REGIONAL BIOMASS PROJECT

ASSESSMENT AND TRAINING

FINAL REPORT

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SOPAC

EXECUTIVE SUMMARY

There is a growing awareness that renewable energy (RE) in general and biomass energy in particular, are finally entering a new era in the 21st Century. The biomass industry is now moving from a technology-driven phase to a market-led phase with a combination of social, economic, environmental and market forces now at the core of biomass energy.

Despite the growing understanding internationally of the critical role biomass energy could play in ensuring future supplies of sustainable energy, there are still major general constraints to further the utilisation of biomass energy in Pacific Island Countries (PICs). These include:

- difficulties with data collection on biomass resources;
- institutional barriers;
- local hesitance in accepting new technologies, partly because of economic reasons and lack of local technical skills;
- lack of financial resources e.g. many biomass energy projects do not fall within the conventional investment criteria;
- lack of follow-up support, after sale services, and marketing problems;
- lack of a clear vision of the role of biomass energy by many institutions; and
- lack of maturity of many biomass energy technologies e.g. high costs of RE, low costs of fossil fuels particularly taking into account that these prices do not reflect, in the majority of cases, the environmental costs.

Biomass energy is a sector where a number of opportunities could be developed which would in turn help to improve the provision of energy services and also contribute to energy security for the PICs in particular providing an opportunity to reduce the current heavy reliance on fossil fuels.

INTRODUCTION

This report is being submitted to the Perez-Guerrero Trust Fund (PGTF) for Economic and Technical Cooperation Among Developing Countries Members of the Group of 77 as part of the reporting procedure for the Pacific Regional Biomass Assessment Project. The report is the final of a series of reports for the implementation of the above project. A financial disbursement report is attached as part of this report.

PROJECT IMPLEMENTATION

The project *Regional Biomass Assessment – Phase One: Training* and Assessment was implemented by the South Pacific Applied Geoscience Commission (SOPAC), through its Community Lifelines Programme. This project was made possible through funding received through the PGTF and the Government of the Republic of China/Taiwan. The Government of New Zealand through the SOPAC Small Energy Projects Programme provided additional funding.

There were two components to this project. The first component involved training of country nationals in biomass assessment techniques and methodologies, while the second component focused on identifying and quantifying the biomass energy resources in six Pacific Island Countries namely, Fiji, Kiribati, Samoa, Tonga, Tuvalu and Vanuatu. This involved an assessment of the current and future levels of biomass resource supply and demand in these countries, and an evaluation of the environmental, social and economic sustainability of the biomass supply.

Participating Countries

The total funds available restricted the number of participating countries to six, hence careful consideration was given to the selection of these six participating countries. Specific emphasis was given to selecting countries based on the three main island groupings of Micronesia, Polynesia and Melanesia, geographical locations, size of the islands and resource endowment. The countries that were finally selected include: Fiji, Kiribati, Samoa, Tonga, Tuvalu and Vanuatu. It was anticipated, based on the success of this initial phase, and dependent on funding availability, that the other remaining countries not able to be included should be considered in a second phase.

Activities

The following section provides a detailed account of the activities performed.

(a) Development of Training Material

The set of the biomass resource training materials were developed after consultation with the SOPAC Community Lifelines Programme and relevant stakeholders at the country level, by Imperial College, London. The consultation process took place during the first three months of the implementation period and involved a visit to all the participating countries to ascertain

critical issues pertaining to the development and utilisation of biomass energy resources in each country.

(b) Training

The training in Biomass Resources Assessment in all six participating countries was carried out during the month of May and June 2003. The Consultants from Imperial College Centre conducted the training for Energy Policy and Technology (ICCEPT), with support from Sustainable Resource Management (SRM) and staff of the SOPAC Community Lifelines Programme.

In most cases the training participants were drawn from institutions, NGO's and women's organizations, which would potentially be responsible for formulating/implementing, or facilitating thereof, projects identified during the training course. Participants' project ideas were further explored in the "Poster Presentation" sessions.

The lectures were delivered using the country studies and training manual which had previously been made available to the participants on the ICCEPT website. The salient features of these documents along with further reference material were highlighted in a comprehensive set of slides for each of the topics/subjects being addressed. The slides were supplemented by detailed lecture notes and papers which were photocopied and distributed to participants, along with a CD ROM (prepared and distributed by SOPAC) containing all the resource material presented during the course.

Field visits were also arranged to biomass project sites to evaluate the status of biomass resources available and current uses and to enable participants to discuss with the resource persons potential projects.

An evaluation of the training course by course participants revealed that the lectures were clear and easy to understand, and their content relevant to the course. The lectures were enhanced by the use of visual aids and were effective in enhancing the participants' understanding of the subjects and topics. The participants were given opportunities to ask questions and discuss issues of interest.

(c) Reports

The following reports have been produced by the consultants and are available on-line in the ICCEPT website http://www.iccept.ic.ac.uk :

(a) Individual country biomass resource assessment profiles;
(b) A synthesis report of the biomass resources in the six participating countries;
(c) A master development plan for the biomass resources in the six participating countries; and
(d) A biomass resource assessment training report.

FUNDING

The total funds provided by PGTF were Thirty-four thousand US Dollars (US$34,000.00). The consultancy fee paid to Imperial College was One Hundred and Thirty-five thousand, Four hundred Fijian Dollars (F$135,400.00 – equivalent to about US$63,000.00). Additional funds to off set the shortfall in the consultancy fee paid to the Imperial College were provided by the Government of the Republic of China/Taiwan and supplemented from the SOPAC Small Energy Projects Programme (NZAID).

CONCLUSION

For the six countries covered under this project, the consultants identified some common problems inhibiting the utilisation of biomass energy. Most notable is the difficulty associated with the collection of biomass energy data. Unlike conventional energy sources, the collection of biomass energy data often involves a multi-disciplinary approach that requires specialist knowledge. The lack of economic and technical support provided to biomass energy projects is also seen as a major barrier. The financial mechanism available for energy projects is usually biased against biomass energy projects. Similarly, the lack of follow-up support - post installation in terms of maintenance, repair, marketing and management usually contribute to the failure of the project. In the Pacific there is a tendency for energy projects to be promoted from the perspective of the technology as opposed to the demand for the energy services. This dilemma has contributed a lot to the failure of projects as the technical aspects are generally beyond the capability of the average person in the community.

The project has brought about awareness and a renewed interest in biomass as a potential energy source in PICs. Interestingly, participants were able to identify small-scale biomass energy projects that could be implemented at community level with the minimum of capital outlay. On the other hand, there have been some projects identified that would require a

certain level of government support in terms of funding, institutional support and infrastructure development to ensure their viability and sustainability.

Building on the biomass resource assessment project, SOPAC, in collaboration with Imperial College, has prepared a funding proposal for a second phase. Primarily, the second phase will look at the establishment of a regional taskforce and country-based biomass energy task forces to promote the use of biomass energy in the region. SOPAC is also seeking resources to carry out training in biomass resource assessment in other PICs that did not participate in the first phase of the project.

Attachments (available from the SOPAC Secretariat on request)

1. General Overview of the Training Course
2. Synthesis Report – The Biomass Resources of, Kiribati, Fiji, Samoa, Tonga, Tuvalu and Vanuatu
3. Financial Disbursement Report

Attachment 1

SOPAC/ICCEPT Pacific Islands Biomass Energy Resource Assessment Training Course

General Overview
Including:

What will be covered by the course
A general introduction to biomass as an energy source

Dr. Sarah L. Hemstock (sarah.hemstock@ntlworld.com)

Purpose of the Course

This course is part of an overall programme designed to facilitate the development of island states' biomass resources in order to sustainably provide the populations needs for food and modern energy services. The programme includes:

- The delivery of training materials and manual (relating to biomass: definitions

& assessment methodology; consumption; supply)
- In country training & in country assessment
- Deliver a “Master Development Plan”
- Deliver country reports and a regional synthesis report

Course Overview

What will be covered in the course?

- A general introduction to biomass energy – impact & issues, climate change, sources, role in development, global perspectives.
- Biomass fuel production chains.
- Resources – energy crops, residues & wastes - Country breakdowns
- Methodologies for measuring biomass resources
- Project implementation
- Policy Environment
- Case Studies – coconut oil, forestry residues, waste treatment & management, and sugar cane
- Poster Presentations

Course Breakdown

This course should provide you with specific background knowledge of the following:

- Biomass Assessment Methodology
- Biomass resources in the SOPAC region (country specific)

Brainstorm Background Concepts:

- What is energy?
- What makes a “good” source of energy?

- What is a “renewable” energy?
- What is energy efficiency?
- What does the term “sustainable development” mean? What are the main constraints?

Some basic background info

- Energy is the capacity to do work and the SI unit for energy is the *joule*.
- "Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs." – United Nations World Commission on Environment and

Development

- The “Rational Use Of Energy” is the term used to describe the efficient & environmentally sustainable use of energy sources.

Some basic background info

… but what is BIOMASS?

- **Biomass is all plant and animal matter that has not been fossilised. Harvesting biomass such as crops, trees or dung and using it to generate energy, that is - heat, electricity or motion, is bioenergy/biomass energy.**
- **renewable organic material that can produce energy**
- **fuelwood and forestry residues**

- agricultural by-products and wastes
- municipal and commercial waste
- new energy crops

Brainstorm:

What are the uses of biomass ?

Multiple Uses of Biomass: Six ‘F’s

- Food
- Fuel (can be converted into…)
- Feed (Fodder)
- Feedstock
- Fibre
- Fertilizer

- Biomass products are also frequently a source of a seventh "F" - **Finance**.
- There is also **C**onstruction material – but that doesn't begin with F!!!

Historical Role of Biomass Energy

- **Biomass was the first fuel that mankind learned to use for energy; burning wood for warmth and cooking.**
- **Before the First World War about 40% of the UK's agricultural land was devoted to bioenergy; fuel crop production, mainly grass and oats to feed the horses that then still drove much of the economy.**
- **Today, world-wide bioenergy, much of it still as traditional woodfuel, is by far the most important source of non-fossil fuel energy, meeting around 13% of primary energy demand.**
- **Modern bioenergy is clean, efficient and sustainable. Austria now uses bioenergy for 13% of all its energy needs and the United States generates 3% of its electricity from bioenergy. Bioenergy is the World's most**

important renewable energy and is quietly getting more important all the time.

Current Role of Biomass Energy

- **main source of energy in many developing nations, particularly in its traditional forms, providing on average 35% of the energy to three-quarters of the world's population.**
- **rises to between 60 to 90% in most Sub-Saharan African countries**
- **modern applications are increasing rapidly both in the industrial and developing countries, representing 20-25% of total biomass energy use**
- **NOT a transition fuel as often portrayed, but a fuel that will continue to be the prime source of energy for many people for the foreseeable future***

SLH Notes: Biomass Energy –so what!

Why do we need it?

- Global energy supply is continually evolving in response to the changing needs of industry and consumers. The pace of change is accelerating as energy markets open to competition and new technologies challenge energy supply conventions.
- Countries are just beginning to address the overriding reality of the need to exploit more sustainable and politically secure energy resources.
- The supply of fossil fuels is shifting geographically as existing sources are depleted and new, more economic resources are opened up. This change is most evident in Europe and the United States where dependence on imported energy will grow rapidly in the next decade.
- The politics of environmental protection, especially with regard to Climate Change is forcing Governments to initiate programmes to reduce carbon emissions, improve energy efficiency and exploit less carbon intensive energy sources.
- Bioenergy is at the centre of these changes as the only renewable carbon fuel with the potential to address the full range of energy markets including heat, electricity and transport.
- The renewable energy strategies of both Europe and the United States expect the bioenergy sector to be pre-eminent in the global market for secure, indigenous and renewable energy supplies in the next century and to play a vital role in underpinning the overall transition to sustainable energy.

Biomass Energy –so what! Why do we need it?

- **Changing global energy supply.**
- **Exploitation of more sustainable and politically secure energy resources.**

- **Fossil fuels supply is shifting geographically.**
- **The politics of environmental protection.**
- **It's the only renewable carbon fuel.**

Conclusion:

- **Bioenergy will top the global energy market in the future**

...and how is BIOMASS used to produce useful energy?

(many different conversion technologies and end- products)

Biomass conversion & end use can be easily integrated with existing infrastructure

- Heat
- Light
- Electricity
- "Synthesis Gas"
- Hydrogen
- Ethanol
- Bio-diesel
- Other Chemicals

Combustion
Gasification
Bi-processing

- **Bioenergy - the renewable cycle**

- **Liquid fuels from biomass**
  - **ETHANOL - from fermentation/distillation of sugar/starch crops. Now a 7.5 billion litre industry in USA; developing country producers include Brazil, Zimbabwe, Malawi, Kenya. Blended with petrol (gasoline) from 5% to 100% substitution.**
  - **BIODIESEL - simple esterification process to upgrade different vegetable oils to superior diesel fuel (5% to 100% substitution). Major producers include France, Germany, USA, Malaysia. Small-scale production is possible.**

Barriers to implementation

- Matching supply and demand
- Developing new markets

- Overcoming limited public awareness
- Financial

Attachment 2

SYNTHESIS REPORT FOR THE ISLAND NATIONS OF:

FIJI
KIRIBATI
SAMOA
TONGA
TUVALU
VANUATU

TENDER FOR CONSULTANCY TO:

SOPAC- South Pacific Applied Geoscience Commission.

BIOMASS RESOURCE ASSESSMENT, UNTILISATION AND MANAGEMENT FOR SIX PACIFIC ISLAND COUNTRIES

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SYNTHESIS REPORT FOR SOPAC ISLAND COUNTRIES:

FIJI, KIRIBATI, SAMOA, TONGA, TUVULU, AND VANUATU ISLANDS

1. General Introduction

This report synthesizes the most common and relevant features of the Six SOPAC Island Countries as a whole, and individually, with specific reference to the biomass resource base. Further details can be found in Individual Country Reports (Country.Profiles.doc); the Biomass Resource Handbook, Teaching Course Manual and Case Studies.

This report summarises the following main features: i) general background data, ii) forestry, iii) agriculture, iv) energy with emphasis on biomass; v) energy policy; vi) brief summary of country-specific issues (forestry, agriculture, energy, and challenges).

The Pacific Islands Countries (PICs) given their geographical and physical characteristics (e.g. small catchments, steep and short stream, intensity of tropical storms, frequency of cyclones, etc) make these islands highly vulnerable to a range of environmental impacts at rates and intensities above those found elsewhere in the world. These include geographic isolation, ecological uniqueness and fragility, rapid human population growth, limited land resources, high dependency on marine resources, exposure to extremely damaging natural disasters, low economic diversification, exposure to external and global changes in climate, trade and markets; all of which contribute to increasing environmental vulnerability. Table 1 summarises the major environmental challenges facing SOPAC Country Islands.

1.1 Biomass energy resources. There is a growing awareness that renewable energy (RE) in general and biomass energy in particular, are finally entering a new era in the 21st Century. A new direction is emerging in which greater attention is being paid to quality and the maximisation of benefits to the most needed e.g. the rural and urban poor. Commercialisation is accepted as the most viable approach to the widespread application of RE technologies. The biomass industry is now moving from a technology-driven phase to a market-led phase. Market forces are now at

the core of biomass energy as this is currently considered to be the best guaranteed of success.

Table 1: Summary of the major environmental challenges

Category	Main challenges/difficulties
Land	- Rapid population growth - Land and soil degradation - Land titles problems - Shortages of land - Land contamination (e.g. from mining, chemical, waste)
Forests	- Increase deforestation (e.g. for agriculture and firewood, commercial logging) - Lack of clear forestry policy, or lack of enforcement - Poor human and financial resources - Fire hazards - Natural disasters (e.g. cyclones, droughts)
Biodiversity	- Extensive coral reefs and high marine diversity - Fragile ecosystems - Endemic species - Loss of diversity caused by human and natural conditions
Fresh water	- Water shortages - Shortages and salty ground water - Limited surface water and high losses (e.g. tropical rainfall) - Pollution (e.g. poor sanitation)
Coastal	- Many low-lying land areas - Pollution (e.g. waste disposal, sewage, sediments from mining, deforestation, etc) - Lost of habitats - Natural disasters (e.g. coastal erosion, cyclones, etc)
Climatic	- Large potential effect from climate warming (e.g. low-level land areas which could be flooded) - High exposure climatic variations (e.g. storms, floods, winds, landslides, droughts)
Cross-cutting issues	- Global warming issues - Sea-level rise - Rapid population growth, particularly urban - Loss of traditional systems, high expectations among young - Class system (e.g. land tenure systems)

(Source: Various SOPAC sources)

Technological advances and increase capital flows from industrial to developing nations has allowed for a substantial increase in modern uses of biomass in many countries leading to a better use of these resources. Appropriate methods and

technologies to harness biomass resources efficiently should continue to be a high priority

There are still various major general constrains to further the utilisation of biomass energy, including:

- difficulty with data collection on biomass resources. Unlike conventional energy sources, the collection of biomass data often involves complex multidisciplinary approach that requires specialist knowledge
- institutional barriers
- local hesitance in accepting new technologies, partly because of economic reasons and lack of local technical skills
- lack of financial resources e.g. many of biomass energy projects do not fall within the conventional investment criteria
- lack of follow-up support, after sale services, and marketing problems
- lack of a clear vision of the role of biomass energy by many institutions
- lack of maturity of many biomass energy technologies e.g. high costs of RE, low costs of fossil fuels particularly taking into account that these prices do not reflect, in the majority of cases, the environmental costs

These general trends are also common to the SOPAC Island Countries, although with some specific characteristics. Generally, SOPAC countries support RE e.g. there is a target to achieve 15% of the primary energy supply by 2010; and some individual countries e.g. Vanuatu is aiming at 100% renewable energy economy by 2020. However, and although there are regional policies to support these targets, at national level (most individual countries) still do not include such target in their National Energy Policies and work Programmes.

Although there are a number of regional RE initiatives currently being planned, ready to commence or being implemented, little attention has been given to substantive long term regional projects. Most activity has been based on business as usual scenario due to a general reluctance to change patterns of consumption and production (SOPAC, 2002a).

There are a number of common features to all SOPAC Country Islands covered in this study including:

- Problems posed by isolated and dispersed population centres
- Problems posed by, often, very small markets without significant economics of scale

- 70% of the regional population is without access to electricity, ranging from 10% to 100% at the national level
- The existence of a wide range of ecosystems, predominantly influenced by marine systems, that make infrastructure development difficult and environmental impacts significant
- Most of SOPAC countries do not have indigenous petroleum resources and only a minority have hydropower potential, and thus are highly vulnerable to energy supply disruptions
- Effects on ecosystems posed by environmental damage, habitat loss, and pollution posed by use of fossil fuels are high
- Poor use of RE due to lack of appropriate technology, poor institutional mechanisms, and problems posed by small and dispersed markets
- Limited scope for market reforms caused by the variation, size and density of markets
- Limited human resource capability to respond to these challenges
- Lack of technical expertise and weak institutional structure to plan, manage and maintain RE programmes
- The absence of clear policies and plans to guide RE development
- Lack of successful demonstration projects
- Lack of understanding of the RE resource potential
- Lack of confidence on the technology on the part of policy makers and the general public
- Lack of local financial commitment and support to RE due largely to economic constraints
- Continue reliance on aid-funded projects.
- Energy efficiency has not been a policy priority in most SOPAC countries and as a result there still many opportunities for energy savings in most economic activities which are often ignored
- The role of women who play a central role in energy use has largely been ignored. Women are at the centre of energy and must play a full part in energy policy.

2. BASIC DATA

The following tables show the most important basic data related to the SOPAC member countries covered in this assessment. A brief description for each individual country is also included. For more details see Country.Profiles.doc. A detailed analysis of the basic data is beyond the scope of this project, and therefore the reader is advised to consult other sources for further details [e.g. SOPAC (2002) FAO database]. There are some discrepancies in data due to differing methods, sources, etc, which we have not tried to reconcile.

Table 2 shows the latest data on population in the six SOPAC country islands under consideration. As can be seen, there are considerable differences no only on population size, but also on population density, ranging from as low as 16 inhabitants in Vanuatu to as high as 388 in Tuvalu. Obviously, these differences in population will have different effects on resource production and utilization.

Table 2: Population, density and land area in the SOPAC countries

Country	Year	Last Census	Census Mid-2002	Land area (Km^2)	Population density 2002 (km^2)
Fiji	1996	775 077	823 300	18 333	45
Kiribati	2000	84 494	86 900	811	107
Samoa	2001	174 140	175 000	2 935	60
Tonga	1996	97 784	101 100	649	156
Tuvalu	1991	9 043	10 100	26	388
Vanuatu	1999	186 675	199 600	12 190	16

Source: www.spc.org.nc/

Table 3 is a brief summary of the most important economic features of these countries. One of the main features is that, except for Kiribati, the rest of the countries have a similar living standard. Agriculture plays a diminishing role, but still a key one, particularly in rural areas, while services are becoming an increasingly important economic activity in all islands; it is rather surprising the high contribution of services in those islands.

Table 3: Economic overview of the six SOPAC countries

Country/Territory	Year	GDP (10x6 $)	GDP per capita $	Agriculture (%)	Industry (%)	Services (%)
Fiji	2000	1,605	1,972	16	30	54
Kiribati	2000	42	466	14	7	79
Samoa	2000	237	1,400	15	24	61
Tonga	2000	143	1,425	32	10	58
Tuvalu	1998	138	1,385	n/a	n/a	n/a
Vanuatu	1999	266	1,212	20	9	71

Notes: Dollars are all US; n/a = not available
Source: SOPAC (2002)

Table 4 shows oil market in 2002, which remains no only a major drain on foreign exchange resources in all these islands, but also very vulnerable to supply disruptions. This is despite considerable efforts of the past decade to reduce oil import dependency.

Table 4: Oil markets in the six country islands in 2002
(FOB at US$28/bbl)

Island	Kilolitres	US$ (10x3)
Fiji	454,257	79,995
Kiribati	12,583	2,216
Samoa	53,764	9,468
Tonga	40,128	7,066
Tuvalu	2,790	491
Vanuatu	29,369	5,172

Source: Pacific Islands Forum Secretariat (Petroleum Advisory Service)

3. FORSTRY RESOURCES

Forestry plays a multi purpose role around the world, ranging from ecological, social, environmental, to biological benefits. As many parts of the world, forests are under threat in many of the SOPAC countries, under pressure from population growth, agricultural practices, etc. Deforestation has been a particularly serious concern around the world. Fortunately, in the past decade the rate of deforestation has slow down and even in the some industrial countries, forest cover has actually increased. The forces that have been shaping deforestation are subsistence agriculture (e.g. need for new cultivable land), fuelwood collection, grazing, commercial agriculture, logging, population growth, etc; this is also a common feature in the SOPAC countries. Thus, it is important to have a better understanding of the role of the forests, and their impacts on all these factors so that a proper policy-making system is put in place (Marcoux, 2000).

Forests are major resources in most of the SOPAC countries covered by this study. Forest cover has declined in the past decade, but in relatively small scale, since most countries have introduced specific policies to protect native forests with differing degree of success. In addition most of these countries have an active policy support

for reforestation and plantations. In some countries (e.g. Tonga) forests have largely been depleted, due to logging, commercial and agriculture activities, and fuelwood consumption.

However, it should be born in mind that there are serious difficulties with estimating forest canopy cover and plantations because methodological differences, survival rate, etc. Table 5 shows forest indices cover from 1990-1995, which indicates that in the early 1990s the rate of deforestation was lower in these SOPAC countries than many others around the world. It should be noted that the plantation area differs from that presented in Table 6 for the year 2000, mainly due to changes during the past decade, and to methodological differences.

Table 5: Forest cover indices (1990-1995) in the six SOPAC countries

Country	Total forest 1990 (10x3 ha)	Total forest 1995 (10x3 ha)	Annual change rate (percent)
Fiji	843	835	-0.4
Kiribati	0	0	0
Samoa	144	136	-1.1
Tonga	0	0	0
Tuvalu			-.0.8
Vanuatu	938	900	
Total Forest area	**1,925**	**1,871**	**Average -.0.76**

Source: FAO (www.fao.org/sd/wpdirect/WPan0050.htm)

The available forestry data is still poor, particularly with regard to total volume of biomass, due partly to lack of data on MAI (mean annual increment), total standing biomass, plantation density, thinning and pruning practices, etc.

Table 6: Total forest cover in the SOPAC countries, 2000.

Country	Land area	Total forest area 2000		
		Area	% land area	Area per capita
	10x3 ha	10x3 ha	Percentage	ha
Fiji	1,827	815	44.5	0.2
Kiribati	73	28	38.4	0.3
Samoa	282	105	37.2	0.6
Tonga	73	4	5.5	n.s
Tuvalu	n/a	n/a	n/a	n/a
Vanuatu				
	2,255	952		

n/s= not significant
Source: FAO, Global Forestry Tables 2002, (appendix 3).

Table 7 summarizes plantations by main species only. The differences with individual countries data stem from the fact that other minor species are also included, methodological differences, etc.

Table 7: Forest plantations in the SOPAC countries in 2000 (main species only)

Country	Total plantation area	Annual rate of plantation	Plantation area by species group		
			Broad-leaved	Pinus	Unspecified
	10x3 ha	10x3 ha	10x3 ha	10x3 ha	10x3 ha
Fiji	97	9	47	43	7
Kiribati					
Samoa	5	1	4		
Tonga	1		0.2	0.3	
Tuvalu					
Vanuatu	3	0.2			3
	106	10.2	51.2	43.3	10

Source: FAO: Global Forestry Tables 2002 (appendix 3)

4. AGRICULTURE

Despite its diminishing role, agriculture still plays a key role in social and economic development in these SOPAC countries. For example, in Fiji about 30% of GDP and 70% of exports are attributed to agriculture and related activities, despite the difficulties facing the sugarcane industry, historically a major crop in Fiji. In Kiribati, the agricultural sector employs over 70% of the labour force, primarily in coconut and banana production, the backbone of the economy. In Samoa, the primary sectors are agriculture, forestry and fisheries. In the Tonga Islands, agricultural activities are more limited, and mostly confined to coconut production, but agriculture still represents over a quarter of the economy activities. Tuvalu, given the size and poor quality of soils, is the only country where agricultural activities are severely limited. Finally, in Vanuatu around 80 percent of the population still lives in rural villages, where subsistence agriculture, based around shifting cultivation, is the principal means of livelihood for the majority of the population.

However, in recent years agriculture has undergo an important transformation in most these islands. Traditional Pacific island agricultural systems were highly sustainable. For example, in Vanuatu, steep lands of Pentecoast and Ambae are cultivated for a variety of crops, including commercial kava plantations. These gardens have not

contributed significantly to soil erosion and degradation because of their discontinuous nature amid natural vegetation, minimum tillage practices, and small size. Crops are grown without chemicals and farmers observe long fallow periods. Forest areas were traditionally an integral part of the food security system of the village and provided protection against cyclones and drought. In Tonga, shifting cultivation techniques with mixed cropping under the canopy of up to 100 associated tree species, allowed regeneration of soils, reduced pest problems, and prevented erosion for more than 3000 years. (www.unescap.org/mced2000/pacific/background/agriculture.html)

Modern commercial agriculture has changed the nature of the old system; it is more pervasive and environmentally destructive human activity. Its primary impacts are; (i) the direct removal of existing ecosystems; (ii) the reduction of biodiversity; (iii) destruction of soils; (iv) pollution of the surface and ground waters with agricultural chemicals; (v) pollution of wetlands and the marine environment with silt and agricultural chemicals; (vi) a major contributor to global warming through the loss of trees and generation of methane; and (vii) a contributor to landlessness. Thus, modern agricultural practices are increasingly causing permanent deforestation, removal of wetlands, and other unique habitats in the Pacific islands.

Sustainable traditional farming systems diminished as farmers entered the cash cropping system. Small productive mixed crop gardens with abundant trees were either burned or bulldozed to create large, treeless clearings. Tractors tilled the soil, chemical fertilisers and poisons were applied with subsidised abandon, fallow times were shortened, sometimes replaced with crop rotation, and mixed crop gardens were replaced with monoculture.

In Fiji, widespread burning to clear land or remove sugar cane debris, continues to be a disaster for wildlife, and contributes to soil loss by altering soil characteristics making it more prone to erosion. In Fiji, clear felling of forests for kava plantations reduced the forest habitat needed for yam and other wild foods that formerly were important staples during emergencies.

On smaller islands, burning in combination with goat grazing, has devastated terrestrial ecosystems. Steep slope farming on the high islands has resulted in

extremely serious soil erosion, making these areas more vulnerable to the impact of cyclones and drought. In Samoa, prior to the taro blight, 2,400 ha of forest were being cleared a year for planting commercial fields of taro on steep slopes (www.unescap.org/mced2000/pacific/background/agriculture.html).

5. ENERGY

It is a bit striking that despite many efforts to use indigenous resources, and to decrease dependency on imported oil, the economies of these islands are still, on the main, overwhelmingly dependent on petroleum products. Table 8 illustrates energy consumption, water and sanitation. As can be appreciated, biomass energy is present in all countries, though in varying degrees. Biomass still plays a major role in these islands; hydro is particularly important in Fiji and Tonga. The population connected to the grid, at national level varies from as 85% in Tonga to 25% in Vanuatu.

Table 8: Access to utilities in the Six SOPAC countries under consideration

Country/ Territory	Energy			Water & sanitation	
	Commercial energy consumption (MJ\capita 1998)	Population connected to grid (% pop 1998)	Energy source (H, B, S, W, V, G)	Population with access to sanitation (% of Pop. 1995)	Population with access to safe water (% pop 1995)
Fiji	14 805	60	H, B,W,V, G	85	77
Kiribati	3 960	40	B, S,W	46	76
Samoa	12 015	60	B,H,SW,G	97	90
Tonga	18 000	85	B,S,W,V	85	95
Tuvalu	n/a	30	B,S,W	49	85
Vanuatu	5 040	25	B,S,H,W,G	91	87

Notes: H= Hydro; B= Biomass; S= Solar; W= Wind; V= Wave; G= Geothermal

Source: SOPAC (2002)

It is remarkable that despite the enormous efforts of the past or so decades to develop indigenous energy resources, oil remain the single most important energy source in these islands. This is despite the fact that many of these islands are endowed with a reasonable amount of natural resources, which combined with long distances, should have facilitated the establishment of a renewable energy industry.

The smallness and remoteness of these markets should have favoured more the introduction of RE. Yet, despite some successes, generally speaking, RE has failed to live up expectations. As a result, a rethinking on RE is emerging on how best to put these national resources to better energy use.

There is not any question that SOPAC member countries and in particular the six islands covered in this study, face serious energy problems if steps are not taken to enhance energy supply sources. There is considerable concern on oil dependency, energy security, and environmental problems posed by the use of fossil fuels, and inability to make better use of existing domestic RE potential. Although RE energy would not be the panacea for solving the energy problem, it could certainly play a much bigger role.

Various initiatives are already underway to support RE projects e.g. the Pacific Islands Renewable Energy Project (PIREP)[1], and is expected to provide a detailed RE sector assessment in each of the 14 PICs. There is also another initiative to set up a "Centre of Excellence" on energy, for training, information and dissemination.

It is important to recognise that the solution to the energy problem passes though a combination of factors, ranging from better use of indigenous resources (particularly biomass), combined with other RE technologies, energy efficiency, energy diversification, etc.

For example, World Bank (1992) recommended a less government interference in the energy sector, particularly utilities, and to focus in indigenous energy resources that hold the greatest promise for technical, economic, and financial viability under the Pacific Islands conditions e.g. PV, mi-hydro, and biomass waste for agro-industrial applications

[1] PIREP is a US$811,000 project funded by UNEP/GEF. See Pacific Energy News (PEN), Nov/01-February/2002.

5.1 Biomass and other renewable energy sources

A wide range of demonstration and investment projects, using a variety of technologies, have been carried out in the past tow or so decades, with disappointing results in most cases. Such projects rated from large to small hydro, biomass-based steam generation, alcohol fuels, wood and charcoal stoves, PV, etc.

These technological options have largely failed to develop into viable alternatives to fossil fuels, due mainly to lack of technical, economic, financial and institutional difficulties; geographical difficulties, as inappropriateness of many projects, lack of training, support and commitment; lack of local participation and lack of awareness of the general public of the potential benefits of RE, etc. The most successful so far have been PV, and the use of biomass waste in agro-industries.

As a result, these countries continue to be highly dependent on imported oil, while existing power utilities continue to operate inefficiently. Power utilities have been, in the main, run by ineffective government management resulting in considerable inefficiencies and poor performance. In the late 1990s, there was a policy shit toward privatization in many SOPAC countries, in recognition of such inefficiencies and as an attempt to address them.

The SOPAC countries vary widely in terms of endowment of natural resources and energy patterns, but share a heavy dependence on imported oil and relatively low energy consumption patterns. Despite the significant efforts of the past decade, indigenous energy resources are still poorly known.

Thus, if all these projects have largely failed in the past, what will ensure indigenous RE play a much greater role in energy supply in these countries in the future? Undoubtedly, we need to see these resources in the light of the current know how, past mistakes, technological advances, greater local participation, greater local awareness, climate change, and so forth.

Fuelwood and coconut residues have traditionally been, and continue to be, the most widely used biomass resource in these SOPAC countries. In many countries fuelwood

is the main source of energy in the domestic sector, representing over 50% of primary energy consumption, as shown in Table 9. Woodfuel is primarily used for cooking, and in smaller amounts in some cottage industries e.g. crop drying, coffee, cocoa, and rubber processing; and in sugarcane mills.

Table 9: Summary of biomass supply and demand

Country/ Territory	Biomass demand (Mtoe)		Percentage gross energy demand		Estimated total biomass available (10x3 toe)	
	1990	2002	1990	2002	1990	2002
Fiji	0.533		55.9			
Kiribati	0.015		59.6			
Samoa	0.063		59.5		112.3	
Tonga	0.027		53.2		40.5	
Tuvalu	0.002		53.1			
Vanuatu	0.043		61.6			

Sources: for 1990 figures see World Bank (1992) (Uncompleted)

Jafar (2000) states that of all biomass energy in the Pacific Islands, fuelwood accounts for 67%, coconut residues 18%, and 15% bagasse and other residues. Households are the main consumers with about 60%, industry with 39%, and commerce with 1%. Deforestation for fuelwood is not yet a very serious issues since a large proportion is obtained from agro-forestry residues and plantations e.g. coconut. However, in some peri-urban areas (e.g. Tonga), the clearing of nearby forests, although primarily for agricultural uses, fuelwood has also played a role in increasing pressure on natural resources. Various initiatives have been undertaking to alleviate the problem, including:

- Tree planting
- Dissemination of more efficient cook stoves
- Greater use of coconut residues, kerosene, LPG, etc
- Increase the radius of collection from nearby natural forests

The first two seem to have failed for a variety of reasons, but mainly because as most families obtain their fuelwood free, there were little incentives to invest in energy saving stoves. Charcoal was also tried in a limited scale in Fiji but failed chiefly because charcoal could not be supplied on a regular basis.

Various other initiatives were undertaken to use biomass for power generation with mixed results. For example, attempts to combine timber/forest residues with coconut plantations have proved unfeasible. However, direct combustion of biomass residues (e.g. sugarcane bagasse and sawmills) have been more successful where there has been adequate commercial incentives and technical skills to support it. Thus, it seems clear that to succeed RE must fulfil specific criteria in these country islands which seems difficult to achieve.

Despite the fact that biomass resources are large in some countries, only a small fraction is economically accessible. However, due to population pressure combined with high costs of oil imports, it seems the demand for fuelwood could increase in the future which can cause resource depletion if proper policies are not put in place to protect native forest. For example, better utilization of resources (i.e. more efficient stoves and greater use of under utilized residues). What seems quite certain is that fuelwood will become more difficult to obtain and may become ultimately a trading commodity.

A number of proposals have been put forward to develop social forestry specifically for fuelwood (i.e. in Fiji and Vanuatu), and commodity reforestation in most of the countries. But this concept never took off mainly because generally fuelwood continue to be freely available. For example, many households have coconut and other plantations to provide them with most of the fuelwood needs and thus the market is small and financially unattractive to farmers. Initiatives to promote tree planting as a means of preventing or slowing done deforestation, may not be effective either so far as fuelwood supply is concerned, although it makes good ecological and environmental sense.

There are other factors that need to be addressed if biomass energy is to be a significant source of energy in the future, particularly in its modern forms. Firstly, it must be a clear policy commitment in favour of RE, and secondly land tenure would have to be addressed. Customary land tenure remains potentially a major obstacle with the development of indigenous energy resources; although this is unlikely to change in the near future.

Industrial consumption of biomass is primarily for copra, coffee, tea and rubber drying. SOPAC countries produce large amounts of residues from these crops and industry, which currently are underutilised. Table 10 briefly summarizes the residues potential from the main crops. It should be stated that these figures are quite conservative.

Table 10: Potentially harvestable residues in SOPAC countries (main crops only)

Country	**Harvestable crop residues (10x6 GJ**	**Harvestable forest residues (10x6 GJ)**	**Total harvestable residues (10x6 GJ)**
Fiji	18.39	3	23
Kiribati	0.03	0	0.03
Samoa	0.13	1	1.13
Tonga	0.21	0	0.21
Tuvalu	0	0	0
Vanuatu	0.07	1	1.07

Source: Wood & Hall (1994) (See source for residues calculations).

In the 1980s and early 1990s there was considerable interest in using biomass in these industries and various initiatives were taken to improve these industrial applications. For example, over 80 gasifiers were reported installed at industrial and commercial establishment in the SOPAC countries. In almost all cases the costs of those gasifiers were borne by the establishment using them (World Bank, 1992).

Although many of these gasifiers failed to live to expectations, many lessons have been learnt; given the right conditions there is considerable potential for increasing industrial and commercial applications of biomass in the cottage industries. For example, with some technical improvements in heat gasifiers (i.e. varying fuel quality and more fluctuations in operational loads), there are significant opportunities in the copra, palm oil, and rubber industries. Biodiesel production from coconut is particularly promising and could represent a major economic opportunity for many coconut producers e.g. yield ranging from about 380 to over 5800 litres/ha has been reported (See Appendices).

5. 4 ENERGY POLICY

This section deals mainly with renewable energy, primarily with biomass energy sources. It is recommended that the reader consults other sources for further details on energy policy, and in particular the Committee of Regional Organisations of the Pacific (CROP), and specifically the so-called Raratonga Declaration of August 2002[2]. The Raratonga Declaration identified the following major challenges and concerns with regards to energy for sustainable development:

- Problems posed by isolated and dispersed population centres
- Problems posed by, often, very small markets without significant economics of scale
- 70% of the regional population is without access to electricity, ranging from 10% to 100% at the national level
- The existence of a wide range of ecosystems, predominantly influenced by marine systems, that make infrastructure development difficult and environmental impacts significant
- Most of SOPAC countries do not have indigenous petroleum resources and only a minority have hydropower potential.

These concerns have motivated the Raratonga Declaration, which has identified the following:

- The high environmental vulnerability posed by climate change, particularly for small islands and atolls
- Effects on ecosystems posed by environmental damage, habitat loss, and pollution posed by use of fossil fuels
- Vulnerability to energy supply
- Poor use of RE due to lack of appropriate technology, poor institutional mechanisms, and problems posed by small and dispersed markets
- Limited scope for market reforms caused by the variation, size and density of markets
- Limited human resource capability to respond to these challenges
- Poor representation of women in energy policy decision-making, despite the fact that women are major users of energy.

The key issues with regard to RE identified in the Raratonga Declaration (Anon, 2002), include:

- Lack of technical expertise and weak institutional structure to plan, manage and maintain RE programmes
- The absence of clear policies and plans to guide RE development

[2] The document Pacific Energy Policy (Anon 2002) presents a regional consensus on energy policy for the SOPAC member countries.

- Lack of successful demonstration projects
- Lack of understanding of the RE resource potential
- Lack of confidence on the technology on the part of policy makers and the general public
- Lack of local financial commitment and support to RE
- Continue reliance on aid-funded projects.

The role for RE is:

"An increase share of RE in the region's primary energy supply. To this end, it has recently been agreed that RE should supply 15% of the primary energy by 2010[3], which represents a major milestone in the cooperation among SOPAC member countries in support of RE".

The Rarotonga Declaration proposed the following specific policies in support of RE:

- Promote the increased use of proven RE technologies based on a programmatic approach
- Promote the effective management of both grid-connected and stand-alone RE-based power systems
- Promote a level playing field approach for the application of renewable and conventional energy sources and technologies
- Promote partnerships between the private and public sectors and mobilise external financing to develop RE initiatives

To take advantage of the RE potential, the governments must:

- Tackle the lack of human resources to deal with RE
- Put in place clear energy policies with regard to RE, with clear responsibilities
- Provide better coordination and give much higher priority to RE,
- Initiate a campaign on information aimed at the general public about the potential and benefits of RE in the SOPAC countries.

6. Country-specific issues (Further details in Country.Profiles.doc)

In this section we present a brief summary of the most relevant issues for each of the six countries covered in this study. These are discussed in greater detail in each specific country profile.

[3] This was agreed at the joint meeting of the Governing Council and its Technical Advisory Group at its 31st Annual Session of SOPAC, hosted in Suva, Nauru, on 27th September o 2nd October 2002.

6.1 Fiji islands

The most important relevant natural resources in Fiji include the following.

Forestry. Forestry and related activities are major revenue earners for the Fiji Islands, and will remain so in the future. The country has more than 50% forest cover with almost 1Mha, including all types but many forests are in mountainous areas, and hence this is an important economic limitation. The key issues in the forestry sector are:

- need greater political support for sustainable forest management practices
- need to successfully market its increasing plantation resources while maximising local benefits through domestic processing
- strengthen its efforts in forest conservation and work with landowners to ensure a satisfactory proportion of forests are adequately protected
- better utilization of residues e.g. for energy uses
- Major constraints facing the sector include:
    - lack of proper infrastructure, inadequate skilled personnel, poor timber utilization, and the inability to sustain quality and quantity for domestic and export markets.

In recognition of these problems, the government allocated in the 2002 budget about US$1.5 million for the construction of a Timber Industry Training Institute and a Forestry Training Centre.

Agriculture. Within the agricultural sector in Fiji, the most promising crop residues are sugarcane bagasse (plus tops and leaves) and coconut, although there other crops that could hold some promise in the future. Sugarcane residues remain in the sort term the most promising alternative for use in cogeneration, despite the current difficulties of the sugar industry, which is currently being promoted in the country.

A major constraint to sustainable land use in Fiji is the conflict between landowners and tenants. Tenants farm under uncertainty with a very short-term perspective and show little interest in sustainable land-use practices. Furthermore, the legislation is no properly enforced so the tenant is not compelled to practice good husbandry and soil degradation continues.

Energy. With light industries and tourism acting as the main engines of economic growth, the energy requirements of Fiji have been growing rapidly. Currently 80% of the power requirements are met from the 80 MW hydroelectricity project at Monasavu on the main island. The rest of energy requirements are met from oil imports. Fiji needs to diversify its energy supply sources, particularly to take greater advantage of its domestic energy resources such as biomass, wind, etc. The main features are:

- High energy dependency on imported oil
- Poor utilisation of local resources
- Serious land tenure problems e.g. in the sugarcane industry. This could effects particularly cogeneration and other possible alternatives (i.e. ethanol fuel)
- Non-conventional sources of energy are being popularised in Fiji in response to energy constraints
- Various projects have been undertaken to assess the potential of indigenous energy resources and to develop a regulatory framework. A notable example is the Fiji Sugar Corporation that uses the bagasse for most of its energy requirements. Another major power generation facility has been proposed for the Ba area that would use the excess bagasse from the Rarawai sugar factory and hogfuel (a "waste" product of the timber industry), to supplement the grid. These alternatives will be jeopardised if the problems facing the sugarcane industry are not solved.

6.2. Kiribati islands

Kiribati has few natural resources, being a small country comprising over 30 scattered coral atolls over a very large area. Forestry and agriculture resources are very limited (i.e. there are about 2000 ha of forest, plus 185 ha of mangroves).

Agriculture still represents 70% of the labour force; the only crop with some promising potential for energy is coconut plantations, which currently cover 47% of land use in Kiribati. The production of biodiesel is particularly promising. Currently Kiribati is a net importer of energy, mostly oil.

The key factors in Kiribati, with regard to possible use of national resources for energy are:

Forestry

- Potential impacts from global warming which could inundate much of the country's land area
- Population pressure, particularly on South Tarawa, which is creating major problems for sustainable development
- Land degradation through harvesting for fuelwood, building material, etc

- Habitat pollution through dumping of rubbish
- Need to develop a long term agroforestry plan

Agriculture

- Soil is among the most infertile in the world
- Shortage of water and water contamination
- Land ownership, based in customary inheritance law. This has resulted in land fragmentation to the point that often plots consist of just a few trees
- Remoteness from world markets
- Climatic variability (e.g. long droughts and exposure to cyclones). These impacts translate into decreased agricultural yields, death of livestock, loss of biodiversity, etc.

Energy

- Heavy reliance on imported fossil fuels for its energy generation
- Lack of the technical expertise and infrastructure needed for better utilization of alternative and indigenous energy resources
- High cost of technologies and the ability to install and maintain them is underdeveloped
- The database for electricity consumption is poor, making the forecasting of load demand difficult.
- Old and poorly maintained generating system

6.3. Samoa Islands

Forestry. With over 106,000 ha of forests (all types), forestry plays an important role in Samoa. Samoa has suffered extensively from deforestation, particularly prior to the collapse of taro exports when about 2500 ha were deforested annually. However, it is important to bear in mind that a large proportion of forests in Samoa (c.87,000 ha) are regarded as non-productive, and this posses serious limitation for economic use.

Agriculture. Despite the increase in services and in industrial activities, agriculture remains a major area of economic activity, particularly coconut production of which

there over 23,000 ha. This is particularly so after the collapse of the taro exports in the mid 1990s.

Samoa agriculture also suffers considerably from the vagaries of nature, often hit by major cyclones. Another major problem, both for the development of agriculture and forestry, is land tenure rights, which act as a major barrier.

Energy. Samoa's high dependency on energy imports is further compounded by energy inefficiency. Thus, the government recognizes that there is a strong need to take maximum advantage of the national natural resource (e.g. wave energy has been identified as a high resource potential and is considerably steady throughout the year).

The key issues and concerns can be summarised as follows:

- Deforestation, arising chiefly from an expansion of agriculture, although commercial logging has also played a very significant role
- Environmental problems posed by deforestation include watershed degradation, erosion and soil depletion, and loss of biodiversity
- A shortage of financial resources to implement forestry programmes including energy
- Shortages of professional manpower, and a shortage of human resources in general, to deal with RE technology
- Land tenure rights, and uncertainties over the future direction of core forestry programmes
- High dependency on oil imports and vulnerability to fuel supply disruptions

6.4. Tonga Islands

Forestry. The main national resources of Tonga are forests and agriculture. However, only approximately 4,000 ha of forests remain today. The main purpose of forest policy is environmental and ecological preservation, and thus forests offer few possibilities for other uses, particularly energy.

Agriculture. Agriculture has been the primary sector of the Tonga economy, and is the main source of livelihood for two-thirds of the population; this despite the fact that

in recent years tourism, fisheries and industry are becoming increasingly important. Agricultural activities in Tonga are very limited, mostly confined to coconut production, and food crop for the local population. Thus, agriculture as such, except to coconut production, offers few other possibilities.

Energy. Tonga has developed a National Energy Policy (TNEP) in response to the energy challenges facing the country. Tonga does not have indigenous petroleum resources and majority have power from diesel electricity. A major aim is to increase the proportion of the country's energy from national RE sources. Key issues in renewable energy include:

- A lack of technical expertise and weak institutional structures to plan, manage and maintain renewable energy programmes
- the absence of clear policies and plans to guide renewable energy development
- a lack of successful demonstration projects
- a lack of understanding of the renewable energy resources potential
- a lack of confidence in the technology on the part of policy makers and the general public;
- a lack of local financial commitment and support to renewable energy
- continuing reliance on aid-funded projects

The overall key issues and concerns in Tonga with regard to forestry, agriculture and use of national energy sources are:

- The principle forestry concerns in Tonga relate to deforestation and forest degradation, and an associated need to conserve much of the remaining forests land, in the face of continuing demands for consumption. Most areas of lowland forests have been cleared and this raises concerns over loss of biodiversity, as well as increased incidence of soil erosion and the spread of anthropogenic grasslands.
- The increase in commercial farming of short term crops instead of the traditional agriculture practices is the main cause of forest loss on private lands and remains a key land-use issue in Tonga. Some Tongan islands are vulnerable to the adverse impacts of climate change and sea level rise.
- Lacks of experience in environmental management, and together with limited funding, has been identified as major constraints to achieving sustainable resource use. In terms of managing the forest resources these have negatively impacted on forestry training and the availability of qualified forestry staff.
- Most of the environmental problems arise from growing population and limited natural resources

- Solid waste disposal is also a serious problem in Tonga, particularly in Nuku'alofa where the main garbage dump for household waste and other non-hazardous waste is situated in the mangrove area
- Informal beach and mining, a common practice, also causes major environmental problems.

6.5 Tuvalu Islands

Tuvalu is a very small country (26 km^2) spread over 750,000 km^2 across it EEZ; its soils are poor and cannot support forestry or agriculture in any meaningful scale. The only realistic possibility is coconut, which covers 54% of the land (1620 ha). Coconut palms could be used for both, to produce biodiesel and for woodfuel.

Main problems for Tuvalu include:

- Lack of waste management policy
- Concern with climate change and the potential implications for Tuvalu of raising sea levels
- Depletion of natural resources, already becoming over-exploited; for example, the Funafuti town council has a new policy to prohibit the cutting of trees for use as fuelwood
- Population growth and the effects on natural resources
- Land ownership (e.g. large number of very small plots)
- Perhaps, too much dependency on coconut (e.g. about two-third of land comprises coconut woodland of various densities)
- Difficulties posed by the large distances between the islands

6.6 Vanuatu Islands

Forests. Vanuatu has an active policy to become a 100 percent renewable society, using national resources. Vanuatu's forests (all types) represent almost 75% of the land area. However, many of such forests are located in steep inaccessible sites, and hence they have a limited economic value.

Agriculture. About 80% of the population in Vanuatu lives in rural villages for which agriculture is their main source of livelihood. The most important crops in Vanuatu are coconut (the backbone of the rural economy), cocoa, cattle, Kava, and to a less extent, garden plots, coffee, etc.

Coconut sector has been the mainstay of economy since the turn of the 19th Century.

Considerable efforts have gone to improve the coconut industry over the last two decades since this industry has been, and will continue to be the backbone of the rural economy e.g. about 70% of the rural households own coconuts. Biodiesel production offers an excellent opportunity on Vanuatu. However, the coconut industry in faces serious challenges, including:

- High transportation costs among the islands, due to long distances to markets
- Small markets due to the small population, scattered along a large geographic area
- Coconut is overwhelmingly produced by a very large number of smallholders
- Coconut remains the backbone of the rural economy, not only to satisfy subsistence needs but also to provide the means for cash income. However, few new investment goes into coconut production
- The industry needs to be modernized and innovated but the nature of coconut production makes it very difficult.
- Financial inefficiencies need to be removed , or streamlined, so that prices reflect more market costs
- The industry need to diversify e.g. soup production for the local markets could be encouraged more, better use of residues for fuelwood, etc.

The main general concerns in Vanuatu include:

- Deforestation and forest degradation; large areas of lowland forest have been cleared, and this has lead to severe erosion and has raised concerns over loss of biodiversity.
- Coastal erosion is a significant problem in some areas.
- Overgrazing and burning of forests in the uplands is a significant cause of soil and watershed degradation. The country's lack of environmental management experience, and limited funding, are major constraints to achieving sustainable resource use
- Concerns over the capacity of the Department of Forests to adequately monitor logging operations and fulfil roles envisaged in the Reduced Impact Logging guidelines once current donor-funded projects end
- The focus on only a few timber species promotes high-grading of forests, and consequent degradation, is also another serious concern

Summing Up

The Main possibilities for biomass energy in SOPAC countries are:

- Coconut biodiesel and diesel replacement for transport and electricity (Vanuatu experience plus small island experience in Fiji)

- Waste treatment and biogas production (various country experience and projects- particularly the Apia AD system (currently under construction)

- Sugarcane and wood industry residue use for electricity and heat production, initially in Fiji
- Small scale (>100kWe) gasification systems, attached to schools and tourist resorts, learning from the invaluable 'Onesua School Gasifier' experience in Vanuatu.

Main barriers:

- Problems posed by isolated and dispersed population centres
- Problems posed by, often, very small markets without significant economics of scale
- Poor use of RE due to lack of appropriate technology, poor institutional mechanisms, and problems posed by small and dispersed markets
- Limited human resource capability to respond to these challenges
- Lack of technical expertise and weak institutional structure to plan, manage and maintain RE programmes
- The absence of clear policies and plans to guide RE development
- Lack of confidence on the technology on the part of policy makers and the general public
- Lack of local financial commitment and support to RE
- Poor participation of women in the energy sector. Women are at the centre of energy and must play a full part in energy policy.

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