ENVIROMENTAL IMPACT ASSESSMENT
OF
PROPOSED PHOTOVOLTAIC PLANT AT LIFUKA—HA'APAI

Project Location
Lifuka Island

© 2016 Google
Image © 2016 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2016 CNES / Astrium

SAMANI CONSULT
August 2016

RECEIVED
GCA 17 19/08/17
ACKNOWLEDGEMENT

The kind assistance and understanding of Simon Wilson and Sione Pongi of Tonga Power Limited as well as Ravitesh Chand of CBS Power Solutions (Fiji) Ltd are duly appreciated and acknowledged.

My assistants Lopeti Tufui and Pupunu Moenhoa provided innumerable logistical supports and their contributions are also duly appreciated and acknowledged.
Abstract

The Lifuka Solar Photovoltaic (PV) Plant is a development activity which is aimed at supplying secure and environmentally sustainable energy to homes, schools and other public facilities on the islands of Lifuka and Foa in the Ha'apai Group. The development activity will make possible an integrated power system in which the new technologies of photovoltaic generation and storage system are interfaced to the existing diesel control unit. On completion the development will make possible provision of significant ratio of renewable energy additional to that currently generated by the existing diesel power plant.

A land area of 11,000 square meters has been secured by Tonga Power Limited from His Majesty's estate in Lifuka and the entire area has been cleared as preparation for full-scale implementation of the development activity. The PV Plant will comprise fixed mounted crystalline module technology and three-phase string inverters. The PV module mounting frames and structures will be built with optimized fixed tilt angle in North direction and azimuth of zero. The structure foundations will be of the screw or micro-pole type. The Energy Storage System will consist of a battery system, control unit, battery inverters and housing. System delivery will be of the turn-key system with fully automated operation monitored on a remote basis.

An environmental impact assessment conducted for the proposed development activity has determined no negative and significant environmental, social, cultural and economic impact will materialize at both the construction and operational phases if approval is granted by the relevant authority. Minor negative effects will eventuate during and after removal of vegetation but situation will not become critical due to presence of representative tree cover in adjoining land. Final approval will be made conditional on meeting precautionary matters by the proponent to protect environmental, social, cultural and economic interests of relevant stakeholders.

On completion the PV Plant will have a capacity of 550 kWp peak power additional to existing diesel-powered capacity with a battery storage bank of 660 kWh capacity.
Executive Summary

Tonga Power Limited (TPL), a state-owned enterprise responsible for generation and distribution of electrical energy for all parts of the kingdom, is intending to establish a Photovoltaic Power Plant with a capacity of 550 kWh in Lifuka Island in the Ha’apai Group. The PV plant will be constructed in a 11,000 square meters of land in the outskirts of Ha’ato’u village that has been secured under a leasehold arrangement with His Majesty. The leasehold will accommodate arrays of fixed mounted crystalline module and three-phase string inverters which are connected to a battery storage house of 660 kWh capacity. The leasehold is adjacent to the TPL’s existing diesel power plant in Lifuka and the proposed operation is planned to allow for combination of the new technologies of PV generation and storage system and the existing diesel control unit.

The proposed development activity is part of the Outer Island Renewable Energy Project (OIREP) which targets extending of renewable energy to the outer islands thus making possible reduction of dependence on imported fuels, improvement of on-grid infrastructure thus increasing reliability and efficiency of power supply, and allowance for positive environmental impact through reduction of CO2 emissions.

An environmental impact assessment was conducted during July 2016 found that the proposed site has been cleared en masse with construction awaiting pending approval by the relevant authority. Field investigation was conducted involving sampling of dried plant remains and inspection of both flora and fauna in the adjoining land areas. A survey was also conducted through structured interviewing of respondents from various parts of Pangai and 93% of the sample supports implementation of the proposed development activity.

The environmental impact assessment determined that no significant negative environmental, social, cultural and economic effects would arise if the proposed development activity is allowed to proceed and thus would put forward the following recommendations for consideration by the Environment Assessment committee (EAC).

Recommendation:

1. That the Lifuka Photovoltaic Plant proposal as proposed by Tonga Power Limited be approved.

2. That approval be made conditional on the following:

   (i) That sufficient training of TPL’s staff be made by CBS Power Solutions on various aspects of the technology to ensure that the plant will be adequately and efficiently managed during its lifetime of 25-30 years;

   (ii) That employment opportunities be given to the residents of surrounding communities either directly or indirectly;
(iii) That waste, whether solid or liquid, from the battery system and solar modules as well as inverters be retrieved overseas for disposal by relevant manufacturers.

3. That the Department of Environment monitors implementation of the indicated conditions by the proponent.
# TABLE OF CONTENTS

*Acknowledgement*  

*Abstract*  

*Executive Summary*  

*Table of Contents*  

1.0 Introduction  

2.0 Description of Proposed Development  

2.1 Purpose  

2.2 Direct Benefits  

2.3 Location and Facilities  

2.3.1 Location  

2.3.2 Alternative Location & Facilities  

2.4 Technology  

2.4.1 Technology to be Used  

2.4.2 Construction Techniques  

2.4.3 Availability of Technology  

2.5 Local infrastructure Required  

2.5.1 Road  

2.5.2 Water  

2.6 Inputs  

2.6.1 Capital  

2.6.2 Labor  

2.6.3 Natural Resources  

2.6.4 Duration of Construction & Operation  

3.0 Justification  

3.1 Environmental  

3.2 Economic  

3.3 Cultural  

3.4 Social  

4.0 Description and Analysis of Impacts  

4.1 Existing Environment  

4.1.1 Physical  

4.1.2 Economic  

4.2 Potential Impacts of Construction  

4.2.1 Physical  

4.2.2 Biological  

4.2.3 Social  

4.3 Potential Impacts of Operation  


4.3.1 Physical
4.3.2 Social
4.3.3 Biological
4.3.4 Cultural

5.0 Mitigation Measures
6.0 Alternative Activities & Locations
7.0 The “No Development” Option
8.0 Cumulative Effects
  8.1 Existing Development
  8.2 Future Development
9.0 Public Involvement
  9.1 Interview
  9.2 Discussion
    9.2.1 Analysis
10.0 Impacts on Other Policies/Legislation/Convention
  10.1 General
  10.2 United Nations Convention on Biological Diversity
  10.3 United Nations Framework Convention on Climate Change
  10.4 Tonga Energy Road Map
  10.5 Renewable Energy Act 2008
  10.6 National Strategic Planning Framework 2009

11.0 References

List of Tables
Table 1 Matrix of Possible Impacts
Table 2 Indigenous Flora at Site
Table 3 Activities with Risk & Mitigation Measures
Table 4 Questions for Structured Interview

List of Figures
Figure 1 Pictorial view of Site before Clearance
Figure 2 View of Site at Completion of Construction
1.0 Introduction

'Ulufonua lit. environment, comprises all resources (fonua)—whether living or non-living including human beings — and the inter-relationships that exist between these components (Samani, 2015). *Uesia faka-'ulufonua* lit. environmental impact, is any alteration, whether positive or negative, of the state of any resource(fonua) as a result of human intervention. *Fakafuofua uesia faka-'ulufonua* lit. environmental impact assessment (EIA) is determining the effect of any alteration of any resource given the need to implement any *langa fakalakalaka* lit. development activity which targets improvement of anthropocentric living conditions. As a corollary, any development activity is deemed unnecessary if the combination of its effects leads to significant negative alteration in the state of the 'ulufonua/environment.

Thus, the aim of any EIA is determining the significance of the combined effects, whether positive or negative, of any proposed development activity. Under the Environmental Impact Assessment Act 2003, any proposed development activity is considered to be a major development if it appears from the information provided by the proponent that it has the potential to lead to significant negative effect. Where this is the situation, the proponent is required by the Department of the Environment (EIA lead agency) to undertake an EIA following closely the stipulations of the Environmental Impact Assessment Regulations 2010 (Form 3). On the other hand, a proposed development activity is considered as a minor development if it appears not to have the potential to alter the environment in a significant manner according to the information provided by the proponent. Where this applies, the proponent is required under the EIA Act 2003 and EIA Regulations 2010 to undertake an assessment as directed by Form 1.

The Lifuka Solar Photovoltaic Plant, as proposed, is considered by the EIA lead agency to be a major development and therefore the proponent—Tonga Power Limited (TPL)—is required under the EIA Act 2003 and EIA Regulations 2010 to undertake an EIA following closely the stipulations of Form 3 as provided.

2.0 Description of the Proposed Development

2.1 Purpose

The Government of Tonga (GoT) had in recent years considered the necessity of reducing both the cost of electricity supply and Tonga's vulnerability to fluctuation in oil price (TPL, 2016). Further, the GoT is also a party to the United Nations Framework Convention on Climate Change (UNFCCC) which regulates the amount of greenhouse gases emitted to the atmosphere. Given these realities, the Renewable Energy Act 2008 was enacted to promote the use of renewable energy technologies (Guthrie, 2016).
In order to reduce vulnerability of electricity supply to fluctuating oil prices, the GoT has set a target to generate 50% of its grid based electricity from renewable energy sources and to achieve a 50% reduction in diesel consumption by 2020 in its National Strategic Planning Framework of 2009 (TPL, 2016).

In addition, the Tonga Energy Road Map (TERM) 2010—2020 provides the basis for the GoT development, reform and improvement plan for the energy sector and this framework was developed in close coordination with development partners. TERM has three major goals which include:

- enhancement of the petroleum supply chain;
- deployment of renewable energy technologies; and
- supply and demand side.

The proposed development activity is aimed at supplying secure, environmentally sustainable energy to homes, schools and other public facilities in Lefuka and Foa islands as well as quantification of the solar resource and facilitating the integration of recurrent renewable energy with the conventional diesel grid. Further, the proposed development will build the capability of TPL and its Energy Division especially in terms of the operation and maintenance of renewable technologies (TPL, 2016).

2.2 Direct Benefits

The proposed development activity will make possible reduction of imported fuel dependency through increased use of renewable energy for power generation. Further, the proposed development will also create employment and new income-generating opportunities in both direct and indirect jobs especially in the construction phase. It is envisaged that 5—8 overseas-based experts will be employed as well as 25—30 locals during the construction phase (TPL, 2016).

The indirect jobs relate mainly to an increase in the activities of existing local enterprises for the supply of materials and equipment needed for the activities and daily maintenance of workers and the creation of an enterprise on site for the assembly of the solar plant (Pongi, 2016—pers com).

During the operational phase of the proposed development activity, a photovoltaic (PV) power station on the site will employ more workers. Furthermore, the small and medium-sized enterprise can provide leverage especially in terms of rendering various services, for example, maintenance guard service and industrial cleaning (Guthrie, 2016).
2.3 Location and Facilities
   2.3.1 Location

Figure 1  Pictorial view of Site before Clearance

The proposed development activity is located in a leasehold property of TPL secured from His Majesty's estate. It must be stressed that the site was already cleared at the time of the fieldwork and the relevant information that could be collected in terms of flora was obtained from floral remains that were still available at the site. One may suggest whether this is sufficient but given all the complications, however it is pointed out that the data obtained can be considered ample for the task at hand. Figure 1 presents a pictorial view of the site before clearance was made and it is quite obvious that the area was predominantly covered with coconut trees (*C. nucifera*) with sparse coverage of other indigenous flora consistent with dried
specimens scattered around the site. Figure 2 portrays a view of the site without its flora and it provides a general view of the site and adjoining areas.

The site of the proposed development activity is at the eastern fringe of Ha’ato’u village immediately adjacent to the TPL’s power station and it is only a few minute drive from the site to the central business district area of Pangai. Apart from the existing power station and few residential buildings in the old leasehold property, the new leasehold does not contain any facility however there is plan for a battery house and photovoltaic solar panels to be put in place in the near future.

2.3.2 Alternative location and facilities

Consideration of alternative location for the proposed development activity was not considered necessary given the technology that will be used. The proposed development will generate and store electrical energy from solar source and this will be fed directly in tandem with energy produced from diesel-powered generator to the existing grid line. Given this, there is no need for an alternative location. Moreover, information provided by TPL would indicate that the use of battery storage is a new development in Tonga and as such it must be located in close proximity to an existing power station.

Given the above it is most obvious that the best location for the proposed development is the site preferred by TPL.

2.4 Technology
2.4.1 Technology to be used

The proposed development is aimed primarily at combining the new technologies of photovoltaic (PV) generation, storage systems and interfaces to the diesel control unit. As such, it is an integrated power system with 550 kWp nominal power consisting of PV modules (ca. 1900 units), mounting structures, foundations for the mounting structures, PV on grid-inverter, distribution boxes, grounding, fuses, connection and monitoring according to the existing interfaces and conditions.

As an AC energy storage system, accumulators (re-chargeable batteries) with a total storage capacity of 660kWh including connectors, cable, stands and fuses are considered as contingent components. A bi-directional battery inverter will be employed to connect the batteries to the AC grid and it also includes leadership control system for grid integration and connection according to the existing interfaces and conditions.
The OPzV solar power batteries are made of electrolyte components containing sulfuric acid. The solar modules on the other hand consist of low-iron tempered glass, multi-crystalline silicon and aluminum alloy. According to available information, all these components can be fully recycled either locally or overseas.

2.4.2 Construction Techniques

The PV plant consists of fixed mounted crystalline module technology and three-phase string inverters. The PV module mounting frames and structures will be built with optimized fixed tilt angle in North direction and azimuth of zero. The structure formation is of the screw or micro-pole type.

2.4.3 Availability of Technology

In terms of availability of technology all of the technologies, except those destined for use in the construction of the battery house, will be imported from overseas sources. PV technologies are currently considered very much associated with the western world, however with the influx of solar power to the developing world mainly through bilateral aid there is strong possibility that the PV technologies will soon be emulated locally.

2.5 Local Infrastructure Required

2.5.1 Roads

The cover page picture portrays a general view of the project site with respect to existing road networks in the main town of Pangai. As obvious from the satellite imagery, there is ample network of road joining the project site to various parts of Lifuka. All of existing roads run parallel or at right angle to the site and this alignment allows easy connection with the site and thus makes possible efficient implementation of project activities.

In terms of quality of roads, except for the main road running from Hihifo to Foa which is tar-sealed, all other road networks are limestone-based but this is considered to have inappreciable effect on project implementation.
2.5.2 Water

As in the domestic sphere, water is also a vital component of this proposed development activity especially in the construction phase. A battery house of 25 m x 6 m will be constructed on site and this will require large quantity of water for cement mixing and personal needs of construction personnel.

In the operational phase, water will continue to become vital especially considering the fact that TPL personnel will be employed on site for logistical, maintenance and monitoring responsibilities.

Overall, it is undeniable that water will become a contingent constituent of the proposed development activity, however its use is most unlikely to affect the general availability of the resource to the communities of Pangai nor have any feasible negative impact on the ecological state of the resource.

2.6 Inputs

2.6.1 Capital

The total cost for the Outer Islands Renewable Energy Project (OIREP) of which the Lifuka PV plant is a part is some USD 6.8 m generously supported by grant from the Asian Development Bank (ADB), the Australian Agency for International Development (AusAid) and the GoT. OIREP covers Vava'u, Ha'apai and 'Eua but overall specific details would put allocation for the Lifuka component at approximately 60% of the total grant.

2.6.2 Labour

According to TPL, a labor force of approximately 5—8 foreign-based experts and 25—30 locally available trade-men will be employed at all phases of the proposed development activity. The number may increase during the operational phase due to unforeseen circumstances.

CBS Power Solutions (Fiji) Ltd is the contractor chosen to implement all activities as identified and mutually agreed to by ADB, AusAid, TPL and GoT. Further, Palu Development Ltd is the local counterpart chosen to work with CBS Power Solutions Ltd in the implementation of specific activities. Given this, it should become obvious that the bulk of labor needs, both skilled and unskilled, will be met locally. The role of CBS Power Solutions Ltd will be restricted mainly
to supervision and management plus filling in logistical needs where expertise is not available locally.

2.6.3 Natural Resources

Specific details provided by the proponent in terms of various activities to be implemented in the proposed development activity would suggest that among the resources destined to be used include land, water, wood, sand, limestone aggregates and labor force. Land with an area of 11,000 square meters has been secured under a leasehold arrangement between TPL and the relevant estate-holder.

Water, as indicated earlier, will be used but this will be maximized during the construction phase and is bound to decrease significantly during the operational phase. The current state of reticulated water supply as managed and operated by Tonga Water Board (TWB) is both technically and physically well and the proposed development activity is not in a position to change this in a drastic manner.

Local wood will not be used for construction purposes and therefore timber will be secured from overseas sources. It is understood that there is local timber available at Tonga Timber Forest Products (TTFP) in Tokomololo but choice is very much a matter to be decided by the relevant construction contractor.

Sand is a renewable resource and its use has to be within the maximum sustainable yield (MSY) in order to rule out affecting the resource in a significant manner. Information provided by both CBS Power Solutions Ltd and Palu Development indicate that sand use will be restricted to the construction of a battery house and no other purposes. Given that the measurements are 25 m x 6 m the amount of sand that will be used is considered to be minimal and therefore it is not going to affect the resource in any ecologically significant manner.

In terms of limestone aggregate especially the crushed type, its use will be most likely in cement mixing for flooring and wall enforcement and given this the amount to be used will be minimal and therefore will not pose any significant problem.

Finally, labor need will be met almost entirely from local personnel and given the high unemployment rate in Tonga in general and Ha’apai in particular, the proposed development activity will make useful contributions as far as employment opportunity is concerned let alone the broader positive ramifications on the local economy of Ha’apai.
2.6.4 Duration of Construction and Operation

Among the facilities to be constructed include a battery house, arrays of solar panel, security fence enclosing the entire leasehold, cables to connect the solar panels to the battery house and water pipes connecting the premise to the main. Construction will take 3 months to complete all parts of the development activity.

In terms of relevant approval procedures, the leasehold arrangement and water connection have been secured with the EIA requirement still pending.

3.0 Justification

To justify a proposed action is really to show why it is considered worthwhile implementing it given all the costs involved. Accordingly, it is bound to be imperfect but the potential benefits to the society deemed it necessary for implementation. Table 1 presents a matrix of possible impacts of the proposed development activity, both positive and negative.

<table>
<thead>
<tr>
<th>Action</th>
<th>Environmental</th>
<th>Economic</th>
<th>Cultural</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of Flora</td>
<td>Decreasing soil fertility</td>
<td>Energy input</td>
<td>Loss of herbal plants</td>
<td>Decreasing cultivated land</td>
</tr>
<tr>
<td></td>
<td>Loss of carbon sink</td>
<td></td>
<td>Loss of ornamental plants</td>
<td></td>
</tr>
<tr>
<td>Removal of Habitat</td>
<td>Less avifauna</td>
<td>Impoverished</td>
<td>Loss of culture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less fauna</td>
<td>tourism</td>
<td></td>
<td>Loss of gathering ground</td>
</tr>
<tr>
<td>Construction of</td>
<td>Noise</td>
<td>Multiplier</td>
<td>Cultural impoverishment</td>
<td>Employment</td>
</tr>
<tr>
<td>Facilities</td>
<td>Groundwater contamination</td>
<td>effects</td>
<td></td>
<td>Market</td>
</tr>
<tr>
<td>Operation</td>
<td>Groundwater contamination</td>
<td>Saving on energy production</td>
<td>Cultural encouragement</td>
<td>Employment</td>
</tr>
<tr>
<td></td>
<td>Less carbon emission</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1 Matrix of Impacts

From the outset, it must be stated quite clearly that given all the details provided by the proponent in terms of all activities to be implemented in relation to the proposed development
activity and field observation made by the consultant, it is quite obvious that the potential benefits will outweigh the potential costs. As such, the following justifications are put forward for consideration.

3.1 Environmental

The issue of climate change is capturing the interest of almost all countries in the world including Tonga and there is increasing emphasis on implementation of mitigation measures as matters of first priority. Combustion of carbon-based fuels either for generation of electrical energy and transportation has proved to be the major source of greenhouse gas emissions in Tonga. Given the need to address the issue effectively the global community has made commitment through international law to improve the situation. As a sovereign nation which benefits from active participation in global environmental governance Tonga has acceded to the United Nations Framework Convention on Climate Change (UNFCCC) which regulates emission of greenhouse gases globally. Further, climate change has proved to be closely associated with increasing occurrence of destructive natural disasters such as cyclones and given Tonga’s vulnerability to these the role played by the GoT in global environmental governance is well justified.

3.2 Economic

Tonga’s supply of electrical energy is currently obtained from combustion of imported diesel oil. The cost of imported diesel fuel is increasing from time to time and there is little that GoT can do to change this situation. Thus, the price of diesel fuel continues to rise resulting in escalating energy cost to be borne by the consumers. From economic and political perspectives, lessening of dependence on carbon-based fuel for generation of electrical energy is considered as priority hence, the move by TPL to renewable sources of energy such as solar photovoltaic energy. The Ha’apai Solar Photovoltaic Plant Project is a move in this direction.

The proposed development activity will also make possible saving in terms of decreasing amount of diesel fuel used for energy generation and given that the investment has a lifetime of 25 years, the saving in economic terms will run into several millions TOP.

3.3 Cultural
Ha'apai is well-known at national level for the quality of cultural artifacts that it produces. This is especially true in terms of traditional mats and skirts and there is push to ensure that this tradition is maintained. As a female-dominated industry, partaking in weaving sprees is often done in group both during the day and at night. On the spot observations conveyed increasing popularity of night time weaving for various reasons and the project appears most likely to make positive contribution in this especially in terms of better availability of electrical energy and perhaps at a cheaper rate.

3.4 Social

Unemployment is always a problem in Tonga and the GoT is trying to address this issue wherever necessary. The proposed development activity is already providing employment to some 30 locals in various capacities and there is indication that this will continue at the operational phase although at a decreasing scale. Indirectly, there are also opportunities shared by other service providers such as food caterers, accommodation owners, rental car dealers and owners of restaurants and retail stores.

4.0 Description and analysis of Impacts

4.1 Existing environment

4.1.1 Physical

The proposed development activity is located at the outskirt of Ha'ato'u in Pangai, Lifuka island. The site has a total area of 11,000 square meters which has been secured by TPL under a leasehold arrangement from His Majesty's estate.

The site was originally covered with indigenous floral species but these have been removed by the proponent as part of preparation of the site. Pictorial coverage of the site prior to clearance provides clear indication in terms of types of plants that were available and this can be checked by the dried specimens available on site. Species diversity and richness are bound to be low as information provided by the locals would suggest that the area was used for shifting cultivation for quite sometimes. Table 2 provides a list of indigenous flora which was available at the site as determined from available sources and these appear to be consistent with the floral coverage of adjoining land areas.
<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ngatata</td>
<td>Ellatostachya falcate</td>
</tr>
<tr>
<td>Masikoka</td>
<td>Glochidion ramiflorum</td>
</tr>
<tr>
<td>Niu</td>
<td>Cocos nucifera</td>
</tr>
<tr>
<td>'Ovava Tonga</td>
<td>Ficus oblique</td>
</tr>
<tr>
<td>Manaui</td>
<td>Garunga floribunda</td>
</tr>
<tr>
<td>Volovalo</td>
<td>Premna serratifolia</td>
</tr>
</tbody>
</table>

Table 2 Indigenous flora at the Site

The soil is sandy loam with a thin coverage of black humus layer of topsoil with varying thickness. Soil fertility is moderate given the high sand content and abundant rainfall is required if good yield is desired.

Depth to the groundwater was measured at a nearby well to be 3.5 m and this would suggest that the available soil has sufficient capacity for purification of any pollutants provided that these are not hazardous materials. This statement is qualified if one considers the ambient state of the groundwater taking into consideration the amount of pollutants being disposed in the island for a long period of time. Apart from incidents of salt water intrusion there has not been any major pollution problems due to contamination by organic or chemical sources.

4.1.2 Economic

Ha’apai is well-known in Tonga for being utterly prudent in terms of what one gains in life and this is a reality which is closely linked to available resource endowment. The Ha’apai group is made up of islands which are widely scattered with limited land areas. The local economy is based almost entirely on fishery resources and given this someone has to be thrifty with what he/she gains in life.

There is no doubt that the GoT is providing expansion measures in agriculture, tourism and fishery in the Ha’apai group as indicated by improvement in existing road networks, domestic air transportation, fishery policies and provision of advisory collaboration with both local farmers and fishermen. These measures are vital as necessary encouragements to make farmers, fishermen and other entrepreneurs more productive and profitable in their respective affairs. One cannot deny the fact that many families in Ha’apai are getting monetary assistance from members living abroad however, realistic and significant improvement in the household and general economic situation is still bound to be generated to a great extent locally and
therefore local residents should be encouraged as much as possible where considered necessary.

When local residents are better off financially, desire for electrical consumer goods such as refrigerators, washing machines, electrical lights and other household requirements is unavoidable and the government is bound to respond in a positive manner. The proposed development activity is one of the strategies that the government is promoting in terms of strengthening the energy sector in Ha'apai and there is indication that similar development will be extended to other communities although on a smaller scale (Guthrie, 2016).

4.2 Potential impacts of Construction
4.2.1 Physical

In physical sense, the proposed development activity will make possible mass clearance and leveling of the entire site. Given this, the site at completion of construction will be a fenced area with arrays of solar panels aligned at azimuth zero adjoined to a battery house which is located nearby. The site is slightly higher at the eastern end with a difference of height of 0.5 m compared to the western end with the result that water will drain with the gradient thus accumulating at the western end depending on percolation rate. Given the nature of the soil which is dominantly sandy loam, percolation rate is high and water can disappear in duration of few hours at the most. Figure 2 provides a view of the site when construction is completed.
4.2.2 Biological

Biological concern arises mainly due to effect of mass removal of plant coverage on biodiversity especially fauna, flora and avifauna. It was not possible to collect data in terms of the ambient nature of flora, fauna and avifauna however data of a secondary nature was collected from dry specimens available at the site and from flora available at adjoining land.

One cannot deny that the entire floral coverage of the site has been cleared and both fauna and avifauna have also migrated and although no sampling was conducted it is most likely that the displaced population found refuge in adjoining land areas.

4.2.3 Social

As indicated in section 3, the land concerned is part of the King’s estate but was cultivated under arrangement by a local shifting cultivator who has been given other portion of the estate for his use. Thus, the cultivator although his occupation of the area was secured under informal arrangement, is not affected in a negative sense as compensation has been made by the estate holder and cultivation and well-being continue as usual.

In terms of other resources such as groundwater and electrical energy, the proposed development will not pose any negative effects on existing users at both the construction and operational phases. Use of water at the construction phase will eventuate mainly in cement mixing and to a lesser extent on social needs of workers and impact will decrease substantially at the operational phase and so the combined effect of water use during both phases will be insignificant.

As for energy use most notably electrical energy, it must be borne in mind that the proposed development activity is aimed specifically at augmenting the electrical energy supply at Lifuka and Foa and although portion of available energy will be used at the construction phase, the overall impact will outweigh any negative effects given the amount of additional electrical energy that the solar plant will generate. Furthermore, positive effects will also materialize at both the national and global levels given the potential reduction in the use of imported diesel fuel for energy generation and the amount of greenhouse gas emissions. So, consideration of the proposed development from an energy perspective favors implementation of the proposed development unequivocally.
In terms of potential impacts of the proposed development on the economic and cultural environment these have been discussed quite extensively in other parts of this report and this is perhaps suffice for the purpose.

4.3 Potential impacts of Operation

4.3.1 Physical

In terms of the physical condition of the land, the area as it is at present (cleared) will stay like that for the duration of the leasehold. Although without its natural coverage of indigenous plants the entire area has been fenced and adequately maintained so from an aesthetic perspective, it is an automatic attraction.

There is potential for pollution due to the use and disposal of battery however the proponent has made commitments to take all necessary precautionary measures to ensure that leakage of chemical pollutants from the batteries will not materialize. Further, commitments have also been made by TPL to send any used batteries for disposal at overseas location.

4.3.2 Social

There are several ways in which the communities of Lifuka and Foa can be affected on a positive note by the operation of the proposed development and these include better supply of electrical energy and availability of employment opportunities. An additional capacity of 550 kWh generated by the PV Plant will increase the overall capacity of the Lifuka Power Plant (solar + conventional) to 922 kWh thus ensuring more reliable source of energy for the communities of Lifuka and Foa. This can serve as an encouragement to small business operators and handicraft makers such as near-shore and shallow water fishermen as well as mat weavers and tapa-cloth makers. Income generation of this nature can become very effective indeed in terms of improvement of social well beings of households let alone facilitating growth of the local economy.

4.3.3 Biological

Similar sorts of effects as experienced by the adjacent communities during the construction phase will materialize during the operational phase, however the overall result will be insignificant. Although the entire floral cover of the site has been removed with the faunal
composition migrating *en masse* to surrounding areas, loss of biodiversity is not going to be a major issue as representative communities both floral and faunal can be found at close range. Field investigation conducted during visit to Ha’apai found similar species of plants in adjoining land properties as indicated by dried specimens from the site as presented in Table 2.

4.3.4 Cultural

Cultural effects can be experienced in the forms of loss of arable land, loss of medicinal plants, loss of avifauna biodiversity, decreasing availability of fuel-wood supply and loss of sites of cultural significance. Although the project site was used for shifting cultivation its current use as site for the project does not pose any problem as far as cultivation is concerned as replacement has been made available to those concerned.

Some of the native plants documented in Table 2 are used by the local people for treatment of minor ailments and their removal does not pose any problem as similar species are found in adjoining lands.

In terms of loss of bird biodiversity and decreasing supply of fuel-wood given the removal of tree cover the effects will not pose any major problem to the adjoining communities given that similar varieties of plants are found available in the adjoining land properties.

Apart from residential areas which are located close to the project site it was not possible to locate any location of cultural significance such as burial or pigeon-snaring mounds in the site or adjoining land areas. The village of Hihifo/Tongaleleka is located close to the project location and is also well-known for its cultural sites but none of these is going to be affected by the proposed development.

5.0 Mitigation measures

Remedial actions or measures are applied only where and when any activity is impacting the natural, social, cultural and economic environments in a negative sense. Table 3 provides details in terms of various activities to be implemented in the proposed development as well as the potential impacts/risks and recommended mitigation measures.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Risk/Impact</th>
<th>Mitigation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of Flora</td>
<td>Biodiversity loss</td>
<td>Although 11,000 square meters of land is foregone</td>
</tr>
<tr>
<td></td>
<td>Decreasing fuel-wood supply</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Impact</td>
<td>Mitigation</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Loss of cultural/medicinal</td>
<td>together with associated loss of biodiversity, fuel-wood supply, arable</td>
<td>文化/医疗植物的损失，以及碳捕捉的减少。这些损失被附近/相邻地区可用的类似资源所抵消。</td>
</tr>
<tr>
<td>plants</td>
<td>supply, arable land, cultural use as well as decreasing CO2 sequestration these are compensated by availability of similar resources in nearby/adjacent land areas.</td>
<td></td>
</tr>
<tr>
<td>Decreasing CO2 sequestration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imposition of battery house</td>
<td>Pollution due to sulfuric acid</td>
<td>State of the art technology for control of potential leakage of sulfuric acid; discarded batteries will be recycled or retrieve to manufacturer for disposal.</td>
</tr>
<tr>
<td>Waste generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste removal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erection of solar panels</td>
<td>Loss of aesthetic beauty</td>
<td>An area covered by solar panels is not compatible to the same area covered by indigenous plants, however the same can be adequately landscaped as possible compensation; Discarded materials will be mainly steel, aluminum and glass and TPL has made commitments to recycle as much as possible for economic rationale or retrieve to manufacturer for disposal where considered necessary; Excessive noise during positioning of piles for solar panels but noise level here is nowhere compatible to existing noise generated by the power generator located nearby, however additional noise is temporary in nature and is restricted to construction phase.</td>
</tr>
<tr>
<td>Waste generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise problem</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Potential activities and mitigation measures
6.0 Alternative activities and locations

The proposed development is aimed primarily at improving the on-grid infrastructure of Lifuka and Foa islands by connecting renewable solar energy to the existing grid infrastructure, increasing reliability and efficiency of power supply, and to having a positive environmental impacts on the islands by reducing CO2 emissions. This in reality means that the PV Plant will put in place a fully automatic control system which is interfaced to the existing diesel power plant. In view of this, the preferred site is what has been chosen by the proponent.

In terms of technology, the situation will not differ if wind generated energy, for example, is the preferred technology as windmill has to be installed in close proximity to the existing diesel power plant. However, this option is prone to become problematic as the site is well sheltered by plants thus denying sufficient wind power for the windmill.

Further, it was possible during field investigation to observe a windmill lying idle on the Foa side of the causeway and according to available information inadequate wind power may be the reason behind this. Selection of a site for a wind plant is often made based on data collected over a long period of time.

In view of the above, there is no doubt that solar technology interfaced to existing diesel power plant as proposed by the proponent is the best option to take.

7.0 The “No-Development” Option

The proposed development targets achievement of the following goals:
- Saving of approximately several hundreds of tons of CO2 emissions annually;
- Allow the GoT to become more independent from external fuel imports;
- Achievement of 50% renewable energy capacity by TPL;
- Less fuel transport on road from ferry terminal;
- Reduced risk of road accident; and
- Contribution to national target of generation of 50% of grid-based electricity from renewable energy sources as well as achieving a 50% reduction in diesel consumption by 2020 as set by the National Strategic Planning Framework.

Pursuing the above-stated goals had been on the agenda of the government since the beginning of the 2000s and a major breakthrough occurred in 2008 when the Renewable Energy Act, a regulatory regime to promote the use of renewable energy technologies, was enacted. To date, the major island groups of Tongatapu and Vava’u have become the main
beneficiaries of donor-funded activities on renewable energy, however the need to extend the same to smaller island groups of the kingdom had become a top priority in the government’s development agenda. The Outer Islands Renewable Energy Project (OIREP)—a package of which the proposed development activity is included—was developed pursuant to the overall renewable energy development framework and other components of the package will follow as far as implementation is concerned given that donor funding from development partners of the government has been secured.

It should become obvious from the above that favorable consideration of the development activity as proposed should not become an issue provided that the proponent lives up to its commitments.

8.0 Cumulative Effects

8.1 Existing developments

The proposed development activity is located at the outskirt of Ha’ato’u village and apart from the Tonga Water Board which is few hundred meters to the south there is no other development currently existing in the surrounding area. The remaining communities of Tonga’aleleka/Hihifo, and Navea are located nearby to the south and north respectively and although the combined effect of these and the proposed development may appear to pose a problem to the natural, social, cultural and economic environments there is justifiable reason to suggest that this may cause an alarm. The surrounding communities together with other development activities such as road, water supply, port, health facilities and schools have impacted on the environment on a continuous basis and to date no major hazard has happened.

8.2 Future development

Lifu is small compared to other parts of the kingdom such as Tongatapu and Vava’u but given that it is the administrative center of the Ha’apai group there is strong belief that it will provide the base for future developments. Currently, there is no firm indication available on possible future developments however there is reason to believe that the scale of any future developments will be similar to current development path.

Overall, the natural, social and cultural environments stand to bear the combined effects of future development but proper planning and informed decision making can make a
lot of difference as far as conservation of environmental resources is concerned. Fritz Schumacher hailed the beauty of being small and appropriate and this is a dictum worth pursuing in the case of Ha‘apai but very much on the scale and dimension of the proposed development (Schumacher, 1980). Given that this is pursued the much lauded objective of sustainable development whether in the natural, social, cultural and economic sense becomes meaningful.

9.0 Public Involvement

9.1 Interview

Samani Consult was engaged initially in the proposed development to conduct the topographical and engineering survey components and these involved boundary relocation, positioning of fence lines and precise measurement of positions for the solar panels. In order to make these possible it was necessary to make few visits to Ha‘apai during the months of June and July 2016.

During the course of these engagements the consultancy firm was also requested to undertake, as an additional responsibility, the preparation of an environmental impact assessment (EIA) for the proposed development as required under the EIA Act 2003. Given the time available and the scale of the task confronting the consultant it was decided that structured interviewing was the appropriate approach for obtaining the views of the public.

A sample of 30 respondents picked at random among residents of Ha‘ato‘u and Tongaleleka was interviewed using questions prepared by the consultant. The questions targeted independent views of the respondents on matters related to the potential effects of the proposed development on the natural, social, cultural and economic situations. Table 4 presents a list of the questions posed and specific aids/pointers as assistance for recording.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you support current initiative by the government to improve electrical energy supply in Ha‘apai?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>How can you justify your response?</td>
<td>Domestic</td>
</tr>
<tr>
<td></td>
<td>Business</td>
</tr>
<tr>
<td></td>
<td>Education</td>
</tr>
<tr>
<td>Questions</td>
<td>Options</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>Solar energy is part of the improvement package but indicate why you consider it important?</td>
<td>Handicraft, Fishery, Tourism, Sufficient supply</td>
</tr>
<tr>
<td>Solar PVC plant will make possible mass clearance of site but indicate whether you support it.</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Why do you think so?</td>
<td>Environment friendly, Sufficient biodiversity, Sufficient land for cultivation, Destructive</td>
</tr>
<tr>
<td>What other contributions that the project may make possible?</td>
<td>Employment, Small business, STD</td>
</tr>
<tr>
<td>Do you prefer expansion of solar energy technology in the future?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Why do you think so?</td>
<td>Clean energy, Affordable</td>
</tr>
<tr>
<td>Was there any awareness outreach in your community in the past?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>If yes, who was the provider?</td>
<td>MEIDECCC, TPL, Others</td>
</tr>
<tr>
<td>Will the Solar PVC Plant affect use of other resources such as water?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Why do you think so?</td>
<td>Temporary, Fragile quality</td>
</tr>
</tbody>
</table>

Table 4 Questions for Structured Interview

9.2 Discussion

Before embarking on an analysis of the responses perhaps some clarifications are necessary in terms of design of the survey instrument. The questions were formulated taking into consideration the general concern of Form 3. Further, although some of the questions may
appear to have a “leading” flavor, however attempt was made to compensate this by seeking justification from the responses.

Further, details provided in the response column were considered necessary as aids/pointers for the interviewer especially in recording the responses and they were not provided to the respondents. The respondents were left independent in the exchanges and probing was made only where clarification was needed.

9.2.1 Analysis

In terms of general acceptance of expansion initiative by the government on electrical energy supply in Lifuka about 93% supports the investment citing opportunity for improvements in areas that will assist income generation, upgrading of standard of living and better facilitation of education. The other 7% felt that the current state of electrical supply is sufficient and resources could be better use in other areas.

As for introduction of solar energy on a large scale to Ha’apai in general and Lifuka in particular the majority of respondent favors the initiative stressing the potential positive contributions of the technology to the environment, local economic situation and the ability of residents to cope with escalating user charges. The other 7% considers the technology as doomed to fail with specific reference to similar development in Vava’u which is now inoperative.

Specifically on the environmental area, the majority view (93%) feels that mass clearance of the project site is justified given that it may not have drastic impact on biodiversity and availability of land for shifting cultivation.

On general other contributions of the project most of the respondents considers that there will be employment opportunities generated with possible multiplier effects on small businesses. The alternative view is some negative social effects citing influx of sexually transmitted diseases given the necessity for introduction of exotic personnel.

In terms of further expansion of solar technology in Ha’apai the majority have strong expectation for this citing the clean nature and affordability of solar electrical energy.

On the awareness front there appears that there is a fair grasp of the solar technology by the majority of the respondent and some made specific reference to awareness outreaches made by government officials during rehabilitation after Cyclone Ian.
Finally, as for effect of the project on other resources such as water the majority feels that impact will occur in terms of quantity especially during construction but the situation will revert to normal during the operational phase.

Overall, it would appear that there is general acceptance of the proposed development by the communities of Pangai with strong and clear expectation for improvement in the electrical supply and other related matters.

10.0 Impact on other Policies/Legislation/Convention

10.1 General

The Lifuka PV Plant is not a “stand alone” development package but is part and parcel of a major initiative within the GoT targeting realistic and concrete improvement in electricity supply and cost, more catalytic contribution of the energy sector most notably electrical energy to national development strategy, and more realistic follow up by GoT of its obligations under some international agreements. The intention here is not to recite a litany of past and current policy frameworks but rather to relate the current project to where it came from and its roles in the scheme of things.

10.1.1 United Nations Convention on Biological Diversity (UNCBD)

This international agreement came into force in 1992 and its primary focus is sustainable use of biological resources of both fauna and flora. Tonga acceded to UNCBD in 1998 and has managed to live up to its obligations up to now. Although that mass removal of floral communities was made possible by the project to make way for installation of solar panels this does not contravene Tonga’s position under international law as no endangered species was displaced or eliminated.

From another perspective UNCBD plays a significant role in international affairs as it is one of the multilateral environmental agreements (MEAs) which paved the way for establishment of the Global Environment Facility (GEF)—the international financial institution which funds global initiatives that target sustainable development in various areas including energy.
10.1.2 United Nations Framework Convention on Climate Change (UNFCCC)

This is another international agreement that came out at the United Nations Conference on Sustainable Development which was held in Rio de Janeiro in 1992 and its main focus is realistic reduction of emission of greenhouse gases from anthropocentric sources. This international law revolutionizes energy production and generation as it initiated massive global interest in renewable and clean energy.

Tonga acceded to the convention in 1998 and has been benefited by grants from both bilateral and multilateral development partners targeting development of the renewable energy sector. This project is a good example of this initiative and will go a long way in ensuring that Tonga lives up to its international obligations under UNFCCC.

10.1.3 Tonga Energy Road Map (TERM)

This national energy framework was institutionalized in the late 2000s out of the Prime Minister’s Office. Although its emphasis was both conventional and renewable energy it marked a major breakthrough in energy development in Tonga as the way was paved for renewable energy to become the mainstay of the energy sector in Tonga. TERM 2010-2020 is a living proof of this and it is a reform and improvement plan for the energy sector developed in close coordination with all relevant stakeholders.

The project and the energy framework that it duly belongs (OIREP) are indeed attempts by the Tonga government to ensure practical and successful implementation of TERM.

10.1.4 Renewable Energy Act 2008

Until the enactment of the Renewable Energy Act 2008 all of energy policies of the 2000s were made by Cabinet enshrined in major policy manifesto such as Strategic Development Plan. REA 2008 marked a major step forward and it provided a regulatory instrument for promoting the use of renewable energy technologies.

The Lifuka Solar PV Project is indeed part and parcel of the evolutionary process in renewable energy in Tonga which was initiated by various energy development frameworks including REA 2008.
10.1.5 National Strategic Planning Framework 2009

The NSP Framework 2009 addressed issues related to vulnerability of the energy sector to fluctuating oil prices. By so doing, it set a target of generating 50% of Tonga’s grid-based electricity from renewable energy resources and to achieve a 50% reduction in diesel consumption by 2020.

The current project is duly part of this process and successful implementation will indeed make concrete contributions toward realization of the thrust of the NSP Framework 2009.
References


