

# Environmental Impact Assessment

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## Proposed Biomass Power Generation Plant at 'Eua

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**Prepared for:**

TONGA POWER LIMITED

Nuku'alofa

Kingdom of Tonga

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## EXECUTIVE SUMMARY

This is an Environmental Impact Assessment report on Tonga Power Limited's proposed biomass power generation plant at 'Eua. This is off the eastern coast of Tongatapu Island, the capital island of the Kingdom of Tonga. The principal objective is to improve energy supply with an increasing use of renewable energy.

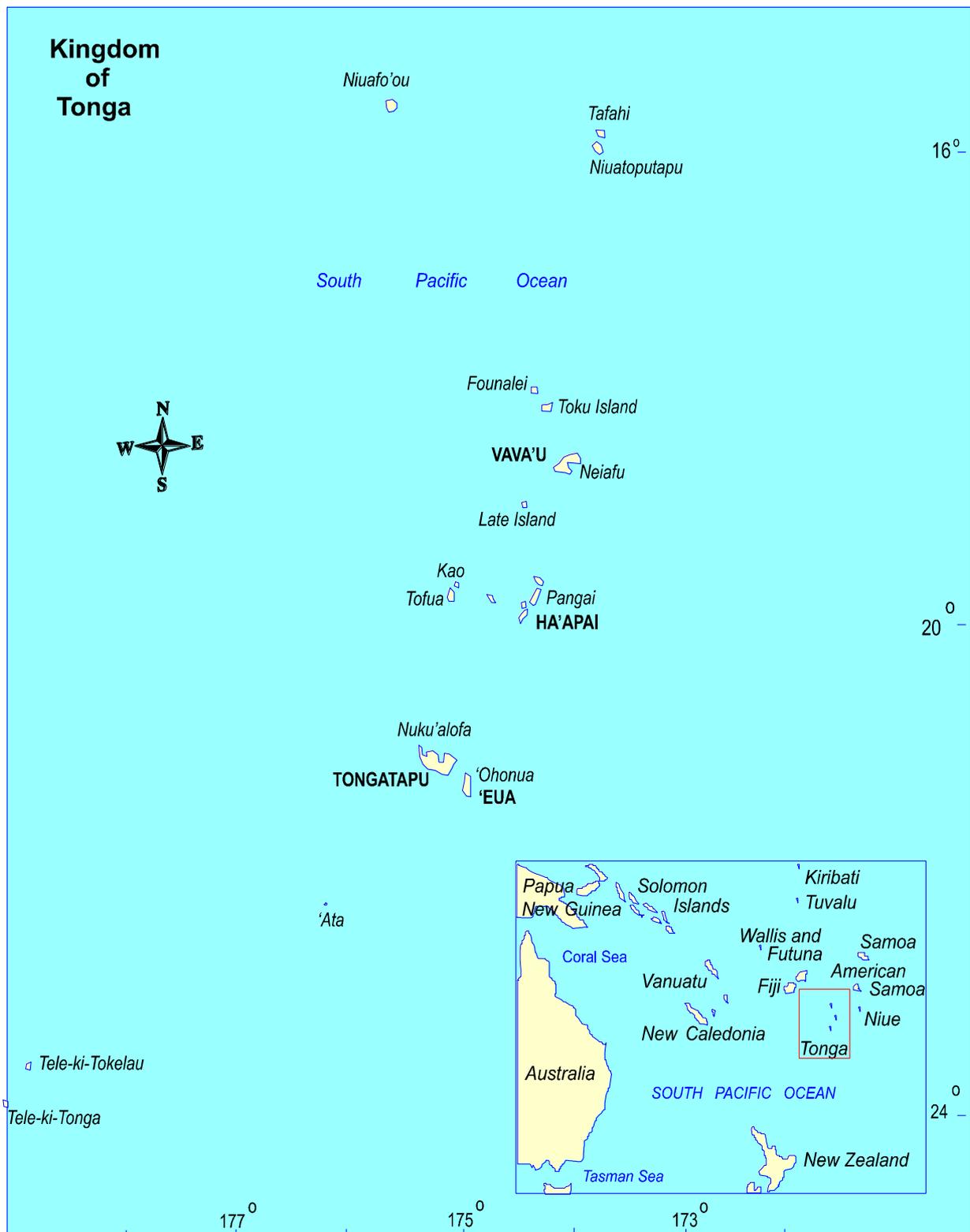
Tonga's Energy Road Map (TERM) provides a detailed pathway towards a low carbon, cost-effective, technically sound, equitable transformation of the entire energy sector in the Kingdom of Tonga. The Government of Tonga launched the plan in 2010, and now has a target of 100% renewable energy by 2020.

The Kingdom is highly dependent on imported fuel to meet its energy requirements. In effect, the total fuel import accounts for about twenty percent of the total import value in 2011. Tonga Power Limited is the sole on-grid electricity production and distribution SOE in Tonga. The grid-supplied electricity accounts for about 98% of electricity and it is based on diesel generation. In 2013, TPL used 12,941,465 litres of diesel for power generation, which cost around \$US19, 500,000. This is essentially a huge cost for a small island state such as Tonga. However, under the current electricity regulatory structure the cost of fuel is essentially passed through to electricity consumers. In effect, the electricity consumers are fully exposed to oil price rises and fluctuations.

TPL, within the framework of TERM 2010-2020, is proposing to establish a biomass plant in 'Eua. This project will be another step forward in addressing the energy issues in Tonga and achieving the TERM 100% renewable target.

# 1 INTRODUCTION

## 1.1 BACKGROUND



Map 1: Kingdom of Tonga.

The Kingdom of Tonga comprises a population of 103,000 persons living on 36 islands. In total there are 170 islands of volcanic and coral origin in four main groups: Tongatapu and 'Eua, Vava'u, Ha'apai and the remote Niuas.

The island of 'Eua is about 19km south-east of the main island, Tongatapu. 'Eua is 19km long and 7km at its widest part. The total land area is about 8,100ha. Topographically, 'Eua is a high island with a ground surface that rises gradually from the west coast. The rises composed of several distinctive terraces to a high eastern ridge, which is 312m m.a.s.l. at its highest part. 'Eua is nicknamed "Fungafonua", loosely translated as the first land, according to Tongan mythology, it is the land that the god Maui stood, and fished out Tongatapu. In parallel, scientific data proved that 'Eua is the oldest island in the kingdom.

The original inhabitants of 'Eua settled in Houma, Ta'anga, Pangai, Tufuvai and 'Ohonua. 'Eua was one of the late intensely populated islands; in fact, the Niuafu'ou people were evacuated to 'Eua after the 1946 volcano eruption. This was preceded by the resettlement by people from 'Ata Island in 1863. The people from 'Ata settled in Kolomaile and Ha'atu'a (southern part of 'Eua), and the Niuafu'ou people settled in Petani, Tongamama'o, Mu'a, Mata'aho, Fata'ulua, Sapa'ata, 'Esia, and Futu.

## 1.2 THE PROPOSED DEVELOPMENT

### 1.2.1 THE PROPOSED TECHNOLOGY

The proposed development is to utilise biomass (lignocellulosic) as an energy source, either directly via combustion to produce heat or indirectly after converting it to a form of biofuel. Forest residue (dead trees, branches, tree stumps), yard clippings, wood chips are wood remains that TPL will use as energy source. Generating electricity from biomass can be done in many different ways, although Woodchip Gasification (Diagram 1) into Gas Engine Generator systems is deemed suitable for 'Eua.

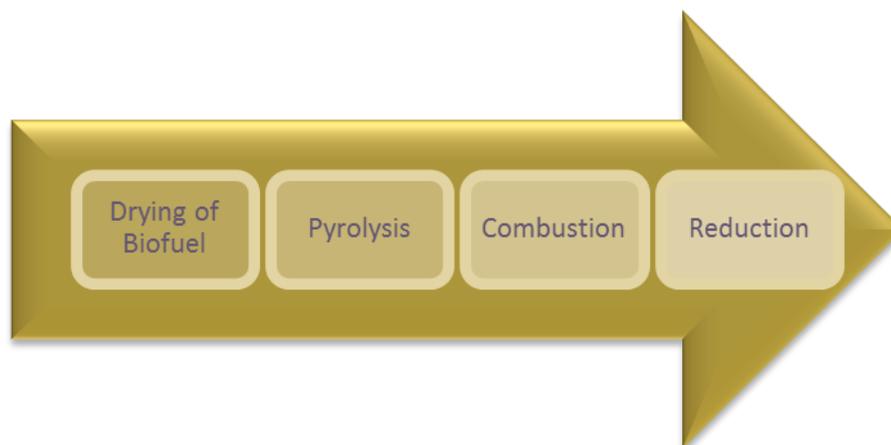


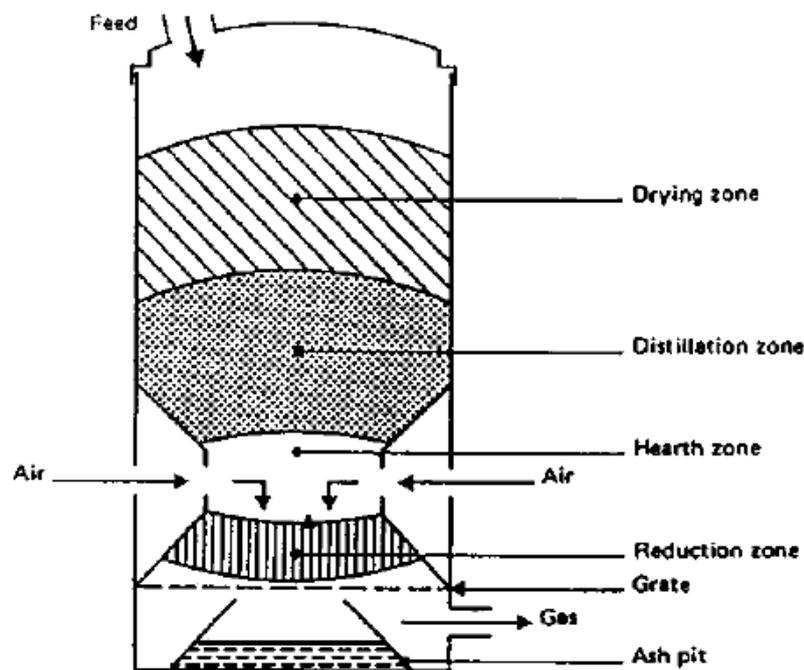
Diagram 1: Gasification Process

The source of this biofuel will be primarily from the 'Eua Forest Estate, which is operated by Tonga Forest Product Limited.

The proposed generation facility is biomass gasification equipment. This will be supplied by a Malaysian company Renewables Plus (RPL); and it is manufactured by Ankur Technologies of India<sup>1</sup>. The gasifier is essentially a chemical reactor where various complex physical and chemical processes transpire. The biofuel is dried, heated, pyrolysed, partially oxidised and reduced in this reactor as it flows through it.

In basic terms, gasification produces combustible gases from carbon containing materials which are dried woodchips in 'Eua's case. The biofuel (woodchips) is fed into a downdraft gasifier from the top, where it passes through a drying zone, a distillation zone, hearth zone, oxidation zone, reduction zone and grate (Diagram 2) to primarily produce Hydrogen and carbon monoxide (Producer Gas). Pyrolysis is achieved in the distillation zone at temperatures between 200 – 300 °C, where volatile gases and char are produced, which are used to reheat the gasifier. The primary products produced from the gasification process are hydrocarbon gases (producer gas), hydrocarbon liquids (oils) and char (carbon black and ash). The gas produced from the gasifier is cleaned to a purity that is optimal for internal combustion engines used to drive generators for electricity generation.

Diagram 2: The Gasifier and Gasification Process:



It is noted here that the Ankur Gasifier is designed so that the tars, a by-product from the pyrolysis phase are drawn through the Combustion phase, where these are broken down or burned. Thus, the energy they contain is recovered, and the mixture of gases in the exit stream is relatively clean.

The 'Eua facility will comprise of a single DD400 gasifier supplying a 250kW Cummins gas engine supplemented during the evening peaks by the existing diesel gensets. The gensets in 'Eua will be converted into dual fuel for the purpose of this project.

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<sup>1</sup> Tonga biofuel to electricity feasibility study and business case prepared for Tonga Power Limited (2013), East Harbour Energy, New Zealand

In a nutshell, the gasification system consists of fuel conditioning units, Gasifier, gas cleaning units and gas utilization units (Diagram 3).

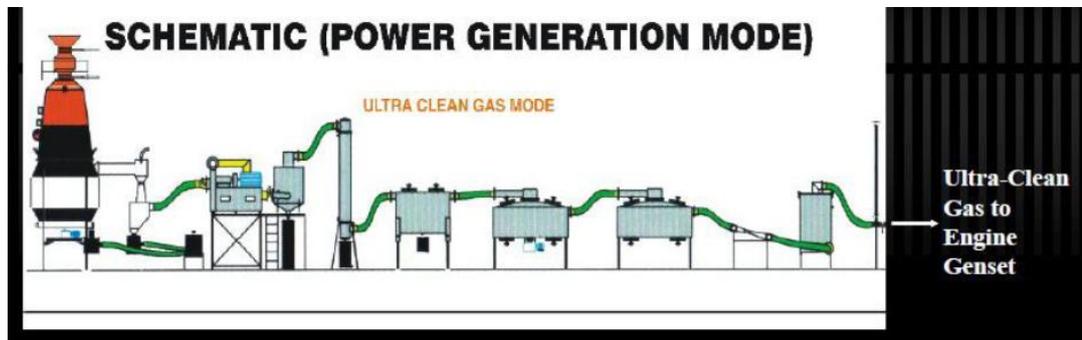


Diagram 3: Biomass Plant Schematic

The basic processes that take place in the biomass gasification plant and supporting equipment (Diagram 4):

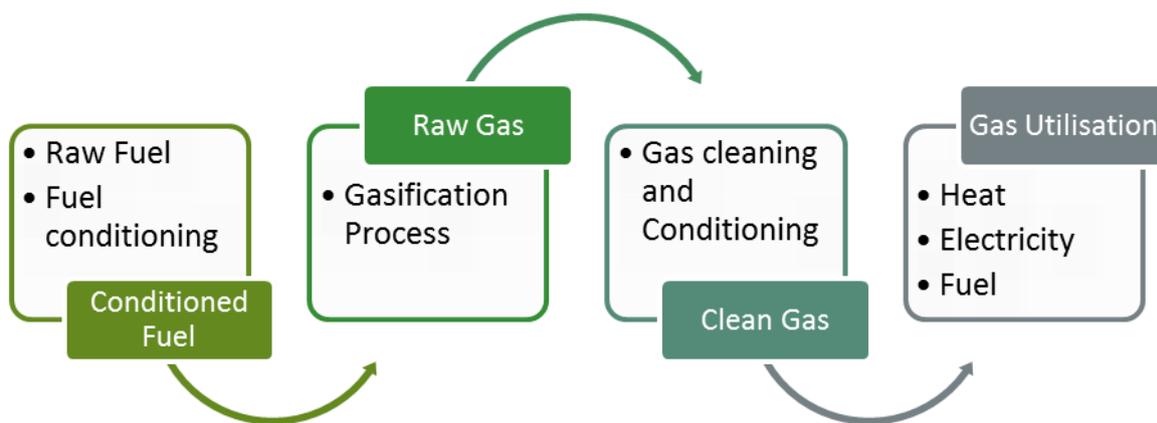


Diagram 4: Gasification Process

### 1.2.2 THE PROS AND CONS OF BIOMASS ENERGY

It should be noted that these are general points and may or may not be the case for 'Eua.

#### **Advantages:**

- Renewable: We will always have sources of biomass such as crops, manure and garbage.
- Energy dependent: Creates energy independence
- Carbon Neutral: Biomass is part of the carbon cycle. Carbon is absorbed from the atmosphere by plants during photosynthesis and when the plants decay or is burnt carbon goes back into the atmosphere. The next crops of plants will absorb that carbon over again, thus continuing the cycle. This is why biomass do not contribute to the global warming and biomass fuel is clean.
- Cost-effective: Biomass energy is inexpensive compared to coal and oil. Typically, they cost about a third of fossil fuels doing the same job.
- Abundant: Biomass is available in large quantities.
- Energy Storing: Unlike other renewable energy sources, biomass fuel can be stored and used to produce energy when needed.

#### **Disadvantages:**

- Expensive: Extraction of biomass can be expensive in some areas. Harvesting and storing of different types of biomass fuel can be expensive.
- Space Requirement: It needs large areas for different processes required in harvesting energy from biomass (especially areas for storage).
- Some materials are not available all year round, especially crop wastes.
- Geography of the country limits the types of biomass used to create energy.
- If overuse, than deforestation and other environmental problems can develop.
- Despite of biomass energy production being carbon neutral, it involves emission of other gasses that can be harmful. In specific biomass energy production, nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) are released and these cannot be reabsorbed by simply replanting the crop plants. So Green House Gases accumulate during production of biomass energy.

### 1.2.3 THE SITE FOR THE PROPOSED BIOMASS PROJECT:

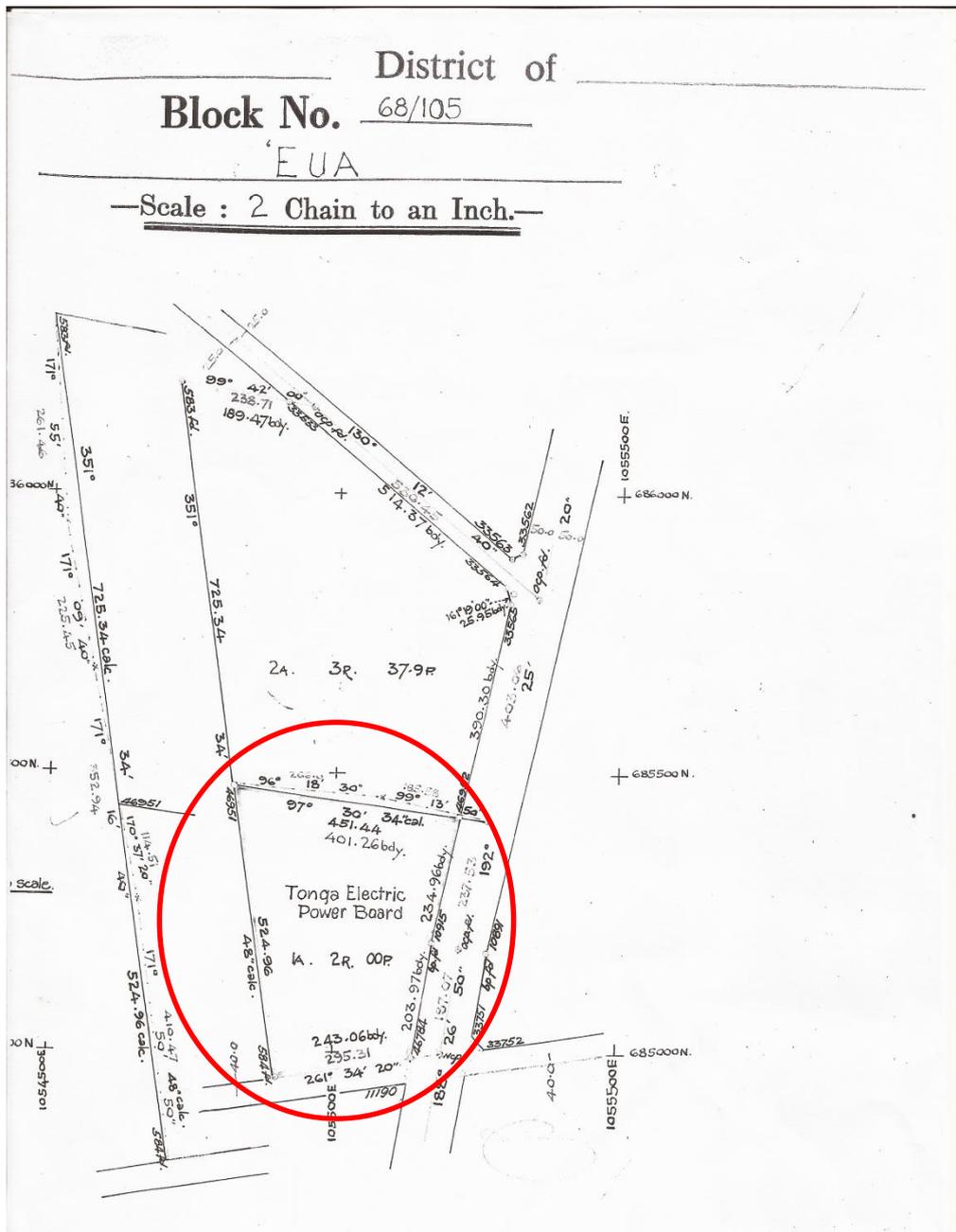
The Biomass Plant will be built on TPL's current power generation site at 'Ohonua, 'Eua.



Map 2: TPL Site at 'Ohonua, 'Eua

The subject land (Map 2) described as leasehold property with the following details:

Lease number:	4252
Lessee:	Tonga Electric Power Board
Lessor:	Government
Area:	1A 2R 00P or 6072m <sup>2</sup>
Purpose:	Residence, office, power station
Rental:	\$540/year
Period:	24/01/1980 – 23/01/2030
Location:	'Ohonua, 'Eua



Map 3: Survey Plan of the area concerned.

The land area required for this proposed biomass project are as follow: Gasifier Building 400m<sup>2</sup>; Engine Building 140m<sup>2</sup>; Biomass fuel storage 700m<sup>2</sup>. In total, the proposed built structure footing is approximately 1,240m<sup>2</sup>. However, given consideration to wood fuel storage (stock pile) and seasoning process, 2,500m<sup>2</sup> will be the ideal area required. The TPL leasehold (Map 3 and Map 4) is 6,072m<sup>2</sup>, which is sufficient land area to provide for the biomass plant.

#### 1.2.4 INPUTS: CAPITAL AND RESOURCES

The total cost for this proposed biomass project is NZD\$2.5 million. The table below shows the breakdown of this amount. In terms of monetary value, it is a huge investment, but in terms of its benefits to the people of 'Eua, it is a rational commitment by all partners, namely TPL and the government.

<b>Capital equipment costs for 'Eua (NZD\$)</b>	
<b>DD400 gasifier; 250kW Cummins engine</b>	
Feedstock handling bin drier (2)	\$57,468
Gasifier	\$472,640
Generation equipment (incl. engines)	\$209,941
Dual Fuel Conversion	Incl.
Hoist support	\$5,937
Balance of plant	\$95,396
Engineering & shipping	\$89,198
Installation commissioning & training (on-site)	\$169,166
Recommended spares	Incl.
Misc. office and O&M equipment	\$5,000
Fire protection (handheld & hoses)	\$5,000
Gas detection in engine room	\$3,000
Site lighting	\$5,000
Front-end loader	\$50,000
Civil/structural	\$554,014
Project management, validation & approvals	\$155,000
1% capital levy to Tonga Government	\$22,050
Water supply	\$10,000
Costs of connection to grid	\$198,132
RPL supervision 3 months (split 60% Tongatapu)	\$15,366
Contingency	\$312,452
<b>Total project cost</b>	<b>\$2,481,809</b>

The National Reserve Bank's exchange rate for the first week of December 2014 was 0.71 (NZD). Using this rate, the project will cost about TOP\$4 million.

#### 1.2.5 ASSESSED ANNUAL AND MAINTENANCE COSTS AND SAVINGS:

The diesel generation cost reduction is estimated at TOP\$ 774,000. However, the cost of operation and management will be TOP\$123,000, Wood Fuel TOP\$129,000, Staff (new) TOP\$125,000. This means that in 'Eua, the total saving for TPL is about TOP\$396,000.00. This is significant for an island like 'Eua.

### 1.2.6 THE CONSTRUCTION SCHEDULE:

Tonga Power biomass generation project schedule																																																				
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43									
Project approved	█																																																			
Contract finalised		█	█																																																	
Contract signed			█	█	█																																															
Procurement				█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█				
Fabrication					█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█			
Factory testing																																																				
Packing																																																				
Shipping																																																				
Civil construction																																																				
Installation																																																				
Fuel supply																																																				
Staff recruitment/training																																																				
Test & commission																																																				
Handover																																																				

The project is estimated to take 43 weeks from the date of formal approval to construction completion. However, the construction of the plant is estimated to take 10 weeks, plus approximately 7 weeks of installation. It is beneficial for the construction phase to be implemented outside Tonga’s cyclone and wet season to avoid unnecessary delays.

## 1.3 PROJECT JUSTIFICATION

### 1.3.1 BRIEF SITUATION ANALYSIS:

Tonga has special concerns that arise from its situation, and these drives national endeavours to use alternative energy, renewable energy.

- ❖ Tonga is environmentally vulnerable through climate change and sea level rise, particularly for the small and low-lying atolls;
- ❖ Existing environmental damages, habitat loss and pollution resulting from development and use of conventional energy sources have significant effects on Tonga’s fragile island ecosystems;
- ❖ Given the limited storage for bulk petroleum fuels, which are sourced over a long supply chain at relatively high prices, Tonga is vulnerable in terms of energy supply security;
- ❖ Tonga’s development of renewable energy resources has been limited by the availability of appropriate technology, poor institutional mechanisms, and the challenges of developing systems for small remote markets at reasonable cost;
- ❖ There is limited scope for market reforms considering the variation in size and density of markets; therefore, appropriate alternatives are necessary for Tonga.

### 1.3.2 ENERGY IN TONGA

To meet its energy requirements, Tonga is primarily dependent on costly imported diesel. The municipal electricity grid supplies approximately 98% of Tonga's energy, of which 94% is generated by diesel fired generators. However, 'Eua is totally dependent on diesel generation. In 2013, TPL used 12,941,465 litres of diesel for power generation. The cost of diesel to TPL in 2013 was around \$US19, 500,000.

Diesel used at 'Eua Plant			
Year ending	Diesel (litres)	TOP\$/litre (estimated)	Cost of Fuel (estimated) TOP\$
Oct-2014	317,034	\$1.847	\$585,561.80
Oct-2013	315,389	\$1.859	\$586,308.15
Oct-12	308,281	\$1.683	\$518,836.92
Oct-2011	313,886	\$1.730	\$543,022.78
Oct-2010	288,710	\$1.491	\$430,466.61

Table 2: Estimated cost of fuel for 'Eua Diesel generation plant

The 'Eua plant fuel consumption between 2010 and October 2014 is 1,543,300 litres, which about TOP\$2.6 million. In general terms, the fuel cost takes about two third of the income generated in 'Eua. Furthermore, if the operational costs are taken off, then the TPL in 'Eua is running at a loss.

Additional pressures of climate change, climate variability, increased frequency and intensity of natural disasters, and sea-level rise which have been compounded by the international fuel, food and financial crises. Tonga must adopt alternative sources of fuel such as wind, biofuel and solar.

In Tonga, biomass-fuelled electricity generation offers the only base-load renewable option for energy generation. It is established that biomass electricity generation is base-load and available at all times except for maintenance periods. The current diesel-fuelled electricity generation cost in 'Eua is about 75 *Seniti* but the cost displacement from biomass-fuelled electricity generation will be about 30 *Seniti*. This is significant given the fuel cost scenario described above.

The proposed NZD\$2.5 million biomass-fuelled electricity generation plant will require long-term biofuel (wood) supply. Further, it will create a sound economic basis for Tonga Forest Product Limited, as the primary wood and fuel supplier. The proposed project will create more jobs in 'Eua from the forestry operations, transport, and plant operation and maintenance. This is in addition to the predicted reduced diesel imports.

The establishment of what will be in Tonga a substantial business in the growing, harvesting and distribution of biomass, including the potential for a "cash for biofuel" for landowners. This is another progress towards achieving the TERM's goal of generating 100% of Tonga's energy needs through renewables by the year 2020. At the same instance, creating skilled jobs in the renewable energy generation.

### 1.3.3 BIOMASS (TFP) INTO BIOFUEL (TPL)

The primary source of biomass is the 'Eua Forest Estate, established in 1970s and managed by the Forestry Division (Ministry of Agriculture, Forestry, Fisheries, and Food) until 1987 through a New Zealand aid programme. This was then transferred to Tonga Timber Limited (TTL), and was operated as a fully commercialised timber estate.

Tonga Forest Products Limited (TFP) is a re-formation of the organization previously known as Tonga Timber Limited (TTL) and a return to its previous core activities of Forestry Development and production of quality wood products. Tonga Timber Ltd (TTL) has been a public enterprise since its incorporation in 1995. TFP is fully owned by the Government of Tonga.

In 2011, TTL underwent Board and Management change in an effort to recover and restore the business and seize immediate and long term opportunities. TFP identifies a new beginning and start. There is a solid construction industry and an increase in infrastructure development taking place in Tonga, with the advent of the new Government.

Potentially, the 'Eua Forest Estate has a sustained yield of about 5,000m<sup>3</sup> of logs per annum. However, only about 700m<sup>3</sup> of logs per annum are being harvested at present. The 'Eua Forest Estate has a monopoly position, as it is the only commercial-scale forestry resource in the kingdom. Further,

The biomass volumes were assessed and confirmed by Foley Nasome Associates that the existing supply at levels required for about 10 years. However, TFP has a new nursery established and re-planting has already begun under NZAid fund. The contract with TPL will further boost TFP's capacity to sustain the forest production.



Diagram 5: TFP logging

Based on Tonga Forest Products information, the following estimation was made:

- Logging Volume
  - Daily harvest of 54 crop trees, to the wharf.
  - Each log at 1.8 tonnes
  - Harvest portion is 1.35 tonnes (=72.9 tonnes per day)
  - Waste portion is 0.45 tonnes (= 24.3 tonnes per day)
    - **24.3 tonnes of wasted wood chip per day**

- Waste regenerated trees cut

2 from every crop tree (weight approx. 0.392 tonnes)

54 crop trees x 2 waste trees = 108 waste trees

**108 x 0.392t = 42.33 tonnes of waste per day**

**Total = 66.63 tonnes of waste per day.**

Potentially, the biomass plant should have about 66 tonnes of biomass fuel each day that the TFP production is in full production.

The annual harvesting production for 2014 (Jul13 –Jun 14) was 5,032 m<sup>3</sup> (60% of total volume tree). For 2015, TFP anticipates that the harvesting production will increase to 8,000 p.a. – 9,000m<sup>3</sup>p.a. However, provided that (TDB) funding for new equipment will be available next year (2015), then harvesting production will increase to 12,000m<sup>3</sup>p.a, which is slightly above the annual sustainable cut for 'Eua. It should be noted that these figures does not factor in the waste wood in the forest after harvesting, which is about 40% of the total forest volume.

Given the characteristics of the biomass fuel namely, moisture level, contamination, CV and other combustion characteristics, the biomass fuel will have to be seasoned, chipped, and dried prior to being used (gasification). This is to ensure that the quality is satisfactory. Further, biomass fuel will be stock piled (buffer stock) under cover storage on site.



## 1.4 EIA REQUIREMENT

### 1.4.1 NATIONAL LAWS AND POLICIES

The Environmental Impact Assessment Act 2003 requires that any significant development must be accompanied by an Environmental Assessment.

The Tonga Strategic Development Framework (TSDF) provides the guiding principles and directions to direct the work of the current administration (2011-2014). The Government's vision is to develop and promote a just equitable and progressive society in which the people of Tonga enjoy good health, peace, harmony and prosperity, in meeting their aspirations in life.

Among the nine outcome<sup>2</sup> objectives described, the following four are relevant:

1. Strong inclusive communities, by engaging districts/villages/communities in meeting their prioritised service needs and ensuring equitable distribution of development benefits.
2. Dynamic public and private sector partnership as the engine growth by promoting better collaboration between government and business, appropriate incentives and streamlining of rules and regulations.
3. Appropriate, well planned and maintained infrastructure that improves the everyday lives of the people and lowers the cost of business, by the adequate funding and implementation of the National Infrastructure Investment Plan.
7. Cultural awareness, environmental sustainability, disaster risk management and climate change adaptation, integrated into all planning and implementation of programmes, by establishing and adhering to appropriate procedures and consultation mechanisms.

Table 4: The relevant environmental legislations/policies and responsible Agency:

Responsible Agency	Existing Laws/Policies
<b>Ministry of Environment and Communication</b>	Environment Impact Assessment Act 2003 Renewable Energy Act 2009
<b>TERM-Unit</b>	Tonga Energy Road Map 2011-2020
<b>Ministry of Lands and Natural Resources</b>	Land Act 1927
<b>Planning and Urban Management Agency</b>	Spatial Planning and Management Act 2012
<b>Electricity Commission</b>	Electricity Act 2007
<b>Ministry of Commerce, Tourism and Labour</b>	Price and Wages Control Act 1988 Petroleum Act
<b>Ministry of Agriculture, Forestry, Fisheries and Food</b>	Forestry Act

<sup>2</sup> TSDF 2011-2014, 8p

## 1.4.2 INTERNATIONAL AND REGIONAL ENVIRONMENTAL AGREEMENTS

In 1998, Tonga ratified three important international conventions namely; the United Nations Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), and the United Nations Convention to Combat Desertification (UNCCD). Hence, Tonga has obligations under each of these conventions to take positive actions to implement the requirements of, and its obligations under each convention. Tonga's obligations include the following responsibilities:

- To undertake national biodiversity and conservation planning
- To identify and monitor biodiversity and its conservation
- To establish conservation and protected areas management
- To raise understanding and awareness
- To utilise EIA for biodiversity conservation
- To prepare national communication
- To develop climate change programmes
- To promote sustainable management
- To prepare plan and strategies to combat desertification and mitigate drought

The Ministry of Environment and Communication (MEC) is the Government authority and has the responsibility to administrate and implement these conventions.

## 2 BASELINE CONDITIONS

### 2.1 THE PHYSICAL ENVIRONMENT

Tonga lies in the trade wind zone of the South Pacific with sub-tropical rather than tropical climate. In General, Tonga's climate is characterised by prevailing wind of south-easterly winds, warm temperatures throughout the year. There is a slight cool season between the months of June to October with a mean temperature of 24.5°C, and a rather hot and humid season from November to May with a mean temperature of 29°C. The cool season runs from June to October and the warm or summer season runs from November to May.

The spread of two general types of small islands over a considerable ocean area means that rainfall varies temporarily and spatially. The period between the months of December to April are the wettest and from June to August the driest. This is a common scenario with the heaviest rainfall during the hot season but it varies from year to year and between the northern and the southern islands. These are further influenced by the El Nino and La Nina phenomena. Niuatoputapu in the north has an average rainfall of about 2540 mm while Tongatapu in the south has an average of 2032 mm per year. Unfortunately, there is lack of climatic data collected at 'Ohonua ('Eua).

However, the average rainfall is 1685mm, with a range of 1100mm to 2222mm<sup>3</sup>. However, others have estimated the mean rainfall to be 2700mm<sup>4</sup>.

Tonga's prevailing winds blow from the easterly quadrant (southeast -east) 7-9 months of the year. However, mean wind speeds are generally low (6-8 m/s); and gale force winds are infrequent, being mostly associated with tropical cyclone. Tonga's location puts it well within the 'hurricane belt' in the Southwest Pacific; consequently it experiences severe weather systems, averaging one tropical cyclone per year. Cyclone activities mostly occur during November to March when the sea is warmest. Wind damage can also affect the foliage of root crops, which are usually inter-cropped. Climatic hazards mainly cyclones and droughts, are not uncommon in Tonga and pose problems for a country dependent on agriculture. It is not clear what impact climate change will have on 'Eua, but greater variability is expected in cyclones and high rainfall. Also, there is marked increase of 0.4°C – 5.8°C in annual mean temperature throughout the kingdom since the 1970s. However, very little evidence that there is any increase in tropical cyclones in Tonga as of date.

## 2.2 GEOLOGY, TOPOGRAPHY AND SOILS

Distinctively among the kingdom, 'Eua has high relief, rising gently from the west coast as a series of three well-defined terraces to a flat-top ridge (western ridge), which follows the curvature of the coast at a height of 120m. The higher ridge has a maximum height of 312m, and this extends along the entire eastern side of 'Eua. From this ridge, the land falls in a series of narrow but steep terraces to the eastern coast.

'Eua is a raised coral island with volcanic core, the landscape has solution and collapsed sinkholes, one of which is well known sinkhole, the Matalanga 'a Maui<sup>5</sup>. However, there are limestone pinnacles and irregular drainage patterns, stream channels are deeply incised in steep-walled channels. In fact, 'Eua is the only island in Tonga with a flowing stream.

The basement geology of 'Eua is described by Hoffmeister (1932) and Tappin and Balance (1994). The island has a core of Eocene-age (46-40 Ma) volcanic rocks that form exposed outcrops along the eastern ridge and cliffs. It is overlain by Eocene foraminiferal and algal limestones which also form outcrops along the eastern ridge. In turn, this is overlain by Miocene volcanoclastic rocks on the eastern ridge, the western slopes, and the central valley. Overlying all the older rocks is Pliocene to Quaternary coral reef limestone that comprises most of the western ridge and central valley, and some minor terraces along both eastern and western coasts.

Most gentle sloping and flat surfaces, including the TPL site, are mantled by andesitic tephra ranging from 0.5m - 2m deep. The presence and impact of andesitic tephra across the coral islands are beneficial. 'Eua has three main soil series, with seven units known, most of which are formed in andesitic tephra between 0.2m-2m deep overlying coral reef limestone or basic volcanic rocks.

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<sup>3</sup> Meteorology Service data

<sup>4</sup> Drake et al. (1996)

<sup>5</sup> Legend tells that this impressive sinkhole was formed when Maui thrust his digging stick into 'Eua and pulled it back and forth in anger of his mother.

However, the soils on the higher terraces are more developed than those on the lower terraces. It is common knowledge in Tonga that 'Eua has good soils. The soils of 'Eua have high clay content, moderately to strongly structured, with medium to high porosity.

The only island with perennial streams in Tonga is 'Eua. This originates from springs in caves on the eastern ridge. In fact, there are several small streams, all drain to the west namely, Hafu, Heke and Telea streams join and flow to the coast at 'Ohonua. The rest of the streams drain to the valley before disappearing below the surface. These streams lower reaches are deeply incised below the limestone ridges. The surface water drains to underground caves and stream systems that interconnect. These include Fern Gully, Saa, Matavai, Ana Pekepeka which are used for public water supply.

## 2.3 THE VEGETATION

### 2.3.1 TONGA FORESTS

There is very little indigenous forest left in Tonga. Nationally, the remaining indigenous forest is in pockets in steep and inaccessible areas, coastal zones, and swamps. The estimated remaining forest area is less than 4,000ha, and much of this on 'Eua. The distinct geography of 'Eua namely, unusual elevation (312m a.s.l.), relatively large area (81km<sup>2</sup>), age (Eocene), sharp relief, deep andesitic soils, and volcanic core, combined to produce a forest that is different from neighbouring islands.

Much of the kingdom's vegetation had been modified, and endemic plants are becoming rare. However, 'Eua still has a good percentage of its natural forest, along the eastern side of the main ridge. The main cause of forestry loss is the human activity, and some are due to natural causes. Native plants disappear due to:

- monetisation of certain plant value;
- loss of habitat;
- competition from invasive species;
- herbivory;
- abandonment of cultigens; and
- natural rarity.

The introduction of commercial land use mid-1900s; and the rapid expansion of agriculture between 1980s-1990s saw much of the western slopes cleared. Thus leaving primary and secondary forest confined to inaccessible pockets on the western side; and mainly on the eastern ridges and cliffs on the eastern side of the island.

### 2.3.2 THE TONGA POWER LIMITED 'EUA SITE

The Tonga Power Limited generation plant is on the outskirts of 'Ohonua, fronting the main road that connects the main township of 'Ohonua and majority of the settlements in the south of the island.

The TPL subject land described as leasehold property with the following details:

Lease Number: 4252  
Lessee: Tonga Electric Power Board  
Lessor: Government  
Area: 1A 2R 00P or 6076m<sup>2</sup>  
Purpose: Residence, office, power station  
Rental: \$540/year  
Period: 24/01/1980 – 23/01/2030  
Location: 'Ohonua, 'Eua

Open Area for  
Biomass Plant



Diesel Fuel  
Depot



Staff Residence

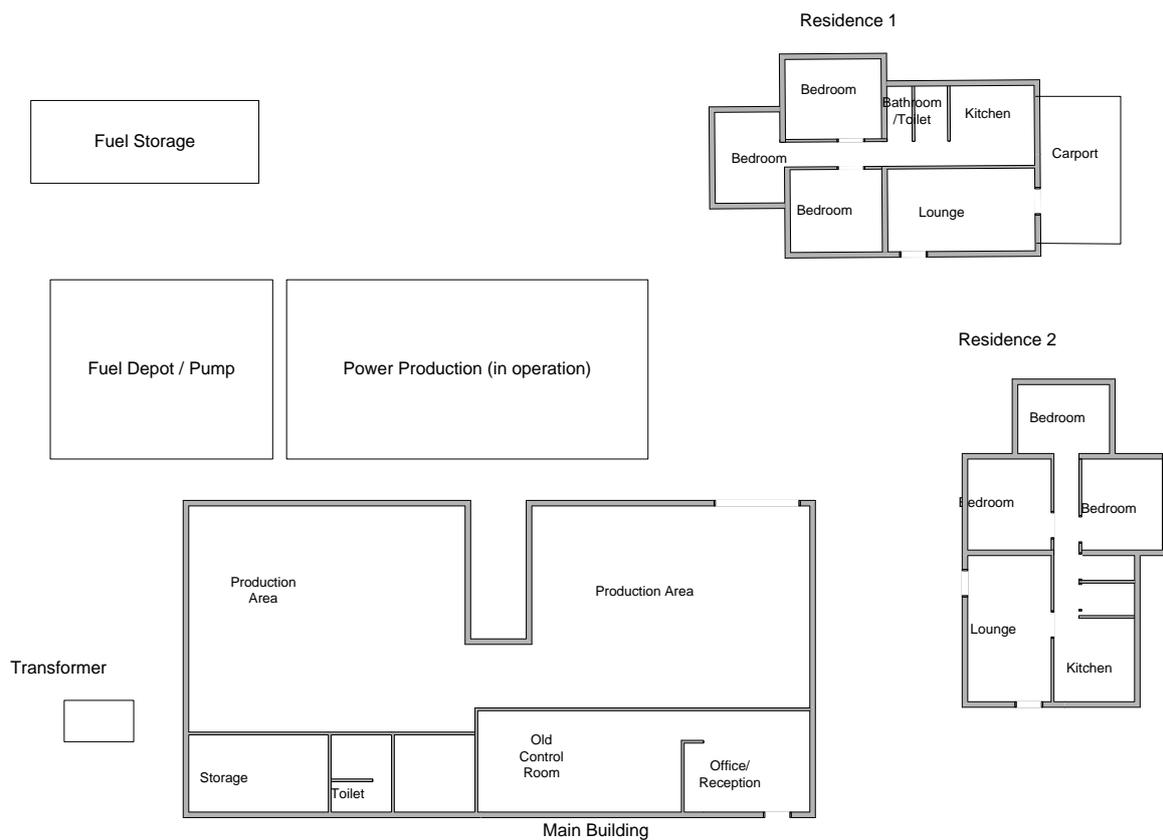


Main Office



Generators

Map 6: TPL Built structures (Floor Plan)



This industrial building is comprised of an office space (reception area); storage of the expired generators; and toilet facilities providing the approximate floor area of 178m<sup>2</sup>.

The constructions including concrete floor; concrete tilt panel/block walls, corrugated iron roof, roller shutter doors; toilet amenities and plumbing services.

In addition, are detached transformer concrete slab of 6m<sup>2</sup>; a containment slab for generator of 105m<sup>2</sup>; slab for an expired oil depot of 36.5m<sup>2</sup> plus a 64m<sup>2</sup> reinforced mass concrete bund for an operating oil depot. Further on the site are the staff's two residential dwellings, each comprised of three bedrooms, kitchen, lounge and bathrooms.

General residential constructions including concrete floor, concrete block walls, corrugated iron roof, louver windows, tiled flooring, and soft board ceilings.

Other Improvements:

The leasehold had been heavily filled and compacted to level, fully fenced, with a gravel filled driveway.

Condition:

As at inspection date (4<sup>th</sup> – 5<sup>th</sup> December 2014), the improvements are generally presented in fair condition.

### 2.3.3 THE BIOMASS SOURCE: TFP FORESTRY PLANTATION

Like TPL, TFP is another state owned enterprise that charged with commercial operating of the 'Eua Forest Estate. The plantation development began mid-1970 with New Zealand Aid fund and seconded personnel from the New Zealand Forest Service. The original plantation was under the Forestry Division, MAFFF, and transferred to Tonga Timber Limited in 2003. Due to management and lack of performance, the plantation is now with the new SOE, Tonga Forest Product.

The forestry estate area is about 719ha in total, but not all is utilised for the plantation.

Land Management Area	Area (ha)
Production - Uncontrolled	316
Production - Controlled	182
Protection – No Harvest	67
Watershed – No Harvest*	138
Others**	16
<b>Total</b>	<b>719</b>

\* includes the Kolomaile core water supply area & the incised Heke and Hafu streams

\*\*includes nurseries, quarries, telecommunication sites etc.

The main species in the plantation are Paini (*Pinus Caribaea*), Sita kula (*Toona ciliata*), mahokani (*Sweetenia macrophylla*), Kauli (*Agathis robusta*), pulukamu (*Eucalyptus spp*), and Ahi (Sandal-wood or *Santalum yasi*).

It is noted here that the most significant impact of recent time is from the sandalwood trade. The ahi has been harvested to a dangerous level in 'Eua, sometimes this is done illegally. However, some community programmes have initiated and distributing seedlings for the people to grow in their own allotments.

## 2.4 THE POPULATION AND SETTLEMENT

### 2.4.1 THE POPULATION OF 'EUA

The population of 'Eua in the 2011 census preliminary report was 5,011. This is a decrease of 3.7 percent from the 2006 (5,206) and an average annual rate of growth of -0.8 percent. 'Eua is only about 4.8 percent of the national population.

Naturally guided, 'Eua is composed of two districts, namely 'Eua Motu'a (Original Settlement) and 'Eua Fo'ou (Modern-day Settlement). Historically, 'Eua Motu'a settlements were the original communities which include 'Ohonua, Ta'anga, Tufuvai, Pangai, Houma, and Kolomaile (Ha'atu'a). 'Eua Fo'ou comprises of Angaha, Futu, 'Esia, Sapa'ata, Fata'ulua, Mu'a, Tongamama'o, Petani, and Mata'aho.

	2011				2006				1996			
	Households	Male	Female	Total	Households	Male	Female	Total	Households	Male	Female	Total
'EUA	865	2,500	2,511	5,011	899	2,702	2,504	5,206	820	2,624	2,310	4,934
'Eua Motu'a	506	1,435	1,420	2,855	515	1,562	1,387	2,949	455	1,492	1,274	2,766
'Eua Fo'ou	359	1,065	1,091	2,156	384	1,140	1,117	2,257	365	1,132	1,036	2,168

Table 5: District Population

It is clear that the proportion of population per district is relatively the same over the last two decades, 57 percent ('Eua Motu'a) and 43 percent ('Eua Fo'ou). However, two noticeable changes are; the negative annual growth rate resulting in a decreasing population for 'Eua, and that 'Eua Fo'ou seem to decrease at a slightly faster rate than 'Eua Motu'a. The latter reflects the higher emigration rate in 'Eua Fo'ou.

During the 2014 Parliamentarian Review<sup>6</sup> trip to 'Eua, the people raised 37 matters for consideration. These ranges from community level to government level, and will require various financial and political commitments. For the purpose of this report, the matters raised were categorised and the most concerns were to do with water, roads, education, electricity tariff, health (hospital), and government administration and fees.

In parallel, the community participatory planning process implemented by MORDI<sup>7</sup> presented a more detailed presentation of the community needs. The following table presents a brief generalisation of the most 10 prominent issues of community concerns/needs out of 33:

	Concerns/Needs Raised	Number of Communities out of a total of 14 communities
1.	Road Network (Poor)	14
2.	Water Supply (poor reticulation lines, water pump)	14
3.	Street Lights (non-existent or inadequate)	14
4.	School (Poorly equipped especially for digital technology, library, classrooms, teachers)	13
5.	Community reserve/playground/youth sports equipment	13
6.	Community Hall / Youth Hall	12
7.	Community and Youth Agricultural tools & machineries	12
8.	Neglected unoccupied homes/allotments	11
9.	Roaming/stray Animals	11
10.	Toilets (in-house, flush)	9

Table 6: Community Needs

The concerns about the electricity tariff (Parliamentarian Report); and the Street Lights and Road concerns (MORDI Report) are relevant for this project.

<sup>6</sup> Lipooti 'a e Vahenga 'Eua 2014

<sup>7</sup> Community Participatory Planning; Formulating of Community Development Plans for 'Eua Island: Raw Data. July 20-29, 2014. Mainstreaming of Rural Development Innovation (MORDI) Tonga Trust

#### 2.4.2 THE TPL LAND AND SURROUNDING LAND USE

The surrounding land allotments comprised of free-standing residences, and tax allotments. However, all tow amenities are accessible to the subject property. The buildings in this locality are of average to above-average quality. In fact, 'Ohonua is the capital town; and it where the Government services, commercial businesses, all levels of schooling, and utility companies are situated.

The surrounding tax allotments are either lay in idol or used as agricultural farming for subsistence purposes and sell at local market. It is common practice among 'Eua farmers to do multiple cropping system of shifting cultivation.

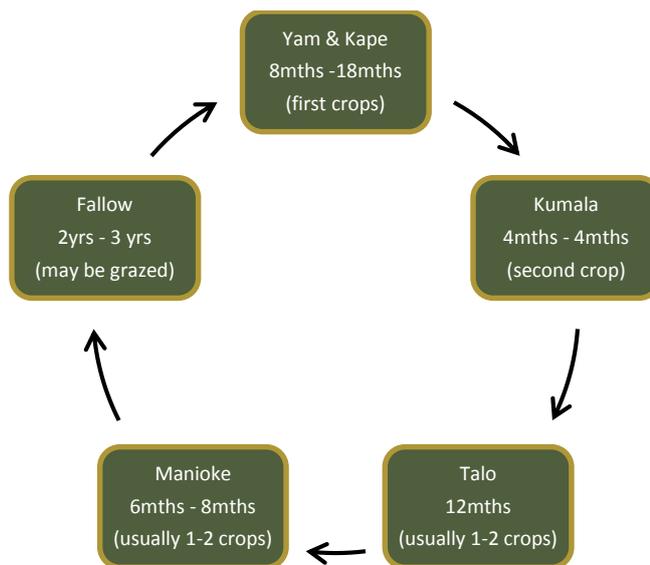


Diagram 6: Typical crop cycle

The cycle starts with land clearing (land preparation) that involves manual labour and/or machinery depending on the crop type, character of and size of the land required.

#### 2.4.3 CULTURAL USES OF PLANTS

Although uncommon within the vicinity of the TPL land, there are other uses that are necessary to mention here.

Some plants have medicinal value, namely Hehea, Toi, Fao, Manonu, Lekileki, Masikoka, Uhi, Telie, etc. However, most of these are found in forestry areas and not in the immediate vicinity of the TPL land. Further, firewood is another use of tree products, although there is an increasing trend of using LPG for domestic uses. 'Eua, in recent years, has become a supplier of large quantities of fuel wood for Tongatapu.

Tapa making is an important cultural product, and the dye is from the koka trees (*Bischofia javanica*) are used to paint traditional designs on tapa. Some mangrove species are also use for this purpose. Tongan oil, virgin coconut oil perfumed with natural flower saps, uses native trees such as Langakali (*Aglaia saltatorium*) and Mohokoi (*Gananga odorata*). For decoration purposes and customary dancing costumes, plants such as Heilala (*Garcinia sessilis*), Puatonga (*Fragaea berteria*) and Sialetonga (*Cardinia toitensis*) are used.

Some plants are also used for medicinal purposes including but not limited to, Uhi (*Euodia hortensis*), Manonu (*Tarena sambusina*), Nonu (*Morinda citrifolia*), Lekileki (*Xylocarpus gradatum*), and Hehea (*Syzygium corynocarpus*). It was noted that there is strong decline in the availability of these plants within the immediate locality of the settlements.

#### 2.4.4 TOURISM

‘Eua tourism is primarily based on low impact activities with trekking as the main activity. Uniquely among Tonga’s island groups, the ‘Eua focus is on eco-tourism experience that includes the whole environment of ‘Eua. In this case, the National Park, the ‘Eua Forest Estate (TFP), and the Royal Estate Forest are important components of the eco-tourism product. These estates form the only natural terrestrial ecosystems that remain in ‘Eua.

#### 2.4.5 ‘EUA WATER SUPPLY

The ‘Eua Watershed has been defined to protect water sources contributing to the Saa, ‘Ana Pekepeka, Matavai Caves and the Fern Gully Stream from contamination (mineral, chemical and biological).

### 3 ENVIRONMENTAL IMPACT ASSESSMENT

#### 3.1 OVERVIEW

In utilising land, regardless of purpose and type of use, there is always some environmental impact. The severity of such impact may range from insignificant to severe. Tonga Power Limited’s proposed location for the biomass plant is its existing leasehold on the fringe of ‘Ohonua. However, this site has been utilised for power generation for more than 30 years. However, the TFP sawmill, the source of the biomass fuel is at Kolomaile. However, I have found minimal concerns on the proposed biomass plant at the TPL site.

The potential environmental impacts considered in the following section are:

##### **Physical Environment**

- Soil compaction from use of heavy machinery

- Loss of top soil during land preparation for construction (limited to plant footing)

##### **Habitat, Flora and Fauna**

- Minimal loss of flora and fauna (as the existing site is only covered with grass)

##### **People and Community**

- Noise and dust nuisance

- Health and Safety

- Employment

- Affordable tariff

##### **Environmental Quality**

Waste Management  
Green House Gas emission  
Handling of chemicals, fuels, and lubricants

**Cumulative impacts**

By-products  
Life-cycle Global Warming Emissions

## 3.2 PHYSICAL ENVIRONMENT

The TPL site terrain is flat with easy rolling behind the leasehold. The TPL land had been cleared and currently just grassland.

### 3.2.1 SOIL COMPACTION

The soils within the locality have moderate to strong physical structure, making them relatively resilient to machineries traction. However, high activity within set boundaries will result in soil compaction. Utilising of heavy machinery during construction and operation (biomass transport) will lead to soil compaction.

### 3.2.2 LOSS OF TOP SOIL

Currently, the open area for the proposed plant is grassland. Expansion of built area and access roads within the TPL compound for the new plant will mean loss of top soils.

## 3.3 HABITAT, FLORA AND FAUNA

Flora: There will be no loss of flora within the TPL site.

Fire: Although highly unlikely, fire could be catastrophic to the adjoining properties.

Fauna: There is no specie that was both endemic and endangered both at TPL site and TFP production site. However, it was evident in 'Eua that human activity is the major threat to sustainability of forest resources.

The risks from human activity are not confined to the TPL developments; and iconic birds and lizards face these all around the island. Unlike most inhabited islands in Tonga, 'Eua has rodents and feral cats and pigs that is an ongoing issue. This is in parallel to the domesticated pigs roaming around villages like 'Ohonua.

## 3.4 PEOPLE AND COMMUNITY

### 3.4.1 NOISE AND DUST NUISANCE TO THE COMMUNITY

Noise and dust disturbance will be imminent during the construction phase. However, the noise will continue on to the operation phase. Given the elevation and proximity of the TPL site to the 'Ohonua settlement, some people may be annoyed.

### 3.4.2 HEALTH AND SAFETY

It is noted here that environmental safety also involves people's health and safety in the workplace. Unfortunately, Tonga does not have a particular law like the Health and Safety in the Workplace Act in New Zealand. However, TPL has a high standard code of practice in its operations.

### 3.4.3 EMPLOYMENT

TPL is currently employing 9 in 'Eua, and with the proposed biomass plant, this number may increase to 14. Furthermore, increasing demand for biomass may mean more employment at the TFP production sites.

## 3.5 ENVIRONMENTAL QUALITY

### 3.5.1 GREEN HOUSE GAS EMISSION

Machinery use will be a long term but small emitter of greenhouse gasses that can only be mitigated by sensible use of vehicles and other machineries during operation.

Despite of biomass energy production being carbon neutral, it involves emission of other gasses that can be harmful. In specific biomass energy production, nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) are released and these cannot be reabsorbed by simply replanting the crop plants. So Green House Gases accumulate during production of biomass energy.

### 3.5.2 WASTE MANAGEMENT

The issue at the TFP milling with saw dust and cut-offs accumulation, will be addressed by utilising such wastes as biomass fuel for TPL.

### 3.5.3 HANDLING OF CHEMICALS, FUELS, LUBRICANTS

TPL has a safety standard for handling chemicals, fuels and lubricants on-site. This quite important as there is a slope and a small gully behind the TPL site, so any chemical spill must be contained and cleaned properly.

## 3.6 CUMULATIVE IMPACTS

### 3.6.1 GASIFIER BY-PRODUCTS

#### 3.6.1.1 BIOCHAR

It is estimated that between 7% - 12% of the dry weight of the biomass fuel will be converted into biochar. This could be about 150 tonnes per year for the 'Eua plant. Fortunately, this material is considered a valuable soil conditioner that promotes growth and enhancing soil quality. However, this may need to be stored for a period of time so that volatiles can disperse before being used.

The biochar can also be re-used as gasifier fuel. The biochar 'chunks' can be fed directly into the fuel stream, and the biochar 'fines' can mould into briquettes with sawdust as a binder.

#### 3.6.1.2 TAR

Ankur systems advise that most of the tar is cracked in the process, therefore only a small amount passes through to the gas-cleaning modules.

#### 3.6.1.3 LIQUIDS

The Ankur system requires water for cooling and gas cleaning. A water treatment system is required in case there is a need to neutralise the small volume of water discharge from the plant.

### 3.6.2 DECLINE IN FOSSIL FUEL COST

The use of biomass fuel to generate electricity will reduce the usage and dependent on diesel. Thus saving fuel costs and also reduces GHG emission.

### 3.6.3 GLOBAL WARMING EMISSIONS

The global warming emissions are associated with growing and harvesting of biomass feedstock, transporting of biomass fuel, and burning and gasifying the biomass fuel. Transportation emissions are roughly similar for all types of biomass. However, there is a wide range of warming emissions from the sourcing of biomass fuel vary widely. Although that there are some biomass fuel sources associated with increased global warming; it is though that the 'Eua biomass has net zero global warming emissions. It is prudent for TFP to be vigilant in managing their harvest and regrow plans in accordance with their EMP.

## 3.7 IMPACTS SUMMARY

The main points to note with regard to the 'Eua Biomass Plant are:

### **Beneficial Impacts**

- A number of beneficial impacts have been identified , particularly with 'Eua people and communities (employment, potential tariff reduction)
- Renewable energy has become a part of the social, economic and political landscape; and it is a national strategic priority

- There are long-term benefits to the local community in terms of employment, new opportunity for biomass fuel market. At the same time, biodiversity and water catchment protection at the 'Eua Forest Estate

### Adverse Impacts

- In terms of the physical environment (erosion, soil compaction), on flora and fauna (fire), people and community (noise and dust, health and safety), and on environment quality (greenhouse gas emission, wastes, water, chemicals). These have been carefully assessed as either not significant or low significant. Noting that some of these are a direct consequence or normal operations, while others may only arise in the event of an accident. Overall, these adverse impacts can be avoided or reduced or managed through a risk management and mitigation measures.

Impact	+/-	Type	Duration	Frequency	Scale	Mitigation	Probability	Significance
<b>Physical Environment</b>								
Erosion (soil)	-	D	S	C	L	NA	L	L
Soil compaction	-	D	L	O	L	NA	M	L
<b>Habitat, Flora, and Fauna</b>								
Habitat	-	I	L	R	L	Y	L	L
Flora	-	I	S	R	L	Y	L	L
Fauna	-	I	S	R	L	Y	L	L
Fire	-	D	L	R	L	NA	L	H
<b>People and the Community</b>								
Noise & Dust Nuisance	-	D	S	O	L	P	H	M
Health & Safety	-	D	L	O	L	Y	M	H
Water	-	D	L	O	L	Y	L	M
Employment								
<b>Environment Quality</b>								
Greenhouse Gas	-	D	L	O	L	Y	M	H
Water Discharge	-	D	L	O	L	Y	L	M
Handling of Chemicals, Fuel, Lubricants	-	D	L	O	L	Y	L	L
<b>Cumulative Impacts</b>								
By-products	-	D	L	O	L	P	L	L
Fuel (Diesel)	+	D	L	O	N	P	M	H
GHG	-	D	L	O	G	Y	H	H

+/- Beneficial or Adverse  
 Type Direct (D), Indirect (I), Secondary (S)  
 Frequency Construction (C), Continuous during Operations (O), Periodic (P), Rare (R)  
 Scale Local (L), National (N), Global (G)  
 Ease of Mitigation Yes (Y), Partial (P), No (N), Not Applicable (NA)  
 Probability of Occurrence Low (L), Medium (M), High (H)  
 Significance Not Significance (NS), Low (L), Medium (M), High (H)

## 4 ENVIRONMENT MANAGEMENT PLAN

### 4.1 INTRODUCTION

This sets out how adverse impacts could be managed and during construction and operation in order to minimise effects on the environment and the local communities. It should be noted that this is the first time that such consideration is seriously acknowledged over the history of the 'Eua power generation plant.

### 4.2 ADMINISTRATIVE ARRANGEMENTS

Tonga Power Limited retains overall responsibility for the construction and operation of the Biomass plant. The Chief Executive Officer of Tonga Power Limited will take responsibility for the environmental management; and will employ special technical environmental expert consultant(s) as required for particular incidents that impact upon the environment and routine monitoring and reporting.

The Tonga Power Limited staff, specifically the Manager and staff at the TPL 'Eua site, and all subcontractors has responsibility for environmental management and mitigation. The safety of the public and the environment is paramount.

The Ministry of Environment and Communication as the regulatory agency will ensure compliance with the EIA code.

### 4.3 MITIGATION AND MONITORING PLAN

#### 4.3.1 MITIGATION PLAN

The proposed mitigation and monitoring are as follow:

#### **During Construction**

- Construction Programme to be done during standard working hours
- Avoid the wet season
- Create a Health and Safety Management Plan and adhere to it
  - Employ experienced operators, adequate signage and protection barriers and the use of correct personal protective equipment (PPE)
  - Damage caused by vehicles must be controlled
  - Managing wastes is important
  - TPL be secured and entries be managed at all times

- Work with the 'Eua communities; utilising available labour and resources

#### **During Operation**

- TPL's Health and Safety and Environmental policies will apply
- TFP will maintain its Code of Harvesting & 'Eua Forest Business Plan 2
- Incorporate dry gas cleaning technologies to reduce emission impacts
- Plant tall trees as 'wind breaker' around the boundaries of the TPL site; to mitigate both noise and dust nuisance. This may also curb wind-blown wood chips

### **4.3.2 MONITORING PLAN**

#### **4.3.2.1 DURING CONSTRUCTION**

- Daily site inspection by supervisors to observe the progress of work, and implementation of environmental, and health and safety mitigation tasks

#### **4.3.2.2 DURING OPERATION**

- Daily site supervision to ensure compliance by workers with the requirements of their task
- Monthly compliance inspection by TPL manager to ensure implementation of environmental, and health and safety mitigation measures; and adhere to the operation and maintenance instruction of the manufacturer
- Quarterly inspection by TPL HQ (and or independent consultant) to ensure adherence to the operation code. The result of this, will be discussed with the manager and any corrective action to be implemented

### **4.3.3 ENVIRONMENTAL MANAGEMENT AND HEALTH TRAINING NEEDS**

- TPL to institute a training programme for their staff including environmental management and health and safety
- Task training relating to particular tasks (e.g. site safety, working in the DD400 plant, transportation (trucking), communication, fork-lift/loader operation, general safety awareness and using of safety equipment, fire hazards and emergency procedures, hazards pertaining to chemicals, fuel, by-products, and site security
- Pollution control: Training on oil-spill and use of PPE
- Training on operating the DD400 by representative of the manufacturer (e.g. operation, servicing, maintenance of the plant)

## 5 PUBLIC CONSULTATION

### 5.1 HOUSEHOLD SURVEY

A sample survey was carried out on Thursday 4<sup>th</sup> and Friday 5<sup>th</sup> of December, 2014 in 'Eua.

#### 5.1.1 HOUSING

Most of the participants have lived in 'Eua since the 1950s, and only a few settled there in the last two decades. The number of people per household reflects the national figure which is about 6 people per family unit. About half of the households have only one family unit per household. Peculiarly there were four households with more than 10 people. About 7 households have 2 or 3 family units living together.

The progress of living standard is evident particularly on the type of residential structures on private land allotments. About 80% live on average and above-average buildings namely; Concrete foundation with timber frames and walls (39%), and Concrete foundation with concrete block walls (40%). These land allotment were all occupied in the 1950s, however most buildings were built in recent times.

#### 5.1.2 EMPLOYMENT

The employment characteristic of the households reflects the familiar aspect of society in 'Eua, about half of the households surveyed did not have anyone with a regular job. About a third have one person currently employed; and a fewer households with two people with jobs (15%). Exceptionally, two households had three people with jobs. However, only a third of people with jobs work for the government organisations, the rest (72%) work in the private sector.

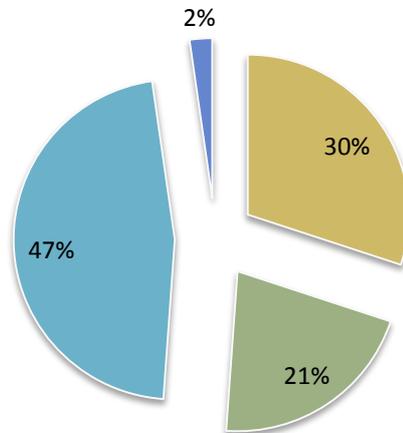
#### 5.1.3 LAND AND LAND USE

Land is an important asset and means of identity for Tongans. Unlike some other islands, 'Eua was one of the last to be intensely settled (1940s). Thus land supply is healthier than most other islands in Tonga. About 80% of the households surveyed have tax allotments, and the impact of this will be reflected in their source of income.

Land use characterises a typical Tongan settlement, where the tax allotment usage support either fully or in partial their daily living.

## Current land use on Tax Allotment

■ Subsistence Only ■ Crops for Sale ■ Livestock ■ Unused



It is noted that 'Livestock' is quite high (47%) but it does not necessarily mean that the whole area is utilised on all tax allotments. It ranges from a one or two cattle or/and horses being kept on the land to a full paddock, fenced with more than 10 animals.

'Eua is not different from other islands in Tonga; the best description for land use is 'mixed farming'. This means that there are people farm for subsistence purposes (30%); and those that farm to be sold in the produce market (21%), will also consume part of their produce. There are very few that farm for pure commercial purposes only.

### 5.1.4 SOURCE OF LIVING

The participating households' main source of living is in the order of: agriculture, employment, handicrafts, remittances, and then fishery. This is quite interesting, first, people are self-reliance, heavily land-based living, and not too dependent on remittances. Secondly, there is great potential to develop the fishery sector. Lastly, the local economy outlook is promising, a lot of opportunities given the natural environment and resources in 'Eua.

Leading on from the above points, it is practical to deem that energy is required for 'Eua's economy to develop further. TPL is the only source of electricity in 'Eua and most people appreciate this. However, most of the households surveyed (60%) strongly believe that the tariff is too expensive. The rest (40%) thinks that it is passable, but wishes it is cheaper.

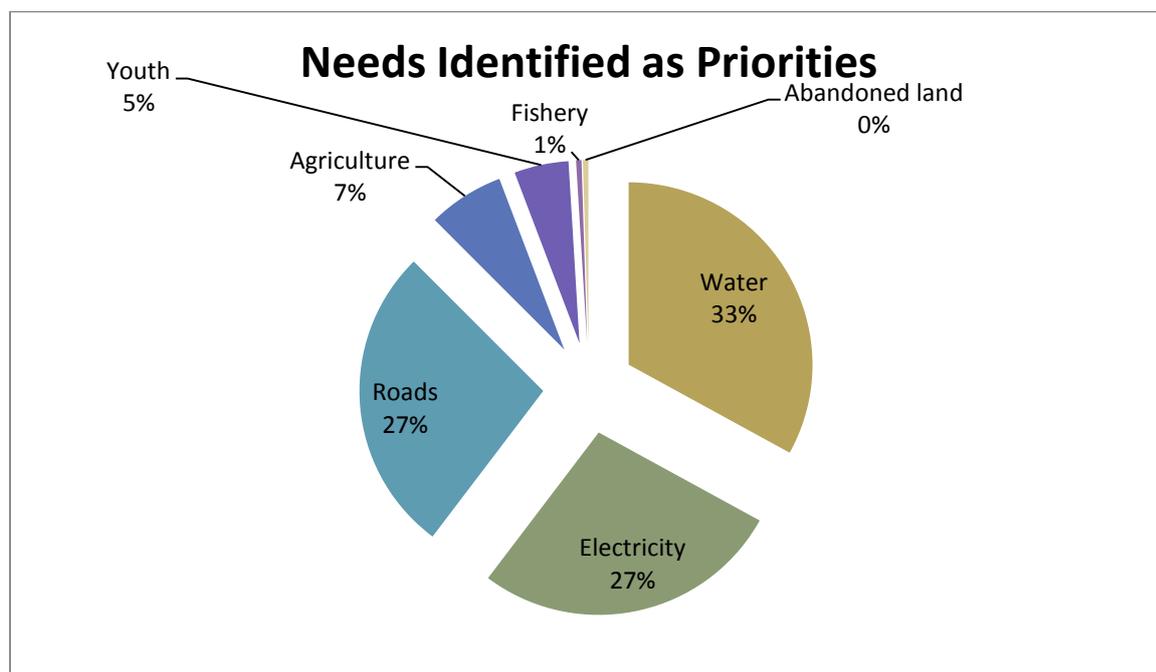
### 5.1.5 SIGN OF CHANGE

Given their source of income and the energy available; it is fair that the changes mostly noticeable and stated were the improved (type) of residential properties. Some participants noticed the increased number of people, which strangely, contradicts the fact that the 'Eua natural growth is low. However, there were a few statements that are significant; the increase in people movement (travel in and out); increase in the number of abandoned residences by people emigrated

(Tongatapu Island or overseas). A few participants raised concerns about the lack of or limited developments in their communities. Incredibly, only one participant stated that he noticed the number of foreign aid in his community.

#### 5.1.6 NEEDS AND PRIORITIES

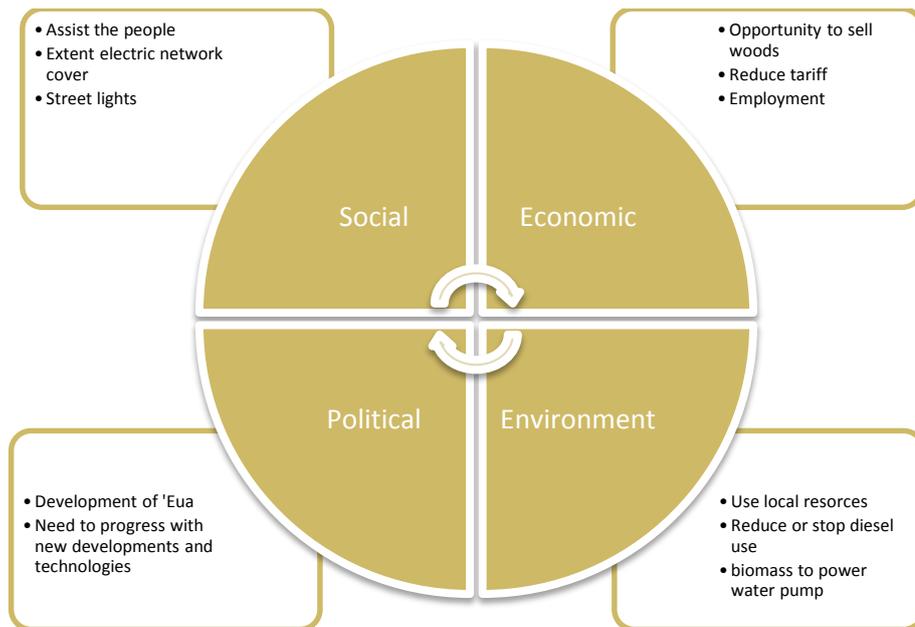
Further, when the question changed and seeking their needs and priorities, people were more excited in expressing these. Water is still their highest priority, as reflected in the Parliamentarian Report this year. 'Eua's problem is not the source; it is the management and reticulation system issue that is the longstanding concerns for the people. Power (electricity) is their second concern, as they need this to be affordable (tariff), uninterrupted service (generation), and available across the island (network). Interestingly, youth gained some attention as people would like more assistance through training, and employment opportunities available.



#### 5.1.7 OPINIONS ON THE PROPOSED BIOMASS PROJECT

The reception expressed over the proposed biomass plant for 'Eua was overwhelmingly positive. All the participating households support the biomass project, although their reasons for their support, and concerns about the project varies. However, the reasons for support and concerns were inter dependent. For example, it is good to use local resources (plants and plant wastes) but they were concern about the sustainability also (wood resources).

The following is a summary of the reasons for supporting the proposed biomass plant:



The participants raise very important reasons for supporting the proposed biomass plant to be implemented in 'Eua. However, when asked if there is anything else they wanted to add, the following is a summary of their response. Most did not have further comments, except for their support. However, the comments received are put in order of priority.

- i. Should implement the project as soon as possible
- ii. Make sure there is no negative impact on the environment
- iii. Make sure the project is sustainable
- iv. Reduce diesel and if possible, stop using diesel
- v. Reduce electricity tariff
- vi. Extend network cover to other parts of 'Eua
- vii. Make sure the project does not impact on food sources
- viii. Noise and smoke nuisance
- ix. Good if the by-product can use as fertiliser
- x. Would like to learn or know more about this new technology

The points expressed in their final comments and priorities, also reflects the reasons for supporting the proposed biomass plant.

## 5.2 CONCLUSION

Overall, the household survey collected good information and a snap shot of the 'Eua society. The social-economic situation is not too different from other parts of Tonga. However, land supply and natural resources in 'Eua are in healthier situation than other islands. Hence, the economic factors do not dominate the needs. In parallel, the environmental factors are well within the local people's interests. Evidently, all of the participating households support the proposed biomass project.

## 6 CONCLUSION

Tonga Power Limited, as an SOE, has been endeavouring to generate and provide electricity for Tonga. At the same time, supports the Government and TERM in seeking alternative fuel, as in this case, biomass energy. TPL is also collaborating with various stakeholders and government agencies, especially the regulating agency MEC, under the EIA 2003.

The conclusion of this report is that TPL proposed biomass project be approved for implementation with conditions described in the EMP. Biomass is not only inexpensive comparing to diesel, but it is a carbon neutrality (do not contribute to the global warming), and biomass fuel is clean. The proposed biomass technology should be implemented and managed so that the electricity production targets are realised without compromising environmental values in the island of 'Eua. TPL must be profoundly vigilant in managing and monitoring the environmental impacts at all times; and adopt mitigative measures as necessary.

In terms of availability of plant materials for fuel, 'Eua is the most appropriate island considering the established forest estates. The operator, TFP has indicated that with new equipment arriving in 2015, their logging capacity will be doubled. This will be a welcoming situation for TPL's biomass plant.

Biomass power has real potential in 'Eua and associated benefits for the 'Eua people. However, protecting the environment will still be the responsibility of all stakeholders (donor, executing agency, implementing agency, community), in realising the common goal of reducing Tonga's reliance on unpredictable and volatile fuel market for its electricity needs. The project is another step towards the Government of Tonga's 100% renewable by 2020 target.

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## 8 APPENDICES:

### 8.1 QUESTIONNAIRE SAMPLE

Dr. Nailasikau Halaituitua, Landcare Solutions Limited. Faka'eke'eke 'o e kakai 'o 'Eua: 4/12/2014

**SAVEA KI HE PALANI KE FOKOTU'U 'O E**  
**MISINI FA'U 'UHILA MEI HONO LILLIU KASA (GASIFICATION)**  
**'OE VEVE 'AKAU (BIOMASS ENERGY).**

**FAKAIKIKI:**

Hingoa tokotaha tali fehu'i:

Hingoa tokotaha ma'u'api (Kapau 'oku kehekehe):

Kolo:

**NGAAHI FEHU'I:**

1. Ta'u ne mou kamata nofo'i mai ai 'a e 'api ni? (*Siakale'i 'a e taha 'o e ngaahi tali ni*)

Kimu'a 1959 / 1960-69 / 1970-79 / 1980s-89 / 1990s-99 / 2000-09 / 2010-14

2. Tokolahi 'oku nofo he 'api ni? (*Siakale'i 'a e fika totonu*)

1    2    3    4    5    6    7    8    9    10+

**Famili 'e fiha?**

3. Fa'unga Fale Nofu'anga:

Kapa            Papa / Fakapou            Papa Fakava'e Piliki            Piliki

4. Fakafuofua ta'u ne langa ai:

Kimu'a he 1959 / 1960-69 / 1970-79 / 1980s-89 / 1990s-99 / 2000-09 / 2010-14

5. Toko fiha kau ma'ungaue 'i 'api?

- Kau ma'u ngaue 'e toko fiha:
  - i. Ngaue faka-Pule'anga toko fiha?
  - ii. Ngaue kautaha taautaha took fiha?

6. 'Oku 'i ai hao 'Api Tukahau? 'Io pe 'Ikai

Malo e Tokoni.

7. Ko e ha e **ngaue pe ngaue 'i 'uta?** (Siakale'i ha taha 'o e ngaahi tali ni)

- iii. Ngaue ki he ma'u me'atokoni 'ata'ata pe.
- iv. Ngaue ki he fakamaketi pe fakatau.
- v. Fanga monumanu?
- vi. 'Oku Lisi (lease) atu pe tuku atu ke ngaue ai ha tokotaha kehe?

8. Ko e ho'o **tefito'i ma'u'anga mo'ui** he taimi ni?

- Lalanga / Ngaue fakamea'a
- Ngaue
- Ngaue
- Toutai
- Tokoni famili mei muli

9. Katakai pe 'oku **fiha ho'o totongi 'uhila fakamahina?**

Fakakaukau ki he totongi 'uhila: \*Mamafa; \*Sai pe; \*Ma'ama'a

10. Faktokanga'i ha ngaahi me'a 'oku ha **fo'ou pe liliu he kolo ni?**

- Lahi e langa
- Tokolahi e kakai
- Me'a kehe?

11. Ko e ha ha ngaahi **tokoni 'oku ke mahu'inga'ia** ai ke fakahoko ki ho kolo? (Filie 3 mahu'inga taha)

- Vai
- 'Uhila
- Hala
- Ngoue
- Toutai
- To'utupu
- Me'akehe?

12. Ongoi mo e fakakaukau ki hono ngaue'aki e **veve 'akau mei he TFP ke fo'u e 'uhila** (biomass power: Gasification)?

Poupou ki ai? 'lo 'ikai

Ko e ha ha'o ngaahi fakakaukau ke poupou'i ho'o tali?

13. 'Oku 'iai ha ngaahi **me'amakehe 'oku ke toe tokanga kiai fekau'aki mo hono fokotu'u 'o e me'angaue ko 'eni ke fo'u e 'uhila mei he veve 'akau?**

## 8.2 HOUSEHOLD PARTICIPANTS

Rev. Lomekina Leone	Pangai
Kalisis Pakalani	Ha'atu'a
Tevita Ma'u	Kolomaile
Siosuia Lihau	Petani
'Ioane Siale	Ha'atu'a
Mosa'ati Ma'u	Ha'atu'a
Sonatanu Ma'u	Ha'atu'a
Filisita Vaiangina	Ta'anga
Sione Fonohema	Ha'atu'a
Sione Tangitau	Hango
Siosi'ana Pani	Angaha
Malia Mo'unga	Angaha
Malia Vetakina	Angaha
Maka Feleti	Tufuvai
'Aisea Fe'ao	'Ohonua
Salesi Fe'ao	'Ohonua
Suli Manukia	Angaha
Tu'ipulotu Lauaki	Angaha
Tevita Kata	Angaha
Sione 'Otutoa	'Ohonua
'Aisake Toamotu	'Ohonua
Kilifi 'Aiasake	'Ohonua
Sione Keke	'Ohonua
Fa'one	'Ohonua
'Ikani Matangitonga	'Ohonua
Lavelua	'Ohonua
Tolu	'Esia
Rev. Sefita	Mata'aho
'Olivet	Mata'aho
Tonga Matangitonga	'Ohonua
Mele Fe'ao	'Ohonua
Pahulu	'Ohonua
Sione Topui	'Ohonua
Semisi 'Ofanoa	'Ohonua
Sione Ongoongo	'Ohonua
'ilami Vaiangina	'Ahau
Ma'afu Filiai	Tongamama'o
Fisi Filiai	Tongamama'o
Mo'unga Palelei	Tongamama'o
Suli Taulav	Mata'aho
'Amini 'Ofa	Mata'aho
Siua Taulava	Mata'aho
Felise Piko	'Esia
Fisipuna Taufu	'Esia
Foliano Taufu	'Esia
Singa Takai	'Ohonua
Taniela Palenapa	Houma

Makipila Fotu	Houma
'Aisea Moala	Houma
Salesi	Houma
'Inoke	Houma
'Epeli Pi'ei	Houma
'Ata Moala	Houma
'Ana Takai	'Ohonua
Mana Vaha	'Ahau
Sanau Ana	Mu'a
'Ofa Falisi	Mu'a
Nenisi Kava	Tufuvai
Kosema Pani	Tufuvai
Sione Kelepi	Tufuvai
'Emele Kaupulu	Tufuvai
Maikolo 'Ofanoa	'Esia
Sela Tonga	'Esia
Tevota Makuti	Tongamama'o
'Elisi	Tongamama'o
Kapeli Tonga	Fata'ulua
Seifi Taufu	'Esia
Maikolo Tonga	'Esia
Sione Fangatua	Mata'aho
Fine Pani	'Ohonua
Sika	'Ohonua