500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga

Document Prepared By Easy Carbon Consultancy Co., Ltd.

Project Title	500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga
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1 PROJECT DETAILS

1.1 Summary Description of the Project

Tonga Energy Road Map Implementation Unit (hereinafter referred to as TERM-IU), the project proponent, has proposed the 500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga (hereinafter referred to as the proposed project) as an important part of implementing the Tonga Energy Road Map (hereinafter referred to as TERM) to improve the energy supply condition in Tonga.

The proposed project will be constructed by Masdar Company from Abu Dhabi, the United Arab Emirates, with a financial grant provided by the Abu Dhabi Fund for Development (hereinafter referred to as ADFD). The proposed project will be operated by Masdar Company for several years (the details will be provided in the operation & maintenance (O&M) contract to be signed later) and then handed over to the TERM-IU for further operation. The estimated power generation capacity of the proposed project is 500kW and the expected electricity supply in the first year is 695MWh. The electricity will be sold to the grid in Vava'u Island, and replace the same amount of electricity generation by diesel-fired power plants in the grid[1].

Vava'u Island, where the proposed project is located, is an island around 300km northeast of Tongatapu Island, the largest and most important island in the country. The whole area of Vava'u Island is 121 km^2 and the population is 15,505 (2008). Although it is the second largest island of Tonga, the area and the population only account for 22% and 16% respectively of those in Tonga.

1.2 Sectoral Scope and Project Type

Sectoral scope: 1 Energy industries (renewable - / non-renewable sources)

The proposed project is a renewable energy project.

The proposed project is not a grouped project.

1.3 Project Proponent

Project proponent	Tonga Energy Road Map Implementation Unit (TERM-IU)
Contact Person	'Akau'ola
Address	TERM-IU Office, 1st Floor Royco Building PO Box 827 Fatafehi Road, Nuku'alofa, Kingdom of Tonga
Email	akauola@gmail.com
Office Phone	+676 24794
Website	www.tonga-energy.to
Responsibilities	1. Coordinate and obtain permits and necessary approvals within the government 2. Dedicate legal resources to complete main contracts 3. Take over the O&M work after the completion of the services under the O&M contract

[1] Feasibility Study for a 500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga

1.4 Other Entities Involved in the Project

Entity Name	Masdar
Contact Person	Serene Serhan
Address	Masdar City Opposite Presidential Flight Khalifa City A P.O. Box 54115 Abu Dhabi, UAE
Email	press@masdar.ae
Office Phone	+971 2 653 6017 / 800-MASDAR (800-627327)
Website	http://www.masdar.ae/en/home/index.aspx
Responsibilities	1. Conduct the tendering process 2. Represent the owner in the Engineering, Procurement and Construction (EPC) contract and O&M contract

Entity Name	Abu Dhabi Fund for Development (ADFD)
Contact Person	Mohammed Al Suwaidi
Address	Bainuna St., P.O.Box 814 Al-Bateen Area, Abu Dhabi, United Arab Emirates
Email	info@adfd.ae
Office Phone	+971 2 6677070
Website	http://www.adfd.ae/pages/default.aspx
Responsibilities	Provide a financial grant for the proposed project

1.5 Project Start Date

01/01/2014

1.6 Project Crediting Period

Crediting period: 01/01/2014 – 31/12/2023

Years of crediting period: 10years 0 month 0 day, twice renewable

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project	√
Mega-project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2014	556
2015	550
2016	544
2017	539
2018	534
2019	528
2020	523

2021	518
2022	513
2023	507
Total estimated ERs	5312
Total number of crediting years	10
Average annual ERs	531

1.8 Description of the Project Activity

Tonga, being an equatorial South Pacific country, has plenty of solar resources. Although the data in Vava'u is lacking, ground measurement at the Popua Solar Power Station in Tongatapu shows an annual global horizontal solar irradiation of 1,627.7kWh per square meter (m^2).[2]

To utilize the abundant solar energy, the proposed project is to be constructed near the Taumu'aloto Power Station for connection to its electricity transmission facilities. 3,570 photovoltaic (PV) modules with surface area of 1.43m^2 each will be manufactured by the Masdar Company. The PV modules will consist of microcrystalline and amorphous silicon thin films with the twin advantages of high charge carrier mobility from the crystalline structure and increased long wavelength absorption from the amorphous structure. Unlike other electricity generation technologies, PV modules produce electricity direct current (DC) rather than alternating current (AC). So for AC electrical power transmission, an inverter is indispensable for changing DC to AC. Since the intermittent PV electricity will take up a large portion of the power supply in Vava'u's grid (13.8%), batteries have to be used for storing energy and smoothing the electricity supply in case of grid collapse. The lifetime of the proposed project is 25 years.

At present, the power in Vava'u's grid is supplied by five diesel generators with installed capacity of 1.87MW in total. As a solar PV power plant, the proposed project will never give rise to any greenhouse gas (GHG) emission. Hence, the proposed project will reduce the GHG emission in the diesel dominated grid through supplying equivalent amount of electricity instead of that from diesel generators.

The key parameters of some devices and the plant are shown as following[3]:

Key parameters of PV array:

Description	Parameter
Manufacturer	Masdar PV GmbH
Model	MPV140-M
Total Number of PV Modules	3,570
Nominal Peak Power[4]	90W
Nominal Voltage	72V
Nominal Current	1.27A
Annual Output Degradation	1%

Key parameters of inverter:

Description	Parameter
Manufacturer	SMA
Model	Sunny Tripower 10000TL
Total Number of Inverters	44

[2] Feasibility Study for a 500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga
[3] Feasibility Study for a 500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga
[4] http://www.tehnosat.ro/pdf/PVmodules/Masdar_MPV95-100-105-110S_aSi_thin_film.pdf

Operating Voltage	150-800V
Unit Nominal Power	10.0kW AC

Key parameters of the proposed PV plant:

Description	Parameter
Type of Power Plant	Photovoltaic
Installed Capacity	500 kW
Annual Output	695MWh
Annual output degradation[5]	1%

1.9 Project Location

The proposed project is located in Neiafu, Vava'u Island, the Kingdom of Tonga. The geographic coordinates of the proposed project site are 178°58′28″W and 18°38′41″S as shown in the following graph.

Fig.1 Location and geographic coordinates of the proposed project

[5] Final On-grid Report Renewable Energy Supply to the Four Island Grids in Tonga April 2010

1.10 Conditions Prior to Project Initiation

Prior to the construction of the proposed project, the electricity in Vava'u Island is provided by five diesel generators in Taumu'aloto Power station with installed capacity of 1.87MW in total. The proposed project is a green field solar power project without any GHG emissions.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

In accordance with the Environment Impact Assessment Act of Tonga, a Major Environment Impact Assessment (mEIA) has been carried out by TERM-IU. For more details of the mEIA, please refer to Section 5.

The proposed project is also in compliance with other related laws in Tonga, such as Renewable Energy Bill 2008.

1.12 Ownership and Other Programs

1.12.1 Proof of Title

According to the Feasibility Study, the proposed project is owned by TERM-IU. More evidences such as contracts will be provided once signed.

1.12.2 Emissions Trading Programs and Other Binding Limits

Not applicable.

1.12.3 Participation under Other GHG Programs

The proposed project neither has been registered, nor is seeking registration under any other GHG emission reduction crediting programs.

1.12.4 Other Forms of Environmental Credit

The proposed project neither has nor intends to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program since it neither has been registered, nor is seeking registration under any other GHG emission reduction crediting programs.

1.12.5 Projects Rejected by Other GHG Programs

The proposed project has not been rejected by any other GHG programs because it neither has been registered, nor is seeking registration under any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

Not applicable as the proposed project is not a grouped project.

Leakage Management

In accordance with the applied methodology "AMS-I.F. – Renewable electricity generation for captive use and mini-grid", "If the energy generating equipment is transferred from another activity, leakage is to be considered." However, the proposed project is a green field project without transfer of any equipment from another activity. Thus, leakage does not require to be taken into consideration for the proposed project.

Commercially Sensitive Information

There is no commercially sensitive information for the proposed project.

Further Information

There is no further information with regard to the eligibility of the proposed project, the net GHG emission reductions or removals, or the quantification of the project's net GHG emission reductions or removals.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

The approved methodology applied in the proposed project activity is AMS-I.F. "Renewable electricity generation for captive use and mini-grid" (Version 2.0)".

The tools applied in the proposed project:

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01)

"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02)

Reference: http://cdm.unfccc.int/methodologies/DB/9V3T8W0N5PMCJH4YVEA04YYFTVHP3Q

2.2 Applicability of Methodology

Para. No.	Applicability Criteria as per AMS-I.F. Version 02	Situations in the proposed project
1	This methodology comprises renewable energy generation units, such as solar, hydro, tidal/wave, wind, geothermal and renewable biomass that supply electricity to user(s). The project activity will displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit i.e. in the absence of the project activity, the users would have been supplied electricity from one or more sources listed below: (a) A national or a regional grid (grid hereafter); (b) Fossil fuel fired captive power plant;	The project activity comprises renewable energy generation units (PV modules) which will supply electricity to users.

	(c) A carbon intensive mini-grid.	
2	The project activity will displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit i.e., in the absence of the project activity, the users would have been supplied electricity from one or more sources listed below: a) A national or a regional grid (grid hereafter); b) Fossil fuel fired captive power plant; c) A carbon intensive mini-grid.	In the absence of the proposed project activity, the electricity on Vava'u Island is supplied by five diesel generating units, with total installed capacity of 1.87MW, which is a mini grid (the sum of installed capacities of all generators connected to the mini-grid is equal to or less than 15 MW). So this qualification is satisfied.
3	For the purpose of this methodology, a mini-grid is defined as small-scale power system with a total capacity not exceeding 15 MW (i.e., the sum of installed capacities of all generators connected to the mini-grid is equal to or less than 15 MW) which is not connected to a national or a regional grid.	The current installed capacity in Vava'u grid is 1.87MW, lower than 15MW. So it is a mini-grid. Hence the proposed project satisfies the applicability criteria
4	Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: · The project activity is implemented in an existing reservoir with no change in the volume of reservoir; · The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m^2; · The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4W/m^2.	Not applicable as the proposed project does not involve any hydro power plant.
5	For biomass power plants, no other biomass other than renewable biomass is to be used in the project plant.	Not applicable as the proposed project does not involve any biomass power plant.
6	This methodology is applicable for project activities that: a) install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); b) involve a capacity addition c) involve a retrofit of (an) existing plant(s); or d) involve a replacement of (an) existing plant(s).	The proposed project is a greenfield project. So it meets this requirement.
7	In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.	This condition is not applicable since the proposed project activity does not involve capacity addition of renewable energy generation units at an existing renewable power generation facility.

8	In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.	This condition is not applicable since the proposed project is a greenfield project and it does not involve retrofit or replacement.
9	If the unit added has both renewable and non-renewable components (e.g., a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the unit added co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	This condition is not applicable as the proposed project activity does not involve unit addition.
10	Combined heat and power (co-generation) systems are not eligible under this category.	The proposed project does not involve any combined heat and power system. So this condition is not applicable.
11	If electricity and/or steam/heat produced by the project activity is delivered to a third party i.e. another facility or facilities within the project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered that ensures that there is no double counting of emission reductions.	Not applicable since the electricity produced by the proposed project will be only used ion Vava'u Island and not delivered to a third party.

2.3 Project Boundary

According to the Paragraph 12 of the applied methodology, "The spatial extent of the project boundary includes industrial, commercial facilities consuming energy generated by the system. In the case of electricity generated and supplied to distributed users (e.g. residential users) via mini/isolated grid(s) the project boundary may be confined to physical, geographical site of renewable generating units. The boundary also extends to the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to." Hence, the project boundary of the proposed project includes the proposed 500kW PV power plant and Taumu'aloto power station, which composes the grid on Vava'u Island solely at present. The boundary diagram including the relevant GHG sources is illustrated as follows:

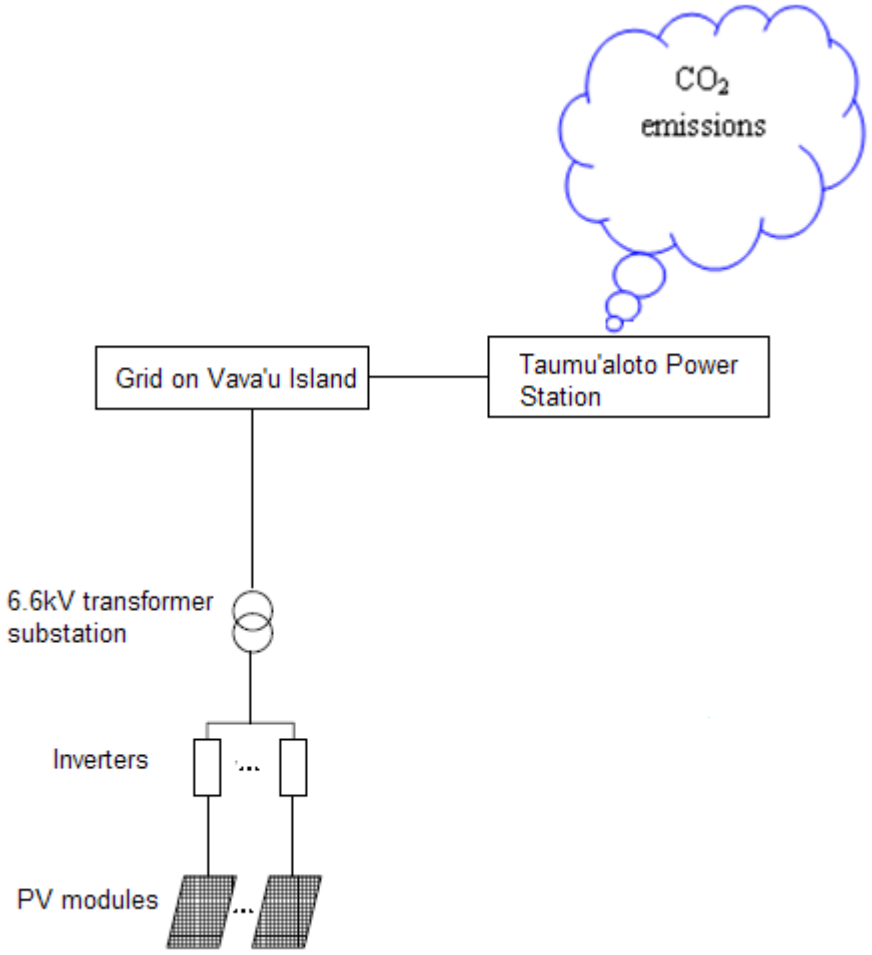

Fig.2 Boundary and emission source of the proposed project

Source		Gas	Included?	Justification/Explanation
Baseline	Electricity generated from the power generating units connected to the grid on Vava'u Island	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source that can be neglected
		N_2O	No	Minor emission source that can be neglected
		Other	No	Minor emission sources that can be neglected
Project	The proposed project	CO_2	No	For PV project GHG emission is zero.
		CH_4	No	
		N_2O	No	

Source		Gas	Included?	Justification/Explanation
		Other	No	

2.4 Baseline Scenario

As per the applied methodology, the baseline scenario is the electricity delivered to the grid by the proposed project activity (for the first ten years it is 664.54MWh on average) that otherwise would have been generated by the operation of grid connected diesel-fired power plants and by the addition of new generation sources.

2.5 Additionality

As per "Information on additionality (Attachment A to Appendix B of 4/CMP.1 Annex II)"[6], a grid-connected PV plant with an installed capacity up to 15MW should be automatically defined as additional without further documentation of barriers. Since the installed capacity of the proposed grid-connected PV plant is only 500kW, the proposed project is additional.

2.6 Methodology Deviations

Not applicable.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

In accordance with the applied methodology, "for a mini-grid system where all generators use exclusively fuel oil and/or diesel fuel, the baseline emissions is the annual electricity generated by the renewable energy unit times an emission factor for a modern diesel generating unit of the relevant capacity operating at optimal load as given in Table I.F.1."

[6] https://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid05.pdf

Table I.F.1

Emission Factors for diesel generator systems (in kg CO_2e/kWh*) for three different levels of load factors**

Cases:	Mini-grid with 24 hour service	(i) Mini-grid with temporary service (4-6 hr/day); (ii) Productive applications; (iii) Water pumps	Mini-grid with storage
Load factors [%]	25%	50%	100%
<15 kW	2.4	1.4	1.2
>=15 <35 kW	1.9	1.3	1.1
>=35 <135 kW	1.3	1.0	1.0
>=135<200 kW	0.9	0.8	0.8
> 200 kW***	0.8	0.8	0.8

*A conversion factor of 3.2 kg CO_2 per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories)

**Values derived from figures reported in RETScreen International's PV 2000 model retrieved from:

>http://retscreen.net/>

***Default values

Since all the five generators in the grid of Vava'u Island use exclusively diesel and the total installed capacity is 1.87MW, the emission factor is 0.8tCO_2e/MWh.

According to the applied methodology,

$BE_y = EG_{BL.y} * EF_{CO2,y}$ (1)

Where:

BE_y Baseline emissions in year y (tCO_2e)

$EG_{BL.y}$ Quantity of net electricity generated by the proposed project in year y

$EF_{CO2,y}$ Emission factor (tCO_2e/MWh), which is 0.8 tCO_2e/MWh for the proposed project

According to the "Feasibility Study for a 500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga", the annual electricity generation from the proposed project is 695MWh. Furthermore, in accordance with the technical specifications of the adopted PV module (MPV140-M)[7], the annual degradation of the output power for the PV module is estimated as 1%. Hence, the electricity generation and corresponding baseline emissions are summarized in the following table:

Year	Estimated electricity generation by the proposed project (MWh)	Estimated GHG emission reductions or removals (tCO_2e)
2014	695.00	556
2015	688.05	550
2016	681.17	544
2017	674.36	539
2018	667.61	534

[7] http://www.masdarpv.com/fileadmin/daten/pdfs/Datenblaetter/DA_OTLRFC_MQSP_EN_2.0.pdf

2019	660.94	528
2020	654.33	523
2021	647.79	518
2022	641.31	513
2023	634.89	507
Total	6,645.45	5312
Average	664.54	531

3.2 Project Emissions

The proposed project is a solar energy project. Besides, there is no on-site consumption of fossil fuels due to the proposed project activity. So as per the applied methodology, the project emission is zero.

3.3 Leakage

According to Section 1.13, leakage of the proposed project is zero.

3.4 Summary of GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2014	556	0	0	556
2015	550	0	0	550
2016	544	0	0	544
2017	539	0	0	539
2018	534	0	0	534
2019	528	0	0	528
2020	523	0	0	523
2021	518	0	0	518
2022	513	0	0	513
2023	507	0	0	507
Total	5312	0	0	5312

4 MONITORING

4.1 Data and Parameters Available at Validation

Data Unit / Parameter:	$EF_{CO2,y}$
Data unit:	tCO_2e/MWh
Description:	Emission factor of the grid on Vava'u Island
Source of data:	Feasibility Study for a 500kW Photovoltaic Plant on Vava'u Island in the Kingdom of Tonga The approved methodology AMS-I.F. "Renewable electricity generation for captive use and mini-grid" (Version 2.0)" Table I.F.1
Value applied:	0.8
Justification of choice of data or description of measurement methods and procedures applied:	In accordance with the feasibility study, the installed capacity of the grid on Vava'u Island where all generators use exclusively diesel fuel is 1.87MW. As per the applied methodology, if the installed capacity of a grid where all generators use exclusively fuel oil and/or diesel fuel is between 200kW and 15MW, the emission factor is 0.8 tCO_2e/MWh.
Any comment:	-

4.2 Data and Parameters Monitored

Data Unit / Parameter:	$EG_{BL,y}$
Data unit:	MWh/year
Description:	Quantity of net electricity generated by the proposed project in year y
Source of data:	Onsite measurement
Description of measurement methods and procedures to be applied:	Both the electricity exported to and imported from the grid will be measured by the bidirectional electricity meters (M1 as main meter and M2 as backup meter). Data will be archived for 2 years.
Frequency of monitoring/recording:	Continuous measurement and monthly recording
Value applied:	

Year	Estimated electricity generation by the proposed project (MWh)

		2014	695.00
		2015	688.05
		2016	681.17
		2017	674.36
		2018	667.61
		2019	660.94
		2020	654.33
		2021	647.79
		2022	641.31
		2023	634.89
		Total	6,645.45
		Average	664.54
Monitoring equipment:	A bidirectional electricity meter as well as its backup meter will be installed to measure the net electricity generated by the proposed project. Since the proposed project has not started to construct, the type, accuracy class and serial number of the electricity meters are not available now.		
QA/QC procedures to be applied:	The meters will be calibrated by a qualified organization according to relative national standards. Receipts for electricity sales will be kept for cross-check in verification when necessary.		
Calculation method:	Electricity exported to the grid minus electricity imported from the grid		
Any comment:	-		

4.3 Description of the Monitoring Plan

1. Monitoring Object

The monitoring is to justify the amount of emission reduction from the VCS project. The monitoring plan will provide credible, accurate, transparent and conservative monitoring data and ensure the real, measurable, long-term GHG emission reduction from the proposed project.

2. Management Structure

The project owner will use this document as guideline in monitoring of the emission reduction performance of the proposed project and adhere to the guidelines set out in this monitoring plan to ensure that the monitoring is credible, transparent and conservative.

The responsibilities of the project staff are as follow:

General Manager: Responsible for supervising the whole monitoring procedure.

VCS Project Manager: Responsible for data management and compiling monitoring report.

Operational and monitoring manager: Responsible for collecting data and do internal audit.

Financial chief: Responsible for collection of sales receipts.

Technical chief: Responsible for preparing operational reports of the project activity, recording the daily operation of the solar farm, including operating periods, equipment defects, etc.

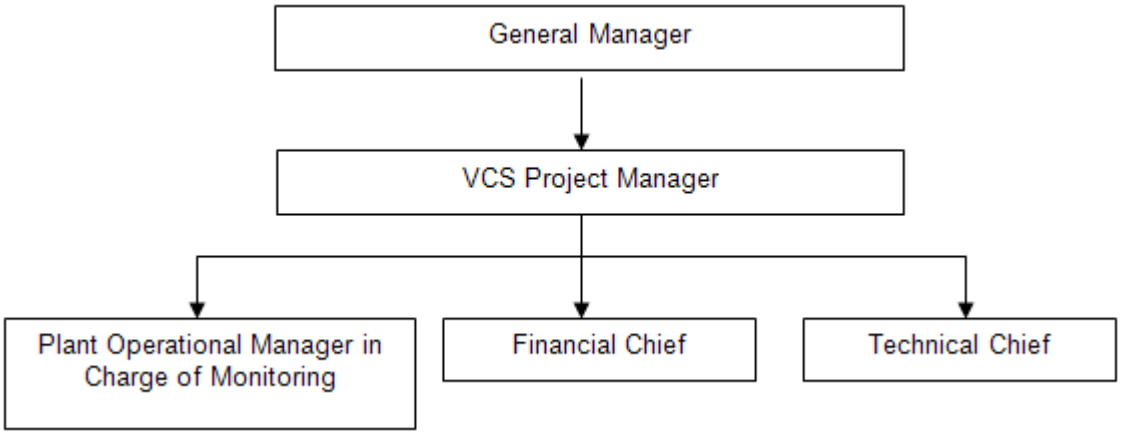

Fig.3 Management structure of the proposed project

3. Monitoring Program and Equipments

The bidirectional electricity meters (M1 and M2) will be installed on the high voltage side of the 6.6kV transformer substation to directly and continuously measure the electricity exported to and imported from the grid. M1 is referred to as the main meter and M2 is the backup meter for M1.

The quantity of net electricity generated by the proposed project equals to the quantity of electricity exported by the proposed project to the grid minus quantity of electricity imported from the grid to the project site.

The location of the main meter (M1) and backup meter (M2) are shown in the following diagram:

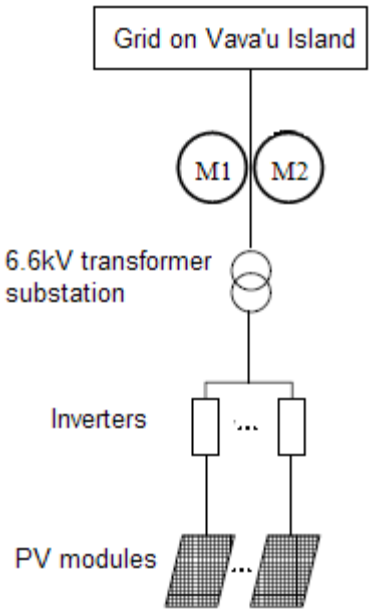

Fig.4 Main equipments and their locations in the proposed project

Before the operation of the proposed project, both the project proponent and the grid company (Tonga Power Limited) will check the equipment to ensure them to work properly.

4. Data Collection

For verification, the main meter's data will be used for baseline emission reduction calculation as long as the inaccuracy of the meter is within the permissible tolerance. The main procedures are as follows:

I. The project owner should collect the two meters' data periodically, and check them at the same time.

II Sales receipts will be issued based on the related procedures after confirmed by the project proponent and the gird company. Copies of the receipts will be stored by the project owner, together with a record of the payment by the grid company.

III The project owner records the power exported to and imported from the grid, and hence calculate the net electricity supplied to the grid;

If the error of the main meter exceeds the tolerance or its malfunction occurs, the grid-connected electricity generated by the proposed project will be resolved by the following measures:

I Adopt the backup meter's data, unless a test by either party reveals it is inaccurate;

II If the inaccuracy of the backup meter is not within the acceptable limits or it cannot work properly, the project proponent and the grid company shall jointly prepare a new agreement of correct reading;

III If the project proponent and the grid company fail to reach an agreement concerning the correct reading, this matter will be submitted for arbitration according to agreed procedures.

In case electricity meter(s) is damaged and no reliable readings can be recorded, the emission reductions achieved during the emergency period will be waived until the electricity meter(s) repaired or replaced by other qualified meter.

5. Calibration of Meters

The metering equipment will be calibrated according to related national standard. The calibration records should be provided to the proposed project proponent, and these records will be maintained safely for verification. Emergency procedures will be prepared to deal with any problem with regard to the metering equipments.

6. Data Management System

To safely keep the record of the data collected during monitoring, the proposed project will set up a complete data management system. The project will perfect the whole monitoring procedure by developing the CDM manual, tracking information from the primary source to the end-data calculations in paper document format. It is the responsibility of the proposed project proponent to provide additional necessary data and information for validation and verification requirements of respective DOE. Physical documentation such as maps, diagrams and environmental assessment will be archived electronically and be kept in a central place, together with this monitoring plan. All paper-based information will be stored by the proposed project owner and kept at least one copy.

At the end of each month, the monitoring data will be filed in a spreadsheet and stored on a hard disk and CD-ROM, and the paper-based printout should be also archived. Furthermore, the project owner collects the sales receipts for the electricity supplied to the grid as a cross-check, and compiles the monitoring report including the monitoring data and relevant evidence at the end of each crediting year.

5 ENVIRONMENTAL IMPACT

A major environmental impact assessment (mEIA) was carried out by TERM-IU on12/04/2012. According to the mEIA and other information of the proposed project, the environmental impact of the proposed project is summarized as follows:

The proposed project will displace diesel-based power generation, reducing CO_2 emissions significantly, thus mitigating the global warming and its adverse impacts on sea level rise.

The construction of the proposed project will bring some environmental impacts. The noise produced during construction process and by heavy vehicle is unavoidable. However, there is no residential area nearby and the disturbance will only last for a short time. Although the proposed location is mostly grass, there are some large trees required to be removed. Other trees surrounding the site need to be trimmed for avoiding potential shading of the PV modules. As a PV plant, light pollution has to be taken into consideration. Fortunately, the population density

around the proposed location is low and there are a lot of trees surrounding the location, reducing this problem to a very small extent.

As a clean energy project, the proposed PV plant will almost not release any pollutant except some garbage produced by operators. After 25-year operation period, the PV modules will be recycled thus no industrial waste will be left in Tonga.

6 STAKEHOLDER COMMENTS

In July of 2012, a stakeholder consultation meeting was held on Vava'u Island. After the meeting, 21 copies of questionnaire were dispatched and all of them were returned to us, although not all the questions were answered. The statistics of the gender, age, education level and occupation of the interviewees are summarized in the following table:

Gender	Male	Female	Not answer				
Number	7	13	1				
Age	20-29	30-39	40-49	50-59	Not answer		
Number	8	11	1	1	0		
Education	Primary school	Secondary school	University	Master	Doctor	Others	Not answer
Number	3	2	6	1	0	6	3
Occupation	Manager	Professional	Service & Sales Worker	Farmer/ Fisher	Student	Others	Not answer
Number	1	11	2	0	0	2	5

The questions and answers in the questionnaire are listed as follows:

1. Does the project have negative influences on your daily life?	Yes	No	Not clear	Not answer
	2	19	0	0
2. Does the project have negative influences on air quality?	Yes	No	Not clear	Not answer
	1	18	2	0
3. Does the project have negative influences on water & marine environment?	Yes	No	Not clear	Not answer
	1	17	3	1
4. Does the project have noise pollution?	Yes	No	Not clear	Not answer
	2	18	1	0
5. Does the project have light pollution?	Yes	No	Not clear	Not answer
	3	15	2	1
6. Does the land expropriation for the	Yes	No	Not clear	Not answer

project have any negative influence on you?	3	18	0	0
7. Do you think the project is favorable for clean energy technology transfer to your country?	Yes	No	Not clear	Not answer
	18	1	2	0
8. Do you think the project will improve the energy supply to your country?	Yes	No	Not clear	Not answer
	21	0	0	0
9. Do you think the project will provide more working opportunities to local people?	Yes	No	Not clear	Not answer
	17	4	0	0
10. Do you think the project will benefit local people?	Yes	No	Not clear	Not answer
	21	0	0	0

Summary of comments received

Although there are some concerns mainly about the noise pollution, light pollution and land expropriation, all the interviewees agree that the proposed project will improve the energy supply and benefit local people. As stated in the Section 5, the noise pollution is unavoidable during construction, but will be alleviated after finishing construction. There are lot of trees around the project site. Therefore the light reflected by the PV panels can be partially shaded by the trees. Furthermore, there is no residential area near the proposed project site. The land used for the proposed project is also not a residential area and leased by TERM-Committee. So land expropriation will not affect local people.

During the construction and operation in the future, the proposed project proponent will collect further opinions with regard to the proposed project from local people and solve the problems accordingly.