



CocoGen Samoa



Cocogen Inception Report



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SOPAC Trip Report 372



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Picture front page: Sunrise in North Savai'i (Herb Wade)



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1. Introduction

In the first week of February 2005, the SOPAC Cocogen-team was officially awarded the consultancy contract for the UNDP-Samoa funded study on the use of biofuels in Electric Power Corporation (EPC) Generators.

In this same week, literature study commenced as a preparation to the consultancy work. Travel arrangements and meetings were scheduled for the first inception mission.

During the week from 7 to 11th of February 2005, Jan Cloin undertook the first fact-finding mission to Samoa.

This inception report is an overview of the findings of the mission to Samoa and aims to formulate recommendations on the focus of the consultancy objectives, its planning and its approach.

2. Objective

This inception report has two main objectives – the first objective is to give an overview of the status of the coconut sector and the electricity sector in Samoa with relation to biofuel use by EPC. The second is to adapt and refine the Terms Of Reference for the Cocogen consultancy in line with the findings of the first objective.

3. Methodology

The data in this inception report are the result of meetings with people, literature research and site visits to various actors of the coconut sector. These data will be compiled and analysed for their impact on the potential future use of biofuels by EPC, focusing on coconut oil. After conclusions on the data analysis, recommendations will be made for the adaptation of the ToR, the planning and the consultancy approach.

4. Findings

4.1 Samoa Country Specifics

The Independent state of Samoa is situated¹ between Australia and the US in the Pacific Ocean. It consists of two main islands (see Figure 1) and a number of smaller islands. The total land area is 2,934 km² and its economic zone roughly 120,000 km².

¹ 13-14 degrees South Latitude and 171-172 degrees West Longitude



The capital, Apia has about 35,000 inhabitants, is located on the Island of Upolu and is the commercial center of the country. Samoa is home to some 180,000 people (2004) that is growing only slightly at 0.5%².

The climate is temperate and most of the year the temperature ranges between 20 and 30°C at an average humidity of 80%. The annual rainfall is 2.88 meters with lows of 2.5 in the west of Savai'i and Upolu and highs in the uplands of up to 6 meters³.

The country is prone to be hit by cyclones that have shown in recent years to potentially lead to serious damage. Especially because this study considers a vulnerable source of biomass such as coconuts, this is an important consideration⁴.

Samoa's National Currency is the Tala (ST\$) with a rate of 2.6 to the US\$ (March 2005).

4.2 Samoan Electricity Sector

Energy is central in the lives of Samoans and the potential for development in the future. The main sources of energy comprise imported petroleum products (35%), biomass (60%) and hydro-electricity (5%)⁵. The important role of biomass is mainly in wood being used for produce drying, cooking and in the Samoan traditional earth oven, Umu.

Table 1 shows the Main Islands of Samoa with its population and its electricity supply.

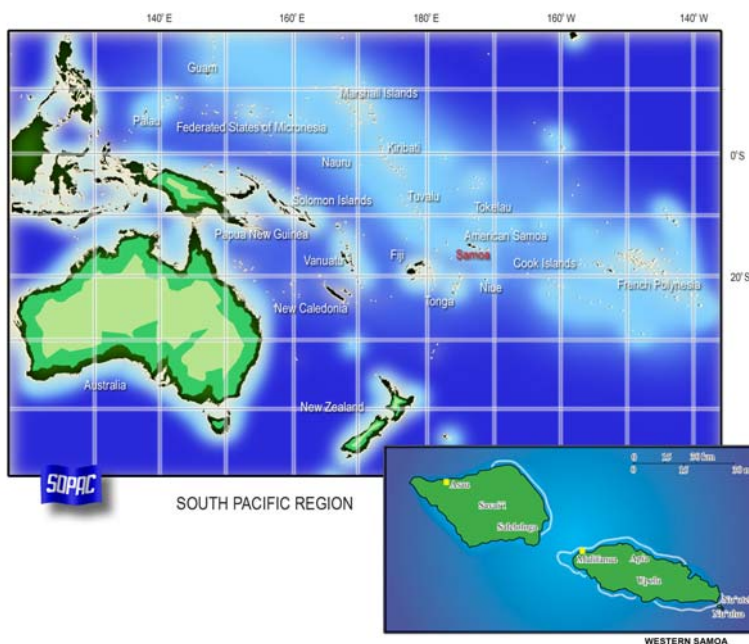


Figure 1: Map of Samoa.

² Source: Census Reports, Government of Samoa

³ Source: Government of Samoa

⁴ Since the start of this study there have been three cyclone warnings already in 2005, fortunately none of which have actually lead to damage or loss of biomass resources.

⁵ Source: Pacific Regional Energy Assessment (1992)



Table 1: Island Areas, Population and Power Supply.			
<i>Source: adapted from PIREP Samoan National Report (2005)</i>			
Island	Area [km ²]	Population (2001)	Electricity Supply
Savai'i	1,708	42,824	Diesel Generation, Grid connected
Upolu	1,123	134,024	Diesel and Hydro, Grid Connected
Manono	3	1500	Connected to Upolu
Apolima	1	150	Diesel mini-grid
All others	1	None	None

Total sales of electricity by the government-owned, and only, power utility Electric Power Corporation (EPC) are given in Figure 2 below. It can be seen that in the last 5 years there has been a steady increase of total production that is projected to further stabilise in the current financial year.

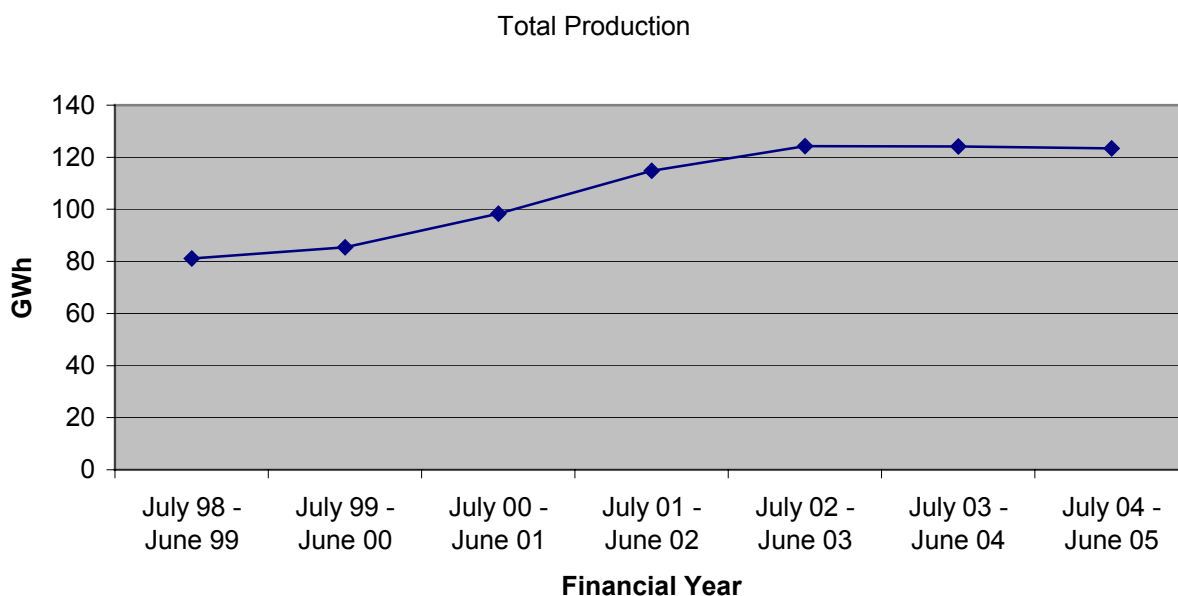


Figure 2: EPC Generation 1998 - 2005 (Source: EPC, incl. 2005 estimates)

Figure 3 shows the composition of the generation by source. EPC has traditionally made use of a hydro station in Upolu that generates, on average, half of the electricity produced, depending on rainfall patterns.

The share of diesel-installed capacity and production has been increasing to keep up with growing demand and unpredictable hydro-capacity.



EPC Production by Source

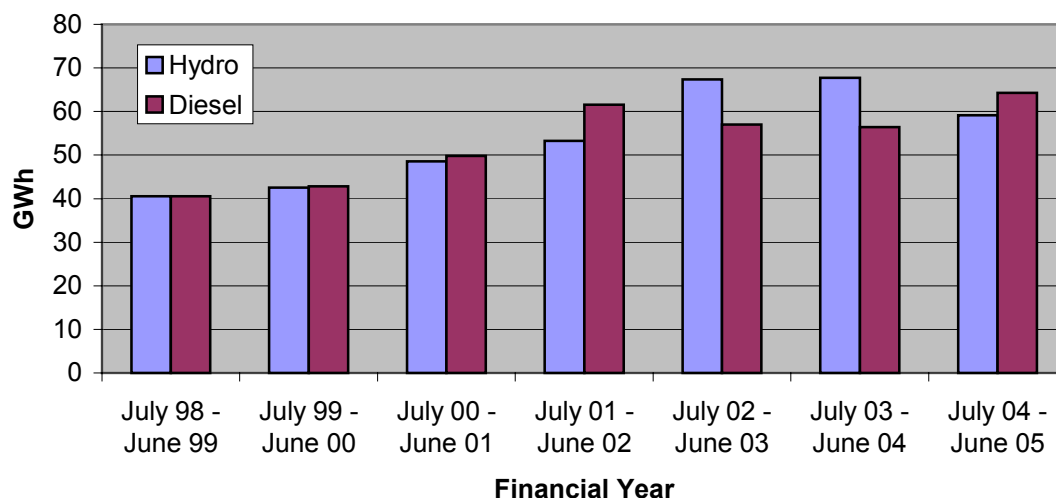


Figure 3: EPC Generation by source (Source: EPC)

From these two graphs, it can be seen that diesel generation is a fact of life in the Samoan power supply. There are advanced plans to develop further hydro resources, however these will not replace all diesel capacity in the medium term.

EPC's outlook is a further increase of 6% annually in the coming 5 years in both peak demand and capacity⁶.

Through a combination of cost savings and environmental considerations, EPC aims to utilise alternative fuels from diesel⁷. In addition, the increasing dependence on imported fossil fuels is another major driver for carrying out a feasibility study into the use of alternative fuels in EPC generators.



Figure 4: EPC Generation unit in Savai'i (Herb Wade)

During discussions with EPC management⁸ it became clear that EPC carried out some trials with alternative fuels in the early 1980s⁹. No records or results of these trials are available today. Because of the technical risks associated with using fuels that are not recommended by the manufacturer of the EPC generating units, there have been no further trials.

⁶ Source: EPC Corporate Plan 2004 - 2007

⁷ Source: Chairman's remarks in EPC Corporate Plan 2004-2007

⁸ See Annex I, list of meetings during country mission February 2005

⁹ "EPC has held a six-month trial using coconut oil as a substitute for diesel in engine operation and expects to carry out further trials" – please refer to Western Samoa: Issues and Options in the Energy Sector, June 1985, p. iv, joint UNDP/World Bank Energy Sector Assessment Program. This publication we forwarded today in electronic version.



It is felt that during the feasibility study, the cost-benefit analysis should take into account the decrease of direct fuel costs, however also including likely increase in maintenance costs. Therefore, a similar cost-benefit analysis on the use of heavy fuel instead of distillate in the generators should be carried out.

The importance of the Cocogen consultancy to not only focus on a desk study but also increase the capacity of EPC personnel through training on the use of biofuels was re-iterated.

4.3 Samoan Coconut Sector

Samoa has been a major exporter of a range of coconut products in the past century. This has been the backbone of the national economy. It is also an integral part of the way of life for most Samoans, providing food, shelter, fuel, home comfort and cash¹⁰.

Through a combination of fluctuating prices, weak management, limited re-investment, cyclones and pest damage, the coconut industry came to a virtual halt in 2000. This is illustrated in Figure 5, showing the coconut export volume in recent years. The industry is getting back on its feet slowly, as can be seen for example from increased output from the Coconut Oil Productions Samoa Limited (COPS) copra mill and the recent re-opening of Desico, a factory for Desiccated Coconut products in February 2005.

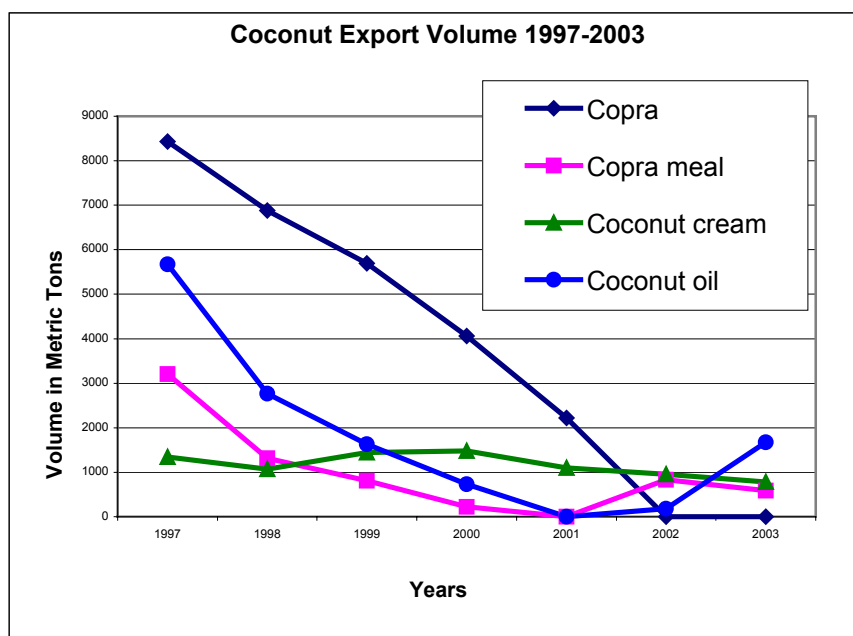


Figure 5: Coconut Export Volume (Source: Coconut Industry Review)

Other coconut-based exports include Copra, Copra Meal, and Coconut Cream.

The world market for coconut products has been proven to be very volatile, with strong competition both between competing coconut producers and also other products such as palm oil.

¹⁰ Adapted from "Coconut Industry Review" (2004)



Samoa plays a small role in the global coconut industry and will be dependent on further price developments for major coconut products on the world market. During the last decade, the price of coconut oil CIF Rotterdam fluctuated between US\$ 350 and US\$ 750 per metric tonne. The medium-term price development of products such as coconut oil is not expected to fluctuate greatly. In the current market arrangements with heavy interdependencies with other vegetable oil products, it is expected the volatility is limited.

The current price of coconut oil CIF Rotterdam is US\$ 620 per metric tonne, while transport cost from Samoa, including storage, financing and insurance result in a net benefit of roughly US\$ 500 per tonne. The February 2005 opportunity costs for raw coconut oil from the only copra mill in Samoa (COPS, owned by Elan Trading Pty Ltd) are thus¹¹ ST\$ 1.18 per litre¹².



Figure 6: Coconuts for sale along the main road in Savai'i (Herb Wade)

The size of the coconut resource has been subject to a number of studies and it is expected that the Cocogen consultancy will add a degree of confidence to the available data. It has become clear from various discussions with the Ministry of Agriculture, with the COPS mill and through site visits in Upolu (STEC plantation, hybrid coconut seedlings gene pool) and Savai'i that if the reward to harvest coconut products is increased, new supply will emerge.

¹¹ See Also "Coconut Oil as a bio-fuel in the Pacific Islands – Challenges and Opportunities", South Pacific Applied Geoscience Commission (2004), Miscellaneous Report 592

¹² Rate Feb 2005: 2.6 Tala/ US\$



5. Analysis

5.1 Supply Chain Analysis of coconut oil

It will be a major effort during the feasibility study to assess the impact of an increased demand for coconuts through biofuel usage by EPC, the required price increase and the resulting supply of coconuts, given the other actors in the coconut industry. Table 2 indicates the prices farmers obtain for different purposes of coconut use.

It can be seen that the limited markets such as drinking nuts and virgin coconut oil have relatively high rewards of 25 to 50 sene per nut. The more or less unlimited markets (for example COPS is craving for copra) have a value of 10 – 15 sene per nut. Copra production will only increase when:

- 1) Higher price is paid per kg of copra;
- 2) Rural and inter-island transport systems improve; and
- 3) Payment becomes more reliable.

The coconut industry review recommends the study of a value-added analysis of the coconut produce supply chain; therefore we assume this has not been done previously. **The Cocogen Feasibility study will therefore aim to assess the elasticity of prices and the potential supply for copra in the coming 3 years.**

Table 2: Prices per Coconut for different purposes.			
<i>Source: "Coconut Industry Review", site visits, stakeholder meetings</i>			
	Current Price¹³ per nut [\$sene]	Labour	Market Opportunities/Limitations
Copra	10 - 14	Gather, Dehusk, Cut Copra, Dry Copra, Transport	Unlimited market opportunities in Upolu, Limited opportunities in Savai'i through transport costs. Farmers have to be patient with payment.
Desico	15	Gather, Dehusk, bring to Plant	Currently limited market, significant growth opportunities
Desico Collected	12	Gather, Dehusk	Currently limited market, moderate growth opportunities
Coconut Cream	12	Gather, Dehusk	Limited Market opportunities, Moderate growth opportunities
Roadside Sale	10-15	Gather	Currently oversupply, moderate growth opportunities
Drinking Nut	25	Climb Tree, Gather, Transport to Market, Pay Stall	Only Green nut Limited market
Virgin Coconut Oil	30-50	Gather, Dehusk, Shell, Grate, Dry, Press Oil	Limited Market, Moderate export growth opportunities

¹³ Source: Coconut Industry Review (2004), site visits, stakeholder meetings.



5.2 Resource Assessment

Following interviews with the Ministry of Agriculture, the Ministry of Finance and the visit to the STEC plantation, it was found that there is a lot of data available on the resource potential of coconuts. However, this information does not seem to be available in a ready-to-process form.

During the period of the consultancy, SOPAC will also conduct training in Samoa on the use of spatial databases and GIS for the Ministry of Agriculture and others.

Given the large amount of data already available at the Ministry of Agriculture, **it is proposed to carry out the resource assessment in close collaboration with the Ministry of Agriculture, the Ministry of Natural Resources and Environment and the SOPAC in-country GIS intern.**

5.3 Cost-benefit analysis Fuel Options

In the Quotation for Services Cocogen, submitted by the SOPAC team, five fuel options have been described. Table 3 lists these fuel options with estimated prices per litre.

Table 3: Prices of Fuel Options per litre.			
<i>Source: Ministry of Finance, site visits, stakeholder meetings</i>			
	Price per Litre [ST\$]	Investment Required	Concerns
Diesel (baseline)	1.44	No	Import Dependence, High Costs
Pure Coconut Oil	1.18	Moderate	Dedicated Engine Required
Dual Fuel System	1.18 (Copra Oil) 1.44 (Diesel)	Moderate	Engine Adaptation Required
Blend Diesel Coconut Oil	1.18 (Copra Oil) 1.44 (Diesel)	Small	Separate Day tank Required
Blend Diesel Biodiesel	1.5–2.5 ¹⁴ (Biodiesel) 1.44 (Diesel)	Large	Biodiesel production Required
Pure Biodiesel	1.5–2.5 (Biodiesel) 1.44 (Diesel)	Large	Biodiesel production Required, Abrasive Effect Biodiesel

¹⁴ Cost estimate based on data from Biodiesel operations in Hawaii; requires further investigation.



Wholesale Prices of Petrol and Diesel in Samoa

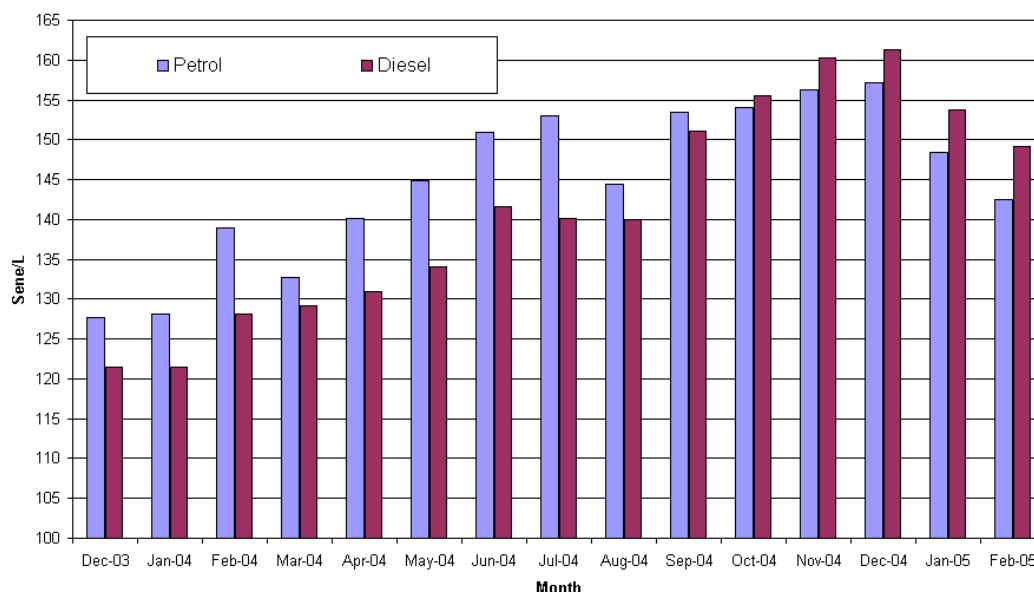


Figure 7: Fuel Wholesale Prices (Ministry of Finance, Samoa, 2005)

Figure 7 shows the wholesale price of fuel for the year. EPC pays the wholesale price as determined by the Government of Samoa. As EPC required roughly 17 Million litres of diesel in 2004, their fuel bill was around 24 Million ST\$. This includes 6.8 Million ST\$ in duty¹⁵.

In order to make sufficient copra oil available to consider it as a significant fuel option **it is proposed to aim for at least 5% of the current diesel fuel to be replaced.** This is equal to an annual supply of 850,000 litres or 765 tonnes¹⁶. This will require an estimate of 4-5 Million nuts to be collected, de-husked, dried and milled. In comparison, Desico is currently absorbing 1 million nuts per annum and says it can boost productivity to 8 million per annum, if the export market materialises.

On the basis of an overall 5% replacement, EPC can gain valuable experience on the basis of which further diesel substitution can be considered.

Such market developments will however undoubtedly lead to an increase in price per nut to an estimated 17-20 sene per nut, or ST\$ 36-40 per 100 pounds¹⁷. At the Ministry of Agriculture this price is perceived to be sufficient for farmers to start replanting their coconut resources. This price increase will also cover for the collecting time, dehusking and drying process associated with copra production, that currently limit the amount of copra produced.

Such prices enable the Savai'i coconut growers to again participate in the copra supply as currently low prices of the commodity lead to inhibitive transport costs.

¹⁵ EPC is reimbursed ST\$1M per annum for the duties on fuel
¹⁶ This is 16% of the annual theoretical capacity of the COPS mill
¹⁷ This implies a price increase for copra of 148%



This observation re-iterates the recommendation from paragraph 5.1 to carry out an in-depth investigation into the current value added/supply chain of coconut products and the logistics involved.

5.4 Collaboration Cocogen – ADB REEP

During meetings with the Asian Development Bank (ADB), Renewable Energy and Energy Efficiency Programme for the Pacific (REEP) consultants; and at the ADB Steering Committee meeting 2005, it became clear that the Cocogen Consultancy and REEP have many focal areas in common. One of the priorities during the steering group meeting is that the REEP consultants prepare a feasibility study for a combined heat and power plant that is to be built in the Government STEC plantation for generation of up to 2 MW heat and 5 MW electricity. The resource assessment component of Cocogen, especially, could provide essential input for this REEP feasibility study. Furthermore, the REEP consultants have agreed to co-fund the travel of a consultant to the Pacific to contribute to the Cocogen work and share his experiences during a SOPAC Biofuel national workshop in Fiji. This collaboration strengthens the regional links of both projects and creates the opportunity for EPC personnel to learn from experiences in Fiji.

Because the time frame for implementation of ADB REEP projects is up to three years in the future, whereas Cocogen was designed to look at the current opportunities, it is therefore proposed **to collaborate closely with the ADB – REEP project on findings and to keep the Cocogen consultancy focused on the opportunities of the current situation and near future (0-3 year).**

5.5 Team Composition

Due to unforeseen organisational and personal circumstances, the technical consultant originally proposed to work as part of the SOPAC team, Mr. Timothy Kopial from PNG has been replaced by a biofuel specialist from France, Dr. Gilles Vaitilingom. As Dr. Vaitilingom is more experienced and therefore has a higher consultancy rate per day, it is proposed to decrease the amount of days designated for the technical consultancy from 40 to 15, keeping the costs within the original budget.

It is therefore proposed to change the budget line for Technical Consultant (US\$6,000) from 40 days at US\$150 to 15 days at US\$400.

This will have an impact on the approach of the technical feasibility, limiting the opportunities to carry out physical testing at EPC generators. **In consultation with EPC, the SOPAC team proposes to carry out only one (1) fuel test with the most likely feasible fuel option.**



6. Recommendations

6.1 General

It is recommended to delay the project implementation in line with EPC requirements to prepare and organise their contribution to the technical component of the Cocogen consultancy. Please find the newly proposed planning for the implementation of the Cocogen consultancy in Annex III.

6.2 Feasibility Study Approach

From the analysis, a number of points are recommended for the continuation of the Cocogen consultancy. It is firstly recommended that the activities and the approach as described in the Cocogen Quotation of Services need amending. There are several issues that need slight adaptation in the approach. These adaptations in focus are listed below:

- Cocogen to assess in detail the value-added chain of coconut oil, the price elasticity and a resulting supply estimate;
- Cocogen to carry out the resource assessment in close collaboration with the Ministry of Agriculture and the Ministry of Natural Resources and Environment and the SOPAC in-country intern for spatial databases and GIS;
- Cocogen to collaborate closely with ADB-REEP consultants;
- Cocogen to focus on applications between now and three years ahead;
- Cocogen technical feasibility study to be carried out by Dr. Gilles Vaitilingom;
- Cocogen in consultation with EPC to carry out one of the most likely feasible fuel option test; and
- Environmental impact assessment to be carried out along the lines of PUMA's Environmental Management Plan (EMP).



Literature List

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"Environmental Guidelines for Selected Industrial and Power Development Projects" (1993) *Asian Development Bank*.

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Annex I – List of Meetings during country mission February 2005

Institution	Name	Subject of Meeting
UNDP Samoa	Mr Thomas Jensen	General preparation and inception meeting, kindly made office available for the preparation of meetings during the week, email and telephone calls.
Ministry of Finance	Mr Iulai Lavea	Courtesy visit to update on the status of the Cocogen Project and general SOPAC assistance to the Samoan Government. The Cocogen project was again endorsed by Ministry of Finance.
Ministry of Finance	Ms Hieremoni Suapaia	General assistance on meetings with Government, general status of energy in Samoan Government was discussed as well as the status of the Energy Policy, which is still in Draft. Ms Suapaia kindly made available macro-economic data on Samoa that will be used in the feasibility study. Also obtained the latest draft of the energy policy and a press release on fuel prices.
JICA	Mr Hisaharu Okuda	Discussed the current JICA assistance to the Samoan Government and how this overlaps or has links with Cocogen. JICA has three volunteers working in the energy sector, one on HV transmission lines (reducing losses for EPC) one is working on maintenance for the Savai'i diesel generators and one is assisting EPC in increasing the capacity of the hydro dam construction.
STEC		Mission to observe the state of the Government Plantation and to see the Gene Pool where new hybrid seedlings are produced for a government coconut planting scheme.
Desico	Mr Taimang Jensen	Observe the operations of the newly refurbished Dessicated Coconut production facility as a gauge for the revitalisation potential of the Samoan Coconut market. Also learn about their collection system as this seems to be a major challenge in the industry.
Ministry of Agriculture	Mr Frank Fong	Discuss the Samoan Coconut Sector as a whole, prepare the resource assessment exercise at the Forestry Division in the Ministry of Agriculture, discuss subsidy scheme that was in place for copra, STEC state of affairs, perceived difference between hybrid trees and Samoan Tall.
COPS/Elan Trading	Mr Rodney Parker	Discuss the current copra oil sector. Recently COPS has milled 1,500 tonnes of oil from Kiribati (mouldy, relatively low quality). COPS has difficulties paying the copra farmers up front through cash flow problems. Expected to improve in the coming 6 months. Transport system to collect copra is another major challenge, especially to get Savai'i involved in the production.
AusAid	Mr Anthony Gill	Courtesy visit to AusAID and gave an update on the activities by SOPAC in the field of energy. AusAID gave an overview of possible linkages with projects however no obvious overlaps were identified.
Ministry of Natural Resources and Environment	Mr Faafetai Sagapolutele	Discuss the situation on waste oil in Samoa; Discuss the requirements of the Government of Samoa to any large-scale development, With regard to the development consent, if procedures are followed, the "Development Consent" should form no problem.
Ministry of Natural Resources and Environment	Mr Sunny Seuseu	Discuss the guidelines as formulated by the government of Samoa on carrying out an environmental impact assessment. Planning and Urban Management Authority will further provide the Planning and Urban Act (2004) which includes guidelines for Environmental Management Plan (EMP).
REEP Meeting	Mr Tommy Scanlan Dr Ieti Taulealo Mr Maausa Joseph Walter Mr Thomas Jensen Ms Hieremoni Suapaia Mr Isukiku Punivalu	Attended the Asian Development Bank (ADB) Renewable Energy and Energy Efficiency (REEP) project meeting. During the meeting, the potential links between the project and Cocogen were discussed. Decided was that the priority projects in RE were going to be 1) Biomass/Biofuel for EPC on the basis of the STEC plantation revitalisation and hydro Resource Assessment in Upolu. The Cocogen project was presented to the participants. It was decided that the Cocogen would act as a feasibility study for the current options; especially the resource assessment will provide input to the REEP project.
EPC	Mr Maausa Joseph Walter Mr Tile Tuimalealifano Mr Tiotio Taulealeausumai	Presented the Cocogen approach. Possible machines for testing were discussed. The technical risks and the actual revival of the coconut industry are perceived to be the main barriers towards implementation of alternative fuels. Training is perceived to be a very important component of the consultancy.



Savaii	Mr Thomas Jensen Mr Herb Wade	Visit to the Island of Savai'i to obtain an impression of the local coconut sector. Unhusked coconuts are for sale along the road for 10 to 15 Tala per 100. There are a number of smaller plantations that have relatively well maintained pastures. Most smallholders seem to farm coconuts as part of subsistence agriculture and only haphazardly sell their coconuts on the market.
REEP- Cocogen Wrap-up meeting	Mr Thomas Jensen Mr Herb Wade	<p>REEP will perform a feasibility study into the construction of a coconut oil power plant based in STEC. The plant would consist of a CoGen unit of 1 MW running on shells, husks and woody biomass from cleaning the plantation and old coconut trees. The heat of the Cogen unit will be used to dry copra. A second unit would be comprised of a separate unit of 2-3 MW compression generator running (partly or fully) on coconut oil fuel. The Power plant is envisaged for the short- to medium-term, i.e. roughly 3 years from now, if found feasible.</p> <p>It was agreed that Cocogen will look into the current options, whereas REEP will look at the options of 3 years and onwards.</p>



Annex II – EPC Diesel Generating Capacity Installed

Power Station ¹⁸	Unit Number	Make	Rated Power [MW]	Operational
Tanugamanono (Upolu)	4 A	Mirrlees K8 MK1	2.2	Yes
	5 A	Mirrlees K8 MK3	4.2	Yes
	7 A	Mirrlees K8 MK3	4.2	Yes
	9 A	Mirrlees K8 MK3	4.2	Yes
	12	Mirrlees K8 MK2	3.5	Yes
Saleloga (Savai'i)	1A	Cummins	0.8	No (Overhaul)
	2A	Cummins	0.4	Yes
	3A	Cummins	0.8	Yes
	5A	Caterpillar	1	Yes
	8	Caterpillar	1.4	Yes
	9	Caterpillar	1.4	Yes

¹⁸ Sources: email communication with EPC Generation Manager and Greenpeace "Towards Energy Independence in Western Samoa" (1995), site visits.



Annex III – Updated Planning Sheet

