-funded US$1..9m partial risk-sharing contingent financing facility (loan possibly with a grant component) can be requested for full-scale exploration and well development.

- avoidance of some 330,000 tonnes of CO_2 emissions from the first 3 MW geothermal plant over twenty years, with additional savings from any subsequent geothermal units.

However, the PPA has yet to be finalised (April 2004), as EGJV and UNELCO could not agree on a power sales price. EGJV was prepared to develop the Takara Springs geothermal resource and sell power at UNELCO's avoided cost (as calculated by EGJV) of US$ 0.1174/kWh. UNELCO offered to buy power from EGJV at its avoided costs, which it calculated at U$0.10/kWh. Because the parties could not agree on the appropriate figure for avoided costs**,** Meritec Ltd. of New Zealand was contracted by UNEP in 2001 to provide independent advice to the GoV. Meritec (UNEP, 2001) estimated UNELCO's avoided cost to be U$0.119/kWh. In April 2001, the Minister of Energy suggested a power purchase price of U$0.1121/kWh (non-weighted average of the three earlier calculations) but the Meritec calculations and the Minister's suggestion were rejected by UNELCO.

Despite further discussions, negotiations have been at impasse since July 2002. UNELCO says it supports the initiative and would like the geothermal project to proceed. UNELCO claims that a second opinion is justified as: i) investment costs are too high (in the order of US$10-15m for 3 MW capacity) and risky; ii) production costs and avoided costs are almost equal; iii) high risk exploration and drilling is still required; and iv) the availability of grants to partly fund the project needs to be further explored. UNELCO is willing to finance part of a new opinion but would also seek co-financing from donors (Chaniel, 2004).[10]

3.2 Hydro

Vanuatu has considerable technical potential for hydropower generation, both for supplying urban power and for meeting very small village demands in remote areas. Hydropower schemes are classified in accordance with their capacity. Although classification can be vague and sometimes seems more-or-less arbitrary, the following range is often used and is adopted here: pico-hydro for output below 1 kW, micro-hydro for output below 300 kW, and mini-hydro for output greater than 300 kW but less than 2 MW.

3.2.1 Hydro for urban power supply

Hydroelectric potential on Espiritu Santo was first studied in 1956 (JICA, 2003). In the early 1980s attention focused on developing mini-hydro to substitute for diesel in Port Vila (Efate) and Luganville (Santo). There were at least three pre-feasibility studies during the 1980s: Electricité de France in 1983; an ADB-funded by COWI Consult of Denmark in 1986; and the UN Department of Technical Cooperation for Development (UNDTCD) through the Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power, based in China, in 1989 (IEA International Small-Hydro Atlas). The studies indicated that the economic feasibility of hydro at Teouma river, Efate would be marginal (reported in PREA, WB 1992). UNELCO recently concurred that there is no economically viable hydro potential on Efate. The maximum capacity at Teouma is 1.2 MW but due to geological and hydrological conditions the required investment costs is prohibitive (Chaniel, 2004).

The viability of hydro at the Sarakata river on Santo appeared to be far more promising, and the GoV approached the Japanese Government for technical and financial assistance. A basic design study was carried out in 1991, after which the government and Japan agreed to develop two of four envisaged 300 kW units under Japanese aid. JICA constructed a

[10] In 2002 SOPAC, in collaboration with the US Geothermal Industries Corporation (USGIC) prepared a funding proposal for carrying out further assessment of the geothermal resource in five Pacific Island Countries, including Vanuatu (SOPAC, 2002). Funding remains to be secured.

relatively low-head (28 metre) two turbine 600 kW system that began operating in March 1995, used for base-load operation, and providing roughly 50% of the Luganville energy (kWh) demand. In 2001 and possibly again in 2003 one of the turbines was out of operation for some six months[11]. There are plans to expand capacity from 600 to 1200 kW but there are unresolved issues between Japan and the GoV.

3.2.2 Hydro for rural power supply

No pico-hydro or mini-hydro power plants have been installed by the GoV or UNELCO. Church missions may have installed a few small systems but no details are available. However, the potential for small rural hydro plants has been explored for at least 15 years.

A pre-feasibility study on micro hydropower development for rural electrification was prepared with German funding in January 1989. Of the various schemes considered, PREA considered the 215 kW Brenwe/Unmet project – to meet the combined demand of villages in the adjacent area and Norsup and Lakatoro towns in Malekula island – to be one of the better projects (WB, 1992). After the GoV agreed to finance a hydrologist through UNDP in 1987, the European Commission (EC) approved the use of Lomé II regional energy programme funds for procurement of hydrological equipment. Equipment arrived and was installed in 1990. There were numerous equipment problems, which were not fully resolved when the hydrologist's contract ended. By late 1993, the problems had been resolved and useful data was soon expected (Johnston, 1994) but the PIREP mission has not been able to establish the post-1993 status of the monitoring equipment or results.

The PIFS managed a German Deutsche Gesellschaft für Technische Zusamenarbeit (GTZ) funded regional small-scale hydropower project involving Papua New Guinea, the Solomon Islands and Vanuatu, implemented in the early and mid-1990s. Consultants from Projekt-Consult in Germany trained energy staff from these countries on planning, execution and operation of small-scale hydropower projects through in-country practical training and regional workshops. Installation of a planned hydropower plant in Vanuatu was cancelled after site economics could not be substantiated (Fairbairn, 2004).

Appropriate Technology for Community and Environment, Inc (APACE, an Australian non-profit company / registered charity) investigated the feasibility of a 75 kW hydro scheme near the Talise river (Maewo Island, Penama Province, central Vanuatu). The project would provide electricity to 361 houses in several villages and a school. The cost, including power reticulation, was estimated as A$624,000 (APACE, 2002). This project is reportedly a priority for funding within the National Planning Office and may be implemented in 2005.

[11] When visited on 4 February 2004, the counter showed only 4733 running hours (197 full days) for generator one versus 68,405 hours (7.8 full years) for generator two.

In 2003, the GoV's Energy Unit and others from the Department of Geology, Mines and Water Resources investigated micro-hydro potential for 13 sites on six islands. Preliminary results, summarised in Table 3-1, suggest about 1500 kW of available power ranging from 15-350 kW per site. Subsequently, a JICA expert has recommended four sites for further study: Lowanau in Tanna, Mbe Tapren in Vanua Lava, Waterfall in Pentecost and Anivo in South Santo. Long-term water flow and rainfall monitoring and more detailed investigations are needed to confirm the hydro potential (GoV, October 2003).

Table 3-1 – Preliminary Estimates of Microhydro Output

Province	Island	River	Head (m)	Flow (l/sec)	Output (kW)
Tafea	Erromango	South	32	1428	300
	Eromango	Dillion	98	64	50
	Tanna	Yayur	45	101	30
	Tanna	Lokunowla	284	55	100
	Tanna	Lokunowla	90	61	35
Torba	Vanua lava	Tahiti	21	100	15
	Vanua lava	Mbe Tapren	47	100	350
Shefa	Epi	Ringdove	284	6	15
Penama	Pentecost	Waterfall	42	360	100
	Pentecost	Melsisi	110	440	300
	Pentecost	Manaro	59	85	3-40
Sanma	Santo	Aniwo	108	180	130
	Santo	Buvo	?	2000	~ 1500
					Total output: over 120

Source: Hydro Potential Reconnaissance: July-Aug, 2003: *Preliminary Site Investigation for Micro Hydro Power Development* (Energy Unit, GoV; Oct. 2003) ~ is 'approximately'

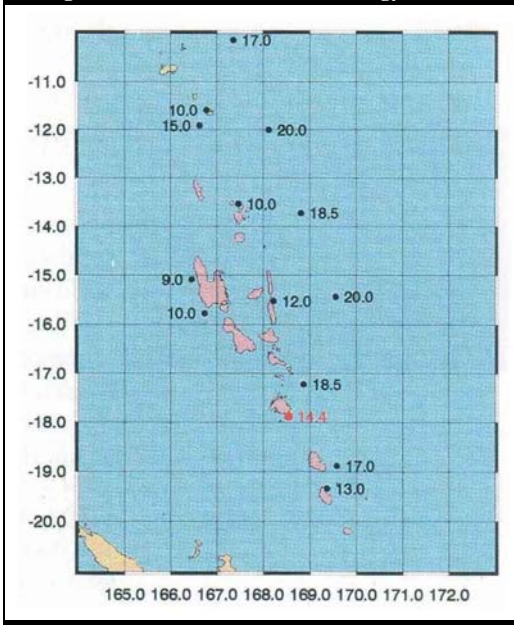
3.2.3 Pico-hydro

One private company in Port Vila imports Vietnamese-made pico-hydro systems. Hong-Auto Enterprise sells Power Pal hydroelectric generators built by the Institute of Material Science, Vietnam and Asian Phoenix Resources Ltd, Canada. The systems (220V, 50 Hz) have capacities ranging from 100 to 1000 watts and cater for individual households or small communities (Matakiviti, 2004). It is not known how many systems have been imported or sold.

3.3 Ocean Based

Although Vanuatu is surrounded by oceans, no use is made of ocean based energy technologies (OTEC, tidal or wave energy) and there is very little knowledge of its potential. This is unsurprising as ocean energy technologies are not proven commercially available technologies.

Figure 3-1 – Vanuatu's Wave Energy Potential



Source: Oceanor studies (SOPAC 1996)

Oceanor of Norway monitored Vanuatu's sea wave potential from November 1990 to December 1991 through a NORAD-funded regional wave energy resource assessment (SOPAC, 1993). The aim was to map the resource (wave height, wave periods and wave energy), through data buoys moored off the shores of several islands, including Efate. Figure 3-1 shows the results, an estimated annual average wave power of 14.4 kW per metre of wavefront from the buoy measurements (red data point) and a range of 9-20 kW/m based on Geosat satellite altimeter calculations (black). For areas producing 10 kW/m, assuming 25% conversion efficiency, it would require 0.4 km of wavefront for an average annual output of 1 MW. If the technology to tap the energy of sea waves were commercially available and

economically viable, Vanuatu could produce much of its electricity (the current installed capacity is about 22 MW) from a few small plants.

As far as the mission could determine, there has been no measurement of deep sea versus surface ocean temperatures to enable estimates of near-shore ocean thermal energy conversion (OTEC) potential. Despite frequent announcements of sea wave and OTEC demonstration projects, it is highly unlikely that Vanuatu or other PICs will deploy ocean energy technologies at any scale for the next decade or so.

3.4 Wind

At present, there is very limited data on the potential for wind energy in Vanuatu. Under the PIFS's Southern Pacific Wind and Solar Monitoring Project, wind speeds were monitored in 1995 and 1996 at the White Sands Country Club on Efate. The site is north of Port Vila, 12 km from the existing power grid at 17^0 49' 28" latitude south and 168^0 24' 14" longitude east at an elevation of 4m above sea level. The annual average wind speed was 5.0 m/s during 1995 and 4.2 m/s in 1996. The highest averages were in August 1995 (7.9 m/s), October 1995 (5.9 m/s), December 1994 and May 1995 (both 5.5 m/s) and the lowest were in February 1996 (2.9 m/s), December 1995 (3.3 m/s) and March 1995 (3.5 m/s). Only 63% of expected data was recovered in 1996, due to malfunctioning data loggers which service personnel were unable to resolve (Environment, 1997), so 1996 data are suspect.

UNELCO is currently monitoring wind at Devil's point, north of Port Vila at heights of 20 m, 30 m and 40 m. Preliminary data for the period May through December 2003 show average monthly wind speeds of 4.2 m/s, well below the 7.2 m/s that was predicted using Fernier analysis. If the wind speeds prove to be acceptable, UNELCO may consider installing a single 250 kW wind turbine, primarily to gain experience with the technology (Chaniel, 2004).

For the investigated locations on Efate the wind resource is probably unfavourable for electricity production as the average wind speeds are well below those generally considered to be necessary for economic electricity production (6 m/s). However, the economics of wind depend on the cost of alternatives, not just wind speed, and wind resources may be better on the windward site of some outer islands. On the outer islands, wind speeds have never been monitored and stand-alone wind generators for isolated rural areas are unlikely to be cost-effective. For some years, the contribution of wind energy will be marginal in Vanuatu.

3.5 Solar

In Vanuatu average annual sunshine hours range from 2000 to 2300 at an average of 6 $kWh/m^2/day$. Solar energy offers substantial technical potential in Vanuatu, and it can be used to heat water (using solar water heaters or SWHs) or to generate electricity (using solar photovoltaics or PV). The actual use of solar technology, discussed in Chapter 4, has been relatively modest.

3.6 Biomass

3.6.1 The timber industry

Unlike the Solomon Islands or Papua New Guinea, the forestry sector is not vital to the national economy, but it is significant. Timber products are Vanuatu's third largest export after copra and beef. Between 1996 and 1999 some 36,000-41,000 m^3 of timber was cut annually (Table 3-2). Since 1989 a ban on the export of unprocessed logs has been in place. This was briefly lifted in 1993 but re-imposed in 1994 and is still in force. Since 2000, timber production has dropped considerably.

Table 3-2 – Vanuatu's Annual Log Production, 1987-1999

Year	Exports (m^3)	Domestic (m^3)	Total (m^3)
1987	23,716	15,521	39,237
1988	5,001	17,899	22,900
1989	15,085	19,923	35,008
1990	-	19,276	19,276
1991	-	27,336	27,336
1992	-	20,355	20,355
1993	4,014	21,084	25,098
1994	-	43,874	43,874
1995	-	32,986	32,986
1996	-	35,854	35,854
1997	-	37,513	37,513
1998	-	36,907	36,907
1999	-	40,676	40,676

Source: Forestry Department Annual Report, 2001

Logs are harvested by two large companies and a few dozen portable sawmillers. Logging companies Santo Veneers and Timbers (SVT) and Melcoffee Sawmills Limited (MSL) operate sawmills based in Luganville, Santo. SVT and MSL harvest all their logs on Santo. Whitewood (*Endospermum Medullosum*) and Milk tree (*Antiaris Toxicaria*) remain the most desirable species, constituting 95% or so of all logs harvested by the two companies. The total volume of timber they harvested declined by about half between 2000 and 2002 (39,860 m^3 in 2000, 24,426 m^3 in 2001 and 18,081 m^3 in 2002), and the annual log production in 2002 was the lowest since 1994. Preliminary data indicate stabilisation in 2003. Table 3-3 below shows the numbers of trees felled, the log intake in cubic metres and the timber volumes produced in 2001 and 2002 by the two main logging companies.

Table 3-3 – Fixed Mill Harvest Volumes (m^3; 2001 and 2002)

Company	2001 volumes			2002 volumes		
	Trees felled	Vol. (m3)	Output vol. (m^3)	Trees felled	Vol. (m3)	Output vol. (m^3)
MSL	4,070	7,259.5	3,630.0	3,679	5,385.1	2,692.6
SVT	5,949	17,166. 2	7,724.8	3,907	12,695.9	5,713.2
TOTAL	10,019	24,425.7	11,354.8	7,586	18,081.1	8,405.7

Source: Department of Forestry, Annual Reports (2001 and 2002)

Various factors contribute to the drastic reduction in timber cut. The eastern part of Santo, which is quite accessible, has run out of available wood resources, and logging companies are currently operating in the southern part of the island, which is very rugged. Disputes between landowners over land and resources was said to be a minimal factor for the reductions in 2001 and 2002 (DoF, 2001 and 2002). Reliance on only two species is a major concern to the GoV as such practice does not reflect the actual forest composition and resource availability for long-term harvest. Production volumes of mobile sawmills (see Annex F) are small compared with the output of the two main logging companies, and stood at 3907 m^3 in 2001 to 1938 m^3 in 2002 (or 16% and 11% respectively of the combined 2001 and 2002 output of MSL and SVT).

3.6.2 Residue available for bioenergy production

During a field trip in February 2004, MSL and SVT were visited to obtain a firsthand idea of the potential of wood-based energy generation. MSL contributes roughly one-third and SVT two-thirds to the annual timber output of Santo. Wood recovery is 50% at best and more likely 40-45 percent. The volume of residues is thus at least equal to the volume of timber output. Statistical records show that timber output at MSL does not exceed 4500 m^3 per year. SVT does not exceed 9000 m^3/yr. These figures can be used as rough estimates for wood residue availability at the respective sawmills.

Although some wood residues go to waste, as was evident from smouldering woodpiles at both sawmills (Figure 2-6), a substantial portion is used for energy generation. MSL operates both a sawmill and a timber factory. All residues from the factory (shavings, dry wood ends), plus some sawdust from the sawmill are fed to a wood-fired boiler (capacity 1,000,000 kcal/hr) that generates heat for the company's drying kilns (capacity 200 m^3). Unused sawdust is used as compost for a tree nursery or collected by local people at low cost or free of charge. Off-cuts are sold as firewood (Vt 6000 or roughly US$55 per small truckload). Remaining wood waste is incinerated in the open air. Prices charged at SVT for wood residues sold as firewood were as follows: small truck: half load Vt 1500 and full load Vt 3000; large truck full load Vt 5000.

Figure 3-2 – Smouldering Wood Waste, Santo

Photo: John Vos; 2004

Without detailed analysis, the potential for significant wood-based power generation by the sawmills does not appear to be promising for a variety of reasons. Both sawmills are connected to the electricity grid, power demand in sawmills typically shows heavy fluctuation and part of the wood residues is currently sold. Annual timber intake is less than 10,000 m^3 at MSL and less than 20,000 m^3 at SVT, and declining. MSL considered installing a wood-fired steam engine a decade ago, and indicative calculations suggested that this would be financially viable. However, management decided against it based on the unavailability of skilled and disciplined operators on Santo. Although MSL has access to reticulated power, it is currently generating its own electricity from a diesel generator. This has proved to be more cost-effective than buying power from the grid and is apparently more cost effective than using MSL's own wood waste for fuel.

Wood waste generated by the portable sawmills is very dispersed and with the possible exception of firewood it is unlikely that it is used for any energy application.

3.6.3 Biomass for domestic cooking and crop drying

As shown earlier in Table 2-9, fuelwood continues to be the primary source of fuel for cooking in both rural and urban low-income households. There are no accurate estimates or recent surveys of household energy consumption in Vanuatu. However, assuming an average annual domestic consumption of 500 kg/capita/annum (based on the results of a series of surveys in the region in the 1980s; WB 1990), approximately 106 kilotonnes of fuelwood are consumed per annum. In addition, small amounts of coconut husk and shells are used as cooking fuels, primarily by rural households. Most copra and cocoa dryers are fuelled with a combination of fuelwood as well as coconut husks and shells (WB, 2002).

Figure 3-3 – Fuelwood at Vila Market

Photo: John Vos, 2004

There does not appear to be an immediate shortage of fuelwood in Vanuatu, especially in the rural areas. In the urban centres of Port Vila and Luganville, with about 27% of Vanuatu's population, fuelwood is beginning to appear in the marketplace, possibly as an indication of the onset of diminishing freely available supply sources in the vicinity.

3.6.4 Biogas

Biogas (a gaseous fuel mixture of methane and carbon dioxide produced from animal dung when organic matter decays in the absence of air) at first sight appears to be an interesting option considering the number of cattle in Vanuatu. However, the collection of dung for biogas plants is generally impracticable without stall-feeding of cattle. Biogas production on any meaningful scale is therefore not considered by the PIREP consultants to be a practical option in the near or medium term future.[12] The PIREP mission was informed that the GoV is looking for technical assistance from the People's Republic of China for biogas. Details are not known but this may be for gas production from piggeries, where China has vast experience. For piggeries where the animals are confined rather than free roaming, biogas can be practical. Effluent control is likely to be of more concern than the energy produced.

Energy can also be produced from municipal waste at landfills (as Samoa and Fiji are assessing), but the modest volumes of waste per capita and the location of the Port Vila landfill make it unlikely that landfill-based energy generation would be economically practical.

3.6.5 Power generation or cogeneration from biomass

As part of the (revamped) Lomé II regional energy programme in the early 1990s, the GoV explored the potential of four industrial / institutional bio-energy projects in 1991: a biomass gasifier, a steam generator, an industrial dryer and a carboniser. Due to the termination of the regional programme by the EC in 1993, none were implemented. In 1992, the World Bank (PREA, WB 1992) recommended serious consideration of biomass co-generation, producing both electricity and heat, at a large estate near Lakatoro on Malekula. It is not known if this was investigated further but the project did not eventuate. As part of a SOPAC biomass resource assessment training activity, a team from the Department of Environmental Science and Technology of Imperial College London recently suggested the installation of a biomass gasifier at Melcoffee Sawmills Limited on Santo (SOPAC, December 2003). Despite these various initiatives no power generation based on solid biomass is in operation, or apparently being seriously considered, in Vanuatu today. Vanuatu's past experience with biomass energy at Onesua, Efate, is briefly described in chapter 4 of this report.

3.6.6 Liquid biofuels

There is considerable experience in Vanuatu, discussed in chapter 4, with the use of coconut oil on a small-scale as a 'biofuel', to substitute, alone or as a blend, for distillate for power generation and transport. The UN's Food and Agricultural Organisation (FAO website, undated) has estimated the total area in Vanuatu covered by coconut plantation at 96,000 hectares in 1997. The PREA estimated in 1992 that over 25% of the coconut groves in Vanuatu were over 50 years old and another 25% were expected to enter this category within the next 15 years, i.e. by 2007 (WB 1992). Depending on the level of replanting, about which the PIREP mission has no information, as much of 50% of Vanuatu's coconut trees might be categorised as senile by now, although probably less. In some recent years, copra output has exceeded 40,000 tonnes, sufficient to produce about 27,000 tonnes of coconut oil (29.7 million litres or ML) with the techniques currently used in Vanuatu. This is equivalent in energy terms to about 28 ML of distillate. During the past decade, distillate imports to Vanuatu have ranged from a low of 19 ML (1999) to a high of 29 ML (2001). In principle Vanuatu could displace all diesel fuel imports with coconut oil-derived biofuel.

[12] It should be noted that the Vanuatu NACCC feels that this is an unwarranted assumption.

More than half of Vanuatu's copra is produced in Santo and Malekula by a large number of smallholders and sold to local buyers who either process it to produce coconut oil or export it directly to European markets. In the past four years production has declined for various reasons including poor world prices, hurricane damage, ageing trees, and the now receding boom market of the late 1990s (leading to emphasis on the more profitable kava). Copra exports have also dropped because of the opening of the Coconut Oil Production Vanuatu Ltd. (COPV) oil mill in Santo in 2000[13] that processes copra into coconut oil. The Santo mill has the capacity to process 3000 tonnes of copra into about 2000 tonnes of oil per month. The extent to which it can use this capacity depends on the supply of copra, which in turn depends on the price the mill offers for copra (dictated by world prices) and the immediate money needs of copra farmers. Competition by rival buyers sometimes also plays a role. Statistics Office data show that in 2002 - 2003, the average production of COPV stood at less than 1000 tonnes of oil per month, most shipped to Rotterdam, Hamburg or Antwerp. The viability of coconut oil for large-scale fuel production in Vanuatu will depend far more on economic, financial, social, and political factors than the technology, which is relatively straightforward.

There have also been studies of the viability of smaller scale production of coconut oil-based biofuels in rural areas. With French support, an MSc study considered the use of coconut oil for generating electricity on Santo (Aurélie Leplus, MSc thesis; January 2003). Recently, a follow-up feasibility study was prepared on biofuel production by the Port Lory co-operative in Santo (CIRAD; draft; January 2004) but the mission has not seen the report. [14]

[13] COPV is controlled by Elan Trading, an Australian company that also has a controlling share in the Madang oil mill in Papua New Guinea and the Vaitele oil mill in Samoa. The experiences of Elan Trading may have a big impact on the extent to which coconut oil is used as a fuel in the Pacific islands.

[14] It is understood that PREFACE secured funds from the Japanese government for further work on bio-fuel. When PREFACE closed, the fund were transferred to SOPAC.

4 EXPERIENCES WITH RENEWABLE ENERGY TECHNOLOGIES IN VANUATU

The practical experience in Vanuatu with RETs – geothermal, hydro, ocean-based energy, wind, solar and biomass (biofuels and other) – are discussed in this chapter. In part because some appropriate GoV staff were unavailable, and several JICA-funded renewable energy advisers had recently left Vanuatu, it has not been possible to obtain nearly as much information as anticipated on planned versus actual costs, energy output and running costs, maintenance experiences, institutional arrangements, expectations of the users compared to actual experience, capacity building and a host of other matters.

4.1 Geothermal

As described in chapter 3, there has been considerable study of the geothermal resource on Efate, proposed commercial development, and but no geothermal power has been developed in Vanuatu.

4.2 Hydro

The government's only experience with hydropower has been the JICA-built, GoV-owned and UNELCO-operated Sarakata system, consisting of 2 x 300 kW turbines which have been used for base load at Santo and produced on average about 4.5 GWh per year since early 1995. The reserve fund (SSRF) has been described earlier and is not repeated here. However, it is noted that the planned expansion of Sarakata to 1200 kW has been delayed pending possible future Japanese support.

4.3 Ocean Based

There has been no experience in Vanuatu with seawave, tidal, OTEC or other ocean-based energy demonstrations.

4.4 Wind

As far as the mission could determine, there have been no installations of wind energy systems in Vanuatu, although wind energy monitoring is continuing.

4.5 Solar

Vanuatu has a long history of experience with solar photovoltaics. There has been some limited use of solar energy for water heating (SWH). These are discussed below.

4.5.1 Solar water heaters

Customs data for 1999-2003 made available to the national consultant are incomplete, but seem to indicate that a hundred or SWH systems were imported by retailers for home use and several resorts for commercial use during this four-year period. The Telecom Vanuatu Limited (Telecom) yellow pages list two companies that sell SWHs to the general public: Port Vila Hardware and Wilco Hardware. Apparently individuals purchase most SHWs with little or no GoV involvement in the market. Cursory observations in Port Vila indicated several dozen systems, most of which appeared to be functional.

4.5.2 Solar photovoltaics

For at least the past decade, the GoV has promoted the use of solar energy to generate small amounts of electricity for individual homes and community facilities in areas remote from the grid. Since 1992, the Energy Unit has been involved in eight PV projects, under which solar panels producing approximately 63 peak kilowatts (kW_p) have been installed under Energy Unit supervision. These are summarised in Table 4-1 with more detail in Annex E.

Figure 4-1 – JICA Solar PV Home System, Vanuatu

Source: JICA

Table 4-1 – Summary of Energy Unit's Solar PV Programme, 1992-2002

Year	Summary	Location	Size	Funded by
1992	2 health facilities	2 sites	0.3 kW_p	British High Comm.
1995-2000	Community based	4 sites	2 kW_p	Energy Unit
1995	Community based	6 sites	1 kW_p	ACCT
1996-1997	13 schools	5 islands	5 kW_p	ACCT/FONDEM
1999	220 solar home systems	5 sites; 4 islands	22 kW_p	JICA
2000	45 solar home systems	Efate	4.5 kW_p	Energy Unit
2000-2001	About 200 systems at 27 schools and 18 health facilities	45 sites	22 kW_p	AFD
2001-2002	12 schools, 8 health facilities and 40 staff houses	60 sites	6 kW_p	PREFACE

Notes: 1) Details of these systems are provided in Annex E. See Acronyms for explanations of abbreviations
2) Financial resources for systems financed through the Energy Unit are from the Sarakata reserve fund.

A report for the SPC's *Pacific Rural Renewable Energy France-Australia Common Endeavour* (PREFACE) programme (Lambert, 2002) summarises the equipment, maintenance and payment issues of earlier Vanuatu PV projects.

- *Equipment.* No problems were identified with solar modules and support structures, but sometimes the regulator or controller was incorrectly chosen or not properly designed for the tropical climatic conditions. Electric wiring and appliances must also be well constructed and adapted to the conditions, which was not always the case. Early failure of open cell batteries was partly the result of improper attention to the maintenance of water levels in the batteries. Such attention requires training and management of technicians who need to have access to the high purity water needed for electrolyte replacement.
- *Maintenance.* Maintenance was poor in the early projects due to inadequate support from the responsible service company and the lack of a technician near the site. The provision of a trained "caretaker" with spare parts responsibility was tested in the JICA project and seemed effective after two or three years. The same approach has been replicated for the AFD and PREFACE projects. In the latter, caretakers are to make quarterly visits to each system whereas a qualified Energy Unit technical staff is to visit each system twice per year. The caretakers receive commissions for their activities from the money collected from government staff who receive electricity services. Caretakers as well as users receive training on site and in their own language.
- *Payment approach.* The approach adopted for PREFACE was based on previous experiences in Vanuatu, mainly that of AFD. Due to the remoteness of Torba province, government staff had priority for PV systems, with monthly payments of Vt 1500

deducted from their salaries. For the community systems, the Ministry of Education and Health had agreed to pay Vt 36,000 per annum for every 150 W_p of installed capacity into a special government account. However, this payment is often in arrears. Lambert, the author, wrote that that this payment approach appears to be replicable for government departments and staff but not for other domestic users. Another approach must be tried when general household electrification is provided.

The report states that past lessons were taken into account for the design of PREFACE. The organisational structure (local maintenance) and technical specifications were improved but concerns remain regarding money collection from the Ministries of Health and Education, so a disconnection policy is suggested.

Figure 4-2 – PIREP National Coordinator (left) with Solar PV Home System, Mangaliliu

Photo: John Vos, 2004

On 31 January 2004 the mission visited Epau and Mangaliliu, two of the three villages that were solar electrified on Efate in 2000. The solar home systems had the Suncard® pre-payment system installed but this has never functioned properly. The Energy Unit experienced problems with Suncard access codes, which must be punched in by hand to continue energy supply. The Energy Unit staff member responsible for the project recently resigned and the New Zealand supplier of the South African Suncard has ceased business. Apparently the PV system supplier was unable to find an acceptable solution. Approximately ten (out of 60) systems installed in Epau, and five (out of 21) installed in Mangaliliu had been removed due to non-payment of the monthly fee (Vt 1500 additional to Vt 9,000 upfront installation costs) according to Nemo Matai (Energy Unit SHS technician) and Harry Kalkoa (caretaker in Mangaliliu).

4.5.3 Other solar photovoltaic projects

Although the bulk of donor funded PV projects have been implemented through the Energy Unit, there is at least one exception. Recently the Vanuatu Renewable Energy and Power Association, a locally owned non governmental organisation (NGO), installed twenty portable solar systems at aid posts in Tafea Province. The systems each include a 10 W_p solar module and provide village heath workers with basic lighting at night (Stein, 2004). Telecom has installed 283 solar PV systems for telecommunications power (Table 4-2). Although the mission has no details on the size of the Telecom PV installations, or their operational experience, some additional information is provided in Annex E.

Table 4-2 – Telecom PV Systems

Province	No. of systems
Torba	24
Shefa	60
Sanma	18
Penama	58
Malampa	64
Tafea	59
Total	283

Source: Matakiviti, 2004

Organisations which have promoted PV in Vanuatu are discussed below:

- JICA provided technical assistance for PV projects through a resident expert based at the Energy Unit for at least five years (October 1998-October 2001 and apparently October 2001-October 2003). The Public Works Department expects a new JICA expert to arrive during 2004 and he will spend a small portion of his time supporting Energy Unit PV projects;

- Pacific Energie (New Caledonia) and its Vanuatu representative SOCOMETRA have been involved with the installation of almost all donor-funded PV projects in the 1990s. SOCOMETRA used to sell solar home system kits;
- a company called ACTEK was involved with the installation of the AFD-funded solar PV systems but it is understood that its performance was poor and that the National Technology Institute (INTV) is to upgrade the systems;
- the Telecom Yellow Pages list four companies that sell solar PV systems: i) John Lum and Associates, ii) Vata Electrics, iii) Endel, and iv) Solar Van Power and Lights Services. Energy Unit staff mentioned a fifth company, JEM Solar Trading, which began business in 2002. Little was learned by the mission about the first two companies. The PIREP national consultant attempted to visit Solar Van Power and Light Services in February 2004 but the company had been closed for the previous two months and it is unclear whether it has re-opened for business; and
- a visit by the PIREP national consultant to JEM Solar Trading was more fruitful. JEM sells small solar systems of two types: a 'regular' solar home lighting kit (approximately Vt 40,000 for a battery, 10 W_p panel and 3 x 9 watt lights) and 'portable' solar lanterns (approximately Vt 13,000 for a battery, 3 W_p panel and a small lamp). Some 300 systems (73 lighting kits and 226 portable lanterns) had reportedly been sold by early 2004 (Matakiviti, 2004).

The mission does not have accurate costs of PV assistance to Vanuatu from donors. Equipment, transport and installation costs for the 47 kW_p installed through the ACCT/Fondem, JICA and AFD projects together cost about 5,800 million French Francs (Torba Feasibility Study; GoV, November 2000), or nearly US$ 800,000, assuming the average 2001 franc/US$ exchange rate of 0.1367. This is nearly US$17,000 per kW_p. The PREFACE project was budgeted at A$367,629 of which A$240,000 was for equipment, transport and installation of the 60 PV systems. Per kW_p, this is A$40,000 (about US$ 23,000). Overall, donors provided approximately US$1 million for PV equipment and its installation from 1992-2002.

4.6 Biomass

4.6.1 Power generation from biomass

A 25 KW_e wood fuelled biomass gasifier (Figure 4-3) was installed at Onesua High School, now Onesua Presbyterian College, on Efate under the E.U.'s Lomé II Pacific Regional Energy Programme during the 1980s. The unit functioned well for some eight years and ran for nearly 10,000 operating hours. After about six years of non operation, the plant was rehabilitated in 2000 and returned to operation for about a year. Although it was still functional, the Presbyterian College Council decided to purchase a 40 kW diesel generator and the plant has not operated since then.

Figure 4-3 – Derelict Gasifier, Onesua

Photo: John Vos, 2004

4.6.2 Coconut oil as a fuel

On Efate two small coconut oil producers operate, Motor Traders (MT) and Vanuatu Sea Transit (VAST). Both have specialised in the production of coconut oil as a substitute for diesel fuel, either for use in power generation or transport. In the production process, coconut oil is cleaned and stripped of solids and free fatty acids and then filtered. The two processes differ in the quantity and type of additives that are blended. MT blends coconut oil with diesel. VAST includes an additive to the coconut oil but did not discuss its composition. For more than a year COPV tested different mixtures of coconut oil and kerosene or diesel in its Blackstone generator and in its trucks. Use in the generator has ceased (for unknown reasons) but the COPV boilers continue to be run on exclusively pure on coconut oil (Temakon, 2004). VAST plans to use coconut oil biofuel in a catamaran planned for ferrying copra from outer islands.

MT's owner Tony Deamer has experimented for many years using different coconut oil blends as fuel. He converted numerous rental cars to run on coconut oil, resulting in greatly increased local interest in its potential. Early in 2002, well over 50 mini-buses were running on coconut oil blends and MT sold 2000 litres weekly. When VAST started selling a similar coconut oil based fuel, the number of mini-buses using it daily rose to 200. Another dozen or so vehicles ran on cold pressed coconut oil with very little or no diesel or kerosene added (PEN, 2002 and One Country, 2003). In general, there not have been serious technical difficulties in using coconut oil as a fuel in Vanuatu to replace distillate although there are differences of opinion on the need for blending with kerosene, diesel or other products for ease of starting in cooler weather or for smoother operations.

Government legislation and regulation that came into effect in early 2003 dramatically reduced the use of coconut oil as a diesel fuel substitute. A change in tax laws had the consequence of raising the price of fuel blends. The new rules also made it illegal for MT and VAST (or others) to blend fuels without a license. During 2003 the Government reportedly closed VAST's operation a number of times for allegedly breaching the regulations.

Figure 4-4 – Coconut Oil Production, VAST

Photo: John Vos, 2004

Information provided to the mission on the cost of producing and selling coconut oil as a fuel was

inconsistent. However, all informants agreed that if it were sold duty-free (i.e. free of the equivalent of the import duty imposed on distillate for transport) it would undersell diesel fuel by a considerable margin. Indeed, the high sales in 2002 were primarily because transport operators could purchase coconut oil biofuel at a lower cost than diesel fuel.

5 BARRIERS TO THE DEVELOPMENT AND COMMERCIALISATION OF RETS

This chapter identifies barriers to the development and use of RETs in Vanuatu. During the mission, interviews were held with more than fifty people in Efate and Espiritu Santo, of whom about three-fourths were ni-Vanuatu and the rest foreign businessmen, aid workers, diplomatic personnel or NGO workers based in the country. About twenty individuals participated in a half-day workshop to discuss 'strengths, weaknesses, opportunities and threats' (SWOT) regarding the use and development of RETs in Vanuatu. The results of the SWOT workshop, at which participants willingly and frankly expressed their opinions, are summarised in Annex E. The views in this section of the report are paraphrased but come from people in Vanuatu, not the outside consultants. Nonetheless the summaries of sections 5.1 through 5.7, which emphasise barriers, constitute the mission's own conclusions.[15]

In practice, barriers to renewable energy tend to extend across several classifications; therefore, the assignment to specific groupings below are to some extent subjective.

5.1 Fiscal

Fiscal barriers to RETs include those for which government fiscal policies (import duties, taxes, charges) raised for public finance are biased in favour of conventional energy or biased against renewable energy.

Fiscal Incentives not present. There are no incentives to promote RET investments through 'green' interest rates, or access to foreign capital for RET through government support. UNELCO has received concessional French finance for some of its investments in conventional power systems. In general Vanuatu's fiscal regime is arguably not biased against rural electrification or RETs. Reportedly, any group or community can obtain import duty exemptions on equipment for rural electrification, whether diesel-based or renewable. Fuel for rural electrification is reportedly not exempt from import duty. (However, removal of duty on diesel fuel was reportedly one of the reasons Onesua Presbyterian College has ceased using biofuel in their diesel generator.) On the other hand, there is little fiscal incentive to import RETs (e.g. solar water heaters; 12 volt lights for PV use) rather than conventional systems as import duties and taxes do not differentiate between them.

No tax incentives are provided for blended fuel. Though the coconut oil used in blended bio-diesel is not taxed, the diesel fuel component is not allowed duty free entry making the product less competitive with pure diesel fuel.

Lack of transparency in duty exemptions. There are allegations that decisions on exemptions to import duties are not made in a transparent manner and protect the local elite, while negatively affecting prospects for local biofuels.

There are taxation anomalies that act against consideration renewable energy. The power utility, UNELCO, does not pay import duty on fuel used to generate electricity in Port Vila, effectively a subsidy for petroleum fuel and a disincentive to consider locally produced biofuels.

[15] Strengths expressed by some individuals were often considered as serious weaknesses by others. Often, the differences between strengths and opportunities, or between weaknesses and threats, were vague.

5.2 Financial

In early 2004, the GoV's Energy Unit had eight staff (including three technicians and two support staff) of an approved staffing level of eleven. Over 65% of their time collectively is probably spent on RET matters. Salaries are paid by the government, with some at times funded through the SSRF. Because of senior staff absences during the mission, it was not possible to determine the overall Energy Unit budget, the percentage allocated to RET, the donor finance allocated to RE in recent years, or government subsidies for RET.

Petroleum fuel and LPG in Vanuatu are not under price control, and have been for some years more costly than average for PICs with a similar level of demand. Outer island fuel prices are far higher than those of Port Vila and shipments can be irregular. In general, this is an incentive for RE.

For large-scale (by Vanuatu standards) RE development for urban electric power, finance is probably not a serious barrier. If other issues are resolved, Japan is reportedly willing to finance a 0.6 MW extension to the Sarakata hydro scheme. Private and public investors (i.e. private developers, the GEF and WB's IFC) have expressed strong interest in investing in a proposed 3 MW geothermal power plant for Efate.

Subsidies are biased toward conventional energy. The SSRF had gross revenues from 1995-2002 of Vt 624 million with net income of Vt 389m. Most of the net funds were used to subsidise Luganville electricity tariffs (from the mixed diesel/hydro system run by UNELCO), new connections, street lighting and grid extensions. Vt 34m (about US$ 330,000) or 8.7% of net income was used for financing solar PV systems in remote communities. The fund has benefited specific rural communities but, on balance, has provided far more subsidies for conventional energy than for RE. The current allocation of the funds (70% urban; 30% rural) is a financial barrier against RE.

Duplication of activities. It is alleged that financial resources available from regional organisations tend to be wasted. GoV officials and others note that energy matters are distributed among organisations (petroleum with PIFS, energy overall with SOPAC and environment-related energy such as climate change/GHGs with SPREP). *"These regional organisations have their own procedures which are seen by many as a regional duplication of activities resulting in consuming valuable financial resources for energy developments."*[16]

Biofuel barriers do not appear to be primarily financial. Proponents of coconut oil as a fuel in Vanuatu claim that it can be produced and sold in Vanuatu (on a scale of several hundred vehicles using it) considerably cheaper than distillate, even with the petroleum portion of the blend taxed. There are certainly barriers to the use of coconut oil as a fuel in Vanuatu but at least in the short term these do not appear to be primarily financial.

Weak government financial position. In general, the weak financial position of the government, and a growing demand for basic services in rural areas for a rapidly growing population, may form a financial barrier in the sense that government is unlikely to be willing or able to substantially increase its own funding for rural electrification in general or Renewable Energy (RE) in particular.

No incentive for utility use of renewables. UNELCO has no apparent financial incentive to adopt RE (whether geothermal, hydro, or biofuel) as their concession contract allows them to pass on all fuel price increases to the consumer at the time of quarterly price adjustments.

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[16] The statement is from the NACCC comments of September 2004 on an earlier draft of this report. The Pacific Power Association (PPA), which deals with the member electric power utilities, could be added to the list.

Government itself has no financial incentives for use of renewables. At least in Port Vila and Santo, the government itself has little financial incentive to seek less-costly RE alternatives as it pays a highly subsidised rate (i.e. cross-subsidised by other consumers) of about US 17¢/kWh for its own electricity use. However, the high cost of electricity in Port Vila and Santo overall (about US 30¢/kWh for households rising to US 55¢ above 120 kWh/m), should provide an excellent financial incentive to find alternatives.

The initial cost for renewable energy is often higher than for conventional energy use. A general barrier to RETs, not exclusive by any means to Vanuatu, is the higher initial costs compared to conventional diesel power.

Land tenure issues. Commercial banks suggest that the land tenure system, with traditional ownership of land which cannot be sold, acts as a financial barrier as land owners cannot use land as equity for any loans, whether related to RE, or in general. On a small scale, the Credit Union has reportedly provided loan finance for individual solar home PV systems.

High interest rates. The high interest rates charged by banks is a barrier to the finance of RE projects and the development of private sector energy services.

5.3 Legislative, Regulatory and Policy

Vanuatu has prepared a number of drafts of national energy policies and rural energy policies over the past twenty years with assistance from numerous donors and agencies. However, overall, the lack of legislation, approved energy policies, guidelines and regulations forms a significant barrier to the development of RE. There is no effective control of electricity prices as these are essentially charged on a cost-plus basis, adjusted quarterly.

Although the Council of Ministers approved the establishment of a National Energy Corporation in late 2003, no request has yet gone to parliament for its consideration.

No National Energy Policy. There were numerous drafts of national energy policies developed between 1986 and 2000. None has been formally endorsed by the GoV; effectively there is no clear, overall national energy policy. A 1993 rural electrification policy, revised in 2000, acts as a broad general guide for rural electrification. Detailed guidelines have been prepared with JICA assistance to help the Energy Unit implement the policy.

No up to date Energy Act. Seven drafts of an Electricity Act have been developed since 1998 but it has not yet been enacted. There is no legislation to establish standards, regulations, pricing, or monitoring of the electricity sector. There was provision for an Electricity Commissioner under various concession agreements between the GoV and UNELCO, but this has been unfilled for many years. As noted elsewhere, the Commissioner had limited authority and reportedly had no access to UNELCO's accounts. In April 2004, a World Bank advised the GoV on a regulatory body for utilities (water, electricity and telecommunications), and the government advised the WB of its intension to establish the National Energy Corporation and supporting legislation, so there may be progress in addressing these barriers.

5.4 Institutional

There appears to be no overall coordination of energy sector activities in Vanuatu. The Energy Unit has wide responsibilities but little authority (outside of RETs), limited finances, and few staff. There was an interministerial energy coordinating committee, which met in 2003 to consider the proposed national Energy Corporation, but it appears to be defunct. There is a National Advisory Committee on Climate Change (NACCC), with a secretariat within the Department of Meteorological Services, and membership from various ministries

and departments including the Energy Unit and Environment. It serves as the PIREP coordinating committee but reportedly has no financial resources from the GoV. As the name suggests, it is advisory only. Key institutional issues are summarised below. In some cases, the same institution is seen as a barrier to RE or as an opportunity for its development, depending on the context or individual points of view:

Lack of capacity in the Energy Unit. The GoV's Energy Unit plans and implements RE, particularly rural solar PV systems, and has assessed micro-mini hydro potential in several islands. The unit is seen by some as a strong institutional basis on which to further develop RE and by others as an obstacle due to its alleged inability to establish mechanisms for sustainable operation and maintenance of those RET projects it has helped to implement. The Energy Unit itself proposed the establishment of the NEC to allow RE to be developed more professionally and on a sound financial basis, allowing it to focus on policy and advisory matters.

Institutional problems at UNELCO. UNELCO is perhaps the only institution in Vanuatu that can make RE work on a meaningful scale. It has access to concessional loan funds which can in principle be extended to RE and has the capacity to develop the technical resources necessary for RET development on a large scale. UNELCO has a long history of providing reliable electric power in Port Vila and parts of Santo but its lack of transparency in operations, its finance and in the GoV/UNELCO relationship has left UNELCO open to allegations of blocking renewable energy by supposedly stopping development of the proposed geothermal project and undermining the use of coconut oil as a fuel. At the same time, others see UNELCO as a well-run, professional utility which has already undertaken supply in two unprofitable (or low profit) islands, is following GoV objectives by using the Sarakata funds for subsidising tariffs in Santo, and as being genuinely interested in RETs. Whatever the reality, UNELCO's position on RET development must be clearly defined through more transparency in the GoV/UNELCO relationship and some form of effective oversight and regulation of the power sector in order to lift this barrier of uncertainty.

Fragmented structure for renewable energy development. Vanuatu lacks the well-focused institutions and a framework needed to operate and maintain rural energy systems and services, including RETs. There is a fragmented approach to addressing energy problems with limited collection of data[17] and little apparent sharing of energy related information between government agencies or with the private sector.

Lack of local training capacity for RETs. There is no support for local vocational training institutions for building local RE capacity.

Governance. Governance is widely believed to remain weak in Vanuatu, despite the Comprehensive Reform Programme. Allegations of continued abuses by the political elite on licensing of companies, interpretation of regulations, favouritism, slow responses and a general inertia are all widely believed to be threats to progress of all sorts, including RET development.

Relationship with the donor community. Although the international donor community has contributed strongly to the development of RETs in Vanuatu, interviews with some civil servants, ministers and NGOs indicate that the relationship can be improved between the

[17] In a good comment on an earlier version of the report, it was asked whether energy offices in fact need the data: *"In most cases, data are only needed for consultants' visits. Most energy offices do not regularly use these data due to their unclear energy policy and planning functions. Most are not required to submit national energy status reports' to their ministers or cabinet."* Good data and its analysis are a prerequisite to effective policy development. Most PICs including Vanuatu have had access to considerable training on data collection and analysis but often to limited effect.

donor community and Vanuatu.[18] There has been a tendency for donors to have a shifting focus for RETs that apparently has made it difficult to maintain the long term momentum needed for sound development of specific RETs in Vanuatu.

Duplication of regional programme activities. At the regional level, despite attempts at coordination through the EWG of CROP there remain duplications of activities, as discussed above under financial issues.

5.5 Technical

There are no national standards or certifications to assure that RETs imported into Vanuatu are suitable for local conditions. In general, the perception in Vanuatu is: i) that RE technologies are more robust than a decade or more ago; ii) PV and coconut oil have been relatively well-proven, and iii) ni-Vanuatu can develop the skills to operate and maintain RETs. Unscrupulous or poorly informed foreign "experts" who advocate RETs that are unproven or unsuitable for Vanuatu were seen by some as bigger barriers than the technologies themselves. Some of the identified technical barriers follow:

Small manufacturing capacity. Vanuatu has a very small manufacturing sector and cannot economically develop the capacity to manufacture or assemble RETs, except possibly for biofuels.

Lack of local technical capacity. There is almost no local knowledge about RETs except some regarding solar PV and small-scale processes to make biofuels. There is very little knowledge regarding the extent of RE resources (except solar and coconut palms). Therefore it is difficult for local people to make informed choices regarding suitable technologies to fit their needs.

Existing biofuels are not suitable for small boat use. Given Vanuatu's geography, there is a need for a local biofuel that can be used in outboard motors for coastal transport, as most islands have minimal road networks. There is no commercialised, affordable biofuel option suitable for petrol-fuelled outboard engines that can be produced in rural areas at an acceptable cost.

Plentiful ocean resources cannot yet be exploited. Vanuatu appears to have enormous near-shore ocean energy resources, certainly sea wave and probably ocean thermal. However, there is no proven, commercially available technology to allow Vanuatu to exploit ocean energy resources.

5.6 Market

Although the market for RE technologies and services is small in Vanuatu, and many ni-Vanuatu live outside the market economy, market barriers were not identified by anyone as serious constraints. Clearly there are constraints to rural electrification in a country with under eight percent electrification, but these are not specifically market-related issues. However, there are no incentives for local people to establish businesses to provide RE services.

[18] Although some highly critical comments regarding the donor community and regional organisations were received by the team from civil servants, ministers and NGOs, this is not the official view of the GoV or the NACCC.

5.7 Information and Public Awareness

There was no evidence of public awareness campaigns on energy or climate change. However, there have been positive stories in the local media about coconut oil as a fuel and some about PV for rural electrification. Issues include:

Limited information available in local languages. There is considerable knowledge throughout Vanuatu on how to produce copra, which can be used to replace diesel fuel. However for renewable energy in general, knowledge is largely restricted to a few people in urban areas, and is rarely available in Bislama or other local languages.

Lack of information at the decision maker level. Senior members of the Council of Ministers are well aware that RETs like solar PV and biofuels can be viable for Vanuatu, but they are unaware of the practical problems in implementing them.

5.8 Other

A barrier not covered above is Vanuatu's susceptibility to natural disasters, particularly cyclones, which can destroy equipment such as wind turbines and solar panels and damage the resources needed to produce energy, e.g. coconut trees and other biomass crops.

For those who wish to develop RETs, access to land over a long period was considered to be a serious barrier.[19] Traditional landowners are very protective of their rights and it can be difficult to get access to land for RE, especially if it is believed to benefit government, outsiders, or only a few of the traditional landowners.

Discussions in Vanuatu suggest that it is widely believed that a lack of political will is a serious barrier to RE in general and to the development of biofuels in particular.

[19] Reportedly, land can only be leased for ten years and is non-renewable except for the full agreement of a community. Those who raised the issue spoke of mistrust between parties but did not provide details.

6 IMPLICATIONS OF LARGE SCALE USE OF RENEWABLE ENERGY

6.1 General

The guidelines for the content of this study include examination of the possible implications of the widespread use of RE on the Millennium Development Goals, in particular, poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women. It has not been possible to look into these sufficiently to draw any meaningful conclusions.

The employment effects of major investment in RETs are likely to be quite significant for low-income rural people. Assuming that half of all distillate were replaced by coconut oil biofuel, and 60% of Vanuatu' rural families had electricity provided though small-scale solar PV (or wind or other RETs), the long-term rural income creation would be increased by at least a factor of four over present levels once the full operating phase is reached. Hydro and geothermal systems would not have a big impact on employment following the construction phase.

For GHG emissions and energy production from RETs, Table 2-11 suggests that the biggest impacts in Vanuatu are likely to come from investments in biofuels (about 70% of the total) followed by geothermal and hydro. Any of these, if poorly planned, could have significant environmental impacts. Each is discussed briefly below.

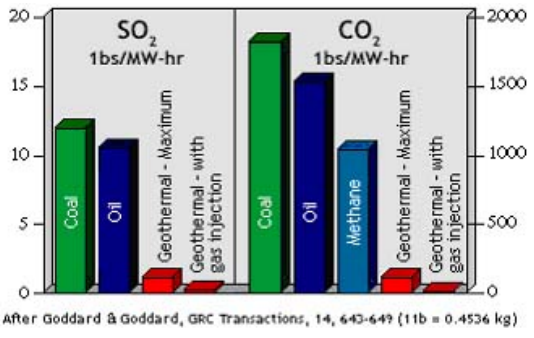
6.2 Biodiesel

It has been assumed (Table 2-11) that copra production in Vanuatu would not need to increase to produce enough fuel to displace most distillate fuel, so the impact should be no more severe than current coconut cultivation practices. In terms of use, biodiesel fuels from coconut or other vegetable oils are very low in emissions, as they contain almost no sulphur or hazardous materials. In case of spillage to the ground or marine environment, they biodegrade readily and do not cause contamination.

6.3 Geothermal

Although geothermal has not traditionally always been considered renewable (as reservoirs eventually deplete, at least temporarily) or benign (due to hydrogen sulphide – H_2S – and other toxic emissions), it is now considered (Figure 6-1) as an environmentally friendly RET. According to the US Department of Energy *"geothermal power plants easily meet the most stringent clean air standards because they emit little carbon dioxide (fossil-fuel power plants produce roughly 1000 to 2000 times as much), no nitrogen oxides, and very low amounts of sulfur dioxide (SO_2). Steam and flash plants emit mostly water vapor. Binary power plants run on a closed-loop system, so no gases are emitted."* For [plants containing H_2S], the sulfur can be *"separated, dewatered, and recycled as feedstock for sulfuric acid production. Future technology will use microbial processes to extract metals contained in the sulfur, allowing further reuse. At most geothermal hot-water power plants, H_2S is present in such low concentrations that it requires no special controls to comply with environmental regulations. … A typical geothermal plant requires several wells.*

Figure 6-1 – Geothermal Power Emissions of SO_2 & CO_2



Source: www.eere.energy.gov/geothermal/environ_impacts.htm

Although drilling these wells has an impact on the land, using advanced directional or slant drilling minimizes that impact. Several wells can be drilled from one pad, so less land is needed for access roads and fluid piping" (USDoE website, undated).

6.4 Small Hydro (under 10 MW)

The International Association for Small Hydro, the European Small Hydro Association and the International Energy Agency's Renewable Energy Working Party all define small hydro to be less than 10 MW. The International Rivers Network (IRN, 2003), an NGO generally which is generally highly critical of hydro development, says, *"small hydro can, if responsibly implemented, be environmentally and socially low-impact. ... To ensure that small hydro projects have low impacts and meet community priorities it is imperative that all small hydro schemes are planned, built and operated in line with the recommendations of the World Bank/IUCN-sponsored World Commission on Dams"* (WCD; guidelines, available from www.dams.org and see a Citizen's Guide to the World Commission on Dams, available from www.irn.org).

7 CAPACITY DEVELOPMENT NEEDS FOR REMOVING THE BARRIERS

This chapter examines Vanuatu's capacity development needs, addressing which may help to remove or reduce key barriers identified in Chapter 5. These are not prioritised. It is not suggested that these are all necessarily appropriate for addressing though further GEF support. Many of the suggestions below do not fit exclusively, or even primarily, into one category; issues addressed under, for example, fiscal barriers may be applicable to several others.

7.1 Fiscal

Section 5.1 identified several possible fiscal barriers to the development and commercialisation of RETs including anomalies in rates of import duty, lack of knowledge of the fiscal (and development) impact of producing coconut oil biofuels locally, non transparent mechanisms for decisions on duty exemptions, and lack of 'green' interest rates or incentives. The PIREP team considers the following to be areas with inadequate capacity to address those issues:

Biofuels. There appears to be inadequate capacity within government to enable the development of biofuel as a large-scale alternative to petroleum. There is need to develop capacity for technical development, for analysing the effects of large scale biofuel production on government revenue and determining other financial issues as well as developing the logistics required for large scale production and delivery of biofuels to urban centres.

Import duties and taxes. There is very limited capacity within government for analysing the effects of interest rates, import duties, energy prices and taxes on the development of RET and EET measures.

7.2 Financial

Access to finance does not appear to be a major barrier to RET development in Vanuatu, although effective use of available – or potentially available – finance is to some extent a constraint. Some of the barriers identified under 'finance' are discussed in this section, others under other headings, (e.g. land tenure under 'other').

Use of the Sarakata reserve fund. The current allocation of the funds (70% urban; 30% rural) acts as a financial barrier against RE. The capacity of the GoV (either the or perhaps the new NEC when established) needs to be improved to more effectively use the reserve fund resources for RE development.

Lack of capacity to develop suitable project documents. The increasing competition for limited donor funds has made the preparation of high quality, well-developed project requests necessary. The GoV and NGOs have insufficient capacity to prepare the complex documentation required by multilateral finance organisations such as ADB and GEF and the high quality project proposals needed to be competitive for funds from bi-lateral donors. Such skills need to be developed.

Wastage of financial resources available for energy by regional organisations. If Vanuatu feels that the allocation of responsibilities among SOPAC, PIFS and SOPAC (possibly PPA could be added to the list), and coordination among them leads to wastage of funds, this should (as suggested by the NACC in comments on an earlier draft of this report) be addressed by the GoV at the regional energy meeting planned for late 2004 and other higher level regional meetings.

High interest rates charged by banks. High interest rates could be reduced through some form of subsidised 'green interest' mechanisms for clearly defined rural RE development and for the encouragement of the development of private sector energy services. This would require capacity development for devising and administering such a scheme.

7.3 Legislative, Regulatory and Policy

Section 5.3 concluded that the lack of legislation, approved energy policies, guidelines and regulations form a significant barrier to the development of renewable energy. Donors and lending agencies often expect a clear policy / legislative/regulatory framework to be in place before approving new energy assistance, or developed as part of their assistance. Before any new initiatives are begun, it should be ascertained whether, and the extent that, the World Bank, ADB or others are addressing, or planning to address these issues.

Energy policy and energy legislation development. The Energy Unit, the Finance Ministry and NGOs do not have the capacity to develop a comprehensive national energy policy or legislation regarding energy that includes the wide range of issues facing Vanuatu. Assistance is needed to help Vanuatu develop these tools.

7.4 Institutional

Some institutional issues have been considered in sections above. Others include the following:

Energy Unit. Capacity is lacking at the Energy Unit in many areas of RET development and project management. A clear vision of the responsibilities and authority of the Energy Unit needs to be established so a focused capacity development programme (whether this is implemented by the Energy Unit or through the NEC) can be developed and implemented. It is understood that the GoV is currently addressing this.

Electric power sector oversight capacity. As previously noted, the GoV lacks an effective mechanism and capacity for oversight of the electric power sector. As the GoV recognises, this needs to be developed.

Regional organisation capacity development. A number of people expressed dissatisfaction with the CROP Energy Working Group as a mechanism for fostering cooperation between regional organisations in providing energy sector assistance. If this is a serious issue, "Vanuatu with other PICs should inform their government delegation to the Forum Meeting about these concerns that they have regarding the relationship among the CROP agencies which they feel it is not in the best interests of effective RE development in the region."[20]

7.5 Technical

Some key technical barriers identified by ni-Vanuatu and other Vanuatu residents relate to information, and are discussed below. Some technical matters relate to the suitability of specific technologies for Vanuatu. Others can perhaps be best addressed on a regional level.

Lack of easily understandable reference materials regarding RETs publicly available in Vanuatu. Although the Internet has many technical resources for persons wishing to understand RETs, the access to the Internet in Vanuatu is not wide spread, tends to be very slow and computer literacy low. Also, the wide range of information available makes it is

[20] One commentator on an earlier draft was concerned at *"unjustified negativity towards the CROP EWG."* The PIREP consultants feel that the EWG is important. We would be remiss in not reporting an issue that came up quite strongly from concerned individuals in Vanuatu (and elsewhere). The text quoted above is the wording requested by Vanuatu's NACCC for inclusion in this report.

difficult for the novice to know which is appropriate to Vanuatu. There needs to be a local repository of information that can be accessed by anyone wishing to gain knowledge about RETs appropriate to Vanuatu, their cost, applicability, operations, maintenance and opportunities for use.

Capacity limits for measuring the RE resource. There is a need to develop the local capacity to carry out assessments for wind, biomass and small hydro resources and to clearly understand the processes involved for the assessment of geothermal and oceanic energy resources. There is relatively little information or experience available in Vanuatu regarding the magnitude and accessibility of RE resources. This is not a serious barrier in the case of solar PV where the Energy Unit has had practical experience in sizing solar arrays needed for specific loads in different parts of the country. The Energy Unit has completed preliminary assessments of small hydro potential and should seek donor funds to look further into promising sites. It would also be appropriate to seek funding to monitor promising wind sites for a period of 18 months or more. For geothermal, the high cost of exploration suggests that further drilling should be left to proponents and potential investors (including GEF and IFC). If there are regional efforts to assess ocean energy potential, Vanuatu should participate but not put its own financial resources into this.

7.6 Market

Market barriers were not identified as serious constraints. Incentives for local people to establish businesses to provide RE services through special interest rates, loan guaranty funds, tax incentives and other incentives are possible. There is little experience or knowledge within the private sector regarding technical, institutional, financial and management issues relating to RET development. There is a demand in both the private and public sectors for relevant and practical training for ni-Vanuatu in various aspects of RETs for designing, marketing, installing, operating, maintaining, and repair of RET systems. No specific suggestions are offered here, except that private sector and NGO staff should be included in RE training; thus far it has concentrated overwhelmingly on government officials.[21]

7.7 Informational and Public Awareness

No studies have been carried out in the region on the effectiveness of awareness campaigns on energy efficiency or renewable energy but studies in developed countries some years ago suggest that impacts are generally both very limited and temporary. In Vanuatu, it would be appropriate to include materials on energy efficiency and RE in school curricula but it is probably not an effective use of public funds to prepare public awareness materials on RE unless focused specifically on an impending project that requires public participation. In the case of coconut oil as a biofuel, the public in the modern sector and local businesses already appear to be well informed.

Lack of capacity to develop renewable energy technical information in local languages. For any RET system installed in rural areas, there should be materials (training, operations, maintenance) for operational and technical staff available in Bislama and/or the local language.

[21] The team had no opportunity to assess the extent and effectiveness of the range of RE training already carried out by regional agencies, donors, NGOs and others. During 2004, the UN's Economic and Social Commission for Asia and the Pacific (ESCAP) are developing a regional RET training programme, in cooperation with regional organisations, specifically for PICs.

7.8 Other

Vanuatu is susceptible to tropical cyclones such as the one that struck in early 2004 shortly after the team left Vanuatu, causing damage to existing RET installations. Although this is not a major barrier, nonetheless, those who advocate particular RETs and develop design specifications need to be aware of the risks, and assure that design considerations adequately take them into account. The second 'other' threat considered by a number of local observers to be a barrier to RETs is land acquisition:

Lack of access to traditional land for RET development. Land tenure and the attitudes of traditional landowners tend to be seen by public servants as barriers to the development of RE, and there has been anecdotal evidence of land issues blocking potential projects in Vanuatu and documented evidence in other PICs. A study with follow-up recommendations for action should be carried out on options and opportunities to involve landowners as potential partners rather than opponents in the development of RETs both small scale (for community, health centre, school, etc. applications) and larger scale (feeding to a grid). This should include case studies of successful and failed approaches in Vanuatu and elsewhere.

8 IMPLEMENTATION OF CAPACITY DEVELOPMENT NEEDS AND CO-FINANCING OPPORTUNITIES

8.1 Studies and Co-financing Opportunities

The following are recommended as specific studies and co-financing opportunities for capacity development.

- **Biofuels.**[22] A feasibility study of the impact of the production of coconut oil-based biofuel in Vanuatu should be carried out at several scales: i) a scale of 5-30 ML per year to replace a large percentage of national distillate imports for power generation and transport; and ii) small-scale production for remote islands and communities to displace distillate for rural electric power and ground transport. The study would consider technical, economic, financial, political, and social issues. It would estimate the effects of various scales of biofuel production on government revenue, including the effect of direct and indirect employment, tax revenues, etc. The report would consider whether it is in the interest of the GoV to produce biofuels at various scales and, if so, recommend a strategy to support this development. (This, of course, extends well beyond fiscal issues.)
- **Import duties and taxes.** A study should be undertaken of the rates of import duties and related taxes, exemption policies, and procedures for establishing duties to determine the extent to which there is a bias for or against the development and use of RETs at small scale (rural, small community) and national scale. It would also consider duties and taxes on petroleum fuels and electricity production. The study would recommend changes that encourage the import, possibly assembly, and use of RETs, including tools, appliances, monitoring equipment, etc. associated with RETs. It would consider the pros and cons (and legality under treaties, conventions and international obligations) of differential import duties on devices that are energy efficient or use indigenous resources.
- **Development of capacity for effective RET project document creation for donor funding.** Though there has been a significant level of support from Vanuatu's traditional donors (Japan, France, Australia, and to a lesser extent the United Kingdom) for RETs, support has fallen off in recent years and there was no ongoing support found in early 2004. Donor organisations today increasingly require high quality project documents with clear economic analysis components, budgets with realistic justifications and well developed logical frameworks and action plans. In particular, the requirements for preparation of acceptable project documents for GEF and ADB are complex and demanding. The capacity of both the private sector and government to develop clear, logical and adequate project documents is limited and training is needed so donor funding can continue to be obtained.
- **Green interest rates.** An assessment should be made of the need for, and practicality of, special interest rates, possibly subsidised by the GoV or donors, for (majority) locally-owned businesses for the establishment of RE services, including design and installation, operation and maintenance, repair and refurbishing, training Ni-Vanuatu in use of RETs, production of training materials in Bislama and other local languages, etc. If it appears that "green" rates would be a useful incentive, an interest subsidy fund or special government loan arrangements for private RET development should be developed.
- **Sarakata fund operational improvement.** There should be an independent management and financial audit of the trust fund and recommendations for

[22] The NACCC is not convinced that such studies are all necessary, perhaps with the exception of one on the effects of biofuel production on revenue, tax, etc. Nonetheless, the suggestions are retained, as financiers always want feasibility studies for specific locations, before agreeing to provide finance for project development.

improvements which accelerate its use for RET development. This should include: i) the extent to which the operating and maintenance charges by UNELCO for managing the Sarakata hydro scheme reflect actual costs, ii) whether the use of net funds by UNELCO and the GoV have been allocated and used according to the explicit and implicit agreements with JICA, iii) an audit of the financial management of the trust fund; and iv) recommendations for improvements which increase, and perhaps maximise, the use of the funds for development of RET for rural Vanuatu. It is understood that the trust fund arrangements were to be reviewed after five years, so this study is timely.

- **Energy policy development.** Advisers funded under external development projects and working closely with the Energy Unit and the Ministry of National Planning and the NGO community, should assist Vanuatu to review its drafts of national energy policy and rural energy policy, and prepare practical policy documents for consideration by Cabinet. These should include strategic plans with activities, timeframes, priorities, and budgetary requirements. The CROP Energy Working Group's Regional Energy Policy and Plan provides a possible template. The DANIDA/UNDP/SOPAC Pacific Islands Energy Policy and Strategic Action Planning project (PIEPSAP), expected to operate from August 2004 for three years, is designed to provide this sort of service but may need co-financing to meet specific capacity development needs.
- **Framework for Utilities Regulation.** The PIREP mission has not had access to the WB studies on a possible framework for regulation utilities, including electricity. However, we would strongly encourage any assistance, from the WB or others, which would lead to independent oversight and regulation of the electric power sector in the interests of the people of Vanuatu. Effective regulation would require people with both financial and technical skills.
- **Energy legislation.** A range of legislative tools are required: i) *Electricity*. The legislation relating to electricity production should be reviewed and revised as appropriate. Legislation to oversee and regulate the power sector should be developed and implemented. ii) *Fuel quality.* Legislation should also be drafted, as required, on quality and standards of petroleum fuel imports; petroleum product storage, blending, handling and transport; control of emissions and spillage; and disposal of wastes. (The PIFS has advised for some years on petroleum legislation. SPREP has offered advisory services on handling petroleum-related emissions and waste products.) iii) *Fuel pricing.* Laws relating to fuel pricing should be reviewed and updated to be consistent with current needs. iv) *RETs*. The desirability of legislation specifically for guiding and monitoring rural RET development should be assessed. There may be a need for legislation to promote, establish and regulate Renewable Energy Service Companies (RESCOs).
- **Energy Unit and NEC**. The functions, authority, and responsibility of the Energy Unit should be clarified. If not already done, an up-to-date staffing structure and job descriptions should be prepared and approved at the appropriate level. The relationship with the NEC should be clearly spelled out. The Energy Unit's responsibilities for managing the SSRF should be clarified in writing, including any changes as a result of the proposed trust fund review. Any responsibilities of the Energy Unit for coordinating energy sector activities overall, providing information to the public, and acting as Secretariat to a National Energy Committee, if appropriate, and its relationship to other committees or advisory groups with an energy mandate (e.g. NAACC, PIREP, PIEPSAP, etc.) should be included. Once these functions, authority and responsibilities are clearly defined, a focused capacity building effort for the Energy Unit and NEC needs to be launched.

- **Development of a public information resource for RETs and EETs**. Financing to develop a library of RET information materials specifically selected and developed for the Vanuatu government, NGO and private users is needed as is selection of a suitable repository for that library. The recent tendency by the donor community to develop such materials for Internet delivery while ignoring the development of traditional library materials is not suitable for Vanuatu due to the low level of Internet connectivity and the slow data rates generally encountered. Without an information resource covering past experience in Vanuatu, other Pacific experience and general issues of economics, technology, management, etc. organisations wishing to develop RETs in Vanuatu may have difficulty developing the technology without a long trial and error period repeating the costly errors already made in other parts of the Pacific and around the world. Entries could include:

  i) *reports on RETs of immediate relevance to PICs*. There have been a number of technical reports prepared over the years by donor agencies and others on RETs and their potential suitability for the PICs. Some are out-of-date, inaccessible, biased or too technical or academic in style. It may be useful for a series of short but authoritative technical reports to be prepared (by SOPAC, SPREP, PPA, NGOs, etc. in some cases possibly jointly) and regularly updated which provide an overview of technical, economic, social, and environmental aspects of RETs of particular relevance to Vanuatu and other PICs. These might initially include solar, wind, and biofuel from coconut oil; and[23]

  ii) *RETs of potential relevance to PICs*. There has been considerable hyperbole regarding ocean energy for the Pacific. It would be useful to have a series of short authoritative reports that explain the extent to which ocean energy systems are commercially proven and suitable for adoption by PICs in the near future. Perhaps even more useful in the short term would be a critical (in the positive sense) assessment of hybrid energy systems (e.g. wind/solar; RETs/diesel), experience in the Pacific and elsewhere, and their suitability for use in remote areas of Vanuatu and other Pacific islands.

  The team notes than in the 1980s, a technical resource library, the 'Commonwealth Regional Renewable Energy Resources Information System' (CERRERIS), was developed by Australia and located in Canberra specifically for the use of the PICs. CRRERRIS was unsuccessful because of inconvenient access, communications problems and the complexity of searching for useful documents. Also the collection was largely academic in nature, all in the English language and not always pertinent to the needs of the PICs. To be useful in Vanuatu, the team believes that it will be necessary for information to be locally available, to be carefully fitted to Vanuatu, in both print and electronic formats and conveniently accessible to public and private users.

- **Assistance in resource assessment capacity development.** A programme to assist the Energy Unit and other appropriate agencies to develop the capacity to locally perform wind, biomass and solar resource assessments is needed. Also, assistance in increasing the local capacity to specify and select contractors for geothermal and ocean energy resource assessments is needed.

[23] SOPAC published a number of technical reports in 2001 and 2002. Issues covered include: hydrogen fuel cells (report MR0416, 2001) OTEC (report MR0417, 2001), space solar power (MR0418, 2001) and geothermal (report MR0452, 2002). No coverage of solar PV, solar thermal, wind, hydro or biomass. It may be worthwhile exploring whether existing materials could be adapted/extended to cover specific PIC needs.

- **Development of a local capacity to prepare RET operation and maintenance training and manuals in the local language.** Developing the capacity of rural technicians to install, operate and maintain RET systems requires local language training. This will require external assistance to develop the manuals and training in a metropolitan language then assist local language experts to develop a standard vocabulary for the technical terms and procedures that have to be expressed in the local language as well as translate the documents into the local language.
- **Land Access.** A study with follow-up recommendations for action should be carried out on options and opportunities to involve landowners as potential partners rather than opponents in the development of RETs both small scale (for community, health centre, school, etc. applications) and larger scale (feeding to a grid). This should include case studies of successful and failed approaches in Vanuatu and elsewhere.
- **Preparation of guidelines for village scale hydro development**. Existing international guidelines for hydro development are for much larger scale implementations than useful for village hydro development in the 5-20 kW range for which there are a large number of opportunities in Vanuatu and Melanesia in general. Financing is needed for the development of guidelines for technical assessment, environmental impact assessment, economic analysis, technical design, institutional possibilities, operational requirements and maintenance requirements.

8.2 Hardware Investments for Co-financing

The following investments have the highest short-to-medium term potential for reducing GHG emissions from petroleum energy use in Vanuatu.

- **Biofuel**. By far the largest potential impact on GHG emissions of new RE investments based on known resources in Vanuatu would be from large scale use of coconut oil as a biofuel. Private investors would probably invest in biofuel if they felt the GoV would not be obstructive.
- **Geothermal.** The second largest GHG impact would be from construction of the proposed Efate geothermal plant. It is understood that the World Bank's IFC has expressed interest in co-financing geothermal development in Vanuatu.
- **Hydro.** The third largest impact would be from mini and micro hydro, which Japan and other donors may be willing to finance.

If finance is available to Vanuatu to develop relatively large scale RETs, all of the above should be seriously considered for support. However, choices regarding RET development should not be made solely on the basis of their potential impact on GHG emissions, which in any case are inconsequential on a global or comparative per-capita basis.[24]

- **Solar PV.** For Vanuatu, the development impacts of RETs are likely to be far greater through a large-scale programme of village scale solar PV investments, including the development of appropriate institutions for their finance and operation, than any of the above technologies. A major PV programme should be seriously considered if donor funding is available.

[24] Vanuatu has no legal obligations to reduce GHGs and is an insignificant producer on a global or even regional scale. The *Climate Analysis Indicators Tool* (CAIT) of the World Resources Institute (WRI, 2003) calculates national emissions to the nearest 1/100 of 1% of the global total. Vanuatu's emissions are shown as 0.00 percent.

9 ANNEXES

Annex A - People Interviewed

Ruben M. Bakeo	PIREP National Coordinator; Head of Planning / Executive Officer, Ministry of Agriculture, Forestry, Fisheries and Cooperatives (tel: 42998) rubenmarkwardbakeo@yahoo.com
Anare Matakiviti	PIREP National Consultant; Energy Adviser, SOPAC Secretariat, Suva, Fiji, tel: (679) 338 1377, fax (679) 337 0040, anare@sopac.org.fj,
Hon Sela Molisa	Minister of Finance (former Minister of Lands, Energy, etc.); tel: 23032
Hon J Reuben Titek	Minister for Lands, Geology, Mines, Energy, Environment and Water Resources (MLGMEEWR); tel: 23105; minoflands@vanuatu.com.vu
Stephen Tahi	Director General (MLGMEEWR), tel 23105, steve.tahi@vanuatu.co.vu
Mark Bebe	Director, Department of Strategic Management, Office of the Prime Minister, tel: 23150
Livo Mele	Director, Forestry Department; tel: 23171 or 23856; fax: 25051
James Toa	Acting Director, Department of Economic and Sector Planning (DESP), Ministry of Finance
Robson Joe	Sector Analyst, DESP
Colin Tavi	Sector Analyst, DESP
Margaret Tamata	Research Officer, Reserve Bank of Vanuatu (RBV)
Nicholas Gordon	Acting Manager, Customs Revenue, Customs Compliance Section, Ministry of Finance (tel: 25357)
Moli Janjea	Senior Energy Technician, Energy Unit (MLGMEEWR); tel: 25201
Fred Siba	Senior Energy Officer, Energy Unit (MLGMEEWR); tel: 25201
Kalwajin Skepta	Acting Director, Public Works Department (PWD); tel 22888
Peter Nepwatt	Extension Officer, Department of Agriculture (tel: 22525; mobile: 47511)
Ernest Bani	Director, Environment Unit (tel: 25302) (Chairman of the NACCC)
Russell Nari	Deputy Director, Environment Unit (tel: 25302)
Jotham Napat	Director, Meteorological Office (Vice Chairman of the NACCC)
Moses Amos	Director of Fisheries (tel: 23119)
Alexin Moli	Sectoral Manager, Ministry of Finance
Nancy Wells	Government Statistician, National Statistics Office, PMB 9010, Port Vila; tel: (678) 22110, fax: (678) 24583
Nikenike Vurobaravu	Head, ESCAP Pacific Liaison Office (EPOC)
Wilson Toa	NZ Aid, New Zealand High Commission); tel: 22933
Leith Veremaito	Program Officer, AusAID, Australian High Commission PO Box 111 Port Vila; tel: 23341; fax: 22292; leith_veremaito@ausaid.gov.au
Benoit Denis	Secretary General / NGO Liaison Officer, French Embassy, PO Box 88 Port Vila; tel: 22353; fax: 22696, ambafra@vanuatu.com.vu
Tam Mainguy	European Commission; tel: 22501
Xhang Xinchao	1st Secretary, Embassy of the Peoples Republic of China (telephone interview)
Ray Cahoon	Senior Project Implementation Specialist and Deputy Country Director Asian Development Bank (ADB) South Pacific Regional Mission, Port Vila, tel: 23300; fax: 23183; jcahoon@adb.org

Albert Karlosarusaru	Senior Program Officer, Japan International Development Agency (JICA), tel: 23546; fax: 22818; hcalo@vanuatu.com.vu (Resident Representative is Tetsuhiro Ike)
David Parmenter	Vanuatu Sea Transit Ltd. (VAST; tel/fax 22174), chemoil@bigpond.com.au
Peter Nepwatt	Vanuatu Sea Transit Ltd. (VAST; tel/fax 22174), mobile: 47511, nikamatua@hotmail.com
Rod Newell	Managing Director, Renereltech, tel: 23872, renereltech@vanuatu.com.vu
Tony Deamer	Motor Traders Ltd., PO Box 1010, Port Vila, tel: 27809, fax: 23898, Motor-traders@vanuatu.com.vu
Nathaniel Bue	Partner, Go-Eden Engineering Consultants, goeden@vanuatu.com.vu Hebrida Building, tel: 26003; mobile: 41250)
John Chaniel	Water Supply Manager, UNELCO, PO Box 26 Port Vila tel: 22211; fax: 25011; john.chaniel@unelco.com.vu
Phil Haynes	Head of Lending, Australia New Zealand Banking Corporation (ANZ) PO Box 9003, Port Vila, tel: 26355; fax: 22230; haynesp2@anz.com
Joseph Baki	Manager Operations Vanuatu, Westpac Banking Corporation PO Box 32 Port Vila; tel: 22084; fax: 24773; jbaki@westpac.com.au
Serge Taga	Business Relations Manager, National Bank of Vanuatu (NBV) tel: 22201; fax: 27227; nationalbank@vanuatu.com.vu
George L Dubois	Manager, Origin Energy Vanuatu Ltd; Wharf Road, Port Vila, PO Box 372, Port Vila; tel: (678) 22046, fax: (678) 23818; e-mail: george.originenergy@vanuatu.com.vu
Hong Huu Nguyen	Managing Director, Hong-Auto Enterprise, PO Box 847 Port Vila, tel:(678) 22286, fax: (678) 24395, e-mail: hingauto@vanuatu.com.vu
John Chaniel	Water Supply Manager, UNELCO, PO Box 26 Port Vila tel: 22211; fax: 25011; john.chaniel@unelco.com.vu
Lenox Brian Vuti	Manager, BP Oil, PO Box 220, Port Vila; tel: (678) 22281, fax: (678) 23156; e-mail: swpvnmgr@vanuatu.com.vu
NGOs:	
Gideon Mael	Vanuatu Association of Non Government Organisations (VANGO), vango@vanuatu.com.vu, tel: 26034
David Stein	Vanuatu Renewable Energy and Power Company, VREPC, solarsolutions@vanautu.com.vu Foundation for the Peoples of the South Pacific (FSP), PO Box 951, Port Vila Tel: (678) 22915; Fax: (678) 24510
Nimo Matai	Caretaker JICA solar PV systems, Epau Village
Michael Shing	Onesua Presbyterian School, Onesua Village
Harry Kalkoa	Caretaker JICA solar PV systems, Manga Village
Neil Croucher	Director, Melcoffee Sawmill, PO Box 224, Luganville, Santo, Tel 36883; Fax: 36875; croucher@vanuatu.com.vu
Rodney Aru	Operations Manager, Melcoffee Sawmill
Stanley Temakon	Coconut Oil Production Vanuatu (COPV). PO Box 203, Luganville, Santo
Emmanuel	Assistant Plant Manager, Coconut Oil Production Vanuatu (COPV)
Jerry Nalan	Hydro Operator, UNELCO Sarakata hydroelectric plant
Amy Ling	Santo Veneer Timbers

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Organisation:	URL address:	Topics:
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APACE Village First Electrification Group	www.apace.uts.edu.au/	Small hydro
Secretariat of the Pacific Community	www.spc.org.nc/preface/	PREFACE energy reports
European Forest Institute	www.efi.fi/	Forestry data
Forum Secretariat	www.forumsec.org.fj	Economic data; investment climate
Food & Agriculture Organization	www.fao.org/DOCREP/003/X6900E/x6900e0y.htm#31.%20Vanuatu	Asia and Pacific National Forestry Programme updates for Vanuatu

Annex C – Photovoltaic Installations in Vanuatu

During the PIREP mission, the GoV staff most familiar with the details of the solar photovoltaics programme were unavailable for discussions. The information in this annex is based mainly on wall charts at the Energy Unit office, written materials (particularly PREFACE, 2000 and Lambert, 2002)25 and some interviews. Because it was not possible to visit remote PV sites, the mission could not determine the patterns of usage, the percentage of individual PV systems which still function effectively, capital and installation costs, the initial installation charge (required from the communities, institutions or individuals) if any, and monthly user charges (and if so, the extent and history of collection). Similarly, it is not known whether recipients understand the PV systems to be theirs or owned by the government. The planned and actual institutional arrangements for operation and maintenance are not known.

British High Commission Funded Solar Systems, 1992. The British funded the installation of two community based systems at health facilities in the northern region of Vanuatu. The Avunatari dispensary on West Malo was equipped with four modules of 47 W_p each and Tasiriki clinic on South -west Santo was equipped with two modules of 47 W_p each. Equipment was supplied, and installation was supervised, by Pacific Energie. The systems, summarised to the right, were installed in November 1992.

Avunatari Dispensary on West Malo	Tasiriki Clinic on South West Santo
four panels of 47 Wp each	twopanels of 47 Wp each
eight lamps fluro 13W/24V	four lamps fluro 13W/24V
two batteries of 12V/130Ah	two batteries of 12V/130Ah

Sarakata Special Reserve Fund financed community based solar systems, 1996-2001. Using Sarakata (SSRF) funds, the Energy Unit funded a number of community-based systems.[26]

- Vathe Conservation Area on East Santo 12 modules of 50 Wp each (600 Wp)
- Leumeres Tourist Resort on Sola, Bank Islands 9 modules of 50 Wp each (450 Wp)
- Lakon Health Clinic on West Gaua 6 modules of 50 Wp each (300 Wp)
- Tikilasoa Presbyterian Church on Nguna 10 modules of 50 Wp each (500 Wp)

The NACC has provided the following list of recent projects

Year	Location	Equipment
2000	Tikilasoa Church on Nguna Island	Eight panels of 50Wp each; 4 batteries 6V/420 Ah; 33 lamps fluoro 13W/24V
2000	Epi Junior Secondary School on Epi Island	four panels of 75Wp each; 4 batteries 6V/260 Ah; 1 inverter 24V/600 VA; lamps fluoro 13W/24V
2000	Bay Barrier Dispensary on South Pentecost	two panels of 75Wp each; two batteries 12V/140 Ah; 11 lamps fluoro 8W/12V; one lamp fluoro 16W/12V
2000	Ledungsivi Dispensary on Central Pentecost	two panels of 75Wp each; two batteries 12V/140 Ah; 11 lamps fluoro 8W/12V; onelamp fluoro 16W/12V
2000	Atangurua Church and Nakamal on North Pentecost	eight panels of 75Wp each; 12 batteries 2V/500 Ah; 24 lamps fluoro 13W/24V; one inverter 24V/600 VA
2001	3 Hands Cooperatives on North Pentecost	12 panels of 75Wp each; 12 batteries 2V/530 Ah; 8 lamps fluoro 13W/24V; two freezers of 200L each
2001	Abwatvenu Church on North Pentecost	four panels of 50Wp each; two batteries 12V/140 Ah; 10 lamps fluoro 13W/12V
2001	Liro Fish Market on Paama Island	four panels of 50Wp each; four batteries 6V/420 Ah; three lamps fluoro 13W/24V; 1 freezer of 200L
2001	Vaiduhu Rural Training Centre on Malo Island	six panels of 75Wp each; four batteries 12V/100 Ah; 19 lamps fluoro 12W/12V

Provided by NACCC Sept 2004; fluoro = fluorescent

[25] See Annex C for references cited and other materials used in the preparation of this report. See Acronyms list at front.

[26] There are apparently considerably more systems than this financed through the SSRF but this was all the information the PIREP team could find documented.

ACCT Funded Solar Systems, July 1995. The French, through the Agence de Coopération Culturelle et Technique (ACCT) funded six community based systems on Ambae and Maewo that were installed in July 1995. The total capacity of the units is approximately 1 kWp. The Vureas school system is used by the school to operate a fax machine and word processor.

Location	Equipment
Vureas High School on East Ambae	four panels of 47 Wp each; two batteries of 12V/130Ah; 1 Inverter 200AC 1x300 W
Ambaebulu School on East Ambae	two panels of 47 Wp each; two batteries of 12V/130Ah; six lamps fluro 13W/24V
Gambule School on Central Maewo	four panels of 47 Wp each; two batteries of 12V/130Ah; 9 lamps fluro 13W/24V
Kerempi Health Center on Central Maewo	four panels of 47 Wp each; 12 lamps fluro 13W/24V; 2 batteries of 12V/130Ah
Nduindui Health Center on West Ambae	four panels of 47 Wp each; 11 lamps fluro 13W/24V; two batteries of 12V/130Ah
Apopo Bible Colledge on West Ambae	four panels of 47 Wp each; two batteries of 12V/130Ah; 10 lamps fluro 13W/24V

French Funded Solar Systems, 1996-1997. The French funded another project involving community-based systems at schools on five islands: Ambrym, Epi, Paama, Malekula and Tanna. In total approximately 4700 Wp was installed. Equipment was supplied and installed by Pacific Energie. The bulk of the systems were installed in December 1996 and January 1997. Conflicting information in different reports suggests that at least some of the installations were completed at a later date. The final report by IEPF/FONDEM (IEPF/Fondem, 1998) details 17 installed systems with a total of 102 modules. Assuming 50 Wp per module the total installed capacity would be 5.1 kWp. Earlier documents report 65 solar PV systems at 13 schools and a total installed capacity of 3.25 kWp. Configurations for the systems (source: undated Source: Energy Division Miscellaneous Report) are listed below. All systems have also at least one 200 kVA inverter (Ianaula School has two inverters). The reasons for inconsistencies are not known.

No.	Island	Place	No. of modules	No. of lights
1	Tanna	Loweipeng	9	43
2	Tanna	Fetukai	7	32
3	Tanna	Yanamwakei	3	10
4	Tanna	Iarkey	3	10
5	Tanna	King's Cross	7	14
6	Tanna	Lowanaton	5	19
7	Tanna	Ianaula	14	48
8	Tanna	Lamapruan	5	19
9	Malekula	Caroline Bay	7	28
10	Malekula	Aitchin	4	16
11	Malekula	Amelvet	5	20
12	Malekula	Aulua	6	25
13	Malekula	South W Bay	8	32
14	Paama	Lehili	8	34
15	Ambrym	Wuro	4	10
16	Epi	Burumba	13	32
17	Epi	Port Quimy	4	10
Total			**112**	**402**

JICA Funded Solar Home Systems, 1999. A Japan International Cooperation Agency (JICA) funded project involved the installation of solar home systems in five villages on four islands: Navuti village on Ambae, Emua and Epau on Efate, Natapao village on Lelep and Lawa village on Malekuka. Total capacity is 22,000 Wp (220 systems of 100 Wp each). Equipment was supplied and installed by South Pacific Electrics in November 1999.

Sarakata Special Reserve Fund financed solar home systems, 2000 Using the SSRF, the Energy Unit funded the electrification of individual homes at three villages on the island of Efate. A total of 45 solar home systems of 100 W_p each were installed at Mangaliliu and Epau villages. The combined capacity of the systems is 4500 W_p. Equipment was supplied, and installation was supervised by, Pacific Energie. The systems were installed in February and March 2000.

Province	Project Site	Installation	Type of Generator	No of Lights
Tanna	Ecole de Loweipeng	Head Teacher's House Classroom	One module Onemodule Two modules	8X13W 2X8W, 2X13W 4X13W, 4X18W
	Fetukai School	Classroom Staff House Staff House Staff House	Three modules Two modules One module One module	1X8W, 15X18W 2X8W, 2X13W 2X8W, 2X13W 4XW, 4X13W
	Ecole de King's Cross	Classroom Staff House	Four modules Two modules	1X8W, 5X18W 3X8W, 3X13W
	Ianaula School	Head Teacher House Classroom Girls Dormitory Classroom Boys Dormitory Dining Hall Staff House Double staff house Double staff house Staff house	One module One module One module One module One module Two modules One module Two modules Two modules One module	4X13W 2X8W, 2X13W 4X13W 4X13W 2X8W, 2X13W 4X13W 2XW, 2X13W 4X8W, 4X13W 4X8W, 4X13W 2X8, 2X13W
	Ecole de Lamapruan	Classroom Classroom Head Teacher's House Classroom	Onemodule Two modules One module Onemodule	2X13W, 3X18W 2X8W, 2X13W, 2X18W 2X8W, 2X13W 2X8, 2X13W
Malakula	Ecole de Aitchin	Classroom Staff House Staff House	One module One module One module	8X13W 2X8W, 2X13W 2X8W, 2X13W
	Amelvet School	Head Teacher's House Triple staff house Classroom	One module Threemodules One module	2X8W, 2X13W 6X8W, 6X13W 4X13W
	Aulua School	Classroom Dining Hall Double staff house Head Teacher's house	Onemodule One module OnemoduleOne module	3X13W 6X13W 2X8W, 2X13W 2X8W, 2X13W
	South West Bay School	Classroom Boys' Dorm Girls' Dorm Dining Hall Double staff house Head Teacher's house	Two modules Onemodule Onemodule Onemodule TwomodulesOne module	4X13W 4X13W 4X13W 8X13W 4X8W, 4X13W 2x8W, 2X13W
Paama	Ecole de Lehili	Dining hall Classroom Staff House Staff House	Three modules One module One module Onemodule	4X8W, 4X13W, 4X18W 2X8W, 8X13W 2X8W, 2X13W 2X8W, 2X13W
Ambrym	Wuro School	Classroom Double staff house	Two modules Two modules	4X13W 2X8W, 4X13W

AFD Funded Solar Systems, 2000-2001. Through the Agence Française de Développement, France funded the Vanuatu Rural Photovoltaic Project (VRPP) involving the installation of 201 solar home systems at 45 sites (twenty-seven schools and eighteen health facilities). As many as eight different system configurations were used, depending on the local energy needs. The PIREP Mission has no details on the configurations but understand that total capacity is 22,000W_p. The equipment was supplied and installed by ACTEK (New Caledonia) in co-operation with INTV (Vanuatu). The systems were installed between August 2000 - May 2001.

Torba PREFACE Funded Solar Systems, 2001-2002. The Torba PREFACE Photovoltaic Project involved the installation of sixty solar PV systems on six main islands of the Banks and Torres Islands, the northernmost islands of Vanuatu. Twelve schools and eight health facilities were equipped with PV systems of 150 W_p each and 40 staff houses were equipped with PV systems of 75 W_p each). Installations at the twenty sites were carried out in April and May, 2002 (Lambert, 2002):

- the 75W_p systems were designed to power 3-4 fluorescent lights of 13 W and a radio of 15W max; and
- the 150 W_p systems would power 3-4 fluorescent lights of 13 W, a mobile 20 W halogen light, a Codan SBB radio transceiver (for health facilities) or small 60W stereo radio (for schools).

Details of the PREFACE project are provided blow:

No.	Group	Island	Site	150 Wp	75 Wp	Total Capacity
1	Banks	Gaua	Losalava School	1	4	450
2	Banks	Gaua	Santa-Maria School	1	3	375
3	Banks	Gaua	Vaget Bilingual School	2	3	525
4	Banks	Gaua	Mataka Health Center	1	3	375
5	Banks	Gaua	Dorig Dispensary	0	0	0
6	Banks	Mere Lava	Nergar School	1	3	375
7	Banks	Mere Lava	Robul Dispensary	1	1	225
8	Banks	Mota	Pasalele School	1	3	375
9	Banks	Mota	Sarawia Dispensary	1	1	225
10	Banks	Mota Lava	Telhei School	1	4	450
11	Banks	Mota Lava	Wongyeskei School	1	3	375
12	Banks	Mota Lava	Bemisas Health Centre	2	2	450
13	Banks	Ureparapara	Shem Rolley	1	2	300
14	Banks	Ureparapara	Lehali Dispensary	1	2	300
15	Banks	Vanua Lava	Hannington Dispensary	1	1	225
16	Banks	Vanua Lava	Quat Vas (Sola) Dispensary	1	0	150
17	Banks	Vanua Lava	Saniang	1	2	300
18	Torres	Loh	Robin School	1	2	300
19	Torres	Loh	Loh Health Center	1	1	225
20	Torres	Hiu	Hiu Dispensary	0	0	0
21	Torres	Hiu	Martin School	0	0	0
Total				***20***	***40***	***6000***

Note: Five of the above sites had existing 75 W_p systems rehabilitated. It is understood that rehabilitation did not add new capacity.

Telecom Vanuatu Ltd Solar PV Installations. Telecom has installed the following systems. No details are available on dates of installation, size, etc. (source: Telecom Vanuatu Ltd, 2004)

Province	Island	Number of PV systems
Torba	Ureparapara	3
	Mota Lava	3
	Vanua Lava	3
	Mota	1
	Gaua	8
	Merelava	2
	Hiu	1
	Loh	1
	Toga	2
Shefa	Efate	38
	Nguna	5
	Pele	1
	Emao	2
	Tongoa	9
	Emae	4
	Tongariki	1
Sanma	Santo	12
	Malo	1
	Tutuba	1
	Bokissa	1
	Aore	2
	Mavea	1
Penama	Pentecost	26
	Ambae	20
	Maewo	12
Malampa	Malekula	26
	Pescarus	1
	Uripiv	1
	Wala	1
	Atchin	1
	Akhamb	1
	Ambrym	19
	Paama	4
	Epi	10
Tafea	Aneityum	4
	Erromango	10
	Aniwa	4
	Futuna	6
	Tanna	*35*
Total		***283***

Annex D – Biomass in Vanuatu

Forest resource. The islands of Vanuatu consist generally of a narrow coastal plain rising through broken foothills to a steep mountainous interior. Forest land (all types) covers about 75% of the total land area, and includes dense tropical rainforests and exotic plantation forests. Much of the natural forest is on steep inaccessible sites and the limited accessible sites contain few species of commercial use. In the islands' interior, much of the natural forest has primarily a protective role. Some of these forests have been degraded by conversion to grazing and in places by burning. In some areas, erosion and soil degradation are significant problems (SOPAC, 2003). All forest is owned by traditional owners (clans) and cannot be sold. There is no government forest estate. Since Independence in 1980 there has been a number of plantation development initiatives but efforts to establish plantations have been small and largely unsuccessful. Although the National Forest Policy of 1997 has a target of 20,000 ha of plantations to be established over the next 20 years, there are only around 3100 ha of forest plantations, not including coconut plantations.

Forest harvesting practices. Because of Vanuatu's steep terrain, only about 20% of the forest resource is economically accessible for harvesting. The commercial quality of the country's natural forests is low relative to other Melanesian countries, with forests characterised by species with low density, poor form, low durability and low strength. The most important timber species are whitewood and Melektri, which constitute 90% or more of the forest harvest. Logging is carried out on both a large scale, to supply markets for export logs and wood processing facilities on Vanuatu, and also on smaller scales with portable sawmills. Most logging is currently concentrated on the island of Espiritu Santo. The sustainable yield from natural forest is estimated to be 68,000 m3 per year, after allowance for steep slopes, heavily dissected landforms, buffer zones, areas with low volumes of commercial species and the ability of portable sawmills to work in areas unsuited to large scale logging operations (SOPAC, 2003). Actual harvest is well within the estimate of overall sustainable yield. Between 1996 and 2000 some 36,000-41,000 m3 were cut annually, and the annual cut has since dropped. However, the concentration on a handful of species makes current logging practices difficult to sustain because these particular species are being over harvested source (EFI, undated).

Year	Annual Timber Products Exports		
	Log Exports FOB Value Vt million	Volume of Processed Exports (m^3)	Processed Exports FOB Value Vt million
1987	0.19	908	1.83
1988	47.10	1,827	59.20
1989	101.42	1,950	101.22
1990	-	1,939	90.06
1991	-	1,674	86.02
1992	-	2,269	146.38
1993	43.14	2,598	224.39
1994	-	5,107	255.43
1995	-	4,160	233.93
1996	-	7,940	362.00
1997	-	14,938	514.89
1998	-	12,917 #	524.16 *
1999	-	12,219 @	536.90 @
2000	-	8,599 **	434.22

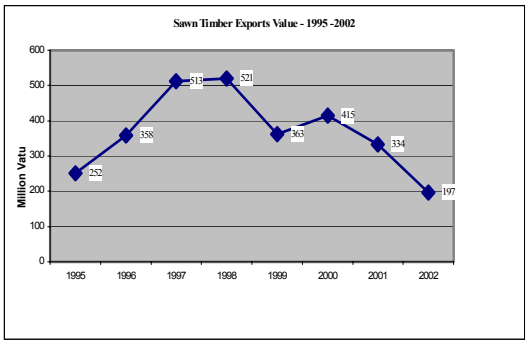
Notes * Includes 33,406 kg of Sandalwood valued at 10,962,000 Vatu

Estimated from sawmillers' returns

@ Data from Santo only (vast majority) does not include Vila export volumes as Customs have not provided. Data prior to 2000 did not include mobile sawmills, as data was not available.

** Export value data (from Customs) is considered by DoF to not cover all forest products correctly and is likely to be underestimate.

The Table and Figure at the right of the page show annual timber product exports and values in recent years.



Source: 2002 Vanuatu Statistics Annual Report

Mobile sawmills. Mobile sawmills or "wakabaut somil" are small mills that can be moved around the forest and sometimes even to the tree-stump to process the wood. Mobile sawmills have become increasingly popular enabling small ni-Vanuatu businesses and communities to utilise their own resources because the sawmill is less complicated than larger mills and affordable through loans. Mobile sawmills exist throughout most of Vanuatu. Around the turn of the century they gained in importance, particularly for landowners intending to harvest and sell their own timber. In 2002, the Department of Forests issued more than 20 timber licenses (2001: 47 licenses) to mobile sawmills to operate mainly on the islands of Santo, Malakula, Efate and Tanna. Mobile sawmills are an important part of the forest industry because they produce timber particularly for the local market, unlike the bigger scale fixed sawmills, which export up to 95% of their production.

As indicated in the table at the right, the volume of logs produced by this group of sawmills dropped dramatically, from 3907 m^3 in 2001 to 1938 m^3 in 2002, a decrease of 1969 m^3, and well below the 10,000 m^3 that was licensed by the Department of Forests in 2001. Various factors contribute to mobile sawmill operators not cutting the licensed amounts. Difficulties faced by the mobile sawmills were normally associated with continual breakdown of machinery. Spare parts were not readily available, and it normally takes three to four months for an ordered spare part to reach the operator. There is typically inadequate training for operators in machine operation, maintenance and practical business management. Mobile saw mills utilise a wide range of hardwood species that are not used by larger fixed mills. This is because mobile sawmills have a strong local market for such species which are widely used for structural timber and furniture manufacturing.

Production Volumes from Mobile Sawmills

Region	Trees felled	Volume (m^3)
2001:		
Central	188	348.356
Sanma	201	372.444
Shefa	983	3,186.668
Total	*1,372*	*3,907.5*
2002:		
Total	*n/a*	*1,937.7*

Source: Department of Forestry, Annual Reports (2001 and 2002)

Coconut resource and production. Copra is the main export commodity of Vanuatu. Copra production is regulated by the Vanuatu Commodities Marketing Board (VCMB), since late 1993 operating under an 'Open Policy' system allowing producers, buyers and exporters to be competitive in their pricing.

The FAO estimated the total area covered by coconut plantation at 96,000 hectares in 1997. Depending on the level of replanting over the last decade the share of senile trees, with low productivity, is estimated at 25-50 percent. More than half of the copra is produced in Santo and Malekula, overwhelmingly by a very large number of smallholders. The copra is sold to local buyers who either process it to produce coconut oil or export it to European markets.

Copra is dried in Vanuatu primarily by two methods. The traditional method, the predominant means of copra drying until the early 1980s, has been by open-fire "smoke dryers". This method leads to an inferior quality product which contributed to depressed

prices for Vanuatu copra and a significant decline in copra production. In the early 1980s an active government programme was started to convert the majority of copra drying to the more efficient method using "hot-air dryers" which also results in a higher quality copra. It is estimated that the majority of Vanuatu's copra is now dried by hot-air dryers.

Copra, Coconut Oil and Copra Meal Production (Tonnes; 2002 and 2003)

Month	Production in 2002:			Production in 2003:		
	Copra	Oil	Meal	Copra	Oil	Meal
January	250.379		220.23	2,437.334	792.026	797.385
February	2001.968	382.822		540.474	617.918	
March	1826.512		201.04	256.476	748.818	365.02
April	1597.694	1,714.111	626.09	854.280	610.914	260.215
May	1732.62		98.21	357.988	214.922	
June	1916.759	2,056.765	383.415	308.760	219.358	
July	2236.709	671.989	720.31	1,323.562	812.654	605.366
August	2355.54	1,715.984	928.6	1,916.970	1,065.012	663.360
September	1531.856		348.665	1,696.566	967.947	
October	1291.548	2,349.019	594.84	1,740.079	1,251.348	1,064.310
November	1734.667	582.325	241.96	1,281.213	795.186	
December	2913.53	874.470	488.402	2,406.005	802.314	502.945
Total (rounded)	*21,389.8*	*10,347.5*	*4,851.8*	*15,119.7*	*8,898.4*	*4,258.6*

Source: Vanuatu National Statistics Office, February 2004

Annex E - SWOT Workshop

A SWOT workshop was held at Dumbea Hall, Port Vila throughout the morning of 5 February 2004. It was arranged by Mr. Ruben M. Bakeo (PIREP National Coordinator and Executive Officer, Ministry of Agriculture, Forestry, Fisheries and Cooperatives) and attended by about 20 participants. The purpose was to determine the views of ni-Vanuatu and other long-term local residents regarding the 'strengths, weaknesses, opportunities and threats' for renewable energy development and commercialisation. The bulk of time was spent in six small groups discussing and listing perceptions of various strengths, weaknesses, opportunities and threats. Discussions were lively and a good deal of information was exchanged. The reports of each group are summarised below.

	STRENGTHS
Group 1 Energy Unit staff; reporting by Moli Janjea	• Government contract with UNELCO (i.e. Sarakata hydropower station) provides funds for rural electrification • The government has assigned the Energy Unit as executing agent for rural electrification • Through Energy Unit, any group or community can obtain equipment for rural electrification with duty exemption
Group 2 Mixed group	• Natural resources (sun, wind, geothermal, waves, coconut, waterfalls) are abundant • The required institutions (e.g. UNELCO, Energy Unit, COPV, VRTC, VAST, Motor Traders) are already in place. • Knowledge • An (informal) rural energy policy is in place
Group 3 Reporting by Peter Nepwatt	• Resources (coconuts) are available in abundance • There is local knowledge on how to produce copra • Coconut oil is an environmentally friendly fuel • Access to technical information on coconut oil, both local and global, (via Internet) • Smallness of population enables rapid introduction in the community • Affordable to run family power generator sets using coconut oil as diesel fuel substitute • Local product, enabling barter of copra for fuel
Group 4 Mixed group	• The resource base
Group 5: Reporting by David Stein:	• Natural resources are available in abundance
Group 6 NACCC, reporting by Ruben Bakeo	• Natural resources are available in abundance • There are plenty supply of coconuts • Examples of how to produce coconut oil as fuel (VAST, COPV) are already available • Expertise on coconut oil production is gradually developing
	Weaknesses
Group 1	• Lack of skilled human resources (training needs to be updated) • Lack of tools and (testing) equipment • Lack of knowledge of renewable energy options other than solar PV • Financial assistance is needed to respond to needy communities in a timely fashion • The UNELCO concession does not allow others to produce and reticulate electric power • Lack of rainfall data (required for hydro development) • Land issues • Policy makers (politicians) are unaware of weaknesses we have in implementing renewable energy
Group 2	• High costs of fossil fuel imports • Information is not circulated to the grassroots level • Competition amongst institutions • The UNELCO concession has been renewed for another 25 years • Landowner disputes • Available knowledge is not being utilised • No proper tools/equipment to assess renewable energy resources

	• Lack of human resources / limited number of knowledgeable people (Energy Unit has only two RE specialists)
Group 3	• Weak and fragmented human resources • Fragmented approach to addressing problems • No information flow (people do not seem to be interested in other people's business) • Institutional weaknesses at the provincial level • "Tunnel vision", there is no formally established institution that operates as liaison to the government and that tackles renewable energy barriers • High costs of installing alternative energy technologies
Group 4	• Information
Group 5	• Lack of information at the grassroots level • Lack of infrastructure • No critical mass of "anything", including purchasing power (money)
Group 6	• Lack of technical expertise • Lack of spare parts • High upfront costs of renewable energy technologies • Government electricity policy (i.e. UNELCO concession) • Lack of information • Lack of resource monitoring data (hydro) • Lack of finance
Opportunities	
Group 1	• Availability of natural resources that are readily available throughout the country • School leavers generate a steady supply of human resources to develop RE understanding • Increasing "greenness" (environmental orientation) amongst politicians
Group 2	• Human resources: there are some specialists in the country • Energy policy can be modified according to the requirements of the government of the day • Perhaps the UNELCO concession can be renegotiated • Topography of Vanuatu • Donors pay more attention to small islands developing states (SIDS) as a result of global concern over climate change and sea level rise
Group 3	• Fossil fuel is very expensive; it is cheaper to provide rural lighting with RET's • It has already been shown that the technology (re. coconut oil production and application) is adopted easily (e.g. 70 trucks were running in Vanuatu on coconut oil derived fuel) • Continuous improvement in household incomes • Local production of coconut oil as diesel fuel substitute helps to stabilise copra prices • By-products of coconut oil production can be used as animal fodder or as solid biomass fuel • UNELCO may be prepared to use coconut oil as a fuel
Group 4	• Resources are available locally, most at no cost to develop • Communities want to lower their energy costs and would prefer utilisation of their available resources for energy production • Empower the community through information and good examples (best practices; showcases)
Group 5	• Pretty open market • High costs of fossil fuel
Group 6	• Participation in the PIREP programme • The arrangements regarding the Sarakata hydro scheme should in principle lead to lower electricity prices • Coconut oil industry is in place • Local knowledge of biofuel
Threats	
Group 1	• Natural disasters (cyclone, earthquakes) • Land disputes (typical) • Climate change • Long-term supply of coconuts (requires tree re-planting)
Group 2	• Political influence and stability • New government may put in place new (energy) policies • Natural disasters (increase of cyclones due to sea level rise) • Human disaster (e.g. land disputes) • Price hikes (imported fuels) • Globalisation

	• Institutional: competitive mentality instead of working together • Policies of external trade partners (USA, Australia, UNELCO's mother company) • Geography (location; land mass) • Culture ("land dispute"; "mainly Tanna people who run local businesses")
Group 3	• VCMB Act (declaring copra an exempt commodity (restricting development to local investors)) • Political instability • Cyclones • Irregular shipping schedules so you need to have your own boat • Short-term responses to shortfalls in government budget (may result in additional taxes being imposed virtually overnight) • Big oil companies repatriate revenues to external companies • The oil companies have too much power
Group 4	• There are no solid examples of using RET's nor of using a model that can work in the local community
Group 5	• Government does not help much to support RE development (there is no enabling environment) • Cultural: "land ownership"; "that is how its is " (complacency)
Group 6	• Reluctance of government to seriously review arrangements with UNELCO • Vested interests of politicians • Energy legislation is not supportive of renewable energy options • Lack of a national energy policy

The following people participated in the workshop:

Solomone Fifita	PIREP Chief Technical Adviser, SPREP, Apia, Samoa
Ruben M. Bakeo	PIREP National Coordinator; rubenmarkwardbakeo@yahoo.com and Head of Planning / Executive Officer, Ministry of Agriculture, Forestry, Fisheries & Cooperatives tel: 42998
Anare Matakiviti	PIREP National Consultant; anare@sopac.org.fj Energy Adviser, SOPAC Secretariat, Suva, Fiji, tel: (679) 338 1377, fax (679) 337 0040,
Hon J Reuben Titek	Minister for Lands, Geology, Mines, Energy, Environment and Water Resources (MLGMEEWR); tel: 23105; minoflands@vanuatu.com.vu
Ernest Bani	Director, Environment Unit tel: 25302
Jotham Napat	Director, Meteorological Office
Robert Manilicos	Senior caretaker PREFACE solar PV systems, Torba
Moli Janjea	Senior Energy Technician, Energy Unit (MLGMEEWR); tel: 25201
Fred Siba	Senior Energy Officer, Energy Unit (MLGMEEWR); tel: 25201
Beverly Escalo	Vanuatu Association of Non Government Organisations (VANGO), vango@vanuatu.com.vu , tel: 26034
Aaron Reedy	Vanuatu Rural Development Training Centre
David Stein	Vanuatu Renewable Energy and Power Company, VREPC, solarsolutions@vanautu.com.vu, c/- FSP, P.O. Box 951, Port Vila Tel: (678) 22915; Fax: (678) 24510
Willie Sacksack	Chamber of Commerce and Industries
Nicholas Gordon	Acting Manager, Customs Revenue, Customs Compliance Section, Ministry of Financetel: 25357
Annie Tenkon	Vanuatu National Workers Union
W. Rayson	Reporter, Daily Post
Peter Nepwatt	Extension Officer, Department of Agriculture tel: 47511
Hanington Tale	Forestry Department

A more complete list of the strengths weaknesses, opportunities and threats to RET development expressed by those interviewed in Vanuatu (both within the SWOT workshop and external to it) is provided below.

Strengths Weaknesses, Opportunities and Threats to RET Development and Commercialisation as Identified by People in Vanuatu	
Strengths	
Fiscal	Any group or community can obtain import duty exemptions on equipment for RE or other rural electrification Vanuatu is small and politicians are accessible, so taxes and import duties can be changed quickly if this is in the national interest
Financial	The Sarakata reserve fund provides funds specifically for RETs for small-scale rural electrification in remote communities Well-established development bank and commercial banking structure accessible to rural people There is a high level of technical assistance per capita with donors willing to support RE, and they have supported RE Trials show that it is cheaper to run family generator sets using coconut oil than to use diesel fuel The experience with several hundred vehicles in 2002 shows that coconut oil can be less expensive than diesel as transport fuel
Legislative, Regulatory and Policy	A draft national energy policy has been prepared for consideration by government and is being reviewed in 2004 An explicit, if informal, rural energy policy is in place with guidelines for the Energy unit The Council of Ministers (Cabinet) has approved the establishment of a National Energy Corporation specifically for large-scale rural electrification by the best available means Cabinet has approached the World Bank to assist with a new regulatory framework for utilities, including electricity Vanuatu has the legal power to appoint an Electricity Commissioner Governance and respect for the law in Vanuatu has improved under the Comprehensive Reform Programme (CRP)
Institutional	The government has established an Energy Unit to plan and implement RE Institutions exist with competence, knowledge and experience with RE (e.g. UNELCO, Energy Unit, COPV, VRTC, VAST, MT) The power utility (UNELCO) has a long history of providing reliable electric power, has recently extended service to remote islands, and is actively exploring wind and geothermal options Vanuatu has technical colleges and trade schools which produce graduates with skills to learn about RETs Several companies in Vanuatu already sell RETs (i.e. PV, pico-hydro) through their retail stores and some offer support
Technical	Abundant natural resources throughout Vanuatu: wind, sun, biomass, hydro, coconuts, geothermal, sea wave, ocean thermal, etc. Small scale RETs, particularly solar PV, are known to work well in all parts of Vanuatu Vanuatu has developed considerable expertise and has practical experience in using coconut oil as a biofuel
Informational and Public Awareness	There is local knowledge throughout Vanuatu on how to produce copra, which can be used for biofuels, cheaply Good access to technical information on coconut oil as a fuel, both locally and globally, (via Internet) Considerable publicity in local media on coconut oil as a fuel Senior members of the Council of Ministers (cabinet) are well aware that RETs like solar PV and biofuels are practical.
Market and Other	Vanuatu is a small but well-developed market economy with entrepreneurs (such as those involved in coconut oil as a fuel) willing to take risks Coconut oil is an environmentally friendly fuel, widely available in Vanuatu People in Vanuatu are willing to adopt new ideas and smallness of our population enables rapid introduction in the community Coconut oil is a local product, enabling the barter of copra for fuel for those outside the cash economy.

Weaknesses	
Fiscal	There is no incentive to import RETs, as import duties do not differentiate between them and other energy equipment Fiscal policy is decided on the basis of revenue, not encouraging sustainable development options There is no import duty rebate for importers of energy saving RETs such as solar water heaters The government has imposed duties on coconut oil (blended with small amounts of diesel or kerosene) without considering the overall impacts of the policy on the development of a biofuel industry or even our loss of foreign exchange through importing petroleum fuels Fiscal decisions which affect RE (e.g. import duties and exemptions) are not made in a transparent manner; it is easy to conclude that they are often made to protect a particular group rather than in the national interest UNELCO does not pay any import duty on fuel used to generate electricity in Port Vila, which is a bias against RETs for which duty is often paid. In addition, gives UNELCO a disincentive to seriously consider locally produced biofuels
Financial	Vanuatu is a poor country with small communities spread over 60 islands. We cannot afford widespread rural electrification. It is a dream. There is no accountability in the use of the Sarakata reserve fund allocations for RE or for any other purposes. This has already caused Japan to refuse to finance an expansion of the Sarakata mini-hydro project in Santo. UNELCO has no financial incentive to use RE as their concession contract allows them to simply pass on all fuel price increases to the consumer. Rural ni-Vanuatu have low cash incomes and lack access to affordable finance The government pays a low subsidised rate for electricity (about half the average rate) which reduces incentives for RE or energy efficiency measures for government's institutions. The economy is growing so slowly that the government is unlikely to allocate enough funding for a successful RE programme due to pressing issues such as health, transport and education The initial costs of installing RETs are very high compared to diesel generation The education ministry made a commitment to allocate enough money to maintain PV systems at rural schools for an agreed period of time but never honoured this commitment. There is little financial responsibility within some government ministries. The land tenure system does not allow commercial banks to use land as collateral for loans
Legislative, Regulatory and Policy	The power utility (UNELCO) has a new long-term concession which does not allow others to produce and reticulate electric power in their four supply areas There is no legislation to control, restrict, guide or oversee electric power development in Vanuatu The government is apparently not serious about the proposed National Energy Corporation as it has not sought the necessary approval of Parliament. Without this, it cannot happen. There is no legislation, or even detailed proposed legislation, such as that for 'Renewable Energy Service Companies' (RESCOs) to guide and control RE in rural communities Government has not appointed an Electricity Commissioner for about 15 years and seems to lack the will to actually address power sector issues, as opposed to talk about it Despite many drafts of national and rural energy policies, no clear policies approved by the Council of Ministers actually exist.
Institutional	Even if institutions function OK at the national level, they are very weak at the provincial level Vanuatu lacks the institutions and framework to operate and maintain rural energy systems, including RETs. Despite the CRP and donor pressure, Vanuatu governance remains ineffective, as evidenced by the government's approval and extension of new long-term concession agreements with UNELCO (through 2031) for sole rights of electric power production. It is widely believed that influential people benefit financially from the arrangement. Institutionally, there is a fragmented approach to addressing energy problems with little sharing of information between government agencies or with the private sector. The Energy unit lacks the skills or incentives or maybe the will to collect funds from communities with solar PV; PV will not be sustainable in this country until this is resolved. The Energy Unit is very weak, as the govt. doesn't genuinely support it. [27] There is no established institution or mechanism that operates as liaison from NGOs and private sector to the government to address and tackle renewable energy barriers Financial assistance is available for rural communities but they do not respond quickly to rural needy communities. GoV Energy Unit lacks human resources; it has only two RE specialists

[27] The NACCC felt it would be more accurate to write, "The drop in rural economies (kava and copra prices went down) and destructions by natural disasters has made it hard for the communities to pay for the system usage and hence making it quite difficult for the Energy Unit to collect funds from these communities." Although this is no doubt true, this section is reporting the actual perceptions that were voiced during discussions. It is useful for the EU to be aware of such perceptions.

	There is considerable and unnecessary competition amongst institutions involved in RE, especially coconut oil as a fuel Vanuatu training institutions are all weak; training capacities need to be updated and improved The business community is dominated by foreigners who may mean well but are too influential; they should not be the ones who decide what is in Vanuatu's interests.
Technical	Vanuatu has a small manufacturing sector and cannot afford to consider the manufacture of RETs or even assembly There is very little knowledge of RETs except solar PV and to some extent small-scale processes to make coconut oil. There is a lack of monitoring or measuring our RE resources, e.g. poor rainfall data and stream gauging required for hydro development or the wind resource for wind energy development. There is a general lack of technical knowledge in rural areas on operating, maintaining and caring for imported technologies of all sorts. Despite the good experiences with coconut oil as a fuel, there are still problems with blocked filters, poor performance, cold weather starting, etc.; not all technical problems have been overcome There are lots of technologies for making coconut oil but no agreement on which are best for Vanuatu There is a serious lack of tools and equipment for testing and maintaining RETs, e.g. solar systems Coconut oil as a fuel is fine but in rural Vanuatu what we really need is a local biofuel which can be used in outboard motors for coastal transport, as most islands have no real road network. This does not exist.
Information and Public Awareness	Policy makers (politicians) are unaware of the many, daily practical problems we have in implementing RETs Even where information is available in Vanuatu, it is often not being used when choosing RETs or approaches Information available in French or English is not circulated to the grassroots level and is often not available in Bislama and certainly not the hundreds of local languages Lack of technical expertise. The government does not even know whether energy is actually a high priority for rural people
Market and Other	The market for gods and services in Vanuatu is quite small, even smaller than the population would suggest as the majority of ni-Vanuatu are effectively outside the market economy. Traditional land owners are very protective of their rights and it can be very difficult to get access to land for RE (or other) purposes; Public servants tend to be poor at resolving land issues and negotiating fair arrangements for access to land A widespread RE programme requires a 'critical mass' but there is no critical mass of anything in Vanuatu The topography of Vanuatu is rugged so it is hard to develop rural infrastructure.
Opportunities	
Fiscal	Vanuatu can quickly eliminate import duties on all renewable energy equipment, equivalent taxes on biofuels which replace imports, on 12 /24 v appliances and lights which are used in solar installations, etc. which will stimulate RE development
Financial	The high cost of electricity in Vanuatu (about US 30¢/kWh for households and about US 55¢ above 120 kWh/m, provides an excellent incentive already to find cheaper alternatives Fuel prices are so high away from Efate and Santo that we already have the financial incentives to produce local biofuels for power generation and ground transport. Fossil fuel is very expensive in remote areas; it is cheaper to provide rural lighting with solar PVs over the lifetime of the equipment. The arrangements for financing RE through the Sarakata fund, despite problems, demonstrate an approach that works that can be extended further with more funds allocated towards RE. Vanuatu has an open, responsive market that can and will adapt quickly to appropriate financial signals and incentives. There are opportunities for more hydro development which is affordable and should in principle lead to lower electricity prices Vanuatu has opportunities now through the IFC and GEF to obtain finance to develop our geothermal resource for electricity on Efate. Donors are paying attention to small islands developing states as a result of global concern over climate change and sea level rise, which gives us new opportunities for donor finance for RE Local production of coconut oil as a diesel fuel substitute can help to stabilise copra prices and maintain a financially viable coconut industry A slow but continuous improvement in household incomes means that ni-Vanuatu can increasingly afford RE

	The Credit Union has financed some solar PV systems and may be willing to expand loans for RETs A serious effort to replace diesel fuel with coconut oil would reduce Vanuatu's greenhouse gas emissions, provide good publicity internationally, and possibly result in additional assistance for further RE development.
Legislative, Regulatory and Policy	Energy policies can be easily and quickly be modified according to the requirements of the Government of the day Several donors are willing to assist Vanuatu develop appropriate energy polices, regulations and legal tools Vanuatu has the legal power to appoint an Electricity Commissioner any time. The World Bank may find loopholes which allow the government to renegotiate the UNELCO concession or control the electricity sector development Build on the Council of Ministers' vision (policy) for a 100% renewable energy economy by 2010.
Institutional	Even though UNELCO can block others from producing electric power, it has allowed companies to do so in its concessions areas, which provides opportunities for the private sector. Our private sector is small but vibrant and adaptable. There are many expatriate businessmen who want to see Vanuatu develop Communities want to lower their energy costs and would prefer utilisation of their available resources for energy production Empower the community through information and good examples (best practices; showcases) The coconut oil industry is in place now so new institutions are not required for developing coconut oil as a fuel If the government establishes clear guidelines and institutional controls for the use of Sarakata funds, there should be more funds available immediate for RE and more funds in the long term. [28] If UNELCO develops a 'green' corporate attitude, it could quickly justify the development of RE resources such as geothermal, hydro, possibly wind and solar, and find concessional funds needed to do so.
Technical	Those promoting coconut oil as a fuel are technically competent and are willing to share their knowledge. We have the opportunity to use these human resources already here more effectively. The technology for biofuel (re. coconut oil production and application) has been proven in Port Vila. The bus operators accept it. There is an opportunity to expand production quickly and even replace all of our imports of diesel fuel. Through SPREP's PIREP, SOPAC's new Danish energy project and others we have an opportunity to receive good unbiased technical advice on RETs As people become more familiar with solar PV they will realise it is technically sound and there will be an opportunity for it to expand.
Informational and Public Awareness	Participation in PIREP (and other donor programmes) gives us opportunities now to learn more about realistic options. Even without detailed monitoring, there is enough knowledge about some resources, sun and coconuts, to take action now. There seems to be an increasing "greenness" (environmental orientation) amongst our politicians which is an opportunity we can build on.
Market and Other	Several companies provide RETs but some support services are weak or non-existent. There are generally no agents away from Port Vila or Luganville. Well under 20% of households are electrified so there is an opportunity to use RETs instead of costly diesel. If UNELCO is prepared to use coconut oil as a fuel, it would quickly stimulate the biofuel industry here. Rapid population growth produces new generations of school leavers, a steady supply of adaptable human resources to develop RE
Threats	
Fiscal	A serious threat is that of the government imposing import duties, taxes or exemptions that favour a particular group of elite, rather than the benefit to Vanuatu.
Financial	Donors (e.g. the GEF) may be so slow in coming through with expected financial support that they in effect become threats to RETs rather than opportunities to develop them. This seems likely. Slow economic growth and the need to address urgent priorities may leave little local funding for RE development Rapid increases in petroleum prices may be a threat as the government may have less funds available to support RE.

[28] The NACC prefers the wording to be, *"If the government establishes clear guidelines, institutional controls and setting up the National Energy Corporation, there may more funds available for RE through the Sarakata fund and potential donors."* This is no doubt correct but this section is reporting views as expressed to us during discussions. .

	Donors may be less willing to provide funds for SIDS' energy development if we talk about RE but do nothing to really encourage it. The anti-environment, intensely capitalistic policies of external trade partners (especially the USA, also Australia) are a threat to our sovereignty and to rational decisions about development, including RE. The policies of foreign companies (e.g. UNELCO's mother company regarding RE could stymie development in Vanuatu)
Legislative, Regulatory and Policy	Vanuatu may not develop an appropriate national energy policy or rural energy policy so public servants and others may not have appropriate guidelines for their actions The government may continue to avoid its responsibility to regulate the power sector in the public interest. Failure of the government to address Japanese concerns regarding use of the Sarakata fund could slow down RET development as other donors follow Japan's lead. (The NACCC feels that this is untrue but it reflects the perception of some people interviewed.) Imposition of new regulatory measures especially on the use of copra oil as a fuel e.g. A fee of Vt 10 per litre of copra oil produced to be paid to the Vanuatu Commodity Marketing Board (VCMB).
Institutional	Continued abuses by the political elite on licensing of companies, interpretation of regulations, favouritism, slow responses to proposal, general inertia, etc. are threats to progress of all sorts including RE. Political stability has never been high in Vanuatu. Allegiances and coalitions change rapidly so there is little reason to expect continuity in policies or their interpretation and implementation The donor community overall is a threat as it quickly changes its priorities for support so there is no momentum built for RETs The Energy Working Group of CROP tends to bicker and fight over donor funds rather than work together in the interests of the Pacific countries. Sometimes the regional organisations seem to be more of a threat to our developing RE than an asset. Loss of corporate memory due to migration (not exclusive to Vanuatu).
Technical	Donors sometimes provide experts who push a particular technology which may be OK elsewhere but not appropriate for our conditions. Wind resources may prove to be too low to economically exploit for energy in Vanuatu, or far from any demand. UNELCO has spread myths about the toxicity of coconut oil as a fuel which is both a scare tactic and threat to its wider use.
Informational and Public Awareness	There are organisations and individuals promoting unproven RETs and making extravagant claims which our decision-makers could accept as legitimate due to poor information on practical opportunities Accurate information will not get to those who make decisions
Market & Other	The business community is dominated by foreigners, most of whom are urban and have little interest in low margin rural energy systems Natural disasters are very common in Vanuatu (especially cyclones and earthquakes) and this is a serious threat foe the survival of most types of RETs Proposals for RET development, especially that seen as assisting government facilities more than the community, are often subject to disputes over long-term access to land. There is a threat of violent confrontations Globalisation (i.e. Vanuatu's increasing integration into a global economy) may be a threat as we would have less control over our own decisions (including tariff levels, taxes, competition in energy provisions, etc.) Climate change is a long-term threat, particularly for our low-lying islands. Vanuatu's geography (location and isolation, small land mass, widespread population) are barriers to rural development in general, not just RE Shipping services from outer islands are poor and could well undermine any attempts to produce coconut oil on a large scale for any length of time.

Note: RE = renewable energy and RET = renewable energy technology
Source: Interviews by mission in Vanuatu and the SWOT workshop of 5 February 2004 (Annex 4)

Annex F - Supplementary Petroleum Data for Vanuatu

The following data on petroleum product sales was received from the Vanuatu National Advisory Committee on Climate Change as the Vanuatu report was being finalised.

Petroleum Sales for Vanuatu, 1994 – 2002 (thousand litres)									
Products	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Motor Spirit	5,327	5,283	5,220	5,188	5,191	5,155	5,131	5,048	5,039
Aviation Gasoline	296	215	220	175	142	203	178	160	149
Jet Fuel	5,824	6,168	7,089	7,264	7,621	7,285	7,846	7,194	5,589
Other Kerosene	989	962	1,034	1,024	1,032	1,036	1,076	921	926
Distillate	22,577	22,941	22,814	23,050	23,416	23,570	26,335	24,991	24,864
Other	566	587	590	596	565	562	525	519	478
Total	**35,579**	**36,156**	**36,967**	**37,297**	**37,967**	**37,811**	**41,091**	**38,833**	**37,045**

As shown in the figure below, sales have been erratic during the past several years. The dashed line indicates the trend of sales from 1994 through 2002. Sales grew nearly two percent per year from 1994 – 1998 but only one percent per year from 1994 through 2002.