Tonga

Energy Road Map (TERM) Review/Implementation Report

2010-2014

Contents

List of Tables

Abbreviations

ADB	Asian Development Bank
ASTAE	Asia Sustainable and Alternative Energy Program
CEO	Chief Executive Officer
DFAT	Department of Foreign Affairs and Trade
DoE	Department of Energy
DP	Development Partner
DSM	Demand Side Management
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EPU	Energy Planning Unit
EU	European Union
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GmbH - German Federal Enterprise for International Cooperation)
GoT	Government of Tonga
H&S	Health and Safety
HH	Household
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatts per Hour
MECC	Ministry of Environment and Climate Change
MEIDECC	Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications
MFA	Ministry of Foreign Affairs
MFAT	Ministry of Foreign Affairs and Trade
MFNP	Ministry of Finance and National Planning
MI	Ministry of Infrastructure
MLCI	Ministry of Labour, Commerce and Industry
MLSNR	Ministry of Lands, Surveys and Natural Resources
MOU	Memorandum of Understanding
MPE	Ministry of Public Enterprises
MW	Mega Watt
NNUP	Nuku'alofa Network Upgrade Project
NZ	New Zealand
ORC	Organic Rankine Cycle
PALS	Pacific Appliance Labelling and Standards
PDO	Project Development Objective
PICS	Pacific Island Countries
PIGGAREP	Pacific Region Pacific Islands Greenhouse Gas Abatement Project
PRDR	Pacific Regional Data Repository
PRIF	Pacific Region Infrastructure Facility
PV	Photovoltaic
RE	Renewable Energy
SAIDI	System Average Interruption Duration Index
SE4ALL	Sustainable Energy for All
SIDS	Small Island Developing States
SPC	Secretariat of the Pacific Community
TERM	Tonga Energy Road Map

TERM-A	Tonga Energy Road Map Agency
TERM-C	Tonga Energy Road Map Committee
TERM-IU	Tonga Energy Road Map Implementation Unit
TPL	Tonga Power Limited
TA	Technical Assistance
TOP	Tongan Pa'anga
TOR	Terms of Reference
TVNUP	Tonga Village Network Upgrade Project
UAE	United Arab Emirates
UN	United Nations
WB	World Bank

Acknowledgments

The Tonga Energy Roadmap (TERM) is a path towards securing Tonga's energy future. Over the next decade, this undertaking aims to realise sustainable, affordable and equitable access to energy nation-wide.

The Government of Tonga and the Tonga Energy Roadmap Implementation Unit (TERM-IU) wish to extend sincere thanks to all Development Partners for their tremendous support for TERM and contributions to this review. In particular, we would like to thank the ASTAE (Asia Sustainable and Alternative Energy Program) within the World Bank Group for supporting the development of this review report.

Executive Summary

This Progress Report provides an introduction to the Tonga Energy Road Map (TERM) and a report on its activities and discusses performance outcomes, way forward and lessons learned. As a result of intensive dialogue with the Government of Tonga (GoT) and development partners, Tonga developed a ten year plan (2010-2020), the TERM, as the guiding document for GoT actions and development partner support for the energy sector. The objective of the TERM is to lay out a least-cost approach and implementation plan to reduce Tonga's vulnerability to oil price shocks and achieve an increase in quality access to modern energy services in a financially and environmentally sustainable manner. Specific objectives involve renewable energy (RE), energy efficiency (EE), equitable access and affordability, institutional reform and petroleum security of supply.

TERM encompasses three phases:

- Phase 0: Institutional Strengthening and the Legal Framework
- Phase 1: Proof of Concept Renewable Energy projects Implementation
- Phase 2: Private Sector Participation, Efficiency and Renewable Energy Investments, Institutionalising Renewable Energy Investments

Phase 0 activities were intended to be delivered within an 18-month period from the launch of the roadmap (TERM) in June 2010. However, given the complexity and challenges in the operating environment, this has been delayed. A more detailed analysis is presented under intermediate level indicators. Despite the delay, the GoT continued to show political will and significant progress was made with creation of the Department of Energy (DoE) in July 2014 as the institutional structure of TERM. Work is still required to strengthen and fully resource the new DoE to reach its full potential and deliver the objectives of TERM by 2020, but a huge step has been accomplished. With the support of the World Bank (WB), an Energy Bill is also expected to be completed during 2015. Phase 1 activities are well underway, particularly in commissioning solar photovoltaic (PV) plants while Phase 2 activities hinges on the successful delivery of Phase 0 activities, except for the launch of the Tonga Green Incentive Fund which was dropped in 2012, resulting from an assessment that it would be difficult for Development Partners to allocate resources to capitalise such a fund but rather continue with the financing mechanisms through the existing products and services.

The table below provides a snapshot of activities and status.[1]

Table 1: TERM Snapshot

Phase 0 ACTIVITIES	STATUS
1. Recommendations from the Petroleum Supply Chain Study are considered by GoT and decisions made on implementation; initial activities launched	***Moderately Progressing.***
2. Institutional, legal, policy and regulatory updates for petroleum and electricity implemented	***Progressing Well.***
3. Data gathering activities and data collection and monitoring system in place	***Moderately Progressing.***
4. Environmental screening of the TERM to identify environmental considerations of the planned activities in the TERM	***Moderately Progressing.***
5. Analysis of environmental change impact on Tonga to identify any risks to long term safety and security of energy infrastructure	***Slowly Progressing.***
6. Initial end use efficiency / demand side management (DSM) programme launched and development of data and analysis to design and implement more extensive end use efficiency programme underway	***Moderately Progressing.***

[1] This is a high-level status for purposes of providing a general snapshot. Chapter 2 (Report on TERM Activities) provide detailed report on progress and Chapter 3 (Performance Outcomes) present baseline, current and target data and show accomplishment against target indicator.

7. Off-grid programme launched	***Progressing Well.***
8. Necessary Tonga Power Limited (TPL) investments for safety, data acquisition and improved efficiency launched	***Progressing Well.***
9. Tonga Green Incentive Fund launched	***No Progress.***
Phase 1 ACTIVITIES	**STATUS**
1. Implementation of second-generation end-use efficiency DSM measures	***Progressing Well.***
2. Implementation of up to 1 MW on-grid solar PV on Tongatapu and at least one other island grid, including components covering centralised, decentralised and battery storage. Operation, maintenance and training contract in place	***Progressing Well.***
3. Implementation of a Proof of Concept Coconut Oil (660,000l/yr) + a 160kW Waste Gasifier Project. Operation, maintenance and training contract in place	***Slowly Progressing.***
4. Implementation of Landfill Gas independent power producer (IPP)	***Slowly Progressing.***
5. Review of initial experience with petroleum financial risk management and implementation of modifications as required	***Slowly Progressing.***
6. Transaction advisor for Phase 2 projects selected	***Slowly Progressing.***
Phase 2 ACTIVITIES	**STATUS**
1. A formal analysis of the data and findings from the Phase 1 projects	***Slowly Progressing.***
2. Institutionalise the data collection systems set up during Phase 1	***Progress Dependent on completion of Phases 0&1.***
3. A full-scale development of renewable energy projects on an IPP basis	***Progress Dependent on completion of Phases 0&1 and the policy, objectives proposal for the sector.***

An assessment of **performance outcomes** reveals:

- TERM has achieved 6% renewable energy generation and anticipates accomplishing 50% by the year 2020. The comprehensive approach taken by TERM in increasing renewable generation and energy efficiency is supported by its development partners (DPs) as shown by the aid provided. Refer to Annex E listing all energy projects in Tonga with funding support from DPs.
- Access to electricity target of 100% (grid and off-grid) by 2020 is on track with the completion of the Asian Development Bank (ADB), Australia and European Union (EU) funded Outer Island Renewable Energy Project and the continuation of the New Zealand funded Tonga Village Network Upgrade Project (TVNUP).
- To complement RE, EE is important. TERM-IU, (the DoE) and Tonga Power Limited (TPL) are working with the WB and other DPs to identify financing sources for upgrading the Nuku'alofa grid which is expected to save 3 seniti per kWh, due to a more efficient system. The new system will reduce line losses, improve safety and reduce negative environmental impact.
- Affordability is still a major concern. Despite a number of programs implemented by TERM, the outcome has not met the GoT's expectation in relation to affordable energy (with the price of electricity still considered to be one of the highest in the region). Hence, DPs are assisting the government in achieving its national target by 2020.
- The WB-funded work to review the petroleum products import and distribution model, although delayed has commenced, and this is vital for the next phase of TERM development with expected outcome of reducing annual petroleum costs between TOP$4M and TOP$6M.

In terms of the **way forward**, the Phase 0 action plan has seen the TERM Committee (TERM-C) approving the drafting of an Energy Bill. The new Government elected in November and in place January 2015 will appoint a 'working group' to confirm the energy objectives of the Kingdom and agree on policy basis and then to draft an Energy Bill for the Government to consider. Once the Bill is prepared, it would be submitted to Parliament to be passed before the end of 2016. For the petroleum sector, TERM Implementation Unit (TERM-IU), with WB funding support, is undertaking a comprehensive review of the petroleum sub-sector with expected completion by August 2015 in order to design the best-fit model to provide the most affordable prices to Tongan consumers.

For on-grid electricity, the short term focus is solar renewable energy planning and proof of concept trials. Given the current level of achievements, TERM-A and its partners confirmed feasibility studies of Renewable Energy generation sources to identify funding sources for their implementations. These projects can reduce the risk of diesel fuel price shock impacts, and they include the following:

1) Biomass gasification generation.
2) Wind power generation.
3) Waste heat recovery generation.
4) Nuku'alofa network upgrade.

For off-grid electricity, it is important to a) separate policy leadership functions from service delivery; and b) fully launch the off-grid programme including completing the 1.25 MWp outer island solar PV project. In the long term, the focus is on energy efficiency including demand-side management (DSM) , distribution system efficiency with a focus on outer islands.

The TERM has been cited as a model for long term strategic energy planning and execution in the Pacific region. It is also acknowledged as a good development practice across the region and globally - setting out a single plan for all donors to align their assistance and support, rather than government realigning its program based on development partners' funding priorities.

Mobilising funding for technical assistance support and investment in the sector is one of the achievements of TERM, with total investment in the sector reaching TOP$121.7 million[2] as of September 2014. This is a significant investment. Key success factors include:

- High-level GoT commitment and leadership to the TERM; and strong and coordinated development partner support.

Areas for improvement for TERM include addressing:

- Capacity gaps in institutionalising TERM-IU into the newly created DoE while guarding against establishing unsustainably large government departments.
- Capacity to ensure progress on TERM-IU Director's responsibilities.
- Weak project, fiduciary and risk management capacity to deliver Phase 0 Activities.
- Adjusting energy targets to be achievable.
- Risks with recipient-executed Trust Fund instrument for capacity-constrained agency.
- Importance of robust policy frameworks which will allow Tonga to clearly establish and articulate their solution to economic, environmental and social problems.
- Stronger awareness campaigns and continuing to promote strong stakeholder coordination.
- Harmonising energy and climate change policy.
- Ensuring sustainability of funded assets.
- Addressing energy issues in the transportation sector.
- Explicit recognition of private sector participation if RE targets are to be met by 2020.
- Ensuring government's role is focused on policy issues, rather than implementation.
- Presenting a more detailed achievement target on RE, EE and Access to electricity annually, until the year 2020 based on current and forecast project pipeline, by the new Department of Energy.
- Integration of TERM, along with this TERM Review Report into the new DoE Corporate Plan.

[2] Amount is a combination of completed/spent and committed investments (i.e. Maama Mai TOP12M; La'a Lahi TOP6M; Clean Energy Project TOP10M; Vaini On-Grid Solar Farm TOP20 M; OIREP TOP17.9 M; TBU Village Network Upgrade TOP48.2M). Please also refer to Annex E, for indication of investments showing TERM projects with Development partner support).

Chapter 1: Introduction

1.1 Background and Rationale

The global oil price shock in 2008 affected the Pacific region significantly, as many Pacific island countries (PICs) rely on imported oil and gas for much or all of their energy needs. In 2000, 75% of Tonga's energy supply relied on imported petroleum products with its grid-supplied electricity wholly generated from imported diesel.

At the Pacific Energy Ministers Meeting in Nuku'alofa, Tonga in April 2009, the Government of Tonga (GoT) put forward a proposal to donors to map out the future of energy use in Tonga. The World Bank (WB) led the response of development partners, which included inputs from a large number of organisations, including all the Pacific Region Infrastructure Facility (PRIF) development partners. As a result of this process, which involved intensive dialogue with GoT and development partners, Tonga developed a ten year plan (2010-2020), the Tonga Energy Road Map (TERM)[3] launched by GoT in June 2010.

TERM serves as the guiding document for GoT actions and development partner support for the energy sector. The objective of the TERM is to lay out a least-cost approach and implementation plan to reduce Tonga's vulnerability to oil price shocks and achieve an increase in quality access to modern energy services in a financially and environmentally sustainable manner.

Institutional responsibility for the energy sector in Tonga is fragmented. There is a privately operated petroleum sub-sector with government wholesale price regulation, while government influences the electricity sub-sector through the government owned Tonga Power Limited (TPL) for on-grid electricity and a rural electrification 'program' run through the Ministry of Lands, Survey and Natural Resources (MLSNR). As such, there was no GoT entity with the mandate and capacity to maintain a strategic overview of the electricity and petroleum sub-sectors. The fragmentation is reflected in the diverse Acts of Parliament that govern the energy sector.

1.2 Governance

Until TERM, there had been no 'one stop shop' department or ministry to provide policy and planning advice to the government as well as monitoring and reporting on the energy sector. In April 2012, Cabinet approved the creation of TERM-Agency (TERM-A) as a government agency accountable directly to Cabinet and responsible for achieving the objectives of TERM. Within TERM-A, GoT created an interim one stop shop policy advisory body by establishing the TERM Implementation Unit (TERM-IU), headed by a Director that reports directly to the TERM Committee (TERM-C). TERM-C is to oversee and govern the planning and implementation process of the Road Map. TERM-C is chaired by the Office of the Prime Minister and includes all Chief Executive Officers (CEOs) of GoT agencies that are relevant to the TERM, including MLSNR; Ministry of Finance and National Planning (MFNP), Ministry of Labour, Commerce and Industry (MLCI), Ministry of Environment and Climate Change (MECC), Ministry of Public Enterprises (MPE), Ministry of

[3] Tonga Energy Road Map 2010 – 2020, June 2010.

Infrastructure (MI), Ministry of Foreign Affairs (MFA), Crown Law Office and Public Service Commission.

TERM-IU plays a critical role including coordination and technical advice. It operates in a team and partnership environment where objectives are jointly owned with process and procedures shared and followed.

The GoT recognised that a long-term institutional arrangement within the machinery of government had to be created to provide strong leadership, coordination and oversight for the energy sector. In July 2014, GoT established the Department of Energy (DoE) to become part of a wider Ministry under the leadership of the Prime Minister.

TERM-IU continues to exist and will provide capacity development support to the DoE and coordination support. However, the budget/resourcing for its continued operation has not been formally agreed upon. During the year January – December 2014, the TERM-IU faced pressure in maintaining quality staff and resources to meet operating costs. The external funding which it relies on was drying up. The contract for the consultants [both local and external assisting the TERM-IU ended. At some stage the total TERM-IU staff was 10 however during 2014 there were only 5. The merging of the EPU staff although adding 9, these were personnel from the technical side.

In terms of budget for operating expenses the TERM-IU unit has at time go without wages and salary for up to 8 months. The Government of Tonga assisted by providing resources but the procurement process was long and cumbersome. These issues not only impact financial position but work programme and staff morale. Potential solutions are discussed in more detail in Chapter 4.1.

This document will report on the progress of TERM under TERM-IU day-to-day operational management from the period June 2010 to June 2014.

1.3 GoT Vision and Priorities

The GoT **vision** is to provide 'clean, safe, sustainable and affordable energy for all'. The GoT's **key priorities** in relation to the petroleum and electricity sub-sectors include:

- Incentives for prudent petroleum supply chain contracting and risk management to reduce the price and price fluctuation of imported petroleum products.
- Efficient conversion of petroleum to electricity (i.e. increases in generation efficiency and reduced distribution losses at TPL).
- Efficient conversion of electricity into consumer electricity services (end-use efficiency and demand side management).
- Diversity in energy supply sources based on generation other than from diesel, mainly renewable energy.
- Private sector participation in power generation projects.
- Revision of the arrangements for electricity supply, including tariff structure and utility business model to ensure increased affordability

1.4 TERM Principles and Objectives

The TERM is underpinned by the following **key principles**:

- Least cost approach to meet the objective of reducing Tonga's vulnerability to oil price increases and shocks.

- Technical and institutional improvements to manage interruption and price risks.
- Financial sustainability by ensuring that efficient costs of operating the energy sector, including regulatory, operations, maintenance, fuel and financing costs are recovered through the tariff.
- Savings on efficiency and renewable energy are also reflected in the power tariff to the consumers.
- Social and environmental sustainability by minimising local social and physical environmental impacts and by aligning with global goals on climate change.
- Clear, appropriate and effective institutional, legal and regulatory frameworks that defines the roles of GoT, TPL and the private sector.

In achieving GoT's key priorities in the petroleum and electricity sub-sectors, the TERM sets the following objectives for its key stakeholders:

a. Renewable energy (RE) generated power to meet 50% of the power demand of the Kingdom resulting in a cleaner, safer, secure and sustainable supply.

b. Improvement in system-wide energy efficiency by 18%. These improvements are to come from all phases of:
   i. power generation - % reduction in diesel use by 50%;
   ii. power distribution - reduction in losses by 1.5% annually or 9% cumulatively by 2020; and
   iii. demand side energy efficiency - the usage of power by consumers.

c. Accessible to all – 100% of Tongan consumers to access clean, secure, safe and sustainable energy, including remote islands and towns.

d. Affordable to all – this is the centrepiece of reform efforts. Investment, improvement in efficiency (in all its phases) and the reductions in the use and purchase of expensive fuels must flow-on to consumers in the form of lower tariffs.

e. Reforming the energy sector with the aim of updating and consolidating all functions of the sector into one entity. Currently these roles and functions are spread over seven Ministries and Public Enterprises**.**

f. Reforming the petroleum sub-sector in order to ensure safety (i.e. regulations are in place with strong institutions to monitor them) and the best prices for the importation and distribution of fuel.

The table below represents key events in the evolution of TERM.

Table 2: TERM evolution[4]

Date	Activity or Event
April 2009	GoT put forward a proposal to donors to map out the future of energy use in Tonga at Pacific Energy Ministers' Meeting in Nuku'alofa, Tonga
June 2010	The Tonga Energy Road Map 2010-2020 (TERM) was launched and published
20 August 2010	The TERM approved under Cabinet Decision 739
2011	GoT established the TERM Implementation Unit (TERM-IU)
2011	Energy Expo at the Fa'onelua Convention Centre attracted all kinds of energy businesses to Tonga
February 2012	Interim TERM-IU Director appointed for six month term
20 April 2012	Cabinet approved the TERM-Agency (TERM-A) as a Government Agency accountable directly to Cabinet, and responsible for achieving the objectives of TERM.

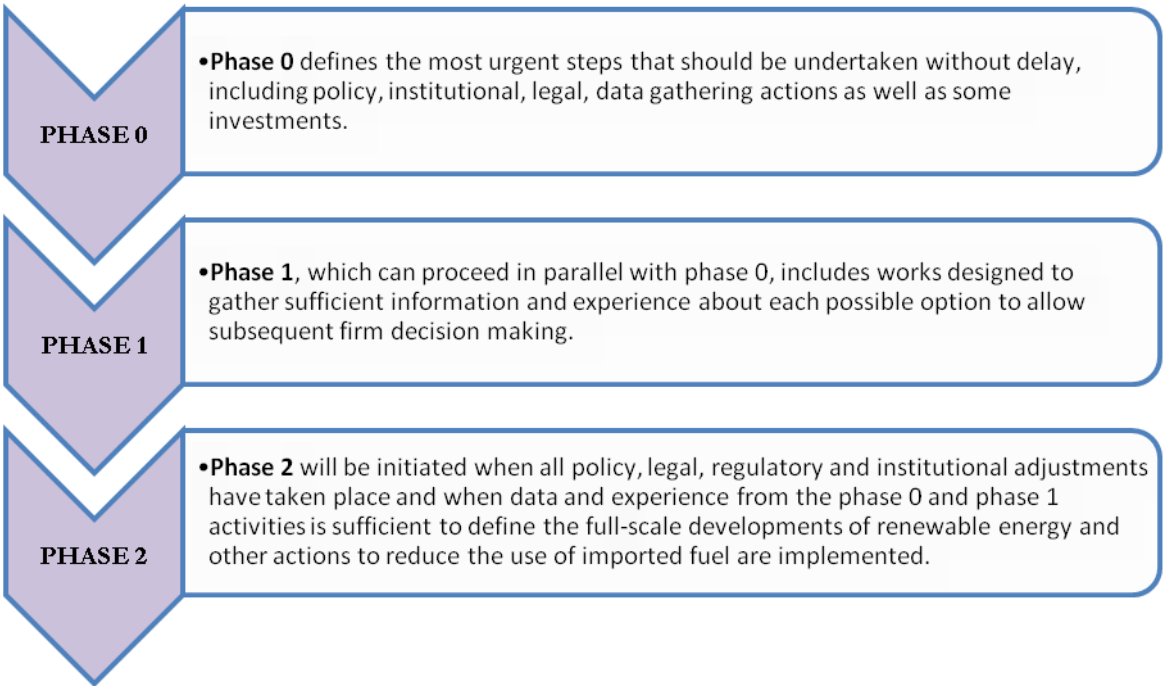
[4] The events listed reflect only the high-level events/provide mere indication and is not a comprehensive list (i.e. does not include key events that TERM is contributing including the Tonga National Infrastructure and Investment Plan 2, Budget Support Outcomes: GOT and Aid Funders, studies and publications, EPU outcomes and activities, among others.

Date	Activity or Event
June 2012	World Bank approved a Grant of US$2.90M through PRIF (Aus DFAT) and ASTAE funding for an Energy Roadmap Institutional and Regulatory Framework Strengthening (TERM IRFS) Project
September 2012	Permanent TERM-IU Director appointed
September 2012	GoT (through TERM-C and Cabinet) approved the consolidation of responsibility for off-grid electricity, and petroleum into TERM
December 2012	TERM-C approved work on drafting an Energy Bill
August 2013	Consolidation of the Energy Planning Unit (EPU) to TERM-IU under an MOU between TERM-IU and the Ministry of LNRSCC
September 2013	Tonga 1st Tariff review was completed and discussed in a roundtable
May 2014	Cabinet approved the creation of a new Ministry, with energy as one of several departments
July 2014	The new Ministry became effective. TERM-IU co-exists while transitioning into the Department of Energy under the Ministry of Meteorology, Energy, Environment, Information, Climate Change, Disaster Management, Environment and Communications (MEIDECC).
September 2014	Hosted the Pacific Renewable Energy and Energy Efficiency Policy-Making Workshop

Chapter 2: Report on TERM Activities

Where Are We Now & How Did We Get Here: Report on TERM Activities

This chapter discusses the activities of TERM on the basis of the 3-phased implementation plan, as follows:



The table below sets-out a snapshot of Phases 0, 1 and 2 activities, with a more detailed elaboration of the progress, actual and planned, for each of the below items in the succeeding sub-section:

2.1 A Snapshot:[5] Phases 0-2 Activities

Table 3: Activities Snapshot

Phase 0 ACTIVITIES	STATUS
1. Recommendations from the Petroleum Supply Chain Study are considered by GoT and decisions made on implementation; initial activities launched.	***Moderately Progressing***
2. Institutional, legal, policy and regulatory updates for petroleum and electricity implemented.	***Progressing Well***
3. Data gathering activities and data collection and monitoring system in place.	***Moderately Progressing***
4. Environmental screening of the TERM to identify environmental considerations of the planned activities in the TERM.	***Moderately Progressing***
5. Analysis of environmental change impact on Tonga to identify any risks to long term safety and security of energy infrastructure.	***Slowly Progressing***
6. Initial end use efficiency / DSM programme launched and development of data and analysis to design and implement more extensive end use efficiency programme underway.	***Moderately Progressing***
7. Off-grid programme launched.	***Progressing Well***
8. Necessary TPL investments for safety, data acquisition and improved efficiency launched.	***Progressing Well***
9. Tonga Green Incentive Fund launched.	***No Progress***[6]
Phase 1 ACTIVITIES	**STATUS**
1. Implementation of second-generation end-use efficiency DSM measures.	***Progressing Well***
2. Implementation of up to 1 MW on-grid solar PV on Tongatapu and at least one other island grid, including components covering centralised, decentralised and battery storage. Operation, maintenance and training contract in place.	***Progressing Well***
3. Implementation of a Proof of Concept Coconut Oil (660,000l/yr) + a 160kW Waste Gasifier Project. Operation, maintenance and training contract in place.	***Slowly Progressing***
4. Implementation of Landfill Gas IPP.	***Slowly Progressing***
5. Review of initial experience with petroleum financial risk management and implementation of modifications as required.	***Slowly Progressing***
6. Transaction advisor for Phase 2 projects selected.	***Slowly Progressing***
Phase 2 ACTIVITIES	**STATUS**
1. A formal analysis of the data and findings from the Phase 1 projects.	***Slowly Progressing***
3. Institutionalise the data collection systems set up during Phase 1.	***Progress Dependent on completion of Phases 1&2***
3. A full-scale development of renewable energy projects on an IPP basis.	***Progress Dependent on completion of Phases 1&2***

[5] The succeeding section 2.2 will provide detailed report on progress and Chapter 3, Performance Outcomes, Performance Outcomes presenting baseline, current and target and showing how much of activities have been achieved against target.

[6] The TGIF was dropped in 2012 given the results of an assessment that showed that it would not be easy for DPs to allocate resources to capitalize such a fund but rather continue with the financing mechanisms through the existing products and services.

2.2 Report on TERM Activities

2.2.1 Phase 0: Institutional Strengthening and the Legal Framework

The Institutional Strengthening work, which is necessary for the effective implementation of the other phases, encompasses TERM as an organisation and the energy sector as a whole for both the petroleum and power sub-sectors.

Although there have been delays in implementing Phase 0 activities, Cabinet Decision 220 of April 2012 restructured the TERM-C under the leadership of the Prime Minister. This was followed by the appointment of the Director of TERM-IU, replacing the interim Director in September 2012 for a more focus delivery of the activities and programs to attain the objectives and outcomes of the TERM.

Since September 2012, government (through TERM-C and Cabinet) has approved the consolidation of responsibility for off-grid electricity, and then petroleum into TERM, with TERM-IU responsible for implementation. This has clarified responsibilities and given TERM-IU the basis for driving action.

Nevertheless, the reality is that Phase 0 remains incomplete and there is still a great deal of work to be done. What follows is a more detailed elaboration of the progress, actual and planned, for each of the activities under Phases 0:

ACTIVITY 1 (PHASE 0)
Recommendations from the Petroleum Supply Chain Study are considered by GoT and decisions made on implementation; initial activities launched.

The GoT has adopted recommendations from the Petroleum Supply Chain Study and implemented a number of reforms to the petroleum sector since June 2010:

i. The fuel price regulator, the Tonga Competent Authority (TCA) methodology for petroleum products and the pricing template for Liquid Petroleum Gas (LPG) and petroleum products.

ii. Strengthening licence requirements for petroleum companies particularly providing the regulator with details on operations and assets.

iii. Investigating two broad proposals to increase the efficiency of the petroleum supply chain by changing the supply model and related effects on competition.

Work has been done under i and ii under the Ministry of Labour, Commerce, Industry and Tourism. Under iii, several studies on operation and business models to reduce costs on the petroleum supply side. These studies were presented to the GoT for consideration. The government, however, wanted further investigation on the two options, particularly an offer by a private sector company to invest in the petroleum sector, but requires long term contract of supply to do this. The GoT has contracted advisory services through the TERM IRFS project to review this proposal and the business model proposed. The preferred provider and TERM-IU signed the contract of services in December 2014, with expected completion of the study by August 2015. Thereafter, GoT will consider the recommendations and launch activities to implement.

Once the business model is approved, progress will be made towards implementing the recommended reforms to Tonga's legal, regulatory and licensing arrangements for downstream.

ACTIVITY 2 (PHASE 0)

Institutional, legal, policy and regulatory updates for petroleum and electricity implemented.

TERM-C has approved a number of decisions in relation to institutional, legal, policy and regulatory framework:

- **Consolidation of all policy responsibility for off-grid electricity, and then petroleum into TERM**, with TERM-IU responsible for action.

- To facilitate this consolidation, the **Energy Planning Unit** transition arrangements set-up and transfer effective August 2013.[7]

- **Established a permanent institutional arrangement** and the governance structure to manage, coordinate, monitor and report on the development and delivery to the TERM objectives by 1 July 2014.[8] However, as it transpires the Government moved a step further by approving the setting up of the Ministry of Meteorology, Energy, Environment, Information, Climate Change, Disaster Management, Environment and Communications (MEIDECC) and has been operating since July 2014. Energy is one of the departments in the new Ministry.

- **Drafting an Energy Bill** which would review existing and any proposed legislation and regulations that impact on the Energy Sector with a view to creating a consolidated Energy Bill. This work is being informed by the Energy Sector workshop on RE and EE policy instruments funded by the WB held in Nuku'alofa from 9-11 September 2014. As an output of this workshop, the WB has agreed to provide TA to the Government of Tonga in developing the key elements for an energy policy framework consistent with the objectives of the TERM

- **Tariff review - the completion of the electricity Tariff Review or**ganised by TERM-IU last September 2013 was an important milestone. There is still ongoing concern by the Government of the high consumer's power tariff. Given the very high donor's partners grant funded investment in the power production sector and line losses projects, GoT believes that the tariff should be lower. Since the tariff review however, Cabinet approved the implementation of a lifeline tariff for January 2015 as one of the trigger and prior action under World Bank's second Economic Reform Budget Support Development Policy Operation. The implementation of the 'lifeline tariff' will mark a significant progress in energy affordability policy.

  Note that there were also gains achieved from DP projects including tariff reductions announced by TPL late 2013 with the NZ funded Maama Mai Solar Facility offsetting 3.1% of total generation equating to a tariff reduction of 2 seniti per kWh. Towards the end of 2014, there have been some significant tariff reductions totalling approximately 12% also attributed to stabilised oil prices. In addition, there are expected reductions of electricity costs through increased RE penetration in Ha'apai and 'Eua, following the covenants under the Special Funds Grant Agreement of Outer Island Renewable Energy Project (OIREP). The GoT also requested for a comprehensive review of tariff by IRENA to complement the existing study covering efficiency gains, renewable generation displacement. IRENA provided a draft and presented preliminary findings during the WB-funded Renewable Energy and

[7] Cabinet Decision 220
[8] Cabinet Decision 229

Energy Efficiency Policy Making workshop in September 2014. As indicated, identification of an appropriate business and ownership model for tariff reduction given Tongan's small market is still yet to be done.

- **Renewable Energy and Energy Efficiency Plan** - As part of the budget support process for 2013, the EU has assisted with the development of a plan, which has been released in May 2013 and captured within the framework of TERM.

ACTIVITY 3 (PHASE 0)

Data gathering activities and data collection and monitoring system in place.

- A Communications Officer funded under the TERM IRFS project was recruited to improve the TERM-IU communication strategy from February 2013 to August 2013.

- The basis for managing data gathering and sharing is the energy.gov.to website. TERM-IU launched both the website and database 30 June 2013. TERM-IU will hire a consultant through the IRFS project to update the website, and the new Ministry has agreed to provide the platform to run the website. The monitoring system and resource to implement the system is however, not yet in place.

- Tonga is driving the implementation of the Pacific Regional Data Repository (PRDR) supported by the Region (involving 12 PICs) and endorsed by the United Nations (UN). Funding has been provided by donors to implement the project under the guidance and management of the Secretariat of the Pacific Community (SPC). The major task now is the smooth collection of data from the National sources including that from Tongan Sources.

ACTIVITY 4 (PHASE 0)

Environmental screening of the TERM to identify environmental considerations of the planned activities in the TERM.

- TERM has sought environmental clearance of proposed projects through the Environmental Impact Assessment Committee. This reflects a decision that it was administratively efficient to use existing processes rather than set up new arrangements.

- It is important to harmonise the environmental impact assessment (EIA) of the Tonga Legislative requirement and that of the donor's partners. Although the Environmental and Social Management Framework Technical assistance work was previously put on hold while waiting for the results of the Petroleum study negotiations, it has been decided as of June 2014 that this work should proceed. The Terms of Reference is currently being prepared and the Technical Assistance consultants will be engaged and work commenced by mid- 2015.

ACTIVITY 5 (PHASE 0)

Analysis of environmental change impact on Tonga to identify any risks to long term safety and security of energy infrastructure.

- Under sub-component 2 of the TERM IFRS project, preparation of systems to enable renewable energy projects to be implemented in Tonga Power Limited networks, one chapter of the feasibility report will be undertaken by on climate proofing the utility. This 6-month work is expected to commence during the first quarter of 2015. In addition, Component 1 of the project has allocated funding for TERM-IU to undertake an Environmental and Social Management Framework (ESMF).

ACTIVITY 6 (PHASE 0)

Initial end use efficiency/DSM programme launched and development of data and analysis to design and implement more extensive end use efficiency programme underway.

- The DSM programme has not been launched due to issues with institutional arrangements and resourcing.[9]

- The Promoting Energy in the Pacific Phase 2 (PEEP2) project is coming to its conclusion. The PEEP2 project focus on proof of concept project, standardising of appliances and awareness is having positive impact. In the future, shifting the concept to the national and sustainable level is still required. There is currently significant activity with respect to the replacement of less efficient fluorescent lighting with compact fluorescent lighting on Ha'apai and 'Eua and installation of more efficient lighting on Tongatapu. The idea is to allow end users witness the saving made by more efficient lighting (and appliances) and thus buy most efficient lighting such as LED lights in the future.

- TERM has established a National Energy Efficiency Steering Committee to provide a mechanism for the community to have input to the TERM, and for TERM to reach the community. Note however that the Committee's role has been limited partly attributed to Committee members requesting remuneration for their work which TERM could not afford.

ACTIVITY 7 (PHASE 0)

Off-grid programme launched.

- The Energy Planning Unit, which was merged to TERM-IU in August 2013 (is now the DoE as of July 2014) continued to deliver its services through an off-work grid programme. The majority of the project deals with solar water pumps, electrical appliances and solar refrigeration.

  On 14 November 2013, renewable generation projects consisting of 550 solar home system (SHS) units for the households on the islands of Vava'u, 'Eueiki and 'Atata [in Tongatapu] were commissioned. Other projects including solar farms in 'Eua and Pangai Ha'apai, mini grids in the islands of Nomuka, Felemea, Uiha, Ha'ano in the Ha'apai Group and SHS/grid in the Niuas. Please refer to a list and update of projects attached as Annex A.

- TERM-A and the GoT have secured funding for Renewable Energy (RE) projects (please refer to attached Annex B for a list and update of RE initiatives under TERM initiative) and Grant Agreement for these projects has been signed between the Government of Tonga and the funding development partners.

ACTIVITY 8 (PHASE 0)

Necessary TPL investments for safety, data acquisition and improved efficiency launched.

- Safety - TPL appointed a risk and compliance manager, and has taken significant action on improving training, work practices and provision of safety equipment. Programs to improve the safety of distribution assets are on-going. Safety and educational advertisements were placed on Tonga TV, and are now ongoing. Health and safety (H&S) policies have been assessed and improvements related to reporting and identification of H&S issues have been

[9] Since then, the new DoE is preparing a coordinated plan for Demand Side Management in 2 levels of efficiency: appliance and usage.

implemented with special attention to education of TPL staff; surveying all lines to identify low hanging spans; and commenced discussions with Tonga Communications Corporation (TCC) to set more formalised standards for sharing pole assets. A proposal has been developed for upgrading of the greater Nuku'alofa area network. Funders are being sought. The WB has shown interest, but it requires the GOT to submit a formal request and allow a portion of its grant allocation to be allocated to this project.

- Data acquisition – a full feasibility study has been undertaken for smart metering to replace the existing stock of legacy meters, smart meters will eventually allow essential data on every consumers' premises to be collected. All meters have been replaced, removing old and faulty meters. A complete review of TPL's Geographic Information System (GIS) has been undertaken with proposed actions currently being assessed. The website is used to disclose information gathered, customers can now access their account information online via a web portal. TPL is developing association with the Ministry of Lands to share databases and get access to better spatial info for GPS.

- Improved efficiency – ***Network efficiency:*** this has been a focus with significant improvements in some villages as meters are replaced and old lines upgraded (e.g. Puke village had line losses reduced from 23% to 2%[10]). Total network losses to date have reduced to below 13% from about 18% two years ago. Collection efficiency has been strengthened, with bad debts running at 0.3%.

  Transmission efficiency: Current programs will continue to replace underperforming and unsafe distribution assets.

  Generation efficiency: Renewable generation will displace some diesel generation. This will lead to battery storage technologies being introduced in a couple of years, and TPL will be able to offer some customers incentives to optimise the energy storage profiles. An efficient medium speed generator is now being installed for Tongatapu. It will save over TOP$500k per annum in diesel and operating and maintenance costs compared to current diesel sets. This will be completed by the end of 2014.

ACTIVITY 9 (PHASE 0)

Tonga Green Incentive Fund (TGIF) launched.

- The TGIF is a source of funding for private sector involvement in sustainable development in the Energy sector. This was dropped in 2012 given the results of an assessment that showed that it would not be easy for Development Partners to allocate resources to capitalize such a fund but rather continue with the financing mechanisms through the existing products and services.

2.2.2 Phase 1: Proof of Concept Renewable Energy projects Implementation

This phase which is proceeding in parallel with Phase 0 is the proof of concept phase with the appropriate energy mix to provide the optimum level of generation to meet the total energy requirement of the Kingdom 24 hours a day, 365 days a year. These renewable sources of generation must comply with the key principles of United Nations Sustainable Energy for All (SE4ALL): a safe, secured, sustainable energy for all.

[10] As an outcome from the NZ-funded Tonga Village Network Upgrade Project.

All projects and the associated technologies must comply with the overriding driver of efficiency (in all its phases and in both the energy subsectors). For petroleum: supply, storage and distribution efficiency; for the power sub-sector: generation, management, distribution and in the business of managing and administration of the power business.

For the demand side: demand management, appliances and other factors. Several actions are being pursued by TERM and its partners. The focus has been on efficient of power and the acquisition of the most efficient standardised electrical appliances and equipment.

ACTIVITY 1 (PHASE 1)

Implementation of second-generation end-use efficiency DSM measures.

- Pacific Region Pacific Islands Greenhouse Gas Abatement Project (PIGGAREP) - Installation of 10 solar water pumps in 10 villages in Ha'apai.

- Pacific Appliance Labelling and Standards (PALS). The legislation to prohibit the introduction of unrated refrigerators, and regulate air conditions, is currently in its final stages of consultation and drafting before going into the Tongan Parliament. Once this is done, Tongan consumers are expected to see a reduction in the power bill regarding these appliances.

- Integrating RE into the Tongan Education Curriculum through development of Renewable Energy Resource Guidebook, which was completed and distributed to the schools in 2104.

- Supporting the various local management committees in managing their renewable energy assets through the Solar Home System (SHS). Since the establishment of the SHS in the remote and poorer areas of the Kingdom, the GoT has supported these communities by setting-up local committees to work with users in collecting some money contribution for maintenance and providing spare parts for the SHS. Various Government Ministries are involved, including the Government's office of the island, Ministry of Internal Affairs, EPU and the TERM office.

ACTIVITY 2 (PHASE 1).

Implementation of up to 1 MW on-grid solar PV on Tongatapu and at least one other island grid, including components covering centralised, decentralised and battery storage. Operation, maintenance and training contract in place.

- The Tonga Tapu 1MWh solar farm, Maama Mai funded by the NZ Government was commissioned in 2012. After one year of operation the plant saved 540 thousands litres of diesel with a value of TOP$875,000. It is envisaged this saving will continue for 25 years, the commercial life of the solar panels. A 0.5 MW hour solar farm was also commissioned in Vava'u in 2013 funded by the United Arab Emirates (UAE). Both are with storage capabilities and in a centralised storage. In both cases, training by the Developer was provided.

- This combined total of 1.5 MW on-grid solar PV that has been implemented is set-out in the table below:

Table 4: On Grid Operating Renewable Energy projects to date

Project	Size	Status	Funder	Value		Impact		
				Foreign $	TOP$	Litres diesel saved	Value @ TOP$ 1.70	Contribution
Maama Mai- TBU	1 MW	Completed July 2012	New Zealand	NZ$9m	TOP$12m	540,000 litres of diesel	875,000	4%
La'a Lahi - VV	0.5 MW	Completed Nov 2013	UAE	US$5m	TOP$6m	Projected to save 270,000	459,000	2%
Total	1.5 MW	Operating			TOP$18m	740,000	1,377,000	6%

ACTIVITY 3 (PHASE 1)

Implementation of a Proof of Concept Coconut Oil (660,000l/yr) + a 160kW Waste Gasifier Project. Operation, maintenance and training contract in place.

- The technology and economic feasibility of this option is still being studied.

ACTIVITY 4 (PHASE 1)

Implementation of Landfill Gas IPP.

- Dependent on resource being proved in Phase 0.

ACTIVITY 5 (PHASE 1)

Review of initial experience with petroleum financial risk management and implementation of modifications as required.

- Petroleum study is on-going and is expected to be completed by August 2015. Review of initial experience with petroleum financial risk management and implementation of modifications can be done once recommended actions from the Petroleum study is being implemented.

ACTIVITY 5 (PHASE 1)

Transaction advisor for Phase 2 projects selected.

- No work done to date. Yet to select.

2.2.3 Phase 2: Private Sector Participation, Efficiency and Renewable Energy Investments, Institutionalising Renewable Energy Investments

There will be no real power security if the private sector is not involved in energy production and distribution. The success of Phase 2 is dependent on the successful development and implementation of the previous two phases. The availability of the appropriate and enabling legislative environment and information regarding the feasibility of technology, the level of financial and economic return, and the availability of the financial resources with reasonable costs are all crucial for the successful implementation of this phase.

ACTIVITY 1 (PHASE 2)

A formal analysis of the data and findings from the Phase 1 projects.

- No work has been done to date, until the full maturity of Phase 0 and 1 activities.

It will be complete when all renewable energy projects are completed and running for a year. Data for analysis of the Maama Mai solar plant is available.

ACTIVITY 2 (PHASE 2)

Institutionalise the data collection systems set up during Phase 1.

- No work has been done to date, until the full maturity of Phase 0 and 1 activities and the implementation of the PRDR.

ACTIVITY 3 (PHASE 2)

A full-scale development of renewable energy projects on an IPP basis.

- No work has been done to date, until the full maturity of Phase 0 and 1 activities.

Chapter 3: Performance Outcomes

This chapter looks at quantitative and qualitative evidence in relation to 3 sets of indicators:

i. TERM-IU's objectives set against GoT's vision to provide 'clean, safe, sustainable and affordable energy';
ii. key general indicators set-up in the 2010 TERM Document; and
iii. project level indicators under the Energy Roadmap Institutional and Regulatory Framework Strengthening Project, focused on Phase 0 activities.

It is important to note that there is no formal or systematic monitoring and evaluation function at TERM-IU, and therefore limited information is available to support a comprehensive monitoring and evaluation (M& E) analysis.

3.1 High-level Indicators

Table 5: Government of Tonga High-level Indicators

GoT Determined High-Level Indicators					
Indicator Name	**Unit of Measure**		**Baseline - June 2010**	**2014**	**Target (2020)**
Renewable energy (RE) generated power to meet 50% of the power demand *(refer to Annex C, Strategic Result Area 3 attached)*	% of power demand		0%	6%	50%
Improvement in system wide-energy efficiency by 18% *(refer to Annex C, Strategic Result Areas 1,2 attached)*	Litres used/GwH		307,200 litres/GwH sold	4.08 kWh/litre	251,900 litres/GwH sold
Broken down as follows:					
Improvement in efficiency of conversion of fuel to electricity;	% reduction diesel use		18%	13%	50% [11]
Line losses reduced by 1.5% annually	% Line losses				9%
Accessible to all – 100% of Tongan consumers to access clean, secure, safe and sustainable energy	% of access (combination of grid & off-grid)		80%	88%	100%
Affordable to all *(refer to Annex C, Strategic Result*	Ave. number of HH		1,200 ave. HH disconnected/mo.	1,000 ave. HH disconnected/mo.	< 100 ave. HH disconnected/mo.

[11] It is envisaged that about 5% reduction in diesel use will be achieved by energy measures at TPL (i.e. improvement in specific fuel consumption) and about 45% reduction in diesel will come from substitution of generation from renewable sources.

GoT Determined High-Level Indicators					
Indicator Name	**Unit of Measure**		**Baseline - June 2010**	**2014**	**Target (2020)**
Area 4 attached)	disconnected/ month[12] Lifeline tariff introduced		None	Yes	Lifeline tariff implemented and refined (i.e. first 50kwh paid for by govt.
Reforming the energy sector with the aim of updating and consolidating all functions of the sector into one entity *(refer to Strategic Result Areas 5,6 attached)*	Yes/No		No	Yes (Consolidated July 2014)	Energy Division fully staffed, strengthened and delivering TERM objective

3.2 Analysis

Given the above table on progress against indicators, the following conclusions can be made:

i. TERM has achieved 6% **renewable energy** generation and aims to reach 50% by the year 2020. Although the GoT announced a 100% target by 2020, further assessment of the current situation against possible funding, technical capability of the grid and support shows that 50% is a more realistic target by 2020 and this revised target is what is reflected in this report (which is also agreed and supported by the new Government). Given this level of RE penetration, there is a lot of work from now to 2020 to achieve the 50% target.

ii. The comprehensive approach taken by TERM in increasing renewable generation and energy efficiency is supported by its development partners (DPs) as shown by the aid provided. Refer to Annex E listing all energy projects in Tonga with funding support from DPs.

iii. **Access to electricity target** of 100% (grid and off-grid) by 2020 is on track with the completion of the ADB/Aus/EU-funded Outer Island Renewable Energy Project and the continuation of the NZ-funded Tonga Village Network Upgrade Project (TVNUP).[13] Again, there is more work to be done.

iv. To complement Renewable Energy, **energy efficiency** is important and TERM (within the Department of Energy) is working with Development partners – New Zealand Aid, ADB, WB, EU, GIZ, IUCN, Australia's Department of Foreign Affairs and Trade, UAE, GEF, on projects like the TVNUP,[14] PEEP2, PIGAREP to improve EE. TERM, DoE and TPL are also working with together to upgrade the Nuku'alofa grid which can save 3 seniti per kWh, through a more efficient system.

v. **To support the above** objectives, **all the grids in Tonga must be upgraded**. Tongatapu Villages and Outer islands grid upgrade which comprise of 40% of the grid, is now fully funded. At this stage however, the Nuku'alofa grid which comprise of the majority at 60% is yet to find a source of funding.

[12] This indicator is just one indicator of progress until availability of better data. For example, smart-metering project which will commence in 2015 needs to be factored. It is anticipated that with prepay/smart meters in the home, customers will be able to pre-pay for their supply and better monitor their electricity use to avoid disconnection. In this case, this does not mean that electricity supply is more affordable, when the price may not have changed.

[13] Through the completed Stage One, there was a 25% increase in accessibility to electricity, offering new connections free of charge to households across the 17 villages. Stages 2&3 anticipate additional 20-25% increase in household connections.

[14] For example, the Tonga Village Network Upgrade Project (TVNUP) funded by NZ, is already well under way. Stage One is now complete, and reduced line losses across the17 targeted villages from an average 26% to 6%. With an additional 33 villages to be upgraded through Stages 2&3, the TVNUP will offer more EE improvements by completion in 2018.

vi. **Affordability is still a major concern -** despite a number of programs implemented by TERM, the outcome has not met the GoT's expectation in relation to affordable energy (with the price of electricity still considered to be one of the highest in the region). Hence, development partners are assisting the government in achieving its national target by 2020.

vii. The WB-funded work to **review the petroleum products and distribution model**, although delayed, has commenced, and this is vital for the next phase of TERM development with expected outcome of reducing annual petroleum costs between TOP$4M and TOP$6M.

3.3 TERM Indicators

Below are general indicators encompassing Phases 0-2 set-out under the TERM document launched in 2010.

Table 6: High Level Indicators

High-Level Indicators *(based on TERM document)*					
Indicator Name	**Unit of Measure**		**Baseline - June 2010**	**Current (2014)**	**Target (2020)**
GoT Institutional arrangements in place and operational.	Yes/No	Phase 0	No	Yes / July 1, 2014	TERM-IU fully transitioned and New Department of Energy fully staffed by July 2015
Technical Assistance for policy, legal, regulatory reviews completed and recommendations implemented.	Yes/No	Phase 0	No	Partial - refer to Sec 2, Activities 1&2 Phase 0 progress	Recommendations approved / or not by June 2015
Tonga Green Incentive Fund established and launched.	Yes/No	Phase 0	No	Agreed to be Dropped in 2012.	Agreed to be Dropped in 2012.
Data gathering mechanisms in place and functioning.	Yes/No	Phase 0	No	Partial, refer to Sec 2, Activity 3 Phase 0 progress	By 2018
DSM program launched. Reduction in demand relative to "Do nothing" scenario.	5% within 3 years, 9% within 5 years	Phase 0	1%	3%	9%
Off-grid program launched.	# of HH benefiting from program annually	Phase 0	462	1012 SHS	1156 including new homes.
TPL investments on safety, data acquisition and management and efficiency improvements.	Losses reduced, on average, by 1.5% annually for 6 years. TPL infrastructure meets international standards of safety - Yes/No	Phase 0	Safety – No; Line losses - 18%	Safety – Yes; Line Losses - 13%	Safety – Yes; Line Losses - 10%

High-Level Indicators *(based on TERM document)*					
Landfill Gas Project commissioned.	Yes/No	Phase 1	No	No	Yes
Solar PV Plant(s) commissioned. Annual kWh of displaced diesel generation. Technicians fully capable of PV plant O&M and management of TPL grid with intermittent and decentralised energy supply.	Litres saved per annum Yes/No	Phase 1	0 No	1,053,000 litres/annum Yes	1,313,000 kWh Yes
First CNO / waste gasifier project Plant commissioned.		Phase 1	No	No	Yes by 2020
Evaluation report of Phase 0 & 1 completed and discussed with Tongan stakeholders, development partners, other interested parties.	Yes/No	Phase 2	No	No	Yes by 2020
Transaction Advisors in place.	Yes/No	Phase 2	No	No	Yes by 2020
TGIF Dev. Partner commitments made for 1st set of Phase 2 projects	Yes/No	Phase 2	No	Agreed to be Dropped in 2012.	Agreed to be Dropped in 2012.
Renewable Energy IPP project commissioned.	Yes/No	Phase 2	No	No	Yes by 2020

3.2.1 Analysis

- Phase 0 activities were intended to be delivered within an 18-month period from the launch of the roadmap (TERM) in June 2010. However, given the complexity and challenges in the operating environment, this has taken longer to implement. A more detailed analysis is presented under project level indicators in the next section.

- Despite the delay, the GoT continued to show political will and significant progress was made with achieving the permanent institutional structure of TERM with the creation of the DoE in July 2014, but with TERM-A, C and IU being left to operate and support the achievement of the TERM targets. Work still needs to be done to strengthen and fully resource the new DoE to reach its full potential and to confirm the position of TERM A to deliver the objectives of TERM by 2020 but a huge step has been accomplished. An Energy Bill is also expected to be completed during 2015.

- Notably, Phase 1 activities are well underway, particularly in commissioning solar PV plants while Phase 2 activities hinges on the successful delivery of Phase 0 activities.

3.3 Intermediate Indicators

The intermediate level indicators are more detailed indicators adopted by the WB for its Energy Roadmap Institutional and Regulatory Framework Strengthening Project specifically for Phase 0 activities, comprised of Project Development Objective (PDO) and intermediate results indicators which feed into the higher level TERM-level indicators. This project funded by Australia and ASTAE consists of two components focusing on (a) strengthening the energy sector framework and structure; and (b) preparing TPL for renewable energy supply. The GoT will request an extension of closing date of this project until 30 June 2016.

Table 7: Intermediate Indicators - Energy Roadmap Institutional and Regulatory Framework Strengthening Project

Project Development Objective Indicators						
Indicator Name	**Core**	**Unit of Measure**		**Baseline**	**Current**	**End Target**
Improvements in network reliability indexes.		Minutes	Value	155.00	91.00	86.50
			Date	12-Nov-2012	30-June-2014	30-Jun-2016
			Comments	System Average Interruption Duration Index (SAIDI), measured as minutes/customer/month. Twelve- month rolling average for Tongatapu, excluding extreme events. The unit of measure was corrected since the last ISR from minutes/ customer/year to minutes/ customer/month.		TPL confirmed a corrected end target on October 24, 2013. The previous end-target provided by TPL was 124 mins/ customer/month, but TPL advised that it subsequently reviewed and corrected this number.
Petroleum risk management framework completed		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-2016
			Comments	No risk framework currently in place.	No risk framework currently in place.	Risk management framework adopted.
Summary report of processes and documents required for investment in generation systems		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-2015
			Comments	No current processes defined.	As of the 11-Sep-2013 reporting period, there were no processes defined. Now TPL currently have processes and documents for implementation of RE generation projects such as Power Purchase Agreement (PPA) and Small Distributed Generation Policy.	Documents and processes well defined and used as the basis for the implementation of multiple projects.
A well-developed power system planning		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-2016

Project Development Objective Indicators						
Indicator Name	**Core**	**Unit of Measure**		**Baseline**	**Current**	**End Target**
document for the years 2012-2017			Comments	Power system planning documentation, asset management plan, and strategic plan exist; but need to be strengthened.	As of the 11-Sep-2013 there was no plan in place. TPL now have a clear strategic plan that has resulted in several projects being tabled with the TERM-C for approval to seek funding – some have already been approved for funding and are currently underway.	Power system plan becomes a living document that is revised by TPL to reflect implementation status, and disclosed to TERM-C.
Ability of TPL to model and predict the effects of new generation on the power systems		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-2016
			Comments	No overall system modelling software utilised.	Modelling software is to be purchased in July 2014 and up-skilling of staff to commence accordingly.	TPL have power system modelling capability in-house.
Environmental and Social Management Framework completed.		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-20156
			Comments	Significant gaps in existing environmental and social management framework.	This activity has been put on hold but budget is now available and TOR will be developed and submitted by February 2015. .	Framework completed and submitted to Cabinet for approval.
Development Plan for the grid completed		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-20156
			Comments	Outdated studies with insufficient detail to support good planning.	WB has provided its no objection to the TOR	Plan completed as basis of future investments in the grid.

Intermediate Results Indicators						
Indicator Name	**Core**	**Unit of Measure**		**Baseline**	**Current**	**End Target**
Adequate staffing of TERM-IU		Yes/No	Value	No	No	Yes
			Date	30-Jun-2012	30-June-2014	30-Jun-2016
			Comments	Preliminary working with TERM-IU and with interim director and minimal staff. All key administrative staffing required within 3 months of effectiveness. Sector specialists by second year of implementation.	Formal TERM-IU established with permanent Director in place, support staff and project implementation support.	Adequate staffing through the new Ministry, including both administrative staff and sector specialists. Staff to be maintained throughout implementation.
Control and protection equipment installation to enable the network for intermittent renewable energy generation.		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-2016
			Comments	Control and protection systems currently inadequate for high penetration renewable energy generation.		Equipment installed, calibrated and operational.
Feasibility studies relating to fuel substitution, coconut biomass/biofuel, wind generation, solar PV generation, energy storage and demand side management.		Yes/No	Value	No	No	Yes
			Date	07-Nov-2012	30-June-2014	30-Jun-2016
			Comments	Technical and commercial viability of large scale implementation of renewable energy generation is not well determined.		Feasibility studies and technical options reports completed with support from other TERM DPs.

3.3.1 Analysis

Project Development Objective Indicators

- There are improvements in network reliability indexes improved (from SAIDI of 155 minutes/customer/month in 2010 to 91 minutes /customer/month in June 2014).
- Petroleum risk management framework still to be put in place.
- TPL now have a clear strategic and well-developed power system planning.
- Plan that has resulted in several projects being tabled with the TERM-C for approval to seek funding – some have already been approved for funding and work on feasibility studies are currently underway. Thereafter TERM and the GOT will be looking for funders.

- Ability of TPL to model and predict the effects of new generation on the power systems - modelling software have now been purchased and up-skilling of staff to commence accordingly.
- Environmental and Social Management Framework is still to be completed.
- Impact of the project on affordability has to be assessed and agreed upon.
- Development Plan for the grid - still to be completed as basis of future investments in the grid. Work is underway.

Intermediate Results Indicators

- Adequate staffing of TERM-IU: Formal TERM-IU established with permanent Director with support staff in place. The new DoE has now been established, but still with inadequate support staff dedicated for the TERM program, thus it must be ensured that there is resources and staffing through the new Ministry, including policy and legal advisors, as well as technical specialists, to deliver on TERM objectives.
- The roles of each, TERM-IU and DoE, has to be clearly defined to avoid duplication
- Control and protection equipment installation to enable the network for intermittent renewable energy generation not yet in place.
- Feasibility studies on technical and commercial viability of large scale implementation of renewable energy generation is not yet in place.
- The University of South Pacific (USP) has already completed a study on tidal wave available for use by PICs, but does not cover an in-depth analysis of the specific site in Vava'u and Ha'pai as a viable renewable energy option. TPL and TERM-IU are now coordinating with the USP author for clarification and scope of possible future work in Tonga and will approach development partners to pursue the study if required.

Chapter 4: The Way Forward

4.1 Institutional Strengthening and the Legal Framework

4.1.1 Where do we want to be?

4.1.1.1 **Policies, Legislation and Regulation**

A key objective of TERM, through Phase 0, is to achieve a more integrated and coherent energy sector with a streamlined set of policies, legislation and regulation that will enable the accomplishment of the various objectives set.

Achieving a coherent approach to the energy sector will necessitate legislative revisions, with the aim of moving towards a single 'Energy Act' that would provide the basis for government action in the sector. This might be done in one piece of legislation, but a study of the costs and benefits of doing this would be essential. The aim is to achieve a legislative and policy framework that will contribute to the following public benefits:

- a reduction in the vulnerability of the Tongan economy to oil price spikes;
- a reduction in the cost of electricity for the people of Tonga;
- a more coherent accountability framework – people of Tonga will be able to understand who is accountable for Government policy on energy;
- machinery of Government that minimises bureaucracy and the cost of policy direction; and
- a legislative framework that enables least cost supply of electricity and petroleum products in a sustainable way

New legislation would draw on the existing Acts, with a review to determine how they might be improved, or replaced. Clearly, the legislation would need to encompass the three sub-sectors – petroleum, grid electricity and off-grid electricity. It would also draw on current and evolving practice with respect to renewable energy and energy efficiency. Most regulations under the relevant legislation (Electricity Act 2007, RE Act 2008, Petroleum Act 1959, Price and Wage Control Act 1988) have not been revised for many years and are clearly in need of review.

4.1.2.2 **Organisational Structure**

With the government institutionalising TERM-IU through the creation of the DoE, capacity gaps should be examined while guarding against establishing unsustainably large government departments. This section looks at defining the strategy, structure and the proposed financing options to achieve the objectives of TERM.

4.1.2 Action Plan

4.1.2.1 **Policies, Legislation and Regulation**

TERM-C has already approved the drafting of an Energy Bill. Once the Bill is prepared, it would have to follow the approved legislation process by obtaining Cabinet and then Parliament approval requesting the signature of His Majesty King Tupou the 6th. The plan is to have the Bill approved by Presented to Cabinet by the second half of 2015.

In order to develop the Energy Bill, TERM-IU is receiving technical assistance from the WB in carrying out a review of the energy regulatory framework, focusing in particular on mapping the governance and regulatory arrangements for the provision of electricity service, to clarify the existing remit, powers and duties of the various institutions involved in the regulation and provision of electricity services. This exercise will allow TERM-IU to identify any gaps in the existing framework, and to develop a plan of reform in consultation with competent ministries, the Regulator, TPL and Cabinet. The ongoing Government changes and the creation of the new Ministry of Energy, as well as any related changes that may occur to the regulatory bodies, will be extremely relevant to the outcome of this work and will be taken into account as they emerge.

With funding support from WB, TERM-IU held a workshop from 9-11 September 2014 on renewable energy and energy efficiency policymaking in small Pacific Island Countries (PICs). As an outcome of this workshop, the WB has agreed to finance a TA to the Government of Tonga in developing the key elements for an energy policy framework consistent with the objectives of the TERM.

4.1.2.2 **Organisational Structure**

With the government institutionalising TERM-IU through the creation of the DoE, capacity gaps should be examined while guarding against establishing unsustainably large government departments. This section looks at defining the strategy, structure and the proposed financing options to achieve the objectives of TERM.

4.1.2.2.1 **Defining strategy, structure and responsibilities**

Role of TERM within the Department of Energy - TERM will deliver on the work programme as set-out in the TERM Document, to develop policies and programs to achieve 2020 goals of (1) 50% of power supply from renewables, (2) 18% system-wide energy efficiency, (3) 100% access to electricity and (4) affordable electricity to all Tongans. TERM also supports the legislative framework that protects the public interest in all aspects of the Energy Sector.

Doctrine/Principles that underpin TERM - TERM focus is on policy, planning, regulation and advising government on the Energy Sector, NOT delivering services;

- TERM does not duplicate activities that are undertaken elsewhere in the Energy Sector;
- TERM stays a small professional unit, using contractors to meet specialist requirements;
- TERM ensures transparency of information about the Energy Sector [only a limited range of information that relates to individuals and organizations is confidential];

Structure/ Organisation - The staffing level required to continue the work programme of TERM is proposed to be small so that there is a clear focus on policy and strategy, not delivery of services. The role of staff is to ensure that overall objectives are met and that the direction on most appropriate energy policy and consolidation of all existing energy legislation is maintained. The substantial work on developing energy policy will be undertaken by specialist contractors.

At the minimum, it is envisioned that the staff would comprise of the following:

- Director
- Policy Manager (to be shared with the Ministry DoE)
- Operations Officer/National Coordinator / Communications Officer
- Accounts and Administration Officer (to be part of the Corporate Services of the Ministry)
- Energy Efficiency Officer (could be covered by skills/expertise of DoE staff absorbed from EPU)

Functions of TERM in coordination with the DoE - The functions to be performed by proposed staff:

a) Leadership - Director (currently filled)

- Strategy and policy advice to Minister (including providing effective secretariat function to the various working groups like the Petroleum study and work on resetting the Concession Agreement), and development. TERM-IU has been approved by Cabinet to provide secretariat responsibilities to the WG on the petroleum study, energy policy development, regulator and the Working Group looking at the resetting of the power concessional contract. These are major initiatives and go towards the end of 2015.
- Management of TERM,
- High level relationships with stakeholders, including DPs.
- Source funding from donors for energy projects

b) Policy & Planning (Policy Manager) (vacant - concurrently done by Director)
- Policy
- Legislation & Regulation
- Planning
- Renewable Energy

c) Communications & Information - Operations Officer/National Coordinator / Communications Officer (vacant - function not being done)
- Monitoring the sector performance
- Information sharing
- Energy Efficiency [consumer information/promotion component of EE]

d) Administration & Coordination - Accounts and Administration Officer with the support of Operations Officer (currently filled but limited to accounts, administration and support to the Director)
- Administration
- Finance (managing relations with DPs/Aid Management and Corporate Services of the Ministry)
- Project Coordination

The PRIF Coordination Office (PCO) offered to provide funding for an institutional gap analysis. However, MoFNP determined that support will be useful if it addresses the operational set-up for the entire ministry. Thus support is premature given the staffing of the Ministry is embryonic and the permanent CEO is yet to be appointed. The offer from PCO however is open for re-consideration in the future.

4.1.2.2.1 TERM and Financing

The Government and TERM-A have to determine and take ownership whether the remainder of TERM will be implemented to achieve the targets and outcomes set by the Energy roadmap. If yes, the next step is to resolve how the TERM work programme will be incorporated and resources/funded in DoE's new Corporate Plan. It is proposed that there be a transition period until the end of 2015, to allow for the current work programme of TERM to be completed and/or ready for full implementation by DoE. The following funding options can be considered:

a) **Budget support** - TERM-IU approached the Ministry of Finance for support towards TERM's operational expenses based on energy actions included in budget support operations from DPs. The EU provided Budget support to the GoT with draw down contingent on meeting indicators for the energy sector. Given that TERM is critical to achieving indicators for the energy sector and Budget support goes to general funds, TERM-IU may advocate to MoFNP for a small share of this Budget support to fund its operating costs.

b) **Donor funding** - Seek new and additional donor funding to effectively carry on the work programme of TERM to completion.

c) **Full Government funding** - through the Annual Budget, GoT finances the operating costs of TERM.

4.2 Petroleum

4.2.1 Where do we want to be?

The GoT's vision of the petroleum subsector is not well articulated. The sector has been largely left to the private sector with government's engagement largely restricted to The Competent Authority role in regulating the wholesale price.

There is a need to provide a government perspective on what the sub-sector of the future should deliver for Tonga, in particular to mitigate and manage the risks and consequences of this energy dependency, and to secure a sub-sector that is as efficient as possible and so provide fuel that is least cost under the circumstances.

In the medium to long term, Tonga aims to have a petroleum sub-sector that is efficient and minimises the unit cost for imported fuels; provides a level of storage that provides reasonable security; and seeks to achieve greater efficiencies in customer use and distribution.

4.2.2 Action Plan

Several appraisals have recommended the review and consolidation of the petroleum sector under a single Ministry governed by integrated energy legislation as well as conducting a review of the business environment and design of best-fit model to provide the most affordable prices to Tongan consumers. Under the TERM IRFS project, TERM-IU is undertaking a comprehensive review of the petroleum sub-sector expected to be complete by August 2015.

This is a major piece of work and will guide the development of Tonga's Energy Bill and Act and the business model for the supply and distribution of petroleum with associated investments.

4.3 On-Grid Electricity

The TERM-IU works closely with the Government and the Tonga Power Limited initially in planning, obtaining funding for RE, EE for energy generation and distribution. It also works with direct stakeholders including the Development Partners in developing legislative and institutional framework to enable the attainment of the set objectives.

4.3.1 Where do we want to be?

Vision. In the broadest terms, the vision for Tonga is an electricity system that:

- minimises the need for imported fuels;
- matches generation options to the daily demand curve; and
- seeks to achieve greater efficiencies in customer use and distribution.

Objective. In the medium to long term, Tonga aims to have:

- Electricity generation, whether distributed or centralised, that is primarily renewable energy based, using indigenous sources of fuel (sun, water, wind, biomass). This predominantly renewable energy generation needs to provide a significant proportion of base load capacity that matches supply to the demand curve without expensive storage.
- A distribution system that is effective, efficient and robust, enabling the sharing of electricity through the community, whether generation is distributed or centralised.
- Efficient energy use by customers to enable them to maximise the value of electricity while containing costs.
- Financially sustainable electricity sub-sector through establishing and running the system at optimal cost driven by efficient operations and maintenance regime.

By 2020, the on-grid electricity system will have transitioned from a traditional diesel generation utility to a balanced renewable/diesel system with the following features:

- 50% of generation will be by renewables from 0% in 2010 and 6% in 2014.
- At least 25% of the 50% will be firm capacity renewable – whether wave, tidal/hydro, biomass or other.
- The distribution system will have reduced line loss to 8%, and have reached a standard of robustness (appropriate to the South Pacific) such that there will be minimal damage from a Category 3 cyclone, and have minimal cost of repair from damage in a Category 5 cyclone [(e.g. 90% of connections to customers will be underground).
- Energy efficiency measures among customers will have reduced the overall usage from the 2011/2012 level from the current 52.4 Gigawatt hours to 50 Gigawatt hours.

Planning. Government policy and planning leadership that:

- Enables TPL to focus on operational and investment efficiencies within a framework that government provides to achieve the desired ends.
- Enhances cooperation between the government's Minister and the newly created Department of Energy responsible for energy policy and planning, the Minister and Ministry responsible for public enterprises and TPL in having a seamless approach to planning.

4.3.2 Action Plan

Context - Technology Developments. There is general agreement that technology will reshape the future for grid supplied electricity for both centralised and distributed generation. Picking a winner in how these developments will play out (e.g. will future systems be dominated by small customer mounted RE that is shared through a smart grid, or will there be a breakthrough in wave or hydrogen or other major technology that will enable large centralised generation) is risky for a small island nation like Tonga.

Renewable energy generation technologies beyond solar continue to evolve – e.g. wave – as well as developments in PV technology. Notwithstanding the latter, the reduction in the price of PV arrays appears to be more a function of cheaper manufacturing costs (out of China) rather than the implementation of technology developments.

Storage still appears to be an area where development is desultory in the Pacific. There remain issues with maintenance and disposal that provide problems for small island nations. However, battery storage is required, if Tonga wants to be truly renewable and efficient in providing RE especially from the sun, wind and tidal wave.

Action Plan. Given the difficulties in picking the best technology that Tonga should have in 15 years, the focus needs to be on flexibility to respond appropriately.

The Roadmap looks at the sector up to 2020. The proposed planning period for the new Department of Energy up to the end of the 2020 would have two overlapping phases or parts.

Short to Mid-Term: 2014 – 2016 where the aim is to have completed:

- the solar RE already in planning (the current list includes: Masdar 0.5MW on Vava'u; ADB/Aus/EU 1.25 MWp-commissioned November 2014 of grid connected solar on the Outer Islands; JICA 1.0MW solar at Vaini); and
- proof of concept trials on firm capacity renewable options (including optimising generation options). TPL and TERM-IU have identified four (4) projects that have the potential to reduce the risk of diesel fuel price shock impacts to the Tonga economy, tariff reductions, financial returns and

social and community benefits. These projects (which currently do not have committed funding) include:

- Project 1- Biomass gasification generation
- Project 2- Wind power generation
- Project 3- Waste heat recovery generation
- Project 4- Nuku'alofa network upgrade

A description of these proposed projects and the status of the development work undertaken to date on each of these and comparison of the key parameters used to compare the project outcomes is provided in Annex D.

- detailed action plan for phasing out the existing diesel assets displaced by the 2020 50% RE target.

Full Period: 2014 – 2020 where the focus is on Demand Side Management:[15]

- **Energy Efficiency** – optimising electricity consumed, and particularly reducing daily (night time) peaks.
- **Distribution System Efficiency** – ensuring that electricity, no matter whether generated centrally or distributed, can be shared across a grid; and ensuring loss minimisation and capacity to both withstand extreme weather, and be relatively easily repaired after such events disrupt supply.
- **Focus on Outer Islands first** – priority should be given to the Outer Islands because the pay-off is greater in terms of unit costs for diesel generation. In some areas households are yet to connect to clean and sustainability energy (power).

An overview of the broad/strategic direction could look like the following.

Table 8: Overview of strategic direction for on-grid electricity

No	Area	Baseline 2011/12	2019/2020	2029/2030	Monitoring and Measurement
1.	Renewable share of Generated Electricity	0	50% of power (KWH) generated from renewable sources against total power generated	70%	Based on TPL annual kWh generation from RE sources vs annual total kWH from all generation plants
2.	Firm capacity renewables share of Generated Electricity, as of now.	0	35%	25%	Based on TPL annual kWh measured at each generation plant and that generated by renewable sources
3.	Fossil fuel consumption per unit of electricity produced	13 million litres of diesel used to generate 52.4 Gigawatt/hours 4.03Kwh/litre	10.2million litres to produce 52.4Gwh 5.14 Kwh/Litre	4.5 million litres to produce 52.4GWh [cut back to the new level] 11.6Kwh/litre	Based on TPL annual diesel fuel use and annual kWh generated
4.	Demand Side Management	52.4 Gigawatt/hours	50 Gigawatt/ hours	47 Gigawatt/ hours	More effective measure still to be developed

[15] DSM will be discussed in more detail under succeeding section 4.5

No	Area	Baseline 2011/12	2019/2020	2029/2030	Monitoring and Measurement
5.	Distribution - Energy Efficiency – losses on grid	Now measured at 14.8% of total generation	Reduced to 10% of total generation	Reduced to 8% of total generation	Difference between annual energy generated at TPL generation plants and energy metered at customer's premises
6.	Distribution system robustness		40%	90%	Still need a measure

Planning. TERM-IU, and the new DoE and TPL must collaborate in developing a Sub-Sector Plan that provides one basis for tackling the on-grid electricity challenges and opportunities.

A key requirement here is managing the transition from the current TPL business model to one where TPL has a significant proportion of its generation capacity in renewables (solar and biomass) within the five year period.

Two specific issues must be addressed in doing this:

- There is likely to be a requirement for specific support to manage the stranded assets arising from the broad strategy; and
- EE and possibly a reduction in demand could increase KWh tariff and assistance may be required to manage this to address affordability issues.

4.4 Off-Grid Electricity

Most of the work of the off grid generation and planning has been done by the EPU (now the DoE) with the support of TERM-IU through policy advise on project proposal, operation and management.

4.4.1 Where do we want to be?

The vision for this sub-sector is to have viable communities on the Outer Islands that have affordable and sustainable electricity supply.

Without electricity, Outer Islands would likely go into rapid decline. People living on these islands are more likely to shift if they do not have access to electricity, and the improved quality of life it can bring. Census data shows that there has been a steady drift in population to major centres in Tonga and broadly via emigration to the Tongan diaspora.

Electricity creates a demand for cash that in turn encourages people to become more productive (by fishing, weaving mats, selling ice, among others to pay for the cost of electricity that they enjoy and cannot do without). This can help stimulate the local economy.

Rural development often starts with housing, followed by water and roads, electricity and telecommunications. Without electricity, it is difficult to have sustainable economic development.

4.4.2 Action Plan

This vision is not dissimilar to the goals of the past. The difference is that the broad vision is translated into specific and measurable targets that should ensure better focus and so better results.

To address those criticisms, it is proposed that government separate the policy leadership function from service delivery. The latter needs to be undertaken not within the public service, but rather by a state owned enterprise, a private sector organisation or a non-governmental organisation.[16]

The arrangements earlier established to consolidate responsibility for the electricity sub-sectors in TERM-IU had been seen as a short term measure to ensure that there is a coordinated approach. The long term approach is to have a small unit focused on policy and planning that 'steers' the sub-sector but does not get involved in service delivery. The new DoE can consider setting-up a framework for others to deliver the services required for the off-grid sub-sector. An IRENA study noted the option to establish 'an implementation agency' under TPL (e.g. TPL Rural). This would be a separate, stand-alone unit with its own accounts, finances and human resources. It went on to observe that the GoT would need to establish 'clear regulations for the development of fees and tariffs for outer island electricity supplies. The capacity both in manpower and in skill set of the government energy agency, the electricity provider and the private sector must be developed.'

Methodology and Key Activities. Through energy efficiency improvements in the residential, commercial, and government sectors, this program will improve the efficiency with which consumers use power. The program will develop and implement:

- a comprehensive database on what has worked and what has not worked in the past;
- policies and capacity building for the government and private sector in providing the support to enable communities to successfully manage their use of the technology and institutions necessary; and
- specific programs and interventions to meet identified needs in specific communities.

Results and knowledge products will be disseminated across the community and island groups to encourage replication of those approaches that are most effective, and to avoid the problems that have occurred in past programs.

Table 9: On-Grid Electricity Sub-sector: Proposed Outputs

Output 1: Stakeholder access to comprehensive information on technology and institutional arrangements necessary. The main output will be an accessible database, with particular attention on how to disseminate the information usefully in communities that do not have access to the internet.
Output 2: Meet basic needs through domestic renewable energy programs implemented effectively and sustainably. While the specifics are yet to be determined, this output will involve a number of tangible implementation initiatives.
Output 3: Stimulate the local economies in the Outer Islands where they are viable through systems that provide an affordable and sustainable mini-grid electricity supply. **This output will include:** a. Selection of appropriate technology that will include renewable and alternative energies; b. Installation of the necessary infrastructure; c. Identify the most appropriate business options to operate and manage the assets including Establishing or reinforcing communities through institutional arrangements that enable self-management and sustainable delivery systems; or private sector intervention d. Provide training to support effective and sustainable operation; e. Establish self-monitoring systems that inform the communities and government [i.e. increasing use of power by reporting chargeable kWh and the extent of use of load banks.
Output 4: Effective, efficient and timely disposal of discarded equipment. This output should ensure that there is an accounting for the various pieces of equipment put into Outer

[16] Note that under OIREP, ADB and Australia-DFAT fully support the latter option.

Islands and that the equipment that is no longer operational or no longer required is appropriately/safely disposed of.
Output 5: Effective project management established. This output will ensure the program of activities is implemented on time and to budget. Significant activities under this output should be listed in an attachment.

4.5 Energy Efficiency and Demand Side Management

This will involve a significant public awareness activities, advice and promotion. A major part of the work will be conducted by the DoE with TERM providing advice participation in the actual delivery of the programs.

4.5.1 Where do we want to be?

The aim for this sub-sector is least cost generation and reduction of fossil fuel use by the power sector without a corresponding reduction in energy services. The outcome will be that end consumers use power efficiently. Assuming macroeconomic conditions remain stable, the initiative will reduce energy intensity as well as promote energy security and reductions in greenhouse gas emissions from the power sector.

There will need to be more work on the metrics to be able to differentiate the contribution of energy efficiency from other factors that lead to an increase or reduction in consumption. The specific aim is to see an 18% reduction in consumption for the same level of energy services.

The PEEP2 project has reached its conclusion. The project's focus is on proof of concept initiatives, including standardising appliances and awareness which is having a positive impact. LED streetlights for upgrade have been delivered to Tongatapu and the Outer Islands. These will replace the old high-pressure sodium lights and will reduce the cost of street lighting without compromising light quality. A next phase PEEP 3 has been requested from Development Partners which will shift the concept to the national and sustainable level in the future.

4.5.2 Action Plan

The new DoE can look into addressing energy efficiency limitations by prioritising the establishment of appropriate institutional arrangements; implementing suitable policy and legislative support; collecting, analysing, and disseminating energy data required for identification and monitoring of demand-side efficiency improvements; and implementing national energy efficiency programs and public awareness campaigns.

The new DoE can also continue to work towards achieving greater affordability of energy services for consumers, although there is a need to ensure that reducing the overall demand does not lead to an increase in unit cost because the cost of fixed investment has to be spread over that reduced use.

Methodology and Key Activities
Through energy efficiency improvements in the residential, commercial, and government sectors, this program will improve the efficiency with which consumers use power. The program will develop and implement:

- a comprehensive database on energy use by sector and appliance;
- energy efficiency policies and capacity building for the government and private sector; and
- energy efficiency programs and interventions in the public lighting, residential lighting, and residential, private, and public buildings.

Results and knowledge products will be disseminated across the community and island groups to encourage replication.

To ensure that least-cost energy efficiency initiatives are selected, the new DoE can continue to seek Development Partner assistance in carrying out financial and economic analysis to compare the chosen solutions to alternative renewable energy options and supply-side efficiency improvements, as well as to the short-run marginal cost of diesel power generation. Consideration will be given to measurement targets that include simple and discounted payback period, marginal cost, and cost per kilowatt-hour.

Table 10: Energy Efficiency and Demand Side Management: Proposed Outputs

Output 1: Stakeholder access to comprehensive information on energy use.
This output will complement the analysis carried out by conducting surveys to complete the picture of existing and projected appliance and equipment characteristics, patterns of use, and useful lifetimes. The main output will be an accessible database of energy use by sector and major appliance category.

Output 2: Energy efficiency practices mainstreamed into government policies and procedures.
This output will involve:

- establishing practical and implementable energy efficiency targets and their incorporation into national energy policies and plans;
- suppressing sale and use of high-energy-consumption appliances and equipment through import regulations brought about by the development and enforcement of effective minimum energy performance standards and/or energy labelling;
- improving energy efficiency best practices for newly built residential, commercial, and government buildings, including the establishment of simple, effective, and enforceable energy efficiency provisions in building codes for new buildings;
- developing and implementing training programs for local experts in undertaking energy audits and in providing energy efficient products and services; and
- supporting the development of motivated and organised service providers that have incentives to implement energy efficiency activities.

Output 3: Energy efficiency programs implemented effectively and sustainably.
While the specifics are yet to be determined, this output will involve a number of tangible implementation initiatives, including:

- upgrading street lighting using energy efficient and long- life technologies;
- providing energy efficient lighting systems to residential, commercial, and government buildings;
- undertaking energy audits in hotels and other non-residential private buildings and subsequently implementing recommended improvements in air-conditioning, lighting, refrigeration, water heating, and management schemes; and
- undertaking energy audits and subsequently implementing recommended improvements in government buildings.

Output 4: Information dissemination and improved public awareness.
This output will include:

- disseminating information to public and private stakeholders on the benefits of energy-saving technologies and practices through public education programs, workshops, and media; and
- leveraging benefits and information exchange beyond Tonga by using regional workshops, innovative information and communication technologies, and knowledge products.

Output 5: Effective project management established.
This output will ensure the program of activities is implemented on time and to budget. Significant activities under this output are listed in Appendix 1.

Chapter 5: Lessons Learned & Recommendations

The TERM has been cited as a model for long term strategic energy planning and execution in the Pacific region and other Small Island Developing States (SIDS). It is also acknowledged as a good development practice across the region and globally - setting out a single plan for all donors to align their assistance and support, rather than government realigning its priorities based on development partners' interests.

Mobilising funding for technical assistance support and Investment in the sector is one of the achievements of TERM, with total investment in the sector reaching TOP$121.7 million as of September 2014. This is a significant investment. Key success factors include:

1. **High-level GoT commitment and leadership to the TERM.** GoT has shown strong commitment to TERM by establishing TERM-C as the key policy decision making body for the TERM process. The TERM-C is chaired by the Prime Minister with the Minister for the Environment and Climate Change as deputy chair and has representation from all the relevant government ministries at CEO level. TERM-C provides oversight not only on the development of policy but also the approval of key reforms involving institutional restructuring and legislative review.

2. **Strong and coordinated development partner support**. The TERM process has been driven by the GoT in partnership with the donor partners. This partnership has worked effectively with a specialist energy team in the World Bank taking the technical lead on behalf of other funding partners. TERM-IU has benefitted from generous grant financing from a number of DPs including but not limited to NZ MFAT, UAE, World Bank, ADB, Aus-DFAT, JICA and IRENA (please refer to Annex D for TERM activities and summary of progress financed by DPs) .

However, there are areas for improvement. The operation of TERM for the past 4 years offers some important lessons. Looking forward, these lessons provide opportunities in which changes could be made to improve the functioning of TERM, maintain, expand and fast track the on-going programme and leverage on the synergies and linkages built over the past 4 years.

1. **Resources/Staffing** - The staffing level required to continue the work programme of TERM is proposed to be small so that there is a clear focus on policy and strategy, not delivery of services. However, with the cessation of donor funding for TERM-IU's operating costs, the Government and TERM-A have to determine and take ownership whether the remainder of TERM will be implemented to achieve the targets and outcomes set by the Energy roadmap. To aid in transitioning TERM into the new DoE, a transition period until the end of 2015 will allow for the current work programme of TERM to be completed and/or ready for full implementation by DoE, and eventually TERM-IU's role become core functions of the Energy Division. Options to finance the transitional phase and the remainder of TERM work programme through 2020 include budget support, donor funding and GoT budget.

2. On the basis of current practice to date, the Director of TERM-IU had to spend time travelling and otherwise seeking additional funding for TERM operations and projects. Therefore, it is essential to **allocate specific accountabilities to personnel** (when recruited) with the capacity to ensure progress on their responsibilities in his absence.

3. Weak project, fiduciary and risk management capacity plus inappropriate procurement model (client procurement) without the adequate resources to deliver **Institutional Strengthening (Phase 0) Activities** – while Phase 0 activities were envisioned to be completed within an 18 month period from TERM's launch in June 2010, no significant outputs were achieved with the first 18 months dominated by preparatory work. Further, while in a catch-up mode, technological deployment work under Phase 1 absorbed scarce management capacity. As a result, the important building blocks associated with the Institutional strengthening reform were neglected.

4. **Continued Development partner support and coordination is essential** - donor interest on technology only deployment continues. If the reform agenda is to avoid technology only propositions, increased focus needs to be given to scaling effort on institutional strengthening initiatives.

5. **Continued leadership and ownership from government -** is essential for sustainability to reach targets. Real progress requires TERM-C commitment, effort and decisions, and then implementation. With the new Government, evidence of government ownership could be strengthened if it was accompanied by a Joint Memorandum of Understanding (MOU) or similar.

6. **Adjusting Energy targets to be achievable** - it is ideal to establish an ambitious vision and target for the future of the country's energy economy. However, there is a need to adjust and create workable plans to meet the revised timetables and refocus if the targets are not met within the original timeframes. Thus, while TERM-IU's targets and action plan to 2020 and tracking achievement from 2010 baseline is commendable, it will be critical for the new Department of Energy to present a more detailed achievement target on RE, EE and Access to electricity annually, until the year 2020 based on current and forecast project pipeline. Action plans should be strengthened by the inclusion of timeframes by which the activities should be completed.

7. **Risks with recipient-executed Trust Fund instrument** for capacity-constrained agency - There are challenges in utilising a Recipient-executed instrument when the implementing agency (TERM-IU) lacks a track record and experience with WB projects. In particular, the WB's requirement that the recipient agency (TERM-IU) execute and handle administrative responsibilities such as financial management and procurement has led to significant delays given the many demands on limited resources. It was helpful, however, to have a project implementation champion to assist with these compliance requirements. Evaluate the feasibility of using the Central Procurement Unit of the Ministry of Finance to provide fiduciary support to all Ministries and ensure consistency in GoT's procurement processes.

8. **Policy framework** - the importance of robust policy frameworks which will allow Tonga to clearly establish and articulate their solution to economic, environmental and social problems confronting the country. Work on the regulation aspects of the power sector is equally important.

9. **Communication and Stakeholder coordination** - the need to ensure a stronger awareness campaign and continue to promote strong stakeholder coordination drawing together the assistance, ambition and skill sets on offer from donor organisations importance of ongoing reform to institutional structures and legal frameworks in facilitating private sector interest.

10. **Harmonising energy and climate change policy** - the focus of TERM on renewable energy generation and energy efficiency support climate change mitigation policy of Tonga. International climate change finance sources could support sustainability of TERM's focus on RE and EE. As a crucial infrastructure for Tonga, TERM has a role in climate change adaptation and disaster risk reduction and should be taken into consideration in the strategy and work plan of TERM. (i.e. opportunities in looking at synergies in climate financing, participate in shaping Tonga's next Joint National Action Plan (JNAP, 2016-2020) on Climate Change Adaptation and Disaster Risk Management).

11. **Ensuring sustainability of funded assets** - include a phased approach to transfer asset development and operation & maintenance (O&M) responsibilities to TPL for Government-owned assets such as on and off grid solar PV system. This should include asset investment targets within the regulatory contract and financing (partly) through the tariff. Outsourcing all or part (i.e. mini grid component) of O&M service to TPL or other experienced experts[17] to enhance the accountability of the O&M service and the sustainability of the funded assets.

12. **Addressing sustainable fuel issues in the transportation sector -** Noting that transportation is the most significant sector in terms of energy demand, this needs to be considered in a plan to enhance RE contribution to the transportation sector.

13. **Private sector participation -** Explicit recognition of private sector participation is essential if RE targets are to be met by 2020. In the establishment of IPPs, fair and transparent Power Purchase Agreements (PPAs) need to be designed, ensuring competitiveness with current generation costs and adequate returns for the private sector.

14. **Off-grid power supply** - Ensuring government's role is focused on policy issues, rather than implementation. Whilst acknowledgement has been made to Energy Efficiency projects, these need to be brought to the forefront and implementation of these prioritised. How these are reflected in the TERM needs to be clarified, with prioritisation of least cost options reconsidered.

15. **Integration of TERM into the new DoE Corporate Plan** - while TERM has been restructured into the new DoE, TERM mandate and responsibilities, remains to be incorporated in DoE's Corporate Plan. It would be highly beneficial for this TERM Review Report to be considered as part of DoE's new Corporate Plan, when it is submitted to Government for policy and budget considerations.

[17] both ADB and AUS-DFAT, highlighted a preference for this approach in the latest MOU signed during a grant review mission by ADB last 2-5 December 2014 of the Outer Islands Renewable Energy Project (OIREP) funded by both donors.

Annex A: Energy Efficiency Work and Off Grid Renewable Energy Generation Projects under EPU

Project	Funder (s)	Aim	Status
1. Pacific Region Pacific Islands Greenhouse Gas Abatement Project + [PIGGAREP+], Water Pumping Phase 1 • **Installation of 10 solar water pumps in 10 village water supply in the Ha'apai** • **Fund availability US$460K**	SIDS DOCK, supported by GEF, UNDP and Sprep Office	• reduction in the growth rate of GHG emissions from fossil fuel use in the Pacific Island Countries (PICs) through the removal of the barriers to the widespread and cost effective use of feasible renewable energy (RE) technologies.	• 10 solar powered pumps will be installed at Ha'ano/Pukotala, Faleloa, Lotofoa, Fotua, Fangale'ounga, Koulo, Holopeka, Uiha and Fe;lemea water supplies next month.
2.Pacific Appliance Labelling And Standards [PALS]	Australia through SPC	• ensure that they are efficient in power consumption and thus reduce the use of fossil fuel and the emission of	• The second final draft of the regulation has to be presented to the Minister responsible for the principal Act.
3. Integrating Renewable Energy into the Tongan Education Curriculum through development of Renewable Energy Resource Guidebook	GEF through UNDP/SPREP	• improve awareness at school level of the benefits of renewable energy	• Final Draft of the resources will be ready by the end of May 2014. Resource book must also be approved by Ministry of Education to be used.
4. Supporting the various local management committees in managing their renewable energy assets SHS.	GOT	• Ensure sustainability of the solar system installed	• Replacement parts have been procured and Government must exempt duty and levies on solar equipment funded by local communities.
5. Solar powered water pumping systems for all villages of 'uta Vava'u.	PEC Fund	• To put off diesel based water pumping engines • Reduce water tariff • Safeguard water table	• Project has been approved to implement. Financial Agreement will be signed soon between Tonga Government and Forum Secretariat.
6. Solar powered freezers systems for all remote islands of Vava'u and Ha'apai	PEC Fund	• To boost economic status of remote community • Maintain healthy and quality food in remote areas.	• Project has been approved to implement. Financial Agreement will be signed soon.
7. **Mini and off-grid solar system for 6 outer islands**	ADB and EU	• optimised use of on-grid and off-grid generation systems, and increased consumer access to electricity generated by solar power due to reduction in cost	Project is being implemented.

Annex B: Renewable Energy Initiatives Under TERM Initiative

1. ON-GRID

Target: 50% share of renewable energy in electricity generation by 2020.
Objective: Offsetting part of current and future grid-based generation with renewable energy sources.
Activities Phase I

Project Activity	Cap. MW	Status/ Explanation	Estimated % Contribution.	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	% Cum.	Annual Littre of Fuel Saved ['000]	Tons of CO_2 Savings
Maama Mai Solar Farm	1.4	In full operation at Popua	4				✓			4	470 Diesel	
Wind Farm 1	0.11	In full operation at Nakolo	0.31				✓			4.31		
UAE Masdar Solar Farm	0.5	Full operation by 2014 in Vava'u	1.43				✓			5.74		
JICA Solar Farm	1.0	Contract has been signed and in operation by 2015	2.86					✓		8.60		
ADB Outer Island RE Project	0.8	For Pangai and 'Ohonua	2.29						✓	10.89	2.5%	971
Biomass Gasification	1.6	Tongatapu .94MW & 'Eua .22MW	4.54						✓	15.46	85% of ADO	
Wind Farm 2	2.5	2.5MW per site in Tongatapu	7.14						✓	22.60		
Biofuel		Tongatapu							✓		10 of ADO	
Landfill gas of IPP		Tongatapu	1.5 of capacity						✓			

2. OFF-GRID

Target: 100% by 2020.
Objective: Improving accessibility in remote and isolated areas to meeting the needs of consumers too remote to be connected to a grid
Strategic Actions:

- Develop capacity building of governance structure at community level
- Provide institutional strengthening at financial, management and technical level
- Review and complete rural electrification programme including using of alternative energy sources
- Ensure of continuity, consistency of accessibility to energy supply from remote areas

PHASE 0 – OFF GRID ACTIVITIES:													
Project Activity	**Cap. kWp**	**Status/ Explanation**	**Donor**	**% Contribution.**	**2010/ 2011**	**2011/ 2012**	**2012/ 2013**	**2013/ 2014**	**2014/ 2015**	**2015/ 2016**	**% Cum.**	**Annual Litre of Fuel Save ['000]**	**CO_2 Savings**
Diesel Mini-Grid [kW]	491.2	4 Islands in Ha'apai Group [Ha'ano, 'Uiha, Ha'afeva, Nomuka]	AUS-DFAT	29.32	✓						29.32		
Outer Island Electrification Program prior to 2010	57.76	8 villages in Niuafo'ou, Tafahi, 6 islands in Ha'apai all managed under incorporated society	NZAid, France, AUS-DFAT	21.09	✓						50.41		
Rehabilitation of Mango and Mo'unga'one PV Project in the Ha'apai Group	7.68	Operated under incorporated society	Italy, Austria, IUCN	2.8		✓					53.21		
Electrification of Lofanga in the Ha'apai Group	6.72	Operated under incorporated society	Italy, Austria, IUCN	2.45			✓				55.66		
Electrification of Institutional Buildings in Niuatoputapu	0.96	Operated under incorporated society	Tonga Govt, GIZ	0.88			✓				56.54		
Introduction of Clean Energy by Solar Home Systems	107.12	Operated under incorporated society.	JICA, GEF, GIZ	32.25			✓	✓			88.79	52 Kerosene	

PHASE 0 – OFF GRID ACTIVITIES:													
Project Activity	**Cap. kWp**	**Status/ Explanation**	**Donor**	**% Contribution.**	**2010/ 2011**	**2011/ 2012**	**2012/ 2013**	**2013/ 2014**	**2014/ 2015**	**2015/ 2016**	**% Cum.**	**Annual Litre of Fuel Save ['000]**	**CO_2 Savings**
Outer Island Renewable Energy Project	450	70kWp each in Nomuka, Ha'afeva, Ha'ano, 'Uiha. 150kWp distributed in Niuatoputapu, 20kWp SHS in Niuafo'ou	ADB	11.21					✓		100	186.67 Diesel	526
Reduced fossil fuel use in rural community water pumping Phase I Ha'apai	23.5	10 PV powered water pumping systems installed at Ha'ano, Foa, Lifujka & 'Uiha islands	Danish, SIDS Dock							✓	-	9.71 Diesel	
Reduced fossil fuel use in rural community water pumping Phase II Vava'u	64.22	30 PV powered water pumping systems for 'Uta Vava'u	Japan, PIFS							✓	-	26.54 Diesel	
Reduced fossil fuel use in remote community trading expeditions and promote efficiency and health	464	76 solar powered freezers used in remote communities	Japan, PIFS							✓	-	191.76 Diesel/ Motor Spirit	
Reduced fossil fuel use in rural community water pumping Phase III Tongatapu	158.41	74 PV powered water pumping systems for Tongatapu. Project in proposal stage	SIDS Dock							✓	-	65.47 Diesel	

Annex C: Implementation Target Matrices 2013-2016

ENERGY EFFICIENCY | Supply Side

Table 1 - Strategic Result Area 1: Efficiency of conversion of petroleum to electricity (increases in efficiency and reduced losses at TPL) – 18% reduction diesel use

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output	Expected impact	Indicator	2011/2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
PHASE 0 – TECHNICAL												
Strategic Action:												
Necessary TPL investments for safety, data acquisition and improved efficiency launched												
Top Priority Activities:												
(1.1)- Tonga Village Network Upgrade Project	2012/2017	Under implemen-tation *(Stage 1-* Upgrade 2000 connections in 17 villages*, finished in June 2013* **Stags 2&3** (NZ$22.5m) Commenced 2014 – 2018, 33 villages*)*	NZ-MFAT	NZ$30.m	Upgrade 2000 connections in 17 villages/ Rebuild and upgrade the network across 50 rural villages, & offering free new connections to HH.	Improved network efficiency, reliability and safety. Increased access to electricity, and diesel savings due to reduced line losses.	Reduction in line loss in rural areas/ Increase in connections	14.80%	To 12%	To 11%	To 10%	Technical data supplied by TPL auditor to verify data
(1.2)-Nuku'alofa Grid Upgrading Project	2015/2019	Being proposed	TBD	NZ$31.5 m	Upgrade reticulation network and 8,000 homes and	Saving in energy generated Safety. Total savings on generating	Reduction in petroleum used	0%	0%	0%	4%	Same as above

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output	Expected impact	Indicator	2011/2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
					businesses connections and 5,000 poles	costs s/kWh 2.23						
(1.3)-Improve overall station efficiency	2014/2016	Being proposed	Not known	Not known	Energy saved	Saving in energy generated Safety	Reduction in petroleum used	0%	0%	By 6%	By 7-8%	Station data and analysis of data by expert
(1.4)-Recover waste heat for additional electricity generation	2013/2014	Being proposed *(technical aspects have already done, NZ shows interest)*	NZ-MFAT	NZ$2.24 m (TOP$3.3m)	700mWh	Fuel efficiency. Total savings on generating costs s/kWh 1.00	Level of efficiency	0%	0%	2% refer to tpl	3.50%	Same as above
(1.5)-Installation of prepaid meters	2013/2014	Approved	NZ-MFAT	US$0.5 m	3,000 units replaced	Lower level of disconnection	%energy saving	0%	0%	1000 meters	2000 meters	Same as above
MRX Bulk Purchases												
CA, Oil Companies												
Petroleum Reviews												
TOTAL					0	0	0	0.148	0	0	0.075	

ENERGY EFFICIENCY | Demand Side

Table 2 - Strategic Result Area 3: Efficiency of conversion of electricity into consumer electricity services (Demand Side Management measures) – 10% energy saving

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output	Expected impact	Indicator	2011/2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
PHASE 0 – TECHNICAL												
Strategic Action:												
Improve demand side efficiency												
Top Priority Activities:												
(2.1)-Install new street lights with low power LED bulbs or dimming technology	2012-2013	Being implemented *(started installing the lights Novembe r 2013).*	PEEP2	$0.2m PEEP2	300 lights increasing in next 3yrs	Lower demand	% energy saving	0%	0%	2%	3%	Records of work from developer and confirmed by TPL
(2.2)-Reduce demand in large government buildings through modifications to cooling systems, lighting and equipment	2012-2013	Negotiated	PEEP2	$0.2m PEEP2	6,000 tube lights	Reduction in cost of lighting	% energy saving	0%	0%	1%	2%	Records of each Ministry and TPL power bills
(2.3)-Replace tube bulbs with compact fluorescent lights to reduce lighting demand in residential, commercial and religious sectors	2016	MOU has already done for this activity	PEEP2	$0.2m PEEP2	Not known	Not known	Not known	Not known	Not known	Not known	Not known	
(2.4)-Initial end-use efficiency/DSM program launched and development of data and analysis to design and implement more extensive end use	2013	Being proposed *(the survey has been done, data*	PEEP2	$50,000	*Future projects to help the needs of the households to reduce the amount of*	*Lower demand*	% energy saving	Not known	Not known	10%	10%	

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output	Expected impact	Indicator	2011/2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
efficiency program underway		*input is finished) but data is being held)*			*energy they use*							
(2.5)-Minimum Energy Performance Standards and Electrical Appliance Labelling Regulation for Tonga	2013-2014	First draft of the regulation is being distributed to stakeholders for comments/ inputs. Consultation stage.	Australia via SPC	148,692.00	Established enabling environment for S & L in Tonga	Efficient electrical appliance available in the local market	MEPS&L Regulation enforced in Tonga	Not known	Not known			Regulation endorsed under Consumer Protection Act 2000
(2.6)-Development of national efficient lighting strategy	2013-2014	CFL from Tonga is current testing in UNEP Lab	UNEP	8,303.66	MEPS& Labelling for Lighting Products in Tonga	More reliable, efficient lighting product available in Tonga	MEPS&L for Lighting product endorse and enforced.	Not known	Not known			UNEP Test results and MEPS&L adopted
(2.7)- Reconstruction Solar Lantern Component of Of Cyclone Ian Recovery Project	2014	On-going implementation	ADB	USD470,000 (shopping)								
PHASE 1 – TECHNICAL												
Implementation of second-generation end-use efficiency/DSM measures	TBA											
Sectoral Petroleum Consumption and measures	TBA											
SIDS Dock Transport Initiatives	TBA											
TOTAL				206,996	0	0	0	0	0	0.13	0.15	

RENEWABLE ENERGY | Share in Power Generation

Table 3: Strategic Result Area 3: Replacing a portion of current or future grid-based generation with renewable energy – target 32% reduction in diesel use

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output [RE Installed Capacity-MW]	Expected impact	Indicator	2011/2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
PHASE 0 – TECHNICAL												
Strategic Action:												
Implementation of up to 1 MW on-grid solar PV on Tongatapu, and at least one other island grid including components covering centralised, decentralised and battery storage. Operation, maintenance and training contract in place	2012-2015											
Top Priority Activities:												
(3.1)-Solar PV Grid Vava'u	2013-2014	Under construction	UAE	6,480,000	0.50	Reduction in diesel use Power saving	% power demand	0%	2%	2%	2%	Same as above
(3.2)-Vaini Solar Farm	2014-2015	Construction began early 2014. *Opening of bids October 2013 with construction in February 2014 and opening on the 25th March 2015.*	JICA	20,000,000	1.00	Reduction in diesel use Power saving	% power demand	0%	0%	0%	4%	Same as above
(3.3)- Outer island RE project - Solar PV Grid Ha'apai, 'Eua and Niuas	2014-2015	Construction *starting date October 2013)*	AUS DFAT & ADB	10,800,000	1.24	Reduction in diesel use Power saving	% power demand	0%	0%	2%	2%	Same as above

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output [RE Installed Capacity-MW]	Expected impact	Indicator	2011/2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
(3.4)-Biomass Gasification Tongatapu and 'Eua	2014-2015	Concept stage	TBD	13,300,000	1.50	Reduction in diesel use Power saving. Total savings on generating costs s/kWh 7.35	% power demand	0%	0%	23%	23%	Same as above
(3.5)-Wind Turbines Without Storage	2015-2016	Concept stage (NZ has committed to funding the wind **feasibility study** only, and until this is complete, NZ cannot yet commit a funding/investment decision.		28,500,000	2.50	Reduction in diesel use Power saving. Total savings on generating costs s/kWh 4.04	% power demand	0%	0%	0%	6%	Project data collection and independent verification
(3.6)-Proof of Concept Coconut Oil Project	2015-2016	Under consideration		Not known	600K litres	Reduction in diesel use	%diesel reduced	0%	0%	0%	10%	Same as above
(3.7)-Landfill gas IPP	2015-2016	Under consideration		Not known	0.68	Reduction in diesel use	%diesel reduced	0%	0%	0%	1.60%	Same as above
PHASE 2 – TECHNICAL												
Full scale development of renewable energy projects on IPP basis, utilising the Tonga Green Fund	TBA											
TOTAL				79,080,000	7.42	0	0	0	0.02	0.27	0.486	

RENEWABLE ENERGY | Off-Grid Power Supply

Table 4: Strategic Result Area 4 Accessibility to affordable electricity sources in remote/rural areas and reduce dependency on fossil fuel through productive use of RE technologies

Strategic Action/Activity	Timeline	Status	Donor	TOP [million]	Expected output	Expected impact	Indicator	2011/ 2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
PHASE 0 – TECHNICAL												
Strategic Action:												
Off-grid programme launched												
Top Priority Activities:												
(4.1)-outer island solar PV Project	2013/14	Under negotiation	ADB/ AUS-DFAT	10,800,000	1.24MW installed	coverage of overall demand in outer islands	% of overall demand	0%	0%	2.50%	2.50%	Project data collection and independent verification. Project monitoring and evaluation reports
Low Priority Activities:												
(4.2)-Clean energy by SHS	2012/13	All 13 islands Commis-sioned with ongoing capacity develop-ment and inspection	JICA/GIZ/ GEF	10,266,000.00	552 SHS installed in 13 islands in habitat islands of Tongatapu and Vava'u	52K litres of kerosene displaced using 552 SHS in 13 islands annually - Accessed to affordable clean, indigenous electricity source	Amount of fossil fuel saved [lt]	0%	52,000	52,000	52,000	Project data collection and independent verification. Project monitoring and evaluation reports
(4.3)-Community Solar Powered Water Pumping Phase I -	2013/2014	Project documentation	Danish/ SIDS Dock	716,326.68	10 PV powered water	10 diesel based engines being put off using	Amount of diesel fuel saved	nil	5,070	10,140	10,140	

Strategic Action/Activity	Timeline	Status	Donor	TOP [million]	Expected output	Expected impact	Indicator	2011/ 2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
Ha'apai		finalised by UNDP with tendering processes for equipment supply and install be taken place before end of 2013			pumping systems installed at Ha'ano, Foa, Lifujka & 'Uiha islands	PV tech. 15litres of diesel for every 200 people will be saved every week						
(4.4)-Community Solar Powered Water Pumping Phase II - Vava'u	2014/15	ADB additional co-financing confirmed and DPP is currently developing under PEC/ADB guidelines	Japan PALM 5	1,740,000.00	30 PV powered water pumping systems installed in Vava'u	30 diesel based engines being put off using PV tech. Approx. 15litres of diesel for every 200 people will be saved every week	Amount of diesel fuel saved	nil	48,570	97,139	97,139	Project Reports
(4.5)-Remote Community Solar Powered Freezers	2014/15	ADB additional co-financing confirmed and DPP is currently developing under PEC/ADB guidelines	Japan PALM 5	5,220,000.00	76 solar powered freezers used in remote communities	Boost economic activities in remote communities and minimize fuel usage on transport and fishing adventures	Amount of fossil fuel saved and number of groups engaged in productive use of RE in remote islands		22 business recorded	23 business recorded	24 business recorded	Project data collection and reports
(4.6)-Community Solar Powered Water Pumping Phase IIIa - Tongatapu	2014/ 2015	Project concept is being assessed	Italian/ Austrian	341,565.00	20 PV powered water pumping	20 diesel based engines being put off using PV tech.	Amount of fossil fuel saved		4,160	8,320	8,320	Project Report

Strategic Action/Activity	Timeline	Status	Donor	TOP [million]	Expected output	Expected impact	Indicator	2011/ 2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
		by IUCN			systems installed in selected communities in Tongatapu	Approx. 15litres of diesel for every 200 people will be saved every week						
(4.7)-Community Solar Powered Water Pumping Phase IIIb - Tongatapu	2014-2015	Proposal is currently considered for funding in SIDS Dock Secretariat	Not Known		About 55 PV powered water pumping systems installed in the remaining communities in Tongatapu	55 diesel based engines being put off using PV tech. Approx. 15litres of diesel for every 200 people will be saved every week	Amount of fossil fuel saved			34934.5	69,869.00	
PHASE 2 – TECHNICAL												
Full scale development of renewable energy projects on IPP basis, utilizing the Tonga Green Initiative Fund	TBA											
Ongoing monitoring of RESCOs Setup												
TOTAL				**29,083,891.68**	-	-	-	-	**109,799.50**	**202,533.53**	**237,468.03**	

RESOURCE CAPACITY DEVELOPMENT & TECHNOLOGY TRANSFER

Table 5 - Strategic Result Area 5: Enabling Activities to enhance resources, awareness and capacity to facilitate short and long term national strategies on energy

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output	Expected impact	Indicator	2011/ 2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
PHASE 0 – TECHNICAL												
Strategic Action:												
Top Priority Activities:												
(5.1)-Tidal power feasibility study and project	2013/14	Being organised		200,000.00	not known	coverage of overall demand	% of overall demand	0%	0%	10%	10%	Same as above
(5.2)- Complementing national energy strategy by integrating Renewable Energy into Education Curriculum	2013-2014	TOR currently developed with invitation for proposal	GEF/ SPREP	190,857.12	Resource Guidebook for Teachers and students published and used in schools	Necessary know-how for growth of RE utilisation and propagation among teachers and student increased	Percentage of students selected RE as major topic for research, letter writings, practical works etc	nil	nil	30%	60%	Project Report, Ministry's annual Report
(5.3)- Study of the main obstacles of solar water heater (SWH) sector and find solutions to improve its development	2013-2014	Survey and consultation is currently undertaken	SPC	NA	Report of obstacles and solution	Report will be transform into action	Hardware projects developed			1	2	
(5.3)- Resource development	2013-2016	Past schemes have completed and it will be an ongoing effort for biomass and biofuel technologies, Proposal will be ready soon.	Tonga /DPs	NA	100K seedlings distributed, planted and monitored per year	Improved resource and no effect on biomass resource	Number of trees planted and monitored	nil	nil	100000	100000	

Strategic Action/Activity	Timeline	Status	Donor	Cost $	Expected output	Expected impact	Indicator	2011/ 2012 Baseline	2013/ 2014	2014/ 2015	2015/ 2016	Means of Verification
(5.3)- Resource Monitoring, Evaluation and Verification	2013-2016	Wind monitoring is an ongoing effort and proposal is currently developing to cover solar insolation as well as other islands	France /DPs	70,000	Two monitoring towers [1 in Ha'atafu, 1 in Vava'u] installed including solar metres	Good set of data for resource assessment	Number of Towers installed and data analysed/verified		1	2	2	

Annex D[18]: Description of the proposed projects for the short-to-medium term (for funding)

PROJECT 1: BIOMASS GASIFICATION GENERATION

A feasibility study and business case has been prepared relating to two biomass fuelled electricity generation plants, one on 'Eua and one on Tongatapu. The facilities will be fuelled primarily by wood sourced from Tonga Forest Product's (TFP) forest on the island of 'Eua, which was planted using New Zealand Aid funding in the 1970's. TFP will also seek to use additional forestry resources on Tongatapu as well as the potential to use His Majesty's land on 'Eua and Tongatapu.

The proposed generation facilities will likely use biomass gasification equipment supplied by Malaysian company Renewables Plus (RPL) and manufactured by Ankur Technologies of India, which has a long history of producing biomass gasification generation plant. RPL offers a turnkey project delivery model. The final contract negotiations, and update of pricing will decide the supplier and installation. The key components of the biomass gasifier are shown in figure below.

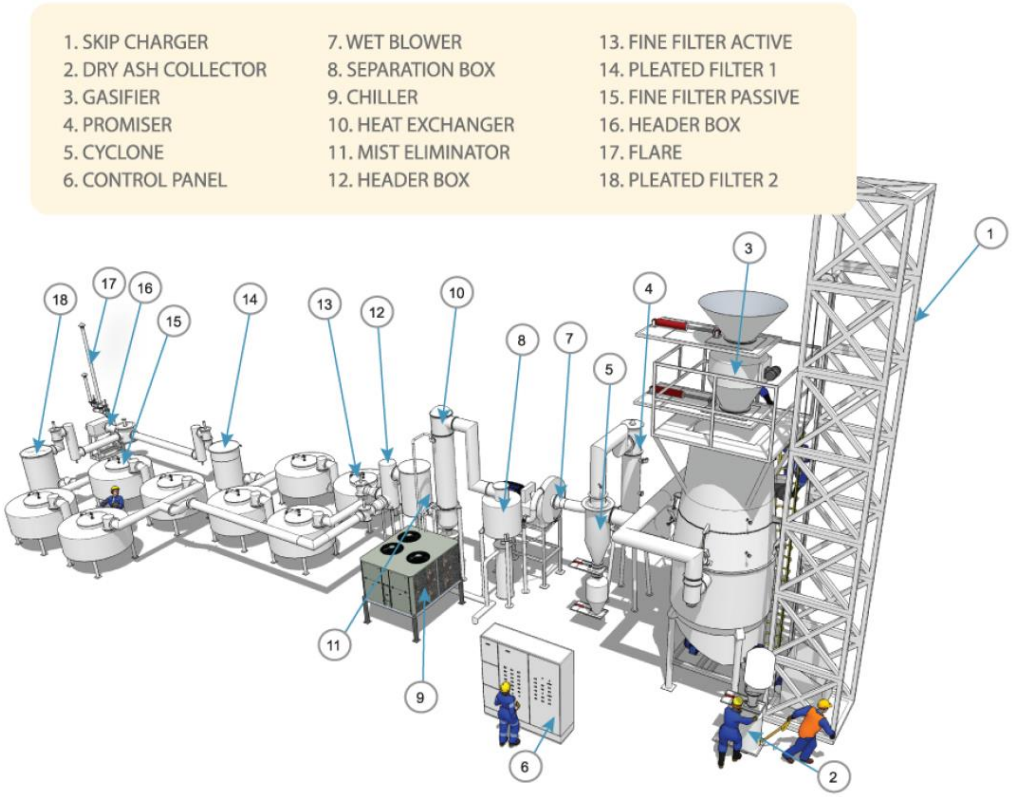


Figure 1: Key components of a biomass gasifier (Source: Renewables Plus)

The 'Eua facility will comprise a single DD400 (or perhaps slightly smaller) gasifier supplying a 250 kW Cummins gas engine supplemented during the evening peaks by one of the existing diesel generation sets, which will both be converted to dual fuel, or by electricity stored in batteries if a Photo voltaic (PV) generation system with battery storage is installed on the island. The system will

[18] Source: Tonga Power Ltd. and TERM-IU *Generation and Network Development Plan 2013-2018*.

operate in load-following mode and displace around 80% of the diesel use on the island, or close to 90% if photovoltaic (PV) generation is installed. The project assessment and economics assumes that the ADB Outer Island Project will deliver 200 kW of solar generation at 'Eua, including battery storage. The biomass plant is deemed to fit well with the solar project.

On Tongatapu the generation facility will be constructed alongside the proposed PV generation array at Vaini in the centre of the island. It will comprise a larger DD1500 gasifier and two 800kW Caterpillar engines to generate a net 1.25 MW. This will provide base-load generation in support of intermittent generation from solar photovoltaic and wind generation.

A formal tender process has been conducted for the generation plant. System configurations and costs were finalised with the shortlisted suppliers RPL and Ankur and firm quotations for supply are in place. It is planned, subject to finance being secured, to have the facilities constructed and commissioned by the middle 2014, under a turnkey contract.

The performance of the proposed gasifier equipment has been reviewed by visits to existing operating facilities in India and Thailand by representatives of TPL and East Harbour Energy. A technical audit covering the suitability of the equipment and its manufacturer has also been undertaken by T R Miles Technical Consultants of Oregon, USA. The review and audit confirmed the suitability of the proposed equipment provided appropriate wood fuel was supplied and it was operated to specification.

The Tonga Forest Products (TFP) resource on the island of 'Eua has been surveyed by a US group "Hatchett, Warnock, Whittemore, Edwards, Henry et al" and this assessment has been peer reviewed by Steve Foley of Foley Nasome Associates of Fiji, who also prepared a high-level business plan and costing model for TFP. This has now been updated and a comprehensive forest management plan has been developed. This plan includes activities necessary to expand the forestry business into sustainable wood chip supply, including nursery establishment, planting plans, and investment required for the chipping and transport arrangements. This plan is used as a basis for establishing the required new services and setting delivered fuel prices. The steep increase in harvest rates from current very low levels will challenge TFP, requiring new equipment and some continuation of forestry management support by NZMFAT.

The TFP owned forest has an area of around 500 ha of which around 320 ha were planted in the 1970's and 1980's in a range of species, predominantly Caribbean Pine and Cedar. The forest has been indifferently managed until recently and harvest rates have been low. While it contains good stands of millable timber, it is generally characterised by a mature age profile, significant areas of damaged trees, and high volumes of second-growth natives within the stands.

Additional fuel is also available in the King's Estate on 'Eua, indications are that cutting rights to this can be secured, and further land is available on the island for planting fuel crops for medium-term supply. The TFP harvest rate from the 'Eua forest is structured on a sustainable basis and a replanting programme is being initiated, with some of the area to be devoted to fuel crops in support of longer-term supply.

TFP is currently resourcing its business for a major expansion in timber sales and also biofuel supply. The secure income provided by a long-term contract for wood fuel sales to TPL will provide an important basis for this development, but will also feed revenues back into the local economy (TFP like TPL is 100% Government owned). To establish the biofuel recovery operation, new logging and fuel processing equipment is required. In addition land access, nursery development, planting and replanting programmes requires an investment in TFP of NZ$3.9 million.

TFP will contract to deliver fuel to the two generation facilities, a standalone contract for shipping the fuel from 'Eua to Tongatapu will be negotiated through a tender process by TFP and TPL. Formal tenders have been received for this shipping service and are currently being evaluated. A transport cost for the wood chips delivered the 'Eua mill to the Vaini site on Tongatapu has been included in the wood chip price, a separate shipping cost of T$40/tonne between 'Eua and Tongatapu has been added. It is believed that there is potential to reduce the shipping costs by up to 40% in negotiations with prospective shippers.

The fuel will be chipped in the 'Eua forest and stored on hard stand at either the 'Eua mill or at the 'Eua generation facility (covered storage has been allowed for in the generation project). It is planned to hold 3-weeks supply for both facilities as a buffer stock on 'Eua, and also 3-weeks buffer stock at the Tongatapu facility. The fuel for Tongatapu will be trucked in bins to the port where it will be loaded directly on a vessel for the approximately 2.5-hour trip to Tongatapu and then trucked to the generation facility.

Foley Nasome's predicted fuel cost, which has been agreed between TPL and TFP, is T$70/tonne. This covers the extraction of the wood fuel from the 'Eua forest, seasoning, chipping and transport to the storage facility on the island. The figure includes a solid margin for TFP. This is the wood-fuel cost for the 'Eua generation facility.

With the addition of the cost of shipping, the delivered cost of wood-fuel to Vaini is T$110/tonne. Additional to this volume from 'Eua 3,000 tonnes pa of wood fuel will be secured on Tongatapu, which with the briquetted char from the gasifier provides the balance of the required quantities of wood-fuel for the Tongatapu facility. The shipping costs will not apply to Tongatapu sourced wood chips.

Biomass-fuelled electricity generation is base-load and available at all times except for maintenance periods. It displaces diesel-fuelled generation directly.

The plant on Tongatapu will generate at 1.25 MW at an annual expected availability of 8,000 hours per year (the supplier guaranteed figures, which will be confirmed prior to commitment), or 10,000 MWh per annum, which equates to 20% of Tonga's annual generating requirements. The facility on 'Eua will generate around 1,032 MWh pa in load-following mode (this figure reduced by the nominal output of 200 kW of PV generation plus batteries) and in conjunction with the solar photovoltaic displace with the PV nearly 90% of the diesel use on the island.

The capital cost of the Tongatapu facility is estimated at NZ$6.5m while the smaller 'Eua facility has a capital cost of NZ$2.5m. Together, this is an investment of NZ$9.0m to generate 11,000 MWh pa of electricity and displace 22% of Tonga's electricity generation.

The biomass-fuelled electricity generation plants will require long-term wood-fuel supply and the project will create a sound economic basis for the development of TFP as a wood and fuel supplier. It will create a significant number of jobs in forestry operations, shipping and plant operation and maintenance thereby offering material economic and social benefits to Tonga's economy and its people, in addition to the benefits from reduced diesel imports.

PROJECT 2: **WIND POWER GENERATION**

Multiple studies have been undertaken on whether wind turbines are cost effective on Tonga. All studies have concluded that the wind regime on Tonga is surprisingly high, and that wind generation is feasible. All studies have recommended a turbine model called the Vergnet 275 kW be used because it is a large wind turbine but can be lowered to ground level in the event of a cyclone being predicted. The Vergnet wind turbine is used at many other locations in the Pacific, including Vanuatu, Fiji and Australia. It is considered to be a well-proven and reliable technology. Although multiple studies have been undertaken by various organisations, the studies are all pre-feasibility level; a fully detailed and costed feasibility study is yet to be completed.

The latest wind study is the pre-feasibility study undertaken by Infratec Renewables in 2014, funded by the NZ Government. The NZ Government has since proceeded to fund the full feasibility study. Two potential sites (Ref 6) were investigated at Niutoua and Lapaha (see Figure 2). The report limited the number of turbines used at each site to eight (around 2.2 MW of capacity) due to the constraints on the existing distribution feeder in the area. The limit of the wind farm size was not determined by the dynamic network study report undertaken by DNV KEMA, however the report suggests that approximately 4 MW of wind turbines could be installed on Tongatapu. Further modelling undertaken by TPL suggests that a new trunk feeder circuit, potentially installed on the same poles as the existing Vaini feeder, but with a dedicated feed back across the lagoon to Popua power station, will need to be installed.

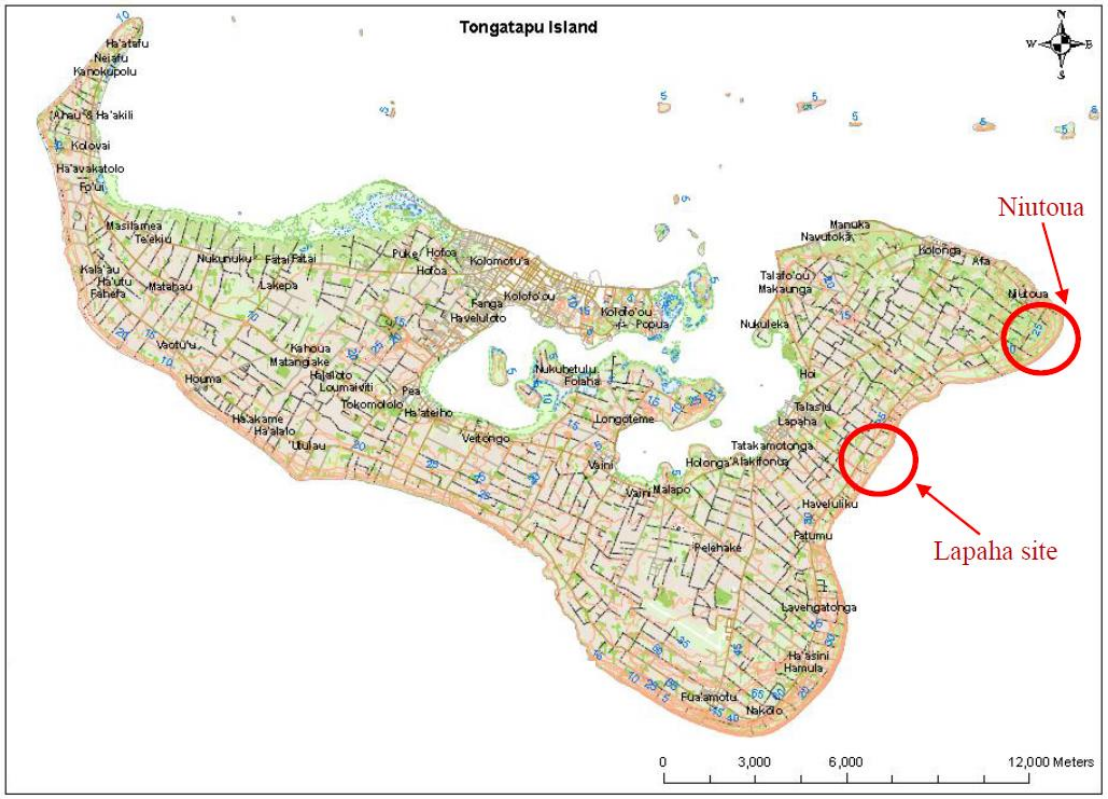


Figure 2: Potential wind farm sites identified (Source Ref 6)

Meteorological masts have been installed at both Lapaha and Niutoua sites and multiple wind resource studies have been undertaken using different software models. The results from each of the analyses are very similar, which is not surprising due to the simple terrain features that are being modelled.

The Garrad Hassan produced prefeasibility study used a budgetary proposal from Vergnet for four wind turbines, provided in August 2012. If a separate feeder is installed from Popua Power Station out the proposed sites, it is likely that sixteen or more of the Vergnet 275kW (total installed capacity 4.4MW) model could be installed. The land area available is not the constraint limiting the potential size of the wind farm (however the lack of suitable transport infrastructure and carnage does limit the size of the turbine that can be installed). The DNV KEMA network study suggests that up to 4MW of wind turbines could be installed, without the need for energy storage or smoothing devices. However, since the DNV KEMA report has been done, JICA have stated that they are installing fast response lithium ion capacitor energy storage devices. These devices will facilitate the installation of wind projects as well as solar, since the solar is not operational at night and the limiting factor on the input of wind into the network is the low night time load of the system.

Doubling the size of the expected project does not double the CAPEX costs. The Garrad Hassan CAPEX costs summed for the Lapaha and Niutoua sites have been used for the rest of the analysis in this report. They are, however, thought to be conservative because:

- The project being considered is now 4.4 MW (16 turbines) rather than the 1.1 MW project Vergnet provided a budget estimate for in 2012 (upon which the turbine costs are based);
- The mobilisation/demobilisation costs of the construction crew and equipment is spread over a much larger project;
- The project management and project development costs are essentially the same whether a project is 1.1 MW or 4.4 MW, as the number of contracts, environmental permits, training etc is all relatively independent of the size of the project; and
- The cost of control systems and operations and maintenance of a larger wind farm are much lower on per wind turbine basis than a smaller project.

The network studies currently being undertaken by AECOM will determine if there are any constraints in the distribution network, or system stability issues that would constrain the normal operation of the wind turbines. It is expected that a distribution feeder may have to be replaced.

The energy output of 16 Vergnet wind turbines with eight turbines installed at each of the Lapaha and Niutoua, has been determined by Garrad Hassan to be **10,453 MWh** or 23% of Tongatapu's energy produced by diesel in 2012. The expected CAPEX for the project is $19,447,000 NZD. This cost represents approximately $4,400 NZD/kW installed. These predicted costs and benefits need to be confirmed by a full feasibility study and updated cost estimates from potential wind turbine suppliers.

With Tonga relying on grant funding for this project, the quantum of the funding required to enable 4.4 MW to be constructed (plus the feeder build) may be on the high side of what is available. It may thus be advisable to limit the initial project scope to 2.2 MW, with allowance for future expansion. This approach will be evaluated through the feasibility study.

PROJECT 3: **WASTE HEAT RECOVERY GENERATION**

A prefeasibility report has been produced by East Harbour Energy consultants investigating the feasibility of using the waste heat from the 2.8 MW diesel generators to generate more electricity using Organic Rankine Cycle (ORC) technology from General Electric called "Clean Cycle ORC".

The Clean Cycle ORC generator is a packaged unit which is expected to produce 140 kW nominal output (about 121 kW net) whenever the MAK diesel gen from which it sources the heat energy is

operating over 75% of its rated capacity. The Clean Cycle units have been specifically designed to generate electricity from heat recovered from engines.

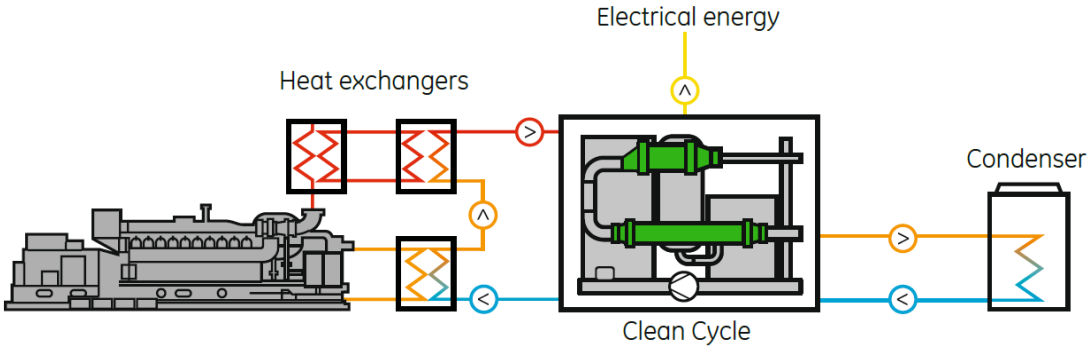


Figure 2: Clean Cycle schematic of energy flows

Heat is captured from the engine exhaust and water jacket in heat exchangers. Organic fluid in the ORC is pumped through the heat exchangers, exposing it to the heat source. The heat converts the fluid into a super-heated vapour, which is expanded across a turbine, causing it to spin. The turbine is integrated into a power module, which creates electricity that can be sold to the grid. After passing through the Integrated Power Module, the vapour is cooled back to a liquid, and the cycle repeats.

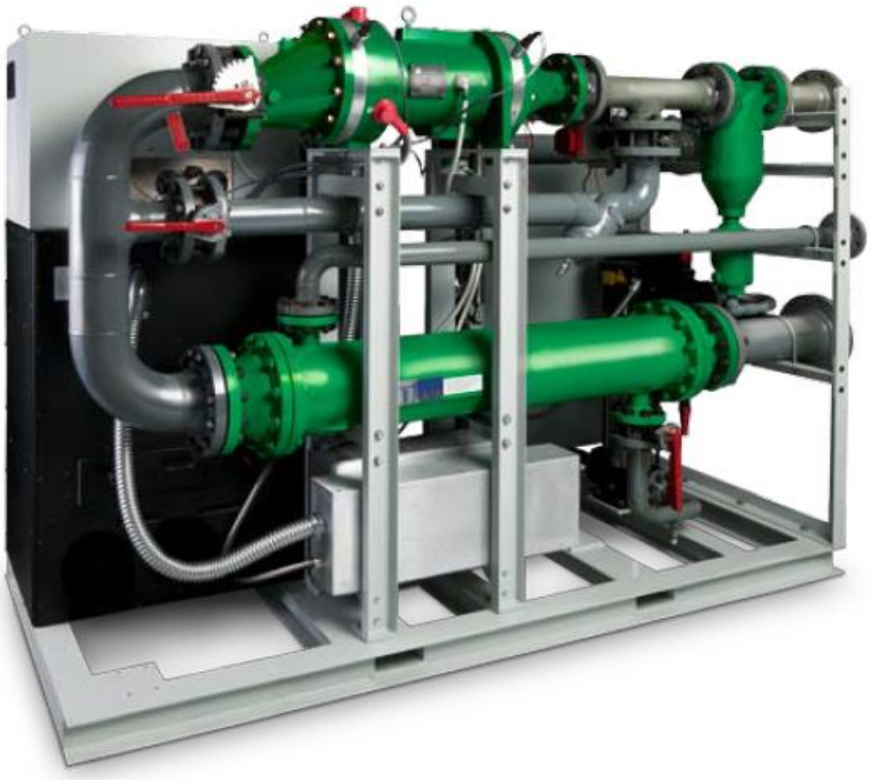


Figure 4: Clean cycle module - condenser and heat exchangers are not shown.

It is proposed that a Clean Cycle heat recovery system be fitted to one or both of the existing and proposed MAK diesel fuelled generators at TPL's Popua generation facility on Tongatapu.

The predicted generation from one and two Clean Cycle units was calculated using performance data supplied by GE and operating data for the MAK engines supplied by TPL. The equipment has low maintenance requirements and correspondingly low operational costs. Consequently the overall cost of electricity generated is almost entirely due to the initial capital costs. A low cost of electricity is dependent on ensuring high load factors on the Clean Cycle system, which means that high load factors are required on the MAK generators. A single Clean Cycle unit is expected to generate about 700 MWh while two units, with lower average loading, would generate about 1,250 MWh annually.

Clean Cycle units generate electricity from waste heat, increasing the electricity generation per unit of diesel fuel used in the MAK generators by 3.5%. This in turn reduces the amount of electricity that must be generated in other Caterpillar diesel generation sets which are less efficient than the MAK generators.

With the increase of renewable energy penetration on Tongatapu, there is a risk that the two MAK generators will be running at lower loads than 75% of their rating for much of the time. If this was the case, then the business case for the units could be impacted detrimentally, as the load factor of Clean Cycle units would be lower.

PROJECT 4: **NUKU'ALOFA NETWORK UPGRADE**

The Nuku'alofa Network Upgrade Project (NNUP) will follow the same model as the NZMFAT funded Tonga Village Network Upgrade Project (TVNUP)-Stage 1 completed in August 2013. The NNUP will run subsequent to stages 2 and 3 of the TVNUP and will provide a safe, reliable and efficient electricity supply to customers in Tongatapu. The project is very similar to the TVNUP project and has similar drivers and outcomes. The estimated cost of the NNUP is NZ$30,000,000 (TOP$42,000,000). The project deliverables include renewing 8,358 customer connections, upgrading 23 km of high voltage lines, upgrading 185 km of low voltage lines, and replacing 5,330 power poles. The NNUP is consistent with the GoT's electricity sector policies as expressed in the Tonga Energy Road Map (TERM) which identifies opportunities in demand side management/energy efficiency to provide a significant reduction in diesel generation output. As a comparison, it was estimated that the TVNUP Stage One involving 17 villages will save approximately $470,000 annually.

The objectives of the NNUP are to:

- Reduce technical and non-technical losses which will improve the overall efficiency of the generation and distribution system providing the potential for TPL to reduce tariffs;
- Improve access to electricity in urban areas where electricity connection has a higher impact on than heavily loaded electrical infrastructure;
- Improve the safety of the electrical supply and thereby reduce the risks of fire and of electrocution to the members of the public, and Tonga Power Limited (TPL) staff;
- Reduce power outages and thereby improve the reliability of supply;
- Improve the quality of supply in terms of voltage stability;
- Improve the resilience of the networks to withstand severe weather events such as cyclones;
- Enable redirection of power flows when localised outages occur, through better integration of urban supply networks; and
- Help establish TPL as a safe, reliable, and economically sustainable utility.

The goal of the NNUP is to facilitate economic and social development in Tonga through the delivery of reliable and affordable electricity to village households and businesses.

The NNUP will cover the greater Nuku'alofa urban area and approximately 8,000 accounts (a new connection rate of up to 20% is estimated), and will comprise:

- The replacement of low voltage (LV) conductors and associated poles up to a meter installed immediately outside of each customer's premises (household or business).
- Associated modifications to the high voltage system as necessary (funded by TPL).
- Connection of an estimated 1,000 premises that currently do not have access to the grid (TPL's data base shows 1,500 de-activated or closed accounts in the Nuku'alofa area).

The intended outcomes for the NNUP are:

1. Reduced network losses, both technical and non-technical (including reduced incidence of power theft).
2. Increased access to electricity.
3. A safe and reliable electricity supply to approximately 7,960 households and businesses in the greater Nuku'alofa area in Tongatapu.
4. Reduced electricity tariffs as a result of reduced diesel fuel consumption (through reduced system losses), reduced capex spend and improved operating and maintenance capability within TPL with direct financial benefit to households and businesses.
5. Social benefits in terms of an affordable and reliable electricity supply.
6. A safe electricity network, both for the public and for staff working on the network assets.

The NNUP will commence subject to availability of funding, but would be expected to take five years to complete. This five year project is intended to run concurrently with the TVNUP stage 2/3 programme.

The project will be implemented and project managed by TPL. A Project Coordination Committee (PCC) with representative from the Government of Tonga and TPL will be established to provide oversight and governance. This approach is in use for the TVNUP and has been proven to provide the levels of control and information flow across the key stakeholders.

TPL will establish a project management team that will oversee implementation including design, construction and financial control. The team will be led by a project manager whose duties will include reporting to the PCC quarterly and to the development partner on project finances six-monthly including an independent audit report. A completion report will be provided at the end of the NNUP.

Procurement of services and materials will be carried out in accordance with the GOT's Public Finance Act (Treasury Instructions) 2010. The exception to this will be the purchase of new power poles, which will continue to be sourced through Tonga Forest Products Limited, a sister Public Enterprise (with costs benchmarked against imported pole prices).

The NNUP is seen as having positive social and human rights impacts. Drawing on TVNUP experience, the project would be classified as low impact in terms of Environmental and Social Impact Guidelines; this is due to adverse localised, site specific impacts that can be reversed or mitigated. To manage these impacts, TPL will prepare and implement an Impact Assessment and Impact Management Plan. It is recognised however that the project will improve the environment through relocation of assets to locations with less environmental impact, and also the improved aesthetics of the new network configuration (for example less impact on vegetation management).

The Nuku'alofa network upgrade is estimated to reduce diesel consumption by 1.9 GWh per year, which is almost 500,000 litres of diesel each year, or approximately T$800,000 per annum. Figure shows the gap between generation and sales of electricity. Whilst reducing over the years, it is still

much higher than is acceptable. The blue bar in the chart below shows the unaccounted for energy (UFE), much of which represents lost electricity in distribution.

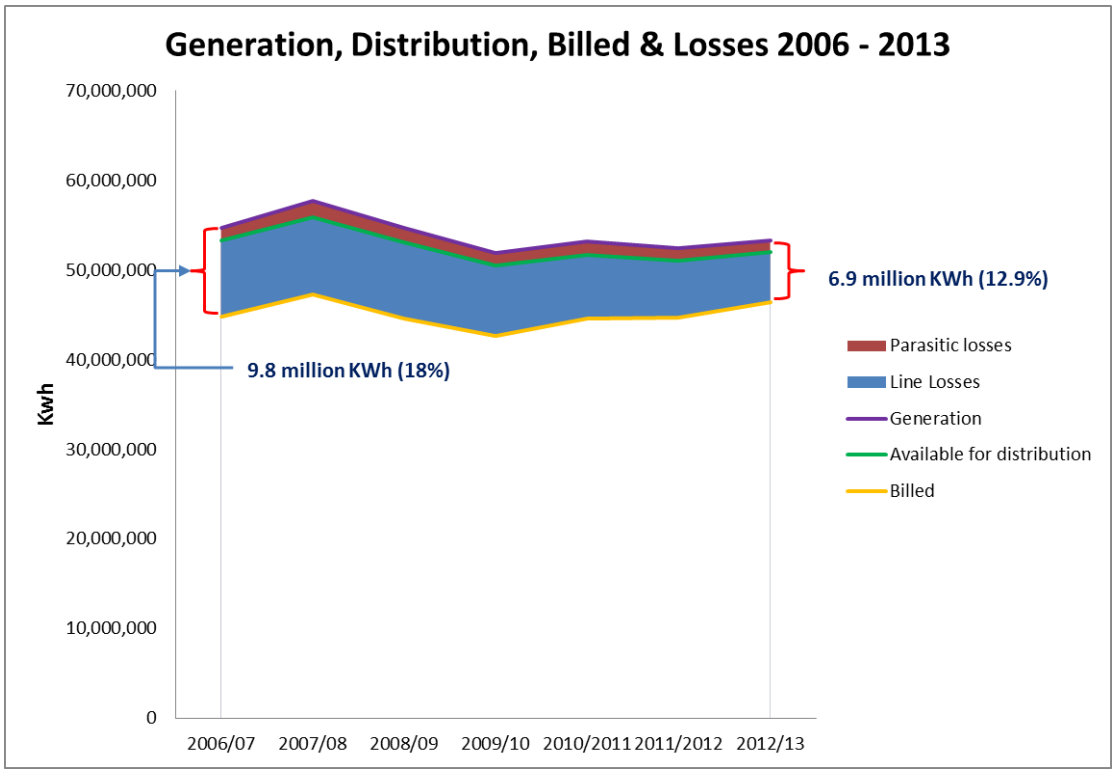


Figure 5: Technical and non-technical losses in the Tongatapu network 2006-2012

The Nuku'alofa network upgrade will dramatically reduce these losses.

Annex E: Overview of TERM Activities (with Development Partner Support)

Donor	Project name	Est start date	Est finish date	Currency	Est total project cost	Source of funds	Status
ADB/AUS-DFAT/ EU	Kingdom of Tonga: Outer Island Renewable Energy Project	Feb 2012	2015	TOP	17,979,897	ADB funding from Japan Fund for Poverty Reduction (JFPR)/AUS with EU on grid	On-going
ADB	Promoting Energy Efficiency in the Pacific: Phase 2 (PEEP2)	Nov 2011	Mar 2015	USD	850,000	PRIF/ADB	Closing workshop held in Samoa 3-5 March 2015
EU	Development of Renewable Energy and Energy Efficiency Plan (REEP)	2013	May 2013	EUR	As part of budget support process, 6.4 MM under 10th EDF	EU	Completed
GIZ	Coping with climate Change in the Pacific Island Region (CCCPIR)	Jan 2012	Jan 2014	Euro	60,000	Germany Ministry for Economic Cooperation and Development (BMZ)	Completed
GIZ	EU-GIZ Adapting to Climate Change and Sustainable Energy (ACSE) Implemented in 14 Pacific Island Countries	April 2014	2018	Euro	650,000	EU EDF10	Tonga attended the regional inception workshop in May and is participating in the call for concept notes. Concept notes submitted to GIZ on 18th July 2014.
IUCN	Solar Water Pumping Phase 3a	Aug 2012	Aug 2012	USD	454,400	Italy and Austria through IUCN	On- going, technical design.

Donor	Project name	Est start date	Est finish date	Currency	Est total project cost	Source of funds	Status
JICA	Implementation of Clean Energy by Solar Home System	Jun 2012	Jun 2013	USD	5.90M	Government of Japan	Completed. Final inspection carried out in September 2014 before warranty period is over.
JICA	Vaini-on grid solar farm	Jan 2014	Mar 2015	TOP	20MM	JICA	On-going
NZ-MFAT	Popua Solar Farm	Nov 2011	Aug 2012	NZD	7.9MM	Govt of NZ	Complete
NZ-MFAT	Tonga Village Network Upgrade	Jun 2011	Jun 2013	NZD	5.4MM	Govt of NZ	Ongoing
PEC	Solar powered water pumping systems for all villages of ‘uta Vava’u	2014	2015	USD	4MM (PEC fund total)	Japan	Grant Finance Agreement signed between GOT and PEC. Agreement with ADB co-financing awaiting signing before implementation.
PEC	Solar powered freezers systems for all remote islands of Vava’u and Ha’apai	2014	2015	USD	4MM (PEC fund total)	Japan	Grant Finance Agreement signed between GOT and PEC. Agreement with ADB co-financing awaiting signing before implementation.
PIAC	TA - International Operations Officer/s	Jun 2012	Sept 2012	USD	56,000	Australia DFAT- PRIF	Completed
PIAC	TA - Institutional Advisor	Aug 2012	Jan 2012	USD	102,000	Australia DFAT -PRIF	Completed
PIAC	TA - Power Sector Tariff Review	Sept 2012	Nov 2012	USD	0.14MM	Australia DFAT -PRIF	Completed

Donor	Project name	Est start date	Est finish date	Currency	Est total project cost	Source of funds	Status
REEEP	REEEP TERM IU Support	Nov 2011		USD	0.12MM	Australia DFAT -PRIF	Completed
GEF 5	PIGGAREP	Jan 2008	Dec 2014	USD	376,900	GEF Star 5 through SPREP / UNDP	All activities completed. However publication and translation of RE resources material may be covered before project completion.
SIDS DOCK	Pacific Islands Greenhouse Gas Abatement Project + Water Pumping	September 2013	Dec 2014	USD	410,000	SIDS DOCK supported by GEF, UNDP & SPREP	Installation to start August 2014 for 10 communities in Ha'apai.
SPC	Pacific Appliance Labelling and Standards (PALS) Programme	Jan 2012	2014	AUD	148,692	Australian Department of Climate Change and Energy Efficiency	A draft of the regulation to be available on the 4th quarter 2014.
SPC	Framework for Action on Energy Security Indicators Report (Pacific Region) Pacific Regional Data Repository for SEA4All (12 P ICS including Tonga)	Jan 2012 Sep 2013	2015 2019	USD	Phase 1 Phase 2- 1.25 million		Ongoing Launched in Aug 2014 & presented during Sept 2014 SIDs
SPC	Petroleum Pricing Advisory Services to Tonga Competent Authority	Regular-monthly					Ongoing
UAE	Vava'u Solar Park	2013	Nov 2013	USD	6,480,000	UAE	Completed

Donor	Project name	Est start date	Est finish date	Currency	Est total project cost	Source of funds	Status
World Bank	Energising the Pacific (development of TERM)	Jul 2008	Jul 2009	USD	1.05 million	Australia DFAT -PRIF	Completed
World Bank	Petroleum Plan Assessment Report	May 2012	Sept 2012	USD			Completed
World Bank	TERM Institutional and Regulatory Framework Strengthening Project	Aug 2012	Jun 2015	USD	2.9 million	Australia DFAT-PRIF/ASTAE	Ongoing
World Bank	TA - Renewable Energy and Energy Efficiency Policy (Workshop, , Policy Review/framework)	June 2014 – Workshop April 2015 – Policy review and framework	Dec 2015			World Bank/ESMAP/ASTAE	Workshop Component – completed Sept 2014 Policy Review – on-going