## Part I: Project Information

**GEF ID**
**10788**

**Project Type**
FSP

**Type of Trust Fund**
GET

**CBIT/NGI**
CBIT **No**
NGI **No**

**Project Title**
Increasing Access to Renewable Energy in Tuvalu

**Countries**
Tuvalu

**Agency(ies)**
ADB

**Other Executing Partner(s)**
Tuvalu Electricity Corporation (TEC)

**Executing Partner Type**
Government

**GEF Focal Area**
Climate Change

**Sector**
Renewable Energy

**Taxonomy**

Focal Areas, Climate Change, Climate Change Mitigation, Renewable Energy, Technology Transfer, Influencing models, Transform policy and regulatory environments, Demonstrate innovative approache, Stakeholders, Communications, Awareness Raising, Beneficiaries, Type of Engagement, Participation, Consultation, Local Communities, Private Sector, Civil Society, Community Based Organization, Gender Equality, Gender results areas, Participation and leadership, Capacity Development, Gender Mainstreaming, Sex-disaggregated indicators, Capacity, Knowledge and Research, Enabling Activities

**Rio Markers**

**Climate Change Mitigation**

Principal Objective 2

**Climate Change Adaptation**

Significant Objective 1

**Biodiversity**

No Contribution 0

**Land Degradation**

No Contribution 0

**Submission Date**

5/11/2023

**Expected Implementation Start**

1/1/2024

**Expected Completion Date**

12/31/2028

**Duration**

60In Months

**Agency Fee($)**

247,706.00

**A. FOCAL/NON-FOCAL AREA ELEMENTS**

| Objectives/Programs | Focal Area Outcomes | Trust Fund | GEF Amount($) | Co-Fin Amount($) |
|---|---|---|---|---|
| CCM-1-1 | Decentralized renewable power with energy storage | GET | 2,752,294.00 | 16,980,000.00 |
| | | **Total Project Cost($)** | **2,752,294.00** | **16,980,000.00** |

**B. Project description summary**

## Project Objective

Project objective: To promote the increased utilization of renewable energy and reduce greenhouse gas emissions in Tuvalu.

| Project Component | Financing Type | Expected Outcomes | Expected Outputs | Trust Fund | GEF Project Financing($) | Confirmed Co-Financing($) |
|---|---|---|---|---|---|---|

| Project Component | Financing Type | Expected Outcomes | Expected Outputs | Trust Fund | GEF Project Financing($) | Confirmed Co-Financing($) |
|---|---|---|---|---|---|---|
| Generation of energy from renewable, innovative technologies | Investment | 1: Climate-resilient floating and ground-mounted solar photovoltaic battery energy storage system, and grid infrastructure installed. | Output 1.1: 224 kWp of fixed, roof and ground-mounted PV installed on Outer Islands This includes some supporting technology.<br><br>***Above covered by ADB/ADF.***<br><br>Output 1.2: 1250 kWp of fixed and roof-top PV installed on Funafuti.<br><br>***Above covered by ADB/ADF and by World Bank.***<br><br>Output 1.3: 1200 kWp of floating PV (FPV) on Funafuti. This includes supporting grid connection infrastructure and O&M equipment.<br><br>***GEF contributes to above. This also includes contribution from ADB/ADF*** | GET | 2,302,294.00 | 14,500,000.00 |

| Project Component | Financing Type | Expected Outcomes | Expected Outputs | Trust Fund | GEF Project Financing($) | Confirmed Co-Financing($) |
|---|---|---|---|---|---|---|
| | | | ***and Government of Tuvalu.***<br><br>Output 1.4: 2MW/4.5MWH of battery energy storage systems (BESS) on Funafuti.<br><br>***Above covered by ADB/ADF and by World Bank.*** | | | |

| Project Component | Financing Type | Expected Outcomes | Expected Outputs | Trust Fund | GEF Project Financing($) | Confirmed Co-Financing($) |
|---|---|---|---|---|---|---|
| Productive uses of energy and energy demand | Technical Assistance | 2: Sustainable blue economy and productive use of energy infrastructure installed<br><br>It is noted that the parallel GEF ID: 10783 project (*Ocean Health for Ocean Wealth - The Voyage to a Blue Economy for the Blue Pacific Continent*) also contributes to this Outcome. | 2.1 Reef generation. Using FPV generated electricity and reef generation technology, reefs will be regenerated at up to 8 times natural rates. (Preliminary target: one hectare)<br><br>2.2 Two e-boats. To be used for school transport and other socio-cultural needs. Spares also provided.<br><br>2.3 One charging station for E-boats. This will be located at the port with two docking stations.<br><br>The facilities will be made of 11 kV chargers, connected to the main grid.<br><br>***All the above are funded by the ADB/ITF co-financing.*** | GET | | 800,000.00 |

| Project Component | Financing Type | Expected Outcomes | Expected Outputs | Trust Fund | GEF Project Financing($) | Confirmed Co-Financing($) |
|---|---|---|---|---|---|---|
| Enabling environment | Technical Assistance | 3: Institutional capacity strengthening implemented | 3.1 Outreach, assessment, consultation and planning. This leads to the design and upgrade of a resilient network, following fully inclusive procedures.<br><br>3.2 Key skills upgraded for TEC. This is essentially building the capacity to manage the electricity system and the PV Technologies.<br><br>3.3 Technical Assessments. This includes a grid study and an assessment of coastal protection around all Funafuti.<br><br>3.4 Institutional and Policy Support. The focus is on the Energy Bill, the roll-out of tariff reforms, and roll-out of meters. | GET | 270,000.00 | 600,000.00 |

| Project Component | Financing Type | Expected Outcomes | Expected Outputs | Trust Fund | GEF Project Financing($) | Confirmed Co-Financing($) |
|---|---|---|---|---|---|---|
| | | | 3.5 Knowledge management. Through the elaboration and implementation of a communications strategy.<br><br>3.6 Project technical supervision. This so supervise all civil works and installation of equipment in the project, including ensuring due diligence is fully respected<br><br>***GEF contributes to 3.2, 3.4 and 3.5. ADB/ADF contributes $0.1 million to each of the above, totalling $0.6.*** | | | |
| Monitoring and Evaluation | Technical Assistance | Monitoring and Evaluation | MTRs, TERs | GET | 50,000.00 | 180,000.00 |
| | | | | **Sub Total ($)** | **2,622,294.00** | **16,080,000.00** |

**Project Management Cost (PMC)**

| | | |
|---|---|---|
| GET | 130,000.00 | 900,000.00 |
| **Sub Total($)** | **130,000.00** | **900,000.00** |
| **Total Project Cost($)** | **2,752,294.00** | **16,980,000.00** |

**Please provide justification**

**The project has been part of the ADB Country Partnership Strategy and Country Operations Business Plan for Tuvalu. It forms part of a broader programmatic initiative across the Pacific, to promote floating solar as one option within the roadmap towards energy security.**

**C. Sources of Co-financing for the Project by name and by type**

| Sources of Co-financing | Name of Co-financier | Type of Co-financing | Investment Mobilized | Amount($) |
|---|---|---|---|---|
| GEF Agency | Asian Development Bank | Grant | Investment mobilized | 8,000,000.00 |
| GEF Agency | Asian Development Bank | Grant | Investment mobilized | 800,000.00 |
| GEF Agency | World Bank | Grant | Investment mobilized | 7,000,000.00 |
| Recipient Country Government | Government of Tuvalu | In-kind | Recurrent expenditures | 1,180,000.00 |
| | | | **Total Co-Financing($)** | **16,980,000.00** |

**Describe how any "Investment Mobilized" was identified**

The investment was mobilized through consultation in-country, working closely with in-country counterparts. In addition, ADB has mobilized funding through an internal trust fund for climate change, the ITF. Government has mobilized grant funding from the World Bank. Trust fund resources requested by agencies, countries, focal area and the programming of funds.

**D. Trust Fund Resources Requested by Agency(ies), Country(ies), Focal Area and the Programming of Funds**

| Agency | Trust Fund | Country | Focal Area | Programming of Funds | Amount($) | Fee($) | Total($) |
|---|---|---|---|---|---|---|---|
| ADB | GET | Tuvalu | Climate Change | CC STAR Allocation | 2,752,294 | 247,706 | 3,000,000.00 |
| | | | **Total Grant Resources($)** | | **2,752,294.00** | **247,706.00** | **3,000,000.00** |

**E. Non Grant Instrument**

NON-GRANT INSTRUMENT at CEO Endorsement

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Includes Non grant instruments? **No**

Includes reflow to GEF? **No**

**F. Project Preparation Grant (PPG)**

PPG Required **true**

**PPG Amount ($)**

**PPG Agency Fee ($)**

| Agency | Trust Fund | Country | Focal Area | Programming of Funds | Amount($) | Fee($) | Total($) |
|---|---|---|---|---|---|---|---|
| | | | | **Total Project Costs($)** | **0.00** | **0.00** | **0.00** |

## Core Indicators

**Indicator 6 Greenhouse Gas Emissions Mitigated**

| Total Target Benefit | (At PIF) | (At CEO Endorsement) | (Achieved at MTR) | (Achieved at TE) |
|---|---|---|---|---|
| Expected metric tons of CO?e (direct) | 46302 | 67958 | 0 | 0 |
| Expected metric tons of CO?e (indirect) | 0 | 0 | 0 | 0 |

**Indicator 6.1 Carbon Sequestered or Emissions Avoided in the AFOLU (Agriculture, Forestry and Other Land Use) sector**

| Total Target Benefit | (At PIF) | (At CEO Endorsement) | (Achieved at MTR) | (Achieved at TE) |
|---|---|---|---|---|
| Expected metric tons of CO?e (direct) | | | | |
| Expected metric tons of CO?e (indirect) | | | | |
| Anticipated start year of accounting | | | | |
| Duration of accounting | | | | |

**Indicator 6.2 Emissions Avoided Outside AFOLU (Agriculture, Forestry and Other Land Use) Sector**

| Total Target Benefit | (At PIF) | (At CEO Endorsement) | (Achieved at MTR) | (Achieved at TE) |
|---|---|---|---|---|
| Expected metric tons of CO?e (direct) | 46,302 | 67,958 | | |
| Expected metric tons of CO?e (indirect) | | | | |
| Anticipated start year of accounting | 2024 | 2025 | | |
| Duration of accounting | 20 | 20 | | |

**Indicator 6.3 Energy Saved (Use this sub-indicator in addition to the sub-indicator 6.2 if applicable)**

| Total Target Benefit | Energy (MJ) (At PIF) | Energy (MJ) (At CEO Endorsement) | Energy (MJ) (Achieved at MTR) | Energy (MJ) (Achieved at TE) |
|---|---|---|---|---|
| Target Energy Saved (MJ) | | | | |

**Indicator 6.4 Increase in Installed Renewable Energy Capacity per Technology (Use this sub-indicator in addition to the sub-indicator 6.2 if applicable)**

| Technology | Capacity (MW) (Expected at PIF) | Capacity (MW) (Expected at CEO Endorsement) | Capacity (MW) (Achieved at MTR) | Capacity (MW) (Achieved at TE) |
|---|---|---|---|---|
| Solar Photovoltaic | 2.30 | 2.68 | | |
| Energy Storage | 2.00 | 2.00 | | |

**Indicator 11 People benefiting from GEF-financed investments**

| | Number (Expected at PIF) | Number (Expected at CEO Endorsement) | Number (Achieved at MTR) | Number (Achieved at TE) |
|---|---|---|---|---|
| **Female** | 3,000 | 3,000 | | |
| **Male** | 3,000 | 3,000 | | |
| **Total** | 6000 | 6000 | 0 | 0 |

Provide additional explanation on targets, other methodologies used, and other focal area specifics (i.e., Aichi targets in BD) including justification where core indicator targets are not provided

The project will lead to the avoided emission of 67,958 tons CO2e. Details of the calculation methodology and assumptions are provided in Section 1.a.6. below. This figure is based on cumulative contributions of all co-financing including the WB project. Note: Duration of Accounting is 25 years. PV modules guaranteed performance is 25 years, thus PV plants technology lifetime is considered 25 years.

## Part II. Project Justification

### 1a. Project Description

Describe any changes in alignment with the project design with the original PIF

| |
|---|
| 1a. Project description.<br><br>1) the global environment and/or adaptation problems, root causes, barriers that need to be addressed (system description) 2) the baseline scenario and any associated baseline projects 3) the proposed alternative scenario with a brief description of expected outcomes and components of the project 4) alignment with GEF focal area and/or Impact Program strategies 5) incremental/additional cost reasoning and expected contributions from the baseline, the GEF TF, and co-financing 6) global environmental benefits (GEF TF) and/or adaptation benefits (LDCF.SCCF) 7) Innovativeness, sustainability and potential for scaling up |

The overall project justification, objective and approach remain unchanged since the development of the PIF.

However, in order to respect parallel developments, two of the PIF Outcomes have been combined into one, and one additional Outcome has been included. Further, as a result of technical assessments (e.g. grid study, assessment of existing infrastructure, site assessments), and external factors (notably significant increases in global costs per unit and transportation costs), there are minor changes (increases) to the targets.

The following table (table 1) gives the respective technology targets from the PIF and this CEOR, as well as the changes in the Output numbering.

| Item | PIF Result | CEOR Result | Comment |
|---|---|---|---|
| Total PV | 2624 kWp<br><br>This was PIF Outputs 1.1, 2.1 and 2.2 | 2675 kWp<br><br>This is CEOR Outputs 1.1, 1.2 and 1.3 | Minor, upward change, despite challenges in securing suitable PV land sites, additional costs related to capacity building and outreach, and major global increases in cost per unit. |
| Floating PV | 450 kWp<br><br>This was PIF Output 2.2 | 1200 kWp<br><br>This is CEOR Output 1.3 | Increased in order to reduce GHG emissions as much as possible. |

| | | | |
|---|---|---|---|
| Battery | 2.0 megawatt/4.5 MWh BESS<br><br>This was PIF Output 2.3 | 2.0 megawatt/4.5 MWh BESS<br><br>This is CEOR Output 1.4 | No changes, despite challenges in securing suitable land sites, additional costs related to capacity building and outreach, and major changes in global unit costs of batteries. |
| Productive Uses of Energy/Sustainable Blue Economy | This was absent in PIF | This is CEOR Outcome 2: Support to diverse socio-economic activities that contribute to the pacific sustainable blue economy (new Outcome 2). | This Outcome is entirely financed by co-finance.<br><br>This new Outcome leads to sustained demand for the energy, thereby helping sustainability, as well as leading to many socio-economic benefits. |

Table 1: Changes to Outcome and Output numbering and technology targets.

The above, plus the consideration of impacts over 25 years (as opposed to 20 in PIF), plus improved estimation methodology, have led to an increase in the projected avoided loss of GHG emissions. Since the PIF, this has increased from 46,302 tonnes to 67,958 tonnes. More details of all above changes are provided in the relevant sections below.

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**1) The global environment problems, root causes and barriers that need to be addressed ? the system description**

**i) The Global Environment and Related Challenges**

**Introduction to the Project Site and Development Challenges**

Tuvalu is a sovereign state located in the South Pacific Ocean with a total land area of 26 square kilometers (km2) distributed across nine coral atolls. The World Bank estimated the total population in Tuvalu in 2021 to be 11,204, with a population growth of around 1% during 2019 - 2021.[1][1] Tuvalu is one of the world?s only four sovereign atoll nations. Tuvalu is a least developed country (LDC), small island developing state (SIDS) and it lies on the World Bank?s Harmonized list of fragile and conflict affected states (FCS).[2]2 Tuvalu?s economy is tiny and is very remote from major markets. It has a narrow production base, a very narrow human resources pool, and a weak banking subsector that constrains credit availability. Growth is mainly driven by public expenditure. The geographical exposure (as tiny reef islands and atolls), its average altitude of 1.83m above sea level, and its limited human resource pool leave it extremely vulnerable to climate hazards and climate change. Both the economy and society in general are highly vulnerable to climate risks and climate change, most notably episodic flooding, and the loss of land and potable water because of sea-level rise and saltwater intrusion.

The economy of Tuvalu and government revenues rely significantly on foreign aid, fees from license fees from foreign fishing vessels and remittances from seafaring Tuvaluans (the latter is thought to provide employment to 15% of the adult male population). There is also reliance on income from the Tuvalu Trust Fund. Tuvalu?s economy can be considered fragile, as fishing revenues, foreign aid and foreign remittances are all highly volatile and highly dependent on the global economy.

In recent years (pre-Covid 19), Tuvalu recorded a solid economic performance with the implementation of several large infrastructure projects and stimulus from high public expenditure. Real GDP growth accelerated to 4.3% in 2018 (from 3.2% in 2017) and stayed at around that level through 2019. For 2019, the government estimated a $1.3 million negative fiscal balance versus a $14.0 million fiscal surplus in 2018 (as a result of a more than 50% increase in actual receipts of fishing license revenues). As a result, external debt is around 22% of GDP, which is considered within sustainable levels. Notwithstanding, the Tuvalu economy is highly vulnerable to external shocks and imported goods ? including food and fuel. Undoubtedly, the global Covid-19 pandemic will have had a major impact on Tuvalu?s economic and financial fundamentals. Notwithstanding, GDP growth remained positive through the pandemic, with 1% in 2020, 1.5% in 2021, an expected 2.2% in 2022 rising to an expected 2.7% in 2023.

Funafuti is an atoll island and is the capital of Tuvalu. It is the most populated island of Tuvalu, with a population of over 6,000, over 50% of the nation's population. It is densely populated with a population density of at least 2,500/km2. The 2012 census (the most recent completed) shows a small general decrease in population for the outer islands and a moderate increase of around 3% for Funafuti ? these population trends are driven by migration from the outer Islands to Funafuti, along with migration from Funafuti to other countries. The total resident population in Funafuti increased from 3,962 to 5,436 over the ten-year period between 2002 and 2012. A 2017 survey indicated a further increase in population to 6,320.[3][3]

According to Wikipedia, Funafuti is ?*a narrow sweep of land between 20 and 400 meters wide encircling a large lagoon (Te Namo)?.* The land is made up of 33 islets with an aggregate area of 2.4 km2. The average elevation is under 2 meters (m) and the highest point is under 6m. Te Namo lagoon is 18 km long at its longest and 14 km wide, at its widest point. It has a total area of approximately 27km2, and ranges in depth from 6 to 57m.

Funafuti is the only true urban area on Tuvalu. As an atoll, it has a high-water table and is vulnerable to saltwater intrusion. Funafuti experiences many of the same urban challenges seen in other cities, particularly poor water supply and sanitation services, challenging solid waste and hygiene management, and a high and growing rate of communicable diseases. Over the last two decades, Funafuti has become particularly vulnerable to climate hazards, with longer and more intense dry periods, more regular flooding and sea level rise, all of which threaten water availability and public health.

**Greenhouse Gas Emissions and the Energy Sector**

Despite its small size, Tuvalu makes a measurable contribution to global greenhouse gas emissions and it is keen to minimize these emissions in order to combat global climate change.

According to Tuvalu?s Nationally Determined Contributions (NDC) and to its Second National Communications to the UNFCCC, the energy sector is the major contributor to $CO_2$ emissions (100%). The waste sector is the main contributor to CH4 emissions (74.7%) followed by the Agriculture sector (24.7%). On a mass basis, emissions of $CO_2$ are by far the most important. This is largely due to the importance of fossil fuel combustion as a source of $CO_2$. Land-use change and forestry is not an important $CO_2$ source in Tuvalu.

In terms of carbon dioxide equivalent ($CO_2e$), Tuvalu?s gross aggregated GHG emissions across all sectors (excluding the LUCF sector) totalled 16.95 Gg $CO_2e$ in 2002 and the net GHG emissions (including the LUCF sector) were practically the same at 16.92 Gg $CO_2e$. Within the energy sector, emissions from electricity generation contribute to 41%, transport sector 40% and the remaining 18% from other sectors.

One of the many constraints to development is Tuvalu?s high dependency on imported energy resources, primarily petroleum products. Tuvalu has no conventional energy resources and is heavily reliant on

imported oil fuels for transport, electricity generation and household use. This has a destabilizing impact on both the macro-economy and micro-economy. At the national level, changing fuel prices and unstable supplies impact the overall balance of payment as well as impacting GDP. At the business and household level, high fuel prices and fluctuations have a destabilizing effect on businesses and households, limiting expansion opportunities, challenging food security, and deterring private sector development. These factors are especially acute in the isolated outer islands.

**Climate Hazards and Climate Change**

Tuvalu has a tropical climate that is characterized by two distinct seasons: a wet season from November to April when most rain falls, and a dry season from May to October. Annual rainfall averages over 355cm. The annual mean temperature is 30?c, moderated by trade winds from the east.[4]4

Tuvalu has historically faced climate hazards and continues to do so. For example, Tuvalu?s livelihood and economic assets were devastated by Tropical Cyclone Pam in 2015. According to World Bank figures[5]5, the disaster is estimated to have affected 40 percent of the population and caused damages of around AUD 14.0 million (or 33.6 percent of 2014 GDP). The infrastructure and housing sectors alone sustained damages of AUD 11.1 million. Climate change will exacerbate the scale of Tuvalu?s climate hazards. According to (CSIRO/BOM, 2014)[6]6, climate change projections for Tuvalu are as follows:

- Average temperatures are projected to rise by up to 2?c by 2050 - leading to higher mean temperatures and higher/more frequent extreme temperatures;
- Annual average rainfall may only change a little. However, rainfall variability (annual, seasonal and sub-seasonal) is projected to increase. This may affect water supply in dry periods;
- Sea levels are projected to rise by up to 33cm by 2050. Sea level rise, together with increases in swells, storms and decreases in atmospheric pressure are projected to lead to even greater storm surges. These increase the risks of coastal erosion and the threats to coastal assets;
- Although there is great uncertainty, it is possible that the effects of climate change on ENSO could exacerbate droughts and affect the water sector.

More recent research points to some new findings with regards to tropical storms and sea level rise, as pertinent to Tuvalu (CSIRO and SPREP, 2021)[7]7. These can be summarized as follows:

- Extreme rainfall and tropical cyclones: for the southwestern Pacific as a whole, the total number of tropical cyclones may decrease, but with an increase in the average intensity and in the impacts through more intense rainfall and swells;
- Sea level rise: recent research has led to a higher high range of projected change? for Tuvalu this means an updated projection by 2090 under very high emissions of up to 1 meter.

Climate change impacts will exacerbate existing development challenges such as deterioration of infrastructure, water shortages, rise in noncommunicable diseases, population pressures on limited resources, and fuel and food supply disruptions.

**ii) Root Causes of Greenhouse Gas Emissions from Funafuti, Tuvalu**

As noted above, Tuvalu?s gross GHG emissions totalled 16.95 Gg $CO_2e$ in 2002, with the energy sector the major contributor (100% of $CO_2$ emissions), and within the energy sector, emissions from electricity generation contribute to 41%, transport sector 40% and the remaining 18% from other sectors.

Issued in 2012, *Tuvalu?s Master Plan for Renewable Energy and Energy Efficiency,* 2012-2020 had two stated goals: (1) To generate electricity with 100% renewable energy by 2020, and (2) To increase energy efficiency on Funafuti by 30%. Subsequently, in its NDC (2015) Tuvalu committed (conditionally) to reduction of emissions of green-house gases from the electricity generation (power) sector, by 100%, i.e. almost zero emissions by 2025[8][8].

In order to operationalize these targets, the Government, with support from ADB, prepared the *Funafuti Road Map to 100% Renewable Energy*[9][9],[10][10] (2019). Unless otherwise stated, the following analysis draws from that Road Map.

Institutions The energy sector in Tuvalu is managed by the Department of Energy in the Ministry for Transport, Energy and Tourism (MTET). The energy utility, the Tuvalu Electrical Corporation (TEC), is a state-owned enterprise charged as sole energy provider in the country. It was established through the Tuvalu Electrical Corporation Act of 1990.

Current power production

Across Tuvalu, an estimated 98% of households have access to electricity (2018 figures), and there are no reports of significant shortages or outages. In 2018, approximately 18% of the electricity was generated from renewable sources. However, until now, the main focus for developing Renewable Energy (RE) has been on the outer islands, with the parallel aims of ensuring 100% access for the population and taking these islands to be 100% sourced by renewables.

As a result, currently, for the Northern islands (Nuitao, Vaitupu, Nanumaga and Nanumea) RE contributes over 90% of the electricity. The Central and Southern Islands (Nukulaelae, Nukufetau, Nui) trail, with current RE contributions lying at 60-70%, although they have specific plans to raise this above 90% (see later sections).

Demand for electricity is growing rapidly at the national level. For example, it grew at 6% per annum from 2013-2017, whilst during the same period the proportion generated from RE grew from 0% to 16%.

Funafuti accounts for over half the population and well over half of Tuvaluan economic activities, and over 85% of electricity supply and consumption[11]11. Funafuti is currently lagging far behind the outer islands in terms of the share of RE in the electricity mix. RE contributes only around 16% of energy production on Funafuti. Accordingly, the country imports and uses large amounts of imported fossil fuels. Key facts are:

? Of the 1.8 million litres of fuel imported in 2018, 95% was for energy production on Funafuti;

? On average, approximately 7-10% of GDP has been spent on imported fuel in recent years (i.e. around US$2 million depending on oil prices) ? thereby making energy the costliest sector of the Tuvalu economy. Although more recent data is not yet available, recent increases in the international costs of fuel due to geopolitical instabilities may have significantly exacerbated this situation;

? The energy production sector of Funafuti is a major contributor to Tuvalu?s net greenhouse gas emissions.

in 2017[12][12], the peak electricity demand on Funafuti was estimated to be 1.36 megawatt (MW). To meet this demand, the existing power system on Funafuti consists principally of the following: (i) three 600 kilowatt (kW) diesel generation units and (ii) various solar photo-voltaic (PV) generation units, with a combined installed (operational) capacity of approximately 735 kW-peak(kWp).

Of the three diesel units, one has been out of service since mid-2018. As a result, clearly, the system has no spare capacity. The other two running units are overdue for major maintenance, which can only occur if the third unit is brought back online. If simultaneous generator faults or breakdowns occur, then extended system wide outages are inevitable. There are also reports of brief planned system wide outages for operational maintenance. Further, the generators are aging and will come to the end of their design life in less than 5 years, with no budget set aside for replacement. That is, the power production system is declining in reliability, leaving Funafuti exposed to the risks of increasing energy insecurity.

In order to guarantee minimum services, the power system on Funafuti currently has a ?fuel saver? control system installed that applies an effective limit on solar PV output of 415 kW. The combination of this limit and inadequate redundancy in the system requires that diesel generation remains the main source of electricity production.

Figure 1 provides the most updated figures on electricity generation on Funafuti. This illustrates the growth of electricity generation from 2015 ? 2020 in Funafuti, and separates out the various sources, including diesel and solar. Figure 1 also indicates how renewables are currently marginal on Funafuti. In 2020, the installed generation capacity was 1800 kW or 1.8 MW from diesel generators(?DG?) which accounts to 74% of the total generation and 750 kW coming from solar PV installations and off-grid generators, which accounts for 26% share of the total generation.[13][13]

| Generation in 2020 | GWh | Share (%) |
|---|---|---|
| **Non-renewable** | 8 | 84 |
| **Renewable** | 2 | 16 |
| • **Hydro** | 0 | |
| • **Solar** | 2 | 16 |
| • **Bioenergy** | 0 | |
| • **Geothermal** | 0 | |
| **Total** | 10 | 100 |

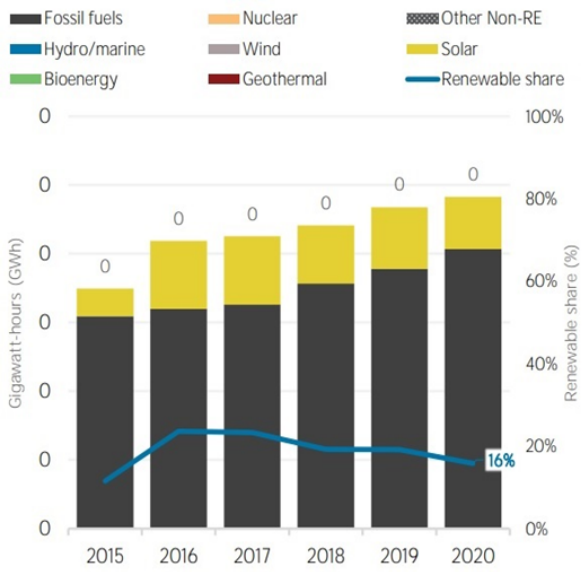


Figure 1: Evolution and share of renewable energy on Funafuti.

Costs and tariffs: Nationally, the current generation costs for electricity in Tuvalu are high, even for the Pacific region. With correct accounting treatment through capitalization and depreciation of 2015 energy projects, the estimated cost recovery was estimated at AU$ 0.82 in early 2021 (US$0.62 at that time) per kWh. The generation costs in Funafuti are high due to reliance on diesel for the bulk of generation.

The current dependence on fossil fuel creates several long-term challenges to socio-economic development on Funafuti and Tuvalu:

? This undermines energy security. Tuvalu depends on ocean shipping to import energy. This resource is therefore affected by climate conditions and/or political considerations;

? Potential high costs and volatility. This affects affordability and financial planning;

? The local pollution generated from the use of diesel;

? Inability to meet commitments to UNFCCC to reduce or eliminate emissions of greenhouse gases.

Previous investments in renewable energy

There have been several projects supporting renewable energy over the past two decades (supported, for example, by the Governments of Italy, New Zealand, Japan, the EU and the United Arab Emirates).

These have focussed mostly on the outer islands. The outer islands are now approaching 100% renewable penetration (with the exceptions of Nui, Nukulaelae and Nukufetau ? see later sections).

Funafuti There have also been several small-scale projects supported by international partners on Funafuti. It is estimated that there is currently 735 kWp of installed solar PV capacity that is operational. This is all land-based or rooftop. The current installed capacity is at the following sites:

- ? 75 kWp at the Princess Margaret Hospital (rooftop);
- ? 65 kWp of ground mounted PV panels at Public Works Department (PWD) compound;
- ? 350 kWp integrated into the diesel generation plant;
- ? 75 kWp at the Marine Warehouse (rooftop);
- ? 130 kWp on Government Offices (rooftop);
- ? 40 kWp on the Media Building (rooftop).

In addition, there is a 42 kW PV system installed at the sports field in 2007 or 2008, with support from the Government of Japan. This is offline due to network cable damage, panel degradation, failure of the containerized inverter mounting and DC cable failures. This is said to have been in this non-operational state for some time: local operators and management consider it to be at the end of its useful life.

**iii) The Solution to GHG Emissions - Achieving 100% RE Generation for all Tuvalu**

The above mentioned ?Road Map? sets out an approach and steps to achieving 100%, or nearly, RE on Funafuti. The Road Map targets and approach, if applied, would address remaining GHG emissions for all Tuvalu.

Approach of the Road Map

The amount of renewable energy in a power system is referred to by two different terms: contribution and penetration. Renewable energy C*ontribution* refers to the portion of load over a *period of time* that is met by renewable energy. For example, a 65% renewable energy contribution would mean that over a year an average 65% of the system energy use is met by renewable energy. Renewable energy *Penetration* refers to the portion of load met by renewable energy at a *single point in time*.

In the past, diesel generators were often preferred for *isolated power systems* as they provide all the requirements for a reliable power supply. The use of diesel generators is notably scalable for a range of loads, has low upfront capital cost, and is very attractive when the price of diesel fuel is relatively low. Isolated power systems are defined as being built to supply the needs of communities or industries which are located far from the modern, interconnected, large-scale power systems. They are typically found in island communities, remote off-grid communities and industry (e,g, mines) sites, and in most cases, consist of a single central power station and a radial distribution network.

For diverse reasons, over the last 15 years, remote communities have increasingly invested in, and are committed to, transforming their isolated power systems from diesel to renewable energies. Initially, in almost all cases, power supplies become **hybrid,** with a mixture of diesel and renewable energy. This experience from building and operating hybrid diesel renewable systems has demonstrated that the price of electricity can be decreased using renewable energy. The experience has also shown, however, that renewable systems, if not managed correctly, can have a negative effect on the stability of a power

system, and can decrease the reliability of power supply, if not appropriately assisted by other technologies.

A careful, measured, step by step approach is required to introduce RE along with assisting technology upgrades to ensures smooth supply and stability. In technical terms, for the hybrid system to be reliable, seven basic power system requirements must be met at all times. These requirements are listed in Table 2.

| **Table 2: Technological requirements to provide reliable, comprehensive electricity supply** |
|---|
| 1. Voltage control: regulation of voltage within a certain narrow band, such as 240V, ?5%;<br>2. Frequency control: regulation of frequency around 50Hz, ?0.5Hz;<br>3. Real (kW) power: provision of sufficient amount of real (kW) power;<br>4. Reactive (kVAR) power: provision of sufficient amount of reactive (kVAR) power;<br>5. Inertia: limiting the excursions of frequency through provision of system inertia;<br>6. Fault currents: maintaining the system stability through provision of fault currents, and;<br>7. Spinning reserve: provision of a sufficient amount of spinning reserve. |

While renewable energy can provide real (kW) power (requirement no. 3 in Table 1) at a competitive price, it may not necessarily be in a position to provide all of the other six system requirements. There are two alternative solutions to this. The first is to ensure high levels of diesel are incorporated into the system. The second approach is to smoothen the output of renewable energy and maintain power system stability using additional technologies. These additional, **enabling technologies** can be expensive and can be challenging to manage.

As a result, the process to transition isolated power systems from diesel-only to 100% renewable systems has to be strategic and managed. This process can be considered across four phases:

1) Diesel-only isolated power systems (no RE);
2) Low renewable energy contribution systems (say 1% - 30% RE);
3) Medium renewable energy contribution systems (say 25% - 60% RE);
4) High renewable energy contribution systems (say 50%+ RE).

With each phase, as more renewable energy is installed into the system, more powerful and more complex enabling technologies are required. These are increasingly expensive, challenging to plan and install, and challenging to manage.

Tuvalu and Funafuti: the Funafuti Road Map to 100% Renewable Electricity Production

Tuvalu aims to reach 100% electricity generation from renewable sources in the near future. As the outer islands are already either close to that goal, or have planned investments to reach the goal, this section discusses the steps necessary and the general challenges faced to reach these objectives for Funafuti. Recalling that Funafuti alone accounts for the great majority of Tuvalu?s energy demand and use. This section draws on the analysis and future plan set out in (Entura, 2019a), as well as additional information provided in (Entura, 2019b)[14][14].

It is currently estimated that approximately 16% of electricity in Funafuti is generated from RE. Based on four stages listed in the above section, Funafuti can be considered in the middle of phase 2 or the ?low? RE stage. Hence, in order to reach the objective of 100%, it has to complete phase 2, then phase 3, and then phase 4. In addition, as the anticipated demand for electricity on Funafuti is growing, the size of each ?phase? is growing.

**Demand**. Entura (2019a) prepared demand forecasts for Funafuti. On Funafuti, demand is forecast to increase annually by 3.0%, thereby more than doubling within 25 years. During the period 2020 to 2045, annual demand is forecast to increase from 7,281 megawatt-hour (MWh) to 14,562 MWh in 2045.

Funafuti has a current peak load of 1.35 MW. In order to meet forecasted demand and RE targets, this will have to:

? progressively increase to 2.82 MW by 2045 at the latest; and,

? transition fully to renewables, through phases 2, 3 and 4.

**Options to meeting demand** Entura (2019a) examined a range of options for generating electricity from renewable sources on Funafuti including wind, solar, wave, tidal flow, ocean thermal and waste to energy. The assessment identified solar PV combined with battery energy storage systems (BESS) to be the most appropriate option. Referring to the technological requirements listed above (Table 1), solar PV, combined with BESS, along with required enabling technology (for required technological control and regulation) can best meet all technological needs for the best price.

The benefits of solar PV include that it is relatively quick and easy to install, low maintenance, relatively abundant throughout the world, and the energy input is free. Further, in Tuvalu and the Pacific region, solar energy is reliable and locally available.

It has to be noted that solar PV panels are still a maturing technology. While solar PV panels are well established with over 50 years of world-wide operation, the technology for their control and solar PV inverters are still developing technologies.

**Road Map Stages** Entura (2019a) sets out the following Road Map to 100% renewable energy *penetration* by 2045 on Funafuti (see Table 3), taking into consideration population and demand growth (these are broadly in line with the theoretical ?phases? described above):

| Diesel capacity (kW) | Cumulative PV Capacity (kWp) | Cumulative Battery Storage (BESS) (kW/kWh) | RE % (year 1) | RE % (average over the period 2020 - 2045) |
|---|---|---|---|---|
| **Existing** | | | | |
| 1800 | 735 | - | 16 | 12 |
| **Stage 1** | | | | |
| 1800 | 1985 | 1000/2000 | 49 | 33 |
| **Stage 2** | | | | |
| 1800 | 4385 | 2000/3000 | 60 | 52 |
| **Stage 3** | | | | |
| 1800 | 7635 | 3000/14000 | Approx. 100 | 86 |

**Table 3: RE on Funafuti - Road map stages and milestones**

The existing situation, as described earlier in this document, consists of approximately 735kW of operational installed generation capacity, negligible BESS, providing approximately 16% of needs.

Stage 1 of the Road Map requires an additional 1,250kWp of RE and significant BESS capacity. In Table 3, the BESS is oversized relative to the renewable energy available in Stage 1, and thus enables the future addition of some solar PV without requiring addition to the BESS. This will shift the renewable penetration from low to high, with short periods of 100% renewable energy penetration (known as zero diesel operation (ZDO)) and load shifting from the BESS.

Stage 2 requires an additional 2,400 kWp of solar PV and is sized based on the optimum capacity of the already installed BESS at the point where the cost of energy (COE) reaches the lowest point. This will increase the renewable energy contribution and duration of high penetration, with extended periods of ZDO and longer load shifting duration.

Stage 3 includes the final additions of solar PV and BESS capacity to increase the renewable energy penetration from 60% to 100%. This will lead to negligible diesel operation and full overnight load shifting provided by the BESS.

In line with Table 3, and based on calculations in Entura (20191a, b), the following are noted:

(i) the most attractive route to 100% renewables is photovoltaic panels, in combination with battery energy storage systems (BESS);
(ii) to achieve a 100% renewable contribution for Funafuti by 2025 would require 7.6 MWp of solar PV and 3 MW / 14 MWh of BESS;
(iii) the ?final mile? is particularly challenging, and correspondingly expensive. This applies to the last few percentage points up to 100% renewables. Hence, consideration should be given to revising the RE target to a more cost-effective target of between 95% and 98%.

**iv) Barriers to Achieving 100% Renewable Energy, based on PV, Penetration in Funafuti and Tuvalu**

The previous section summarizes the steps and needs to achieve 100% RE penetration for Funafuti, through PV and BESS. As any additional needs for the Outer Islands are already covered (see later sections), reaching 100% on Funafuti would essentially mean reaching 100% on Tuvalu. Funafuti has already taken some steps, but progress is slow and considerably behind the goals set out, for example in the NDC.

This is a potentially unique but short-lived opportunity to help shift Funafuti onto a low carbon, highly resilient and renewable energy pathway ? given post-Covid situation and current instability in global fossil fuels market. This would be transition to a largely PV-only energy production system with battery storage. Seizing this opportunity would massively reduce Tuvalu?s GHG emissions, as well as generating other development benefits through energy independence and creation of a sustainable power sector.

There are, however, some barriers to this transition, as set out in the following.

**Land.** The most significant challenge to implementing the Road Map is identifying sites that can house sufficient PV capacity to meet the requirements of each Stage of development. On Tuvalu, land is at a high premium, and the availability, suitability, and cost of land for solar energy are major constraints to its development. Energy competes with other sectors, such as agriculture, commerce, water supply, transport and sanitation, housing etc. for access to land.

The exact area required is dependent on the selected technology and on the physical arrangement. For example, typical tilted ground mount arrays are spaced into rows to provide access for maintenance, this requires more land than raised fixed PV structures that are often in one larger plane and subsequently require less space. Likewise, for rooftop solar, if tilted framing systems are used then additional space is required. Rooftop solar is also constrained by the shape of the roof and by the need for clearances from edges and existing installations and equipment.

The estimated area requirements for each stage are as follows (from Entura, 2019b):

| | **Area required (square meters)** | | |
|---|---|---|---|
| | **Stage 1** | **Stage 2** | **Stage 3** |
| **Solar PV arrays** | 2,340 to 7,030 | 11,250 to 33,750 | 15,230 to 45,700 |

| | | | |
|---|---|---|---|
| **BESS (e.g. modularized Li-Ion Cabinets)** | 14.9 | - | 150 |

**Table 4: Required areas for road map stages**

As free space and land is at a premium, the areas listed in Table 4 are not easily available. **Solution:** The use of **floating PV (FPV**) largely overcomes this barrier. Although small areas of land are required for some supporting technology, the vast majority of the area covered is by panels which are placed on water. For Funafuti, this would mean the installation of the PV panels on wetlands near the airport or on the Te Namo Lagoon.

**Technological challenges.** As set out in the Road Map, in addition to the photovoltaic panels, complementary technologies are required to control and optimise performance of the system, and these technology requirements increase in scope and complexity through each stage. Fundamentally, the requirement, at each stage, is to ensure the following for all system operating scenarios:

(i) System earth reference is maintained;
(ii) Sufficient fault current is available;
(iii) Inverter voltage ride through settings and capabilities are adequate;
(iv) Inverter power output sizing is adequate to manage loss of single largest generating component at any given time; and,
(v) protection discrimination and functions are proven adequate.

Step by step, in line with the system growth, new and increasingly complex equipment is required to meet the above conditions. Tuvalu currently does not have access to this technology, nor the necessary capacity to procure, install, monitor and maintain.

In addition, at some point, the electricity transmission/distribution system may require upgrading or modification. As it stands, the system is adequate to accommodate the Stage 1 and much of Stage 2. However, before stage 2 is complete, it is most likely that changes to cabling capacity and power flow are required - dependant on the specific project connection points and sizing of generation technology.

**Human and institutional capacity**. New technical skills and capacity will be required to manage, maintain and repair the system and the new technologies. The details will also evolve through the stages. This will include capacity for: monitoring and physical testing of solar PV equipment; testing and repairing/replacing inverters; maintenance of battery system; and SCADA system operation. Additionally, as the system becomes more IT based and automated, there will be a need for increased data management and analysis skills to monitor, detect and correct performance issues.

**Consultation.** Conversion of power systems to PV, and upscaling of power systems, will lead to many physical changes on the island. In effect, shifting to PV is a transformational development of a scale not previously seen in this densely populated island. There will potentially be many losers and winners. This could be highly disruptive. For example, the greatly reduced import of diesel may lead to increased costs of diesel, potentially affecting transport and fisheries sector (as economies of scale are lost). Some businesses will benefit, others will lose. Likewise, some households will benefit, others will lose out. A number of small scall infrastructure investments will be required, each requiring the support of communities and stakeholders.

Appropriately and effectively undertaking the consultation exercise is a challenge to ensuring an efficient, effective, and equitable roll out of the new technologies.

**Finance**. Total funding investment costs for completing stages 2 and 3 is estimated at over US$20 million. That is currently far beyond the scope of the government or other potential investors. Revenue losses and economic stagnation during the COVID pandemic have made this even more challenging, both for government or private investors. Further, TEC has operated at a loss since 2013.

**Non-viable demand.** Reviews and evaluation of past remote electrification projects has revealed that economic returns of electrification projects were often considerably lower than expected and a wide range of expected indirect and external benefits did not materialize. One reason for this is that most remote electrification initiatives in the past focused mainly on household and community needs for lighting. This did not generate revenue for utilities and is not sustainable. **Solution:** The recommendation is that remote electrification be developed as part of a broad development approach. That is, a high priority has to be given to strategies for promoting productive uses of energy.

Barriers specific to Floating PV

As mentioned above, the greatest barrier on Funafuti is the availability of suitable land to install solar PV panels and BESS equipment. Ultimately, a key part of the solution to this is to use floating solar PV panels (FPV) on Te Namo Lagoon.

FPV, including PV panels built on stilts above water, has the following advantages when compared to land or rooftop PV: (i) frees up land for other use; (ii) saves on land acquisition and preparation costs; (iii) is easily and quickly deployed ? no land levelling/preparation or foundations needed; (iv) gives higher yields due to the cooling effect of water; (v) as it rises and falls with the sea, it has a unique resilience to flooding, to sea swells and sea level rise and it may be coupled with the development of reefs or other coastal adaptation solutions and finally (vi) can reduce levels of algal growth in water.[15]15 Typically, the increased cost for the floating, anchoring and mooring system is offset by both the reduced land acquisition costs and preparation costs and the higher energy yields.

However, FPV is a relatively new technology, especially for the Pacific. Although growing rapidly, as of June 2020, global installed FPV capacity was 1.8 GW, a tiny amount compared to over 1000 GW PV installed capacity globally (by 2023). As it is a new technology, it?s roll-out on Funafuti faces many specific barriers:

(i) The need for analytical tools and detailed data to determine optimal location of production capacity and construction requirements to ensure climate resilience;
(ii) The need for improved understanding and effective management of potential environmental impacts on the marine/lagoon environment, including of reduction of light reaching water/lagoon floor;
(iii) The need for increased physical strength and technology assured to sustainably produce electricity in the hostile environment ? with possibility of salt corrosion, intense winds, and intense and regular strong wave action. This applies to the units and to the electrical equipment (cables, etc);
(iv) The changes and increases in required cleaning and maintenance, which may require access by boats and divers;
(v) Potential cultural resistance to infrastructure on the lagoon, which has notably traditionally been used for leisure and fishing;
(vi) Potential increased upfront purchase and installation cost, in particular for the initial units at low scale, in a remote setting. This is related not only to the technology, but also the skills and capacity required to install and set up;
(vii) Increased possibility of soiling by birds.

## 2) The baseline scenario and any associated baseline projects

The baseline scenario is a continued, slow progression towards expanding renewables accompanied by continued degradation of the existing diesel generators. This is likely to include urgent purchase of new diesel generators as the only way to quickly meet new demand with existing skill-base and grid technology.

Although there have been several projects supporting renewable energy over the past two decades (supported, for example, by the Governments of Italy, New Zealand, Japan, the EU and the United Arab Emirates), these have focussed mostly on the outer islands. On Funafuti, however, the current situation is a power system almost entirely dependent on an outdated, unreliable diesel generation power system, with limited contributions from a series of uncoordinated PV plants, many of which are also aging or reaching the end of their economic lives.

The baseline includes one small scale initiative to pilot floating photovoltaic technology. This is the GEF/UNDP financed *Facilitation of the Achievement of Sustainable National Energy Targets of Tuvalu* (FASNETT). One activity under the project is to install 100 kWp of Floating PV. These panels are to be installed on Fongafale pond (near the international airport and pig farm on Funafuti). The total cost is estimated at $600,000. This project: (i) demonstrates the floating PV technology (ii) increases understanding of how to roll out floating PV and (iii) builds individual capacity to install and operate floating PV.

If investments do not proceed beyond the above baseline, additional diesel generation will be required, perhaps already during 2023, and then again by 2033 at the latest.[16][16] Given the short timeframe, and the fact that TEC?s current financial position means it has no provision for replacement or acquisition of assets, unless a donor could be found to fund a new diesel generator, then Funafuti could potentially soon face supply shortages during periods of peak load (Entura 2019a).

**3) The proposed alternative scenario with a brief description of expected outcomes and components of the project**

**Theory of Change**

The proposed alternative project has a goal to significantly advance the deployment of renewable energy on Tuvalu, notably Funafuti, taking the island well into stage 2 of its Road Map and laying the basis for completing stage 3. This project addresses the key barriers to RE and FPV on Funafuti discussed above.

To reach this goal, the project will specifically deliver three Outcomes: (i) 1: Climate-resilient floating and ground-mounted solar photovoltaic battery energy storage system, and grid infrastructure installed; (ii) sustainable blue economy and productive use of energy infrastructure installed; and (iii) Institutional capacity strengthening implemented

It is noted that the second Outcome (Sustainable blue economy and productive use of energy infrastructure installed) is also to be supported by a parallel GEF intervention financed by the International Waters focal area. This is the project ?*Pacific I2I Regional Project: Ocean Health for Ocean Wealth - The Voyage to a Blue Economy for the Blue Pacific Continent*? (GEF ID: 10783). It is henceforth referred to as the ?I2I? project. The I2I project, to be implemented by ADB and UNEP, will build upon

and add value to the current proposed project. In the Theory of Change (see below), the I2I project contributes to the following Input/Activity ?Invest in productive uses of electricity (PUE)? and to the following result: ?*Funafuti reaches 40-50% renewables penetration, with associated enabling technologies for further deployment, and innovative, productive uses of electricity generating revenue*?.

The current proposed project will notably demonstrate the technical, financial, and environmental feasibility of floating solar PV to overcome the land and rooftop space constraints and become the key solution in achieving the government?s ambitious renewable energy targets. In addition, the floating solar project will demonstrate cross-sectoral uses of clean electricity that provide demand, revenue and co-benefits, as well as GHG emissions avoidance. The project will also install significant PV and associated technology upgrades.

To deliver these Outcomes, the project supports a series of inputs and activities that are strategically designed to create pathways to removing the barriers. The activities will combine in an integrated manner to collectively remove or reduce the barriers. In this way, whereas a combination of all activities is necessary to remove any single barrier, all barriers will be removed if all activities are successfully implemented. The activities are installing physical infrastructure (notably BESS, FPV, grid infrastructure, system management equipment), capacity building, institutional strengthening and developing the enabling environment for RE.

In summary, the project will use a combination of demonstration, information, analysis and incentives to achieve the removal of the barriers. The following barriers will be removed (or significantly reduced): insufficient data and analysis, shortage of land, requirement for high technological solutions, requirement for individual capacity, need for upfront financial investment, lack of viable demand, and the specific barriers faced by floating PV.

Figure 2 below further illustrates the project?s theory of change.

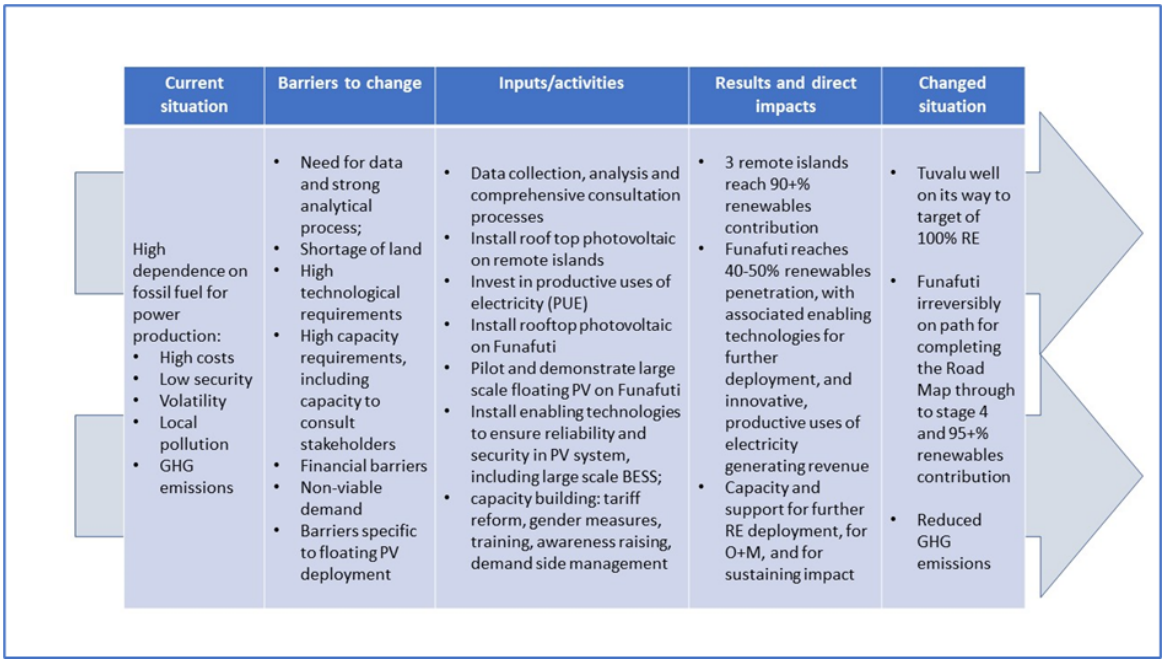


Figure 2: Theory of Change

**Objectives, Outcomes, Outputs and Activities**

The Project Objective is to promote the increased utilization of renewable energy and reduce greenhouse gas emissions in Tuvalu. This is to be achieved by three GEF-related Outcomes

1: Climate-resilient floating and ground-mounted solar photovoltaic battery energy storage system, and grid infrastructure installed

2: Sustainable blue economy and productive use of energy infrastructure installed

3: Institutional capacity strengthening implemented

Outcome 1: Climate-resilient floating and ground-mounted solar photovoltaic battery energy storage system, and grid infrastructure installed

ADB has already committed to financing Tuvalu: *Increasing Access to Renewable Energy Project* Phase 1 (IAREP I). Under this existing commitment, ADB and Government are to finance the installation of 500 kWp rooftop solar PV and 1000 kW/3500 kWh BESS on Funafuti. The Phase 1 project also supports the installation of 224 kWp of ground-mounted PV on the outer islands of Nukufetau, Nukulaelae and Nui.

In addition, the Government of Tuvalu, supported by the World Bank (through the *Tuvalu: Energy Sector Development Project,* ESDP) is also committed to installing PV and supporting technologies on Funafuti (750 kWp ground-mounted solar PV and 1000 kW/1000 kWh BESS on Funafuti).

With support from GEF and additional ADB core funds, ADB is proposing to implement a second Phase 2 of the IAREP project (IAREP II). Phase 2 will finance, for Funafuti, a further 1200 kWp floating solar PV, and all supporting infrastructure.

These are summarized in the following table:

| Project/Sponsor | Aim | | | Sponsor/financier |
|---|---|---|---|---|
| | **Funafuti - all PV capacity and battery storage (BESS)** | **Funafuti - Floating PV only** | **Outer islands - all PV capacity and battery storage (BESS)** | |
| Increasing Access to Renewable Energy Project ? Phase 1 (IAREP I) | 500 kWp capacity 1MW/3.5MWh BESS | 0 capacity | 224 kWp capacity 0 BESS | ADB and Government of Tuvalu |
| Tuvalu: Energy Sector Development Project (ESDP) | 750 kWp capacity 1MW/1MWh BESS | 0 capacity | 0 capacity 0 BESS | GoT/World Bank |
| Increasing Access to Renewable Energy Project ? Phase 2, (IAREP II) | (1200 kWp, 0 BESS) | (1200 kWp) | 0 capacity 0 BESS | ADB, GEF and Government of Tuvalu |
| **TOTALS** | **2450 kWp 2MW/4.5MWH BESS** | **1200 kWp** | **224 kWp 0 BESS** | |

Table 5: Summary of Project Outputs

Outcome 1 consists of the following four Outputs:

? Output 1.1: 224 kWp of PV installed on Outer Islands (financed entirely by co-finance from ADB IAREP I). This includes some supporting technology.

? Output 1.2: 1250 kWp of fixed and roof-top PV installed on Funafuti (financed entirely by co-finance from ADB IAREP I and World Bank ESDP)

? Output 1.3: 1200 kWp of floating PV (FPV) on Funafuti (financed by GEF and co-finance from ADB and Government). This includes supporting grid connection infrastructure and O&M equipment.

? Output 1.4: 2MW/4.5MWH of BESS on Funafuti (financed entirely by co-finance from ADB IAREP 1 and World Bank ESDP).

Details are provided in the following section, with additional details provided for the activities and inputs to be provided by GEF.

Output 1.1: 224 kWp of PV installed on Outer Islands

Most Outer Islands are already very close to full renewable energy production. Only three islands ? Nukulaelae, Nukufetau, Nui - are significantly short of that goal. For these latter three islands, Entura, 2019b (see footnote 14) undertook a full analysis of current supply and demand, current generation technologies and capacity, and future demand. Based on that analysis, it was determined that the following PV generation equipment and associated technology is required:

| Item | Nukulaelae | Nukufetau | Nui |
|---|---|---|---|
| Additional solar PV capacity (kWp) | 44.8 | 78.4 | 100.8 |
| Module capacity (W) | 280 | 280 | 280 |
| Additional module quantity | 160 | 280 | 360 |
| Additional PV Array area (m2) | 240 | 420 | 540 |
| Additional 10kW inverter quantity | 4 | 7 | 9 |
| Additional PV Array ?blocks? (40 modules, 10m x 6m) | 4 | 7 | 9 |

Table 6: Project infrastructure provision, outer islands (Nukulaelae, Nukufetau and Nui)

Entura (2019b) provides full details of the technical assessment, and the required infrastructure, technologies, specifications, drawings, sitings, etc.

Additional equipment is required to be installed within the powerhouse, this is to support PV generation and enabling technology, and also upgrading diesel hybrid fall-back capacity where necessary. This consists of:

- ? System balancing (all sites);
- ? Ancillaries and design (all sites);
- ? New diesel powerhouse (Nukulaelae only);
- ? Distribution upgrades (all sites).

The total costs of this intervention across the three islands is approximately $1.5 million, all covered by ADB and Government co-financing under IAREP I. No GEF contribution.

Outputs 1.2, 1.3 and 1.4. As discussed in earlier sections in order to transition fully to RE and meet the growing demand, and so implement the Road Map for Funafuti, a cumulative installation of 1985 kWp (stage 1), 4385 kWp (stage 2) and 7635 kWp (stage 3) is required. Likewise, it will require 2000/3000 kW/kWh of BESS (stage 2) and 3000/14000 (kW/KWh) (stage 3).

Collectively Outputs 1.2, 1.3 and 1.4 will provide 2450 kWp ? thus taking the system beyond Stage 1 ? and 2MW/4.5MWH of BESS ? thus taking the system to the end of Stage 2.

Output 1.2: 1250 kWp of Fixed and Roof-top PV on Funafuti

Output 1.2 contributes 1250 kWp of fixed and ground mounted PV. The total costs of this Outputs are covered by co-financing under IAREP I and from the Government/World Bank ESDP project.

IAREP I The project was initially conceived to increase the renewable energy penetration in Funafuti from 15% to 32% by providing (i) at least 500 kW of rooftop solar photovoltaic capacity, (ii) at least 1 MW and 2 MWh of BESS, and (iii) associated modern control systems. Due to difficulties associated with the global COVID pandemic and major changes at the global level in the purchasing costs of PV and battery technology, the project outputs are being revised and the project budget is likely to increase significantly. It is currently anticipated that the project outputs in terms of fixed PV (500 kWp) are unchanged. BESS has been increased from 1MW/2MWh to 1MW/4.5MW.

This project will also provide the following grid support equipment: hybrid control system; governor upgrades, diesel controller upgrades and BESS hybrid controller.

World Bank ESDP Project. With regards to renewable energy on Funafuti, the project was conceived to support renewable energy investments and reduce dependence on fossil fuels and enable remote grid monitoring. The project is financed by a Trust Fund (TF) Grant and a parallel IDA Grant. The TF funds are now fully committed and activities complete. The key activity was originally to be the design, supply, and installation/construction of a 786 kilowatts (kW) solar photovoltaic (PV) plant (including solar PV panels, PV structures) and two megawatt hours of battery energy storage system, and ancillary equipment. Due to difficulties associated with the global COVID pandemic, challenges in securing suitable sites, additional costs related to capacity building and outreach, and major changes in global unit costs of PV and battery technology, the project has been restructured several times. It now aims to implement (i) 750 kWp of PV (ii) 1MW/MWh of BESS, (iii) various technology support and capacity building.

The BESS is provided under Output 1.4 below.

Summary of Output 1.2

| Project | Fixed/ground mounted PV (kWp) |
|---|---|
| World Bank ESDP | 750 |
| IAREP I | 500 |
| Totals | 1250 |

Table 7

Output 1.3: 1200 kWp of Floating PV (FPV) on Funafuti

Output 1.3 contributes floating PV, 1200 kWp of the required PV.

This is the principal contribution of the GEF (Climate change focal area) support to the overall project.

The detailed Feasibility Study (FS) ? see Appendix 1? provides full details of the technology selection process, the technology selected, the site selection process and decision, the results of the grid study validating the capacities selected, the specification details of the PV plant, the project financials and information on the required permits. The FS also includes details of the PV panels, the floating structures, the inverters, the required civil works and the required electrical works.

In summary, the installation will project comprise a 1.2MWp/1 MWac FPV solar plant of around 1,25~1,5 hectares located in Funafuti at coordinates 8?30'53.1"S 179?11'53.2"E, in the lagoon and just to the north of the main town centre. The floating solar plant will be assembled in an area meeting technical and due diligence criteria (several alternatives are possible). The floating PV will be anchored to the limestone bed and eventually moored also to a wave breaker. The inverter will also be floating. The PV plant is expected to be connected to one of the nearest ring main units (RMU) (either RMU 4 with 200 kVA near the Funafuti centre or the RMU 5 without transformer north of Funafuti).

From Appendix 1, the main items to be installed and activities are as follows:

- PV Modules;
- Inverters;
- Floating structures for modules and inverters;
- Anchoring/mooring system;
- Wave breaker (geobags and local solution);
- Monitoring and control system;
- Transformer and switchgear;
- DC BOP (Cables, SCB and Accessories);

•AC BOP (Cables, SCB and Accessories);
•Design services, commissioning, and testing;
•Mechanical and Civil works;
•DC Electrical works;
•AC Electrical works;
•Grid substation works and 11 kV cables;
•O&M e-boat.

Resilience to climate hazards

-

A key issue with installing floating technology in the Pacific is resilience to storms, notably waves and surges associated with tropical cyclones. In order to ensure this resilience, updated data and modeling was obtained and used in order to determine the likelihood and range of likely waves ? in terms of direction, strength, energy and frequency.[17][17]

The following measures are taken to ensure the investment is resilient to severe weather events, notably cyclones:

•Location *inside* the lagoon, this area is more protected from harsh or extreme weather conditions such as strong winds and cyclones.
•
East-west configuration for the PV modules at 5? tilt maximum: this will add compactness, lower mechanical and wind loads and will not reduce generation.
•
•Floaters filled with water to make them heavier and also sunk in the water, decreasing drag and lift forces by strong winds and also adding to the mechanical strength of the floating structure
•
•Smaller floating islands up to 600 kWp or so to decrease the mechanical strengths within each floating structure and also to reduce the load on the anchors allowing them to withstand stronger winds. This will result in a more expensive plant though.
•Increased tensile strength of the floating structure modules that are connected to the anchors.
•
Use of a wave breaker. This will be placed in front of the FPV plant for wave attenuation. It will be anchored to the seabed. It could be made of large sandbags or other materials produced locally. This type of coastal protection solution is practical and cheap, being widely used around the world, greatly reducing the project costs and having a low environmental impact.

Output 1.4: 2MW/4.5MWH of Battery Energy Storage System (BESS) on Funafuti

The BESS is required in order to enable an optimal use of the proposed PV and future PV investments.

The amount of BESS to be installed is sufficient to support all the PV installed under Outputs 1.2 and 1.3, and for additional PV to be installed in any subsequent investments.

The BESS is funded entirely by co-financing from WB ESDP and ADB IAREP I. WB ESDP will provide 1MW/1MWh, and IAREP I will provide 1MW/3.5MWh.

There are several requirements on this BESS technology:

- ? The battery shall be capable of increasing the energy storage capacity, without any requirement to increase its inverter capacity;
- ? The battery inverter will be able to operate in parallel with at least one diesel generator, and have full grid forming capability to ensure that the system can operate without a diesel generator when conditions present themselves. In zero diesel mode, the battery inverter will be responsible for setting grid frequency and voltage;
- ? The inverter must be able to moderate reactive power to support the loads on the grid;
- ? The battery cells themselves must be capable of efficient operation and retaining charge and life, and must have high power output capability to support (or displace) the diesel generators;
- ? The battery cells and power conversion system will need to be modular, and typically small unit size / weight to assist with transport and logistics;
- ? The battery cells should be self-containing for fire or explosion risk. Containerised BESS systems, layouts and surrounds should be designed to mitigate fire risks. Briefs from suppliers or contractors may be required for emergency services response;
- ? High cycle life and tolerance to low states of discharge are also important to minimise lifetime O&M costs (particularly battery replacement);
- ? BESS must be fully capable of self-regulation and protection, and operating / surviving for their design life in the site environmental conditions. This includes the provision of forced cooling of inverter and battery systems where required. The conditions are consistently in the low-mid 30s?C during the day;

? Equipment and materials designed and warranted to suit site specific environmental conditions - marine grade corrosion systems, high temperatures and humidity;

? Flooding/inundation risk is to be managed through the detailed design process with equipment layouts elevated to levels above anticipated storm events.

It is planned to install all the BESS ? both World Bank and IAREP funded - at the TEC compound ? most likely under the existing solar PV array at the rear of the compound. This site has various advantages: it is close to existing connection and control infrastructure, the space under the solar arrays is otherwise unutilised and contained within an area allocated for generation, proximity to TEC is advantageous for O&M and power systems thermal capacity is sufficient at this site.

Entura (2019b) provides full details of the technical assessment, required infrastructure, technologies, specifications, drawings, sitings, etc.).

Outcome 2: Sustainable blue economy and productive use of energy infrastructure installed

This Outcome will ensure the electricity generated under Outcome 1 is used towards sustainable, blue aims, thereby contributing to local socio-economic development and improved local environmental conditions, and increased resilience. As this Outcome generates a sustainable *demand* for electricity, it also increases the potential for TEC to collect revenue from electricity consumers and therefore helps TEC towards financial sustainability.

Note, as mentioned above, this Outcome is also supported by a parallel GEF intervention financed in the International Waters focal area, i.e. the project GEF ID 10783: ?*Pacific I2I Regional Project: Ocean Health for Ocean Wealth - The Voyage to a Blue Economy for the Blue Pacific Continent*? (the ?I2I?).

Note, this Outcome is financed entirely by co-finance, GEF makes no contribution. However, it is noted that a parallel initiative, to be supported by GEF ID 10783 (?I2I?) is under development.

The sustainable blue economy (SBE) is defined as o*ne that seeks to promote economic growth and preserve and improve livelihoods across a range of sectors, while ensuring the sustainable use of marine resources. It is an economy based on circularity, collaboration, resilience, opportunity and inter-dependence. Its growth is driven by investment that reduce carbon emissions and pollution, enhance energy efficiency, harness the power of natural capital, and halt the loss of biodiversity and the benefits that these ecosystems provide*.?[18][18]

Initially, PUE were defined as addressing the needs for investments in value-added end-uses beyond electricity. This was later elaborated and defined as ??*Agricultural, commercial and industrial activities involving energy services as a direct/indirect input to the production of goods or provision of services with increase in income or productivity?.*

There is a strong correlation and overlap between PUE and SBE. The introduction, expansion and operationalization of floating solar (as supported under Outcome 1), together with the development of PUE, can make a critical contribution to and can drive the Pacific?s all-round transformation to a sustainable blue economy, including on Tuvalu. This transformation has three dimensions:

FPV is a locally produced, renewable energy technology. All renewable energies produced in Tuvalu are clean at the point of production and independent of regular fuel supplies. This immediately leads to reduced air and marine pollution and to less volatility in supplies and markets. This establishes an improved platform for local socio-economic activities - an intrinsic characteristic of renewable energies is their potential to be far more supportive of resilient, localized economic development.

FPV is a renewable energy technology *with specific, ?SBE? characteristics*. FPV has several characteristics, not necessarily shared with other renewables, that support SBE, especially in the Tuvalu context. First it exploits the enormous water surface and solar resource potential. Second it avoids the use of increasingly scarce and expensive land, thereby saving on land acquisition and preparation costs. Third, it may directly exploit the cooling effects of water to increase efficiency. Fourth it can conserve water through reduced evaporation. Fifth, as it rises and falls with the sea, it has a unique resilience to flooding, to sea swells and sea level rise and it may be coupled with the development of reefs or other coastal adaptation solutions. Finally, particularly in off-grid cases, the siting of the production may directly benefit more vulnerable areas and communities.

FPV is a disruptive innovation. The transition to renewables, including the transition to floating solar, is contributing to an ongoing transformation of the energy sectors across the Pacific. As such it is likely to play a role in shaping the characteristic of future societies and economies. This may happen through various vectors and pathways ? many specific to or magnified by FPV - including:

- ? the siting of energy production will change, and hence so will its distribution;
- ? some or all of the stakeholders involved in energy production and distribution will change;
- ? the timing of energy production will change, notably solar will lead to peaks in supply during daylight hours - and the need for new battery systems, and other storage solutions potentially involving water and ice, and for grid upgrades;
- ? the above will lead to changes and opportunities in the labour market and private sector, leading to many new opportunities to create local employment, value addition and careers;
- ? all the above will influence the cost distribution of energy production, and in turn potentially create a need for tariff reforms; and,
- ? the above may lead to a need for legal and/or regulatory reforms.

Under Outcome 2, specific PUE/SBE investments initially include: reef generation, e-boats and charging stations and coastal protection.

**2.1 Reef generation**

This technology uses energy to foster the regeneration of productive ecosystems as well as contributing to coastal protection.

Reefs across Funafuti are threatened due to human activities, overfishing, ocean acidification, ocean temperature rise, diseases, mismanagement of the land, among others past water pollution and climate change.

Electricity will be used to rehabilitate and improve coral reef health and growth. The mineral accretion method will be used. The mineral accretion method uses electrically conductive materials like steel (being one of the cheapest) to build marine structures of different dimensions, inducing very low-voltage charges (electrolysis of the seawater) that foster the deposition of calcium carbonate and other minerals in the structure increasing coral reef growth and improving reef health. It is estimated that the process of coral reef growth can be accelerated up to 4 times using this method.

It is proposed that Biorock technology be used. Biorock reefs also need to be periodically checked to ensure that cables and connections are intact. If these wires are broken, growth of mineral accretion will stop and growth rates of corals will decrease to normal values and lose their special ability to resist adverse conditions. If problems are found with a cable, it is repaired or replaced as needed[19][19].

Biorock requires a 24 hour electricity supply. Hence, in addition to the energy generated under Output 2, battery storage will be installed to specifically support the reef generation.

The target, through the project, is to support generation of one hectare of reef. However, this is a new and relatively untested technology. Hence actual results may be very different, including being considerably smaller. For full details of the reef generation process, installation techniques and technology, see Appendix 1.

**E-boats and charging stations**

2.2 E-boats In addition to an e-boat under Output 1 to be used for O&M of the FPV, the project will kick-start electric maritime transport by providing the following boats for social and cultural use:

- 2 new electric boats to Ministry of Transport, Energy and Tourism (MTET) with a minimum capacity of 10 people per vessel. A primary use of these will be to transport school-children. In general these will be used for inter-islet travel in and around Funafuti.

- 2 extra electric engines as spares.

2.3 Charging infrastructure The proposed location of the EV charging facilities is the port of Funafuti. As the port is located in the center of the atoll, and close to all the facilities, users can benefit from it

and charge their boats while docking. Two options are proposed in Appendix 1. The facilities will be made of 11 kV chargers, connected to the main grid. Investments may be accompanied by capacity building to develop management and operational capacity - contributing to quality local employment opportunities.

Outcome 3: Institutional capacity strengthening implemented

This Outcome will build capacity in TEC, MTET, government agencies and other stakeholders to be able to identify, develop and manage resilient, complex electricity supply networks that are adapted to the specific needs and resources of Tuvalu, covering both urban areas and remote, sparsely populated islands. This Outcome consists of six activity sets. This Outcome is mostly financed by co-finance (from ADB), with targeted, strategic support from GEF.

Activity 3.1: Outreach, assessment, consultation and planning.

This includes a range of specific activities to scope, conceive, plan, upgrade and construct the electricity supply network, notably including the design of photovoltaic farms and related integration and management technologies. This includes a comprehensive range of steps such as consultation, data collection, analysis, and design of grid, technologies, and related capacity needs etc.

This activity is ongoing with the support of IAREP I and will continue until the project ends in 2029.

**Funding: IAREP I. No GEF.**

Activity 3.2 ? Key skills upgraded for TEC.

This is essentially to provide the range of capacity required to manage the electricity system and the PV Technologies. This is to include: on the job training on technology functioning and use; on management software; on storage and inverter technologies (the theory, the use and the maintenance); on controllers and communications systems; on network systems, and on all electricity grid related needs and challenges. This will give TEC the required capacity to manage, design, install, upgrade and maintain a hybrid (diesel/PV) grid. This notably includes an important focus on (i) asset management and (ii) operations and maintenance capacity ? as these are issues that have shown weaknesses in the past.

- ? Prepare asset inventory and asset management plan, with particular attention to ensuring financial sustainability (not GEF);
- ? Develop and implement strategy to improve overall O&M capacity (not GEF);
- ? Provide training and guidance on the operation of technical support equipment, for example of drones, e-boats etc (not GEF);

? Training on financial management, e.g. on budget preparation, auditing, reporting, etc (GEF);

? Provide training and guidance on stakeholder engagement and community outreach (GEF)

? Provide training on gender training, on inclusivity, on addressing vulnerability, and on health issues such as HIV/AIDS (GEF);

? Provide training training on Floating PV plant design, engineering, construction, commissioning, operation and maintenance, including the systems and software to operate and maintain renewable energy technologies. This will cover technology options, technology characteristics, an introduction to modelling, an introduction to storage and inverter technologies, grid design, etc) (GEF).

**Funding: GEF 130k, IAREP I.**

Activity 3.3 ? Technical Assessments

This includes two technical assessments required to ensure the project will be resilient and adapted to the needs of Funafuti. These assessments are:

(i) Grid study. This study is to determine the capacity and potential bottlenecks in the current grid, and propose the necessary technology and battery storage upgrades to ensure optimal use can be made of the FPV, and that the system will be ready to incorporate further upgrades. This includes the provision of software and related training. This is funded by IAREP I.

(ii) Comprehensive study of coastal protection around Funafuti. Complementing the ongoing GCF funded TCAP and contributing to government plans for reclamation and other development activities, this activity will explore potential technical (hard and soft) solutions for coastal protection from erosion, possibly employing a mix of multiple solutions for optimal and cost-effective outcomes. Whilst contributing directly to national coastal planning processes, the detailed focus will be on protecting FPV and related infrastructure. This is entirely funded by the Irish Trust Fund (ITF).

**Funding: IAREP I, ITF. No GEF.**

Activity 3.4 Institutional and Policy Support

This will focus on improvements in the enabling environment, on governance and on legislation, with the underlying aim of enabling TEC to achieve sustainability, including financial sustainability. Specific actions are to include:

? Undertake general review of tariffs, with notably a comparison of alternative regimes and tariff structures across Pacific. Formulate a proposal for tariff reform (completed, IAREP);

? Support government adoption and roll-out of a revised tariff structure that meets financial sustainability requirements (IAREP, government has adopted the proposed tariff structure, roll-out expected to commence soon)

? Review of tariff reform implementation, including a comparative study of the impacts on tariff of using renewables, and the impacts on the financial sustainability of TEC (GEF);

? Review of Energy Bill and formulation of revisions (GEF);

? Implementation of metering across the grid (GEF).

**Funding: GEF 90k, IAREP I.**

Activity 3.5 Knowledge management

? Elaboration of a Project Communications Strategy;

? Preparation of communications materials (both digital and hard). This may include brochures, posters, videos, websites and social media. This will cover general climate issues, but will mostly focus on highlighting the usefulness and successes of floating solar in preparation for its broader dissemination across Tuvalu and the Pacific;

? Tuvalu participation and contribution to one high profile regional event that highlights and disseminates floating solar as a feasible technology for the Pacific.

**Funding: GEF: 50k.**

Activity 3.6 Project technical supervision

This includes monitoring and supervising the implementation of all civil works under the project and the installation of project equipment through the entire lifetime of the project. This also includes some specific training related to the installed equipment. This also includes ensuring that all safeguards are addressed and gender targets met.

This activity is ongoing with the support of IAREP I and will continue until the project ends in 2029.

**Funding: IAREP I. No GEF.**

## 4) Alignment with GEF focal area and/or Impact Program strategies

This proposed project is fully consistent with the GEF 7 Climate Change Focal Area Strategy Objective 1: *to promote innovation and technology transfer in sustainable energy, through its development of decentralized renewable power combined with energy storage*.

As a result of this Project, the installed RE capacity on Funafuti will increase from under 0.8MW to over 3MW, increasing REs contribution to the overall installed generation capacity from approximately 18% to over 50%, at a time of growing demand. Further, in line with the overall GEF Focal Area objective, this project has the following characteristics:

? It directly contributes to the transformation of the energy sector, accelerating Funafuti from stage 1 to stage 2 of the Funafuti RE roadmap. Subsequently, Tuvalu will transform from being renewable marginal to renewable led;

? It is innovative, firstly by rolling out solar PVs at an accelerated pace in a remote island setting and demonstrating the installation of necessary enabling technologies, but most notably by installing ***floating*** solar PVs at scale - an innovation that can be considered ahead of the curve for remote Pacific nations. It is also innovative in the region for jointly addressing the productive uses of energy, stimulating viable demand, which should contribute to financial sustainability;

? It ensures the enabling of the local capacity ? by providing required power system management technologies and storage, and required capacity building for local power system managers.

The GEF-7 resources will be utilized as an accelerator and risk reducer, removing the barriers to FPV and moving FPV/PV to a scale and firmly on the roadmap towards the ultimate stage 3.

**5) Incremental/additional cost reasoning and expected contributions from the baseline, the GEF TF, and co-financing**

In line with Multilateral bank guidance on counting climate finance[20][20], all activities to support solar power generation can be considered climate change mitigation activities, and all such funding can be counted as climate change finance. Through this definition, as all activities in the baseline and all activities in the alternative scenario contribute to climate change mitigation, they can all be considered ?additional?.

The baseline project is funded by UNDP and FASSNET.

The alternative scenario is funded by GEF, together with ADB, ADB managed Trust Funds, World Bank and the Government of Tuvalu. The allocations are as follows:

Outcome 1

This is funded as follows:

| Activity/ | | Budget estimate (US$1000) |
|---|---|---|

| component | GEF | ADB and GOV IAREP I[21][21] | GOT/WB[22][22] | ADB IAREP Phase II (including ADF and ITF) | GOV IAREP Phase II |
|---|---|---|---|---|---|
| 1.1 Remote islands PV | 0 | 1,750 | 0 | 0 | 0 |
| 1.2 Fixed PV on Funafuti | 0 | 1,250 | 3,500 | 500 | 0 |
| 1.3 FPV on Funafuti | 2,303 | 0 | 0 | 300 | 700 |
| 1.4 BESS | 0 | 2,500 | 3,500 | 500 | 0 |
| **TOTALS** | 2,303 | 5,500 | 7,000 | 1,300 | 700 |

Table 8

Outcome 2

Outcome 2 is entirely financed by a parallel initiative supported by ADB.

Furthermore, as previously noted, there is a parallel initiative, to be supported by GEF International Waters and ADB, UNEP, SPREP. This is the project: ?Pacific I2I Regional Project: Ocean Health for Ocean Wealth - The Voyage to a Blue Economy for the Blue Pacific Continent?, generally referred to as the ?I2I? project.

Outcome 3

GEF and co-financing contributes to Outcome 3 as follows:

| Activity | GEF | Co-financing |
|---|---|---|
| 3.1 Outreach, assessment, consultation and planning | 0 | 100,000 |
| 3.2 Key skills upgraded for TEC. | 130,000 | 100,000 |
| 3.3 Technical Assessments | 0 | 100,000 |
| 3.4 Institutional and Policy Support | 90,000 | 100,000 |
| 3.5 Knowledge management | 50,000 | 100,000 |
| 3.6 Project technical supervision | 0 | 100,000 |
| **Totals** | **270,000** | **600,000** |

Table 9

Summary

From the above tables:

| Outcome | GEF | Co-financing | GEF Contribution |
|---|---|---|---|
| 1: Climate-resilient floating and ground-mounted solar photovoltaic battery energy storage system, and grid | 2.303 | 14.5 | 14% |
| 2. Sustainable blue economy and productive use of energy infrastructure | 0 | 0.8 | 0% |
| 3. Institutional capacity strengthening implemented | 0.27 | 0.6 | 31% |
| **Totals** | **2.573** | **15.9** | **14%** |

Table 10

Note: PMU and M+E is not included in the above.

That is, GEF contributes 14% of alternative project costs, with co-financing covering 86% of the alternative project costs (excluding PMU and M+E).

## 6) Global environmental benefits

The proposed project is designed to help Tuvalu, in particular Funafuti, rapidly move off its current energy pathway that is highly dependent on imported fossil fuels for power generation to a pathway using clean and renewable energy resources that is low-carbon and climate resilient. To achieve this, ADB IAREP (Phases 1 and 2) and the GoT/World Bank ESDP will install generation capacity and will provide enabling technical solutions (e.g. BESS) and associated technical capacity.

The impact is to reduce greenhouse gas (GHG) emissions by displacing electricity produced from diesel to electricity produced from renewable energy technologies, in combination with significant BESS capacity addition and other improvements to the grid to enhance functioning and performance. The overall figures are presented below.

? Output 1.1: 224 kWp of PV installed on Outer Islands (financed entirely by co-finance from ADB IAREP 1). This includes some supporting technology.

? Output 1.2: 1250 kWp of fixed and roof-top PV installed on Funafuti (financed entirely by co-finance from ADB IAREP 1 and World Bank ESDP)

? Output 1.3: 1200 kWp of floating PV (FPV) on Funafuti (financed by GEF and co-finance from ADB and Government). This includes supporting grid connection infrastructure and O&M equipment.

? Output 1.4: 2MW/4.5MWH of BESS on Funafuti

GEF Financed

GEF will finance the installation of 1 MWac/1.2MWp of renewable floating solar PV plant. This is expected to avoid 33,874 tons of carbon dioxide equivalent (CO2e) in greenhouse emissions over its 25-year lifetime, as demonstrated in the following table.

| Carbon Balance Overview of FPV plant | |
|---|---|
| E Grid | 2002 MWh |
| Project lifetime | 25 years |
| Life cycle emissions (LCE) of current grid (due to use of diesil gensets) | 720 Gco2/kWh |
| Carbon balance for Year 1 year | 1441 TCO2 |
| Carbon balance over 25 years | 33,874 tCO2 |

Table 11

Total Project

GEF and co-financing, together, will finance installation of 2.29MWac/2.675 MWp fixed and floating PV plants. This is expected to avoid **67,958 tons** (33,874 + 34,084) of carbon dioxide equivalent (CO2e) in greenhouse emissions over its 25-year lifetime, as demonstrated in the following table.

| Carbon Balance Overview of Solar PV projects | | | |
|---|---|---|---|
| | **1200 kWp FPV plant** | **975 kWp solar rooftop (ADB IAREP I)** | **500 kWp solar rooftop (World Bank ESDP)** |
| **E Grid** | 2002 MWh | 1349,3 MWh | 692 |
| **Project lifetime** | 25 years | 25 years | 25 years |

| | | | |
|---|---|---|---|
| **Life cycle emissions (LCE) of current grid** | 720 Gco2/kWh | 720 Gco2/kWh | 720 Gco2/kWh |
| **Carbon balance for Year 1** | 1441 TCO2e | 958.5 TCO2e | 491.5 |
| **Carbon balance over 25 years** | 33,874 TCO2e | 22,530 TCO2e | 11,554 |

Table 12

This can be considered a conservative analysis, notably as it does not include savings under Outcome 2, the PUEs. Also, the methodology does not account for positive carbon emission reductions due to the reduced amount of shipping activity. As a result of IAREP, there will be less need for shipping to transport diesel to Tuvalu.

The above tables are based on a comparison of with/without project scenarios, and are based on the following assumptions:

? In the baseline, generating 1 kWh from fossil fuels (diesel) leads to 720g CO2e (conversion factor);

? PV Plant load factor[23]23 is almost 21% for rooftop and just over 25% for FPV;

? PV output degrades, annually, with 0.5% loss of production year on year (usual specifications range from 0.2% - 0.7%);

? FPV is 15% more efficient than rooftop PV, due to the cooling effect of water.

? Thermal loss factor of 20 W/m2 K for rooftop solar and 50 W/m2 K for floating PV plant;

? 25 years lifetime.

Note:

The above is based on improved estimations since approval of the PIF. The PIF was considered a conservative estimate, as details of the technologies were not fully known. The three main improvements are:

? consideration of reductions over 25 years (as opposed to 20 in PIF);

? improved ?load? factor for both roof mounted and PV (a load factor of 17% for all was used with the PIF);

? increased use of FPV as opposed to fixed PV (a switch of 450 kWp), which is 15% more efficient due to cooling effect of water.

PVSyst software is used to make above calculations. PVSyst simulations were done using Funafuti location and rooftop solar PV/floating solar plants sizes.

## 7) Innovativeness, sustainability and potential for scaling up

### Innovation

In order to enable sustainable, resilient, and low-carbon development in the region, it is necessary for infrastructure investments to shift to regional and cross-sectoral approaches beyond business as usual, to use available indigenous resources, advanced technologies, new business models and innovative designs. In response to this need, the project has several innovative features and will contribute to innovation across the power sector in Tuvalu. These features include:

First and foremost, floating PV technology is innovative even at the global level, accounting for only around 0.36%[24][24] of all installed PV. There are still several competing technologies, many at the protocol stage. None of these technologies can be considered proven or mature. It is highly likely this project will be a first for the technology that is used, thereby contributing to the global body of knowledge and experience on these issues.

Second, even fixed/mounted remains quite innovative in the Pacific and in Tuvalu, with only a relatively short history and still low generation capacity levels. The transition through the phases 1, 2 and 3 of the Road Map, with a systematic, strategic, evolving use of complex technologies and battery storage systems, will be amongst the first times this has been achieved in the Pacific and on a small island state. It is expected that much experience will be aquired, and this will contribute to the global body of knowledge. Operationalizing this systematic, strategic approach will be truly innovative.

Third, awareness raising activities will promote success stories, technology and innovation, as well as building the capacity of various stakeholders.

Fourth, the project approach of combining installing electricity generation capacity with the development of productive uses of electricity (PUE and SBE under Outcome 2) is a first for Tuvalu. One immediate advantage of this approach, if successful, is that it will lead to productive economic activities, and immediately create opportunities for TEC to sustainably increase its revenue generation through improved tariffs and collection.

Finally, under Outcome 2, although not financed by GEF, the project supports the introduction of innovative reef generation technology, Biorock. The Biorock technology rehabilitates, accelerates and strengthens regeneration processes. The process was originally invented by Professor Wolf Hilbertz to produce natural building materials in the sea, also known has Mineral Accretion or Seament, and has recently been promoted by the Global Coral Reef Alliance.

More generally, the introduction, expansion and operationalization of floating solar and associated PUE can make a critical contribution to driving Tuvalu?s transformation to a sustainable blue economy. This transformation has three dimensions: (i) FPV is a locally produced, renewable energy technology, (ii) FPV is a renewable energy technology *with specific, ?SBE? characteristics, (iii)* FPV is a disruptive innovation as it will change the siting, participating stakeholders, timing and beneficiaries of energy production. As a result, the project can be part of a transition to a situation where Tuvalu experiences increased quality local employment, decreases in pollution and increased food security, amongst other strategic changes.

**Sustainability**

The GoT commitment to the project objective is reflected in its adoption of an 100% RE targets by 2020 (since revised to 2025, and then 2030, primarily as a result of delay challenges associated with the global COVID pandemic). This government commitment is one of the pillars of sustainability.

The IAREP phases I and II directly support the government?s efforts to reduce Tuvalu?s reliance on imported fossil fuels for power generation and transition to sustainable energy systems, and thereby increasing energy security. This will lead to a lowering of costs and an increase in energy security: further strong incentives for government and popular support. Through these direct contributions to government goals and more general socio-economic needs, the project is well anchored and this should aid sustainability.

In order to further ensure the sustained performance of the measures introduced and the sustained impact of the project, the following will be implemented:

? Support to ongoing efforts to increase revenue generation to TEC. With technical support from IAREP Phase 1, a tariff review led the Government cabinet considered five options and decided on the most ambitious and sustainable option ? the ?break even? option.**[25]25** The project is now continuing to work with TEC and government to operationalize this decision. This increases financial sustainability;

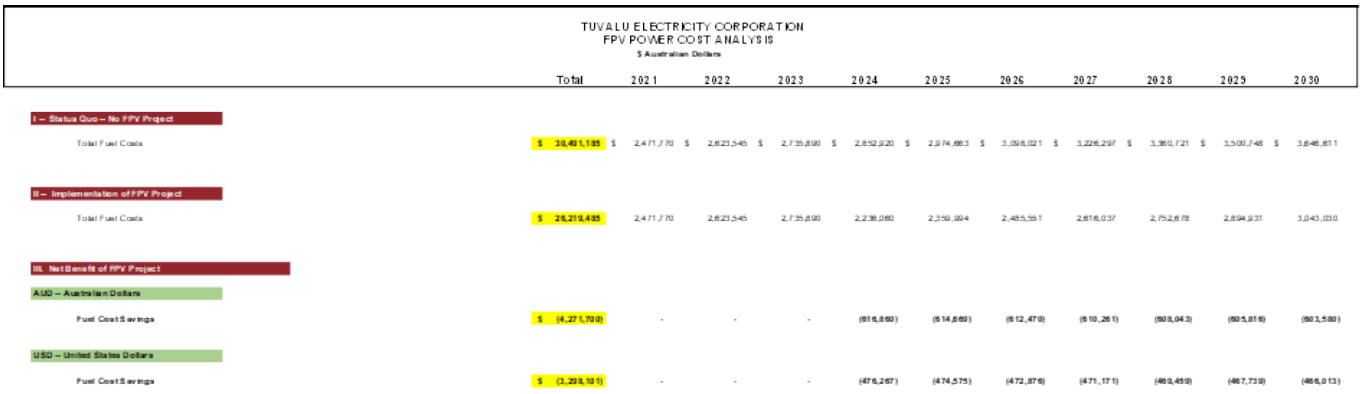
? Support to efforts to lower costs. Increased efficiency, under Outcome 3, (through the smart management systems and improved technologies) will lead to less cost per kW output. This will lead to benefits for both TEC and consumers. This will provide incentives for all stakeholders to maintain support for the RE technologies. This increases financial sustainability;

? Capacity building. The project includes several capacity building and training programs under Outcome 3, covering technological issues (managing and operating the new technologies), management capacity, financial management capacity, revenue enhancement, equipment operations and maintenance (O+M), etc. These include major on-the-job training activities and, where necessary, participation in international training events. These will greatly increase TEC and Tuvalu independence and ability to sustain the high levels of performance;

? Awareness raising. Targeted awareness raising programs will raise public and key stakeholder support for the technologies and power systems, providing additional incentives to maintain high levels of performance.

**Financial sustainability**. As mentioned previously, TEC operates at a loss and has done for several years. This is a significant barrier to investing in operations and maintenance and additional enabling technology, or human resources. The project, by investing in renewable energy and so decreasing the reliance on diesel imports, should lead to TEC operating closer to break-even (however losses can still be expected). This will increase opportunities for TEC to become financially sustainable. The above-mentioned tariff decision will play a key role in this transition.

In addition to increasing revenue through the tariff work, the project will also lead to reduced costs. The project analysis of generation, costs, revenues and tariffs (draft)[26][26] completed in early 2022 projected the following in terms of reducing the costs of generating electricity as a result of the project.



TUVALU ELECTRICITY CORPORATION
FPV POWER COST ANALYSIS
$ Australian Dollars

| | Total | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I – Status Quo – No FPV Project | | | | | | | | | | | |
| Total Fuel Costs | $ 30,491,185 | $ 2,471,770 | $ 2,623,545 | $ 2,735,890 | $ 2,852,920 | $ 2,974,883 | $ 3,098,021 | $ 3,226,297 | $ 3,360,721 | $ 3,500,748 | $ 3,646,611 |
| II – Implementation of FPV Project | | | | | | | | | | | |
| Total Fuel Costs | $ 26,219,435 | 2,471,770 | 2,623,545 | 2,735,890 | 2,236,060 | 2,359,994 | 2,485,551 | 2,616,037 | 2,752,678 | 2,894,931 | 3,043,030 |
| III. Net Benefit of FPV Project | | | | | | | | | | | |
| AUD – Australian Dollars | | | | | | | | | | | |
| Fuel Cost Savings | $ (4,271,750) | - | - | - | (616,860) | (614,889) | (612,470) | (610,261) | (608,043) | (605,816) | (603,580) |
| USD – United States Dollars | | | | | | | | | | | |
| Fuel Cost Savings | $ (3,298,101) | - | - | - | (476,267) | (474,575) | (472,876) | (471,171) | (469,459) | (467,739) | (466,013) |

Figure 3: Projections of costs and revenues

It can be seen that, as a result of the project, once the FPV generation capacity comes on line[27], the project will lead to reduced generation costs of over AU$400,000 *annually* year. It is noted that this was prepared based on 2020/2021 figures. Updated figures are not available, however, subsequent increases in the international fuel price volatility mean that savings would be even greater if calculated now.

**Potential for scaling up**

IAREP Phases I and II support implementation of the middle stages of the Funafuti Road Map to 100% renewable energy on Funafuti. After the completion of this project, Funafuti can be considered at mid-stage 2. Subsequent investments will take Funafuti to the end of stage 2, and into stage 3 and to 100%. That is the first scaling up strategy. It is expected that ADB, World Bank and other partners will continue to support Tuvalu on this transition.

More strategically, the project will develop and demonstrate the use of floating PV on lagoons and relatively calm waters in the Pacific. This will be a major learning process ? many lessons will be learnt as to how, when, where, which FPV technologies to use. The FPV technology is potentially applicable to many sites across the Pacific, sites with constant, high levels of sunlight, and with many lagoons or inland wetlands and lakes (with relatively calm waters and located to urban settlements). Hence, the technology, and the process to rolling it out, can be replicated across many small island states, in the Pacific and beyond. There is important potential for scaling up.

In order to facilitate this scaling-up, ADB in partnership with all governments in Pacific has developed Road Maps for FPV Development on 11 Pacific Island States. These Road Maps, for each country (i) assess potential sites based on multi-criteria analysis (ii) propose suitable sites (iii) asses enabling technology and grid upgrade needs (iii) assess legislative capacity for rolling out FPV and other barriers (iv) include pre-feasibility studies for a first set of investments in FPV in each country. These Road Maps

are currently being used by Governments, ADB and other development partners as a coordination and resource mobilization tool. The Road Maps and sites have been discussed with the concerned utilities in each state. Based on these discussions, the first countries likely to practically start Road Map implementation (as well as Tuvalu) are Kiribati, FSM, RMI and Cook Islands ? for whom either Feasibility Studies or Concept Papers have already been prepared. Other interested parties include Tonga. This process will ultimately be rolled out to all eleven Pacific Island states.

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[1] see: datacommons.org (accessed 2 March 2023)

[2] See World Bank: https://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations

[3] It is noted that, in this report, many statistics pre-date the Covid Pandemic. As a result of international borders being closed for approximately 18 months, followed by a period of difficulties traveling due to very limited flights, it has not yet been possible to update public statistics.

[4] Tuvalu?s Second National Communication to UNFCCC, Government of Tuvalu, 2015

[5] See report No. 98793-TV, 15 August 2015.

[6] *Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports*

[7] ?*NextGen? Projections for the Western Tropical Pacific: Current and Future Climate for Tuvalu.*
[8] Since been revised to 2030 (personal communication, TEC)

[9] *Tuvalu ? Funafuti Road Map,* 2019, Entura. Prepared for Government and ADB under TA 6242.

[10] Noting that Funafuti accounts for over 85% of the national electricity production and consumption.

[11] According to FASNETT project document, figures for 2016.

[12] The latest year for which reliable figures are available. There is no reason for the situation to have changed significantly since.

[13] Source: Updated NDC, Government of Tuvalu, 2023. Note, IRENA (Country Profile Tuvalu, 2020) has different figures. According to IRENA: (i) in 2019, total generation was 9GWh, of which 2GWh (or 23%) was from solar; (ii) of a total 5MW installed capacity, 2 MW or 42% was solar. The assessment work carried out under the preparation of this project suggests that those IRENA figure may be overestimates.

[14] Tuvalu Renewable Energy Project ? Feasibility Report, 2019, Entura. Prepared for Government of Tuvalu and ADB under TA 6242.

[15] Note, on fresh water, the water conservation through reduced evaporation provides a significant advantage of floating solar. However, this can also be achieved on seawater or marine environments. The floating solar plant envisaged in the project will include climate resilience features and other cross-sectoral integrated solutions including but not limited to rainwater harvesting to provide readily available water for module cleaning and agricultural applications (indicatively, vertical farming or aquaculture) and thus addressing energy-water-food-climate nexus ? as the use of energy and water at the same spot can be used to efficiently grow food.

[16] These dates assume the current generation capacity is maintained, should existing units become non-functional, these deadlines will be hit much earlier.

[17] See Begg Z., Wandres M., Damlamian H., (2023). COSPPac Wave Climate Reports. Tuvalu, Funafuti. The Pacific Community (SPC ). Available at http://oceanportal.spc.int/portal/app.html#climate

[18] Sustainable Blue Economy Finance Initiative - A leadership community accelerating the transition towards the sustainable use of the world?s ocean, seas and marine resources (UNEP)

[19] Source: https://www.globalcoral.org/faq/

[20] See, for example, ?Common Principles for Climate Mitigation Finance Tracking?, World Bank (https://www.worldbank.org/content/dam/Worldbank/document/Climate/common-principles-for-climate-mitigation-finance-tracking.pdf)

[21] These costs include overruns and related CSC consultancy. Actual costs are higher, over-runs are taken up by ADF under phase 2.

[22] Estimates based on latest restructuring agreement, September 2022. This includes consultancies, oversight, and related capacity building management.

[23] Refers to amount of electricity generated over average 24 hour period as percentage of situation with 100% sunlight.

[24] 2020 figure

[25] See Cabinet Decision of 31 January 2023.

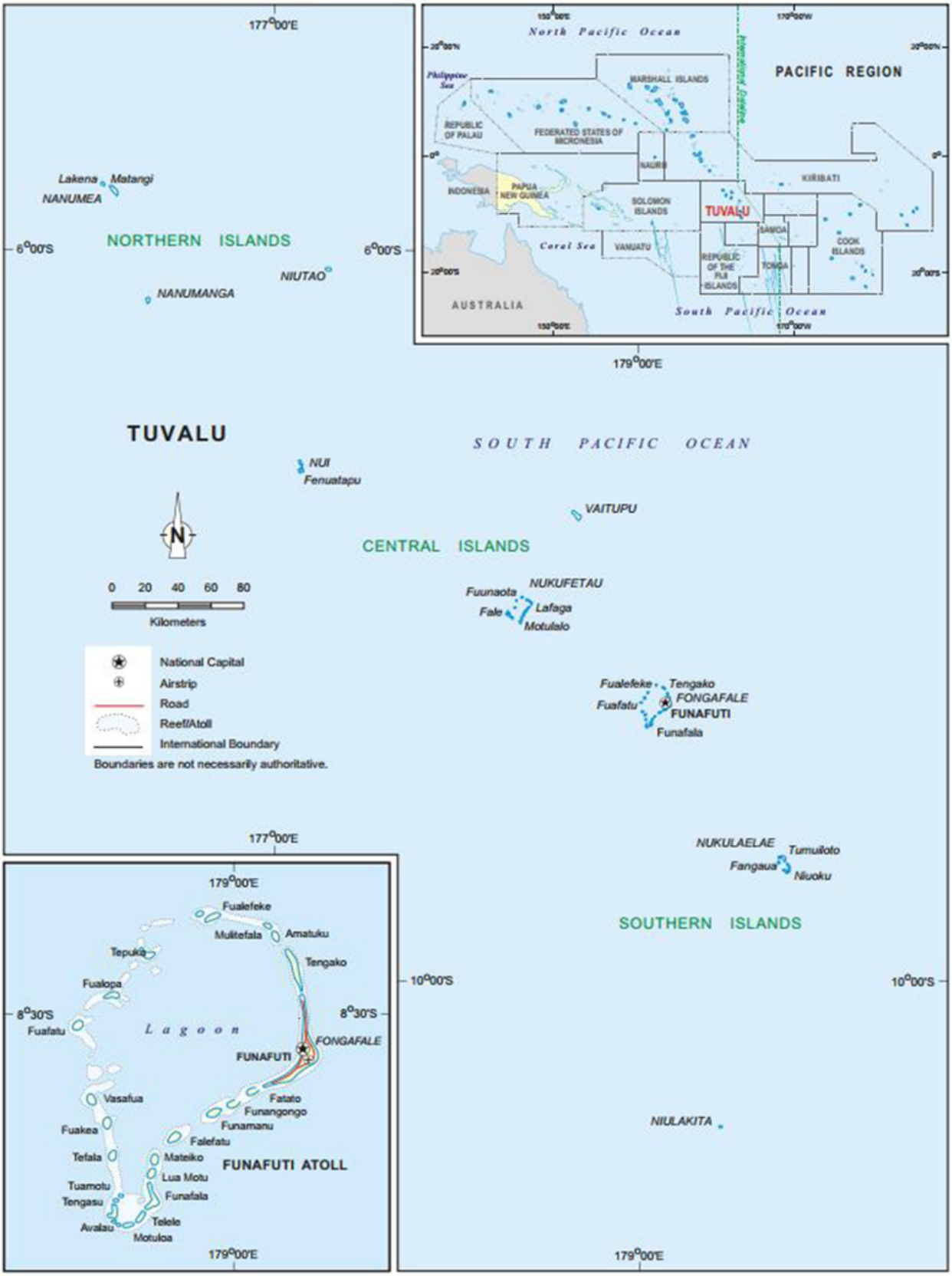
[26] See ?FPV Tariff Review and Analysis? prepared for the Project by Jackson, D. (Draft of February 2022)

[27] The table was prepared in 2020/2021, when it was expected that the FPV would be installed and operating by 2024. Subsequent Covid-related delays have put this back to at least 2025.

**1b. Project Map and Coordinates**

**Please provide geo-referenced information and map where the project interventions will take place.**

The project site is the three outer islands (Nukulaelae, Nukufetau and Nui) and Funafuti, Tuvalu, located in the South, Central Pacific. The coordinates for Funafuti are: 08?31?S 179?12?E. The locations of Tuvalu in the Pacific, of Funafuti and the three outer islands are illustrated in the maps in Annex E.


177°00'E
Lakena
Matangi
NANUMEA
NORTHERN ISLANDS
6°00'S
NIUTAO
NANUMANGA
North Pacific Ocean
PACIFIC REGION
Philippine Sea
MARSHALL ISLANDS
REPUBLIC OF PALAU
FEDERATED STATES OF MICRONESIA
NAURU
KIRIBATI
INDONESIA
PAPUA NEW GUINEA
SOLOMON ISLANDS
TUVALU
SAMOA
Coral Sea
VANUATU
COOK ISLANDS
REPUBLIC OF THE FIJI ISLANDS
TONGA
AUSTRALIA
South Pacific Ocean
179°00'E
TUVALU
SOUTH PACIFIC OCEAN
NUI
Fenuatapu
VAITUPU
CENTRAL ISLANDS
N
0 20 40 60 80
Kilometers
NUKUFETAU
Fuunaota
Fale
Lafaga
Motulalo
Fualefeke
Tengako
Fuafatu
FONGAFALE
FUNAFUTI
Funafala
National Capital
Airstrip
Road
Reef/Atoll
International Boundary
Boundaries are not necessarily authoritative.
177°00'E
179°00'E
Fualefeke
Multefala
Amatuku
Tengako
Tepuka
Fualopa
8°30'S
Fuafatu
Lagoon
FONGAFALE
FUNAFUTI
Vasafua
Fatato
Funangongo
Funamanu
Fuakea
Falefatu
Tefala
Mateiko
FUNAFUTI ATOLL
Lua Motu
Tuamotu
Funafala
Tengasu
Avalau
Telele
Motuloa
179°00'E
NUKULAELAE
Tumuiloto
Fangaua
Niuoku
SOUTHERN ISLANDS
10°00'S
NIULAKITA
179°00'E

On Funafuti, a systematic multi-criteria analysis was undertaken to identify optimal sites for FPV, battery storage and grid connection sites.

The logistic needs for a floating PV plant are greater than for a ground mounted PV. Although the site of the plant is a body of water, the assembly of the plant occurs onshore. Therefore, the evaluation of sites for floating PV projects followed the following criteria:

? Solar irradiation (GHI) and meteorological data including soiling potential (notably including wind and storm analysis to ensure low storm risk);
? Site conditions ? bottom analysis (benthic), bathymetry, seismic, hydrological, security, safety analysis;
? Potential location for the pooling of power with consideration of whether inverters will be floating or placed onshore;
? Accesses to the site including an access to the body of water and an assembly point, which in the case of Tuvalu and due to land scarcity, shall be combined as much as possible with the location for the pooling of power;
? Environmental impacts; and,
? Social impacts.

Based on the above, the FPV area is to be located near the Princess Margaret hospital, north of Funafuti centre. This part of the island is where most of the population live - with around 4,000 inhabitants ? leading to the highest energy demand (1,300 kW peak load). Being inside the lagoon, this area is more protected from harsh or extreme weather conditions such as strong winds and cyclones.

Full details of the site are provided in the Feasibility Study in Appendix 1. These include information on water quality, bathymetry, wave and sea current conditions, meteorological and wind conditions, access and opportunities to evacuate the power produced to the grid.

Given the nature of the technology, wave and sea conditions are a primary factor in the choice of siting and design. Accordingly, specific assessments of wave data and modelling have been developed and obtained for the selected site. These have been used in the comprehensive climate vulnerability and risk assessment (CVRA) of the project (see Appendix 2).

**1c. Child Project?**

**If this is a child project under a program, describe how the components contribute to the overall program impact.**

**2. Stakeholders**

**Select the stakeholders that have participated in consultations during the project identification phase:**

**Civil Society Organizations** Yes

**Indigenous Peoples and Local Communities**

**Private Sector Entities** Yes

**If none of the above, please explain why:**

**Please provide the Stakeholder Engagement Plan or equivalent assessment.**

**Approach**. Both ADB and GEF policy and procedures require projects to engage in, and to carefully document, meaningful consultation with stakeholders. ADB defines ?meaningful consultation? as a process that:

? begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle;
? provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people;
? is undertaken in an atmosphere free of intimidation or coercion;
? is gender inclusive and responsive and tailored to the needs of disadvantaged and vulnerable groups; and
? enables the incorporation of all relevant views of affected people and other stakeholders into decision making such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

a). Consultations during project design

Travel restrictions imposed nationally in response to COVID 19 pandemic limited and delayed direct consultations with affected stakeholders and the gathering of primary data during the early stage of project preparation. Initially, remote on-line consultations using internet-based video conferencing platforms was relied on and several meetings were held but restricted in participation to representatives of ADB, government ministries and corporations, a limited number of local experts and representatives of the TA consultant. Logistical issues in organizing and holding similar on-line consultations with project affected communities meant this option was not utilized.

Direct face-to-face consultations were made possible with the lifting of travel restrictions from early November 2022. Several meetings with government agencies and TEC were conducted virtually on internet-based platforms in 2022, culminating in face-to-face meetings in November 2022 when travel restriction were lifted. Several stakeholder meetings were held in March 2023 with Government agencies, Funafuti Kaupule and the local community. Overall this has included broad-ranging consultation with staff and officers of TEC, all concerned offices of the national and local governments, the national women?s NGO, the potentially affected landowners, the Kaupule (community chiefs) and representatives of the Funafuti Native Lands Trust Board. This consultation occurred through workshops, public meetings, and semi-structured interviews. Full reports of these meetings are in the Poverty and Social Assessment (Appendix 7).

Key take-aways from the consultations. All stakeholders were found to support the project. The overriding request from community stakeholders was for the new infrastructure to help reduce electricity

tariffs ? upon which they were advised that electricity tariffs may not be reduced as a result of the increased penetration of renewable energy because of the large current gap between TEC revenue and expenses.[1] Community stakeholders expressed no other concerns.

b). Consultations and engagement during project execution

A Stakeholder Participation and Engagement Plan (draft) has been prepared ? see Appendix 3.

The project objective includes the increased utilization of renewable energy, through increased generation but also through the increased adoption of PUE. This requires an ongoing engagement with all stakeholder groups. As can be seen from Appendix 3, the following all have a role in project implementation:

? TEC and PMU. These are mostly involved in management, technical support, but also as beneficiaries;
? Local governments (kaupule) and communities. These are mostly involved in an advisory and consultative role, and mostly to make sure that the final design of all inputs are tailored to the needs and ability of the communities on Funafuti;
? TEC customers. They are mostly beneficiaries of an improved knowledge and service. However, some will benefit from business development and employment opportunities under Output 2.

Finally, specific awareness raising and outreach activities to be implemented under Outcome 3 will include a focus on (i) energy awareness (ii) energy efficiency (iii) GHG emissions and climate change.

c). Information dissemination

Multiple modes of communication will be used to increase awareness among a broad range of stakeholders. Information dissemination will occur through notice boards in communities, briefing of chiefs, mass media (especially radio and television), radio talk back, and formal information events and training.

The proposed project will also look for opportunities to use technology, such as cell phone messaging, Facebook or WhatsApp groups to share information and events, and video recording of meetings. These technology tools can also have the advantage of reaching people who may have difficulty physically attending community meetings, such as people with a disability or female household heads. The proposed project will also explore the use of different forms of media, such as radio, television, and theatre groups.

Whatever the method, information must include appropriate contextual adjustments in content, to meet the specific requirements of target groups. This can be achieved by the following:

? Standardizing technical information for use by all stakeholders;
? Assessing target communities prior to introduction of awareness activities to ensure that projects are tailored to community needs;
? Engaging all relevant stakeholders, including vulnerable groups, in planning awareness activities and ensuring access by remote communities;
? Expanding guides and tools for community awareness activities that are focused on the local level; and
? Using diverse mechanisms, including mobile phones and social media, to reach communities with disaster risk and climate change information.

[1] Note, from Entura 2019a, current average tariff is approximately AU$0.5/kWh, whereas actual cost recovery tariff would be greater than AU$0.7. The tariff has remained unchanged since it was legislated in January 2008.

In addition, provide a summary on how stakeholders will be consulted in project execution, the means and timing of engagement, how information will be disseminated, and an explanation of any resource requirements throughout the project/program cycle to ensure proper and meaningful stakeholder engagement

See Stakeholders Plan
**Select what role civil society will play in the project:**

**Consulted only;** No

**Member of Advisory Body; Contractor;** Yes

**Co-financier;**

**Member of project steering committee or equivalent decision-making body;**

**Executor or co-executor;**

**Other (Please explain)** No

The involvement of all sections of society in project development and implementation is particularly important as the technology being introduced is highly innovative and potentially disruptive. Tuvalu is a small country with a close-knit population. National and local government staff have direct personnel contacts and engagement with a large percentage of the general population. Notwithstanding, there is a vibrant civil society and the constructive exchanges of views and opinions is central to the Tuvaluan society.

Accordingly, during project preparation and the implementation of early components, there has been regular and broad-ranging consultation. This has included the staff and officers of TEC, all concerned offices of the national and local governments, the national women?s NGO, the potentially affected landowners, the Kaupule (community chiefs), the representatives of the Funafuti Native Lands Trust Board, and representative local consultation groups. This consultation occurs through field visits, local workshops, public meetings, semi-structured interviews with key informants and bilateral consultations with key stakeholders. The findings so far indicate that, in general, all stakeholders support the project.

Several project activities during implementation aim to further develop this aspect. Notably (i) activity 3.1 (outreach, assessment, consultation and planning) involves stakeholder engagement as part of project due diligence; (ii) activity 3.3 provides training to TEC and key government personnel on stakeholder engagement and community outreach techniques and skills; and, activity 3.5 (Knowledge

management) includes the elaboration and implementation of a communications Strategy. In general, CSOs or NGOs may be involved as service providers for these or other activities, in line with ADB procedures.

**3. Gender Equality and Women's Empowerment**

**Provide the gender analysis or equivalent socio-economic assesment.**

Does the project expect to include any gender-responsive measures to address gender gaps or promote gender equality and women empowerment? Yes

If possible, indicate in which results area the project is expected to contribute to gender equality:

? closing gender gaps in access to and control over natural resources - Yes
? improving women's participation and decision-making - Yes
? generating socio-economic benefits or services for women - Yes
? Does the project?s results framework or logical framework include gender-sensitive indicators? Yes

A gender assessment with gender action plan (GAP) has been prepared as part of project preparation. These are included in Appendix 4a and 4b.

The gender assessment noted that achieving gender equality is a key aim for Tuvalu, and consequently the Government of Tuvalu?s Te Kakeega III National Strategy for Sustainable Development 2016 - 2020 identifies gender as one of its key policy objectives, ?*To promote gender equity and to expand the role of women in development?*. To achieve this, the Office of the Prime Minister Gender Affairs Department is responsible for promoting gender equality and including it in the national discussion. The National Gender Policy (NGP) 2013 is the latest in a series of efforts that started in 1999. The policy focuses on four key measures where public policies could make a difference, including institutional strengthening and capacity building; building economic empowerment of women; promoting women political voices and decision-making; and advancing the legal rights of women. As far back as 2009, the Tuvalu National Energy Policy (NEP) acknowledged ?the needs of different gender groups and noting the distinct needs of men, women, children and social groups will be taken into consideration in any energy development activities? and so it included ?gender equity? as one of six guiding principles.

Despite the above, the gender assessment notes many challenges in reaching gender equity in Tuvalu, particularly in the energy sector. These are observed to be due to long-term, strategic obstacles, and cannot be removed either quickly or easily. For example, only 4.2% of technical positions are held by women across Tuvalu as a whole. it notes that Tuvalu as a patriarchal society, its ?perceptions and influences, impacts women participation at the decision-making levels including parliament, state-owned enterprises, village councils, churches, private sector and households. This is compounded family values, stereotyping, social norms, streaming in schools, interpretation of cultural norms and religious beliefs.? This notably leads to women being discriminated against in the workforce.

As a result, the GAP is ambitious yet based on a realistic understanding of the current situation and opportunities. It includes specific gender indicators for each Output: 4 for Output 1, 6 for Output 2, and 8 for Output 3. Particularly for Output 3, a long term, strategic approach is adopted for mainstreaming gender equity across the sector. Based on previous experience, the target is to ensure that the project hires ?at least 20% women in both technical and non-technical work, with at least 30% in the PMU, and the ambition of 30% all round?.

As a result of the above, the overall impact of implementing the project, and the GAP, is expected to lead to an increased empowerment for women, and to giving women increased agency and control over their livelihoods and resources. As mentioned above, there is an ongoing process to update the gender assessment and GAP, which is expected to lead to further support for gender mainstreaming.

The overall implementation of the GAP will be led by the Social Safeguards and Gender Specialists (internal and local) under the guidance of the Project Management Unit (PMU). The specialists will be responsible for delivering the gender mainstreaming measures and targets during project implementation and establishing sex-disaggregated data collection for project performance and monitoring, in coordination with the contractor, PMU, Gender Affairs Department and other relevant government agencies. The PMU will report the progress of GAP and safeguard activities in its quarterly progress reports and semi-annual GAP progress reports to ADB and the government. These and other gender related tasks will be explicitly incorporated into the TOR of the concerned managers and team member.

**Does the project expect to include any gender-responsive measures to address gender gaps or promote gender equality and women empowerment?**

Yes
**Closing gender gaps in access to and control over natural resources;** Yes

**Improving women's participation and decision making** Yes

**Generating socio-economic benefits or services or women** Yes

**Does the project?s results framework or logical framework include gender-sensitive indicators?**

Yes
**4. Private sector engagement**

**Elaborate on the private sector's engagement in the project, if any.**

Tuvalu?s economy is highly vulnerable to external shocks and income volatility due to its exposure to climate change, geographical remoteness, dependence on imports and reliance on revenue from overseas. Private sector growth is constrained by the small-scale of the economy; the high costs of doing business; and the country?s dispersed population. Hence, the public sector dominates and accounts for over half of the country?s population in permanent employment.

The major private sector organisation in Tuvalu is the Tuvalu National Private Sector Organization, which was established in 2012 and combines the Chamber of Commerce and the former Tuvalu Private Sector Organization. The Tuvalu National Private Sector Organization currently has 50 members from an estimated 200 plus businesses in Tuvalu, and it aims to promote the interests, well-being, and growth of Tuvalu?s private sector. The private sector takes a keen interest in the coverage and quality of infrastructure services as a major consumer of these services.

Private businesses involved in infrastructure provision include a major hardware supplier and a number of smaller suppliers; individuals involved in repair and maintenance of buildings, vehicles and machinery; and individuals engaged in smaller construction jobs. Most of these businesses are operated by individuals rather than companies. Larger buildings, civil works, and significant maintenance works are handled either by the Public Works Department or foreign contractors.

Larger projects undertaken by foreign contractors often engage locally available skills, although these arrangements are more in the nature of employment than subcontracting. Tuvaluans based overseas are beginning to take an interest in bidding for work in Tuvalu, and, in a couple of instances, have registered construction companies locally.

Working within these constraints, the project takes several measures to specifically promote the private sector: These may include:

Under Output 1, local private sector may be involved in implementation, providing goods or services, most likely as a sub-contractor to a lead international contractor. Further, as Output 1 leads to an upgrading of the energy system, it will lead to improved business conditions that facilitate private sector development.

Under Output 2, the focus on PUE is very much aimed at facilitating/fostering private sector development. In many cases the PUE supported activities will create quality local, private-sector employment. Output 2 is expected to have a sizeable beneficial impact on the private sector. Of particular importance is the construction of wave breakers and reef generation installations, which are expected to draw on local private sector inputs.

Output 3 involves a small number of actions that will benefit the private sector. The tariff review and subsequent tariff revisions will lead to increased stability and revenue from electricity ? and a more stable supply ? all good for private sector. The development of business models, for both FPV and PUE, should also create model approaches and capacity for private sector.

**5. Risks to Achieving Project Objectives**

**Elaborate on indicated risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and, if possible, the proposed measures that address these risks at the time of project implementation.(table format acceptable):**

Climate Risks and Challenges

As discussed in the Feasibility Study (FS) and the Climate Vulnerability and Risk Assessment (CVRA) (Appendices 1 and 2), the technology ? floating solar - is to be exposed to climate risks, notably storms, waves, winds and sea level rise. These are to become greater with climate change. As a result, additional analysis has been undertaken of the wave climate in order to determine the implementation specifications.[1]

In summary, the following measures are taken to ensure that the investment is resilient to severe weather events, notably cyclones:

- Location *inside* the lagoon, this area is more protected from harsh or extreme weather conditions such as strong winds and cyclones.
- East-west configuration for the PV modules at 5? tilt maximum: this will add compactness, lower mechanical and wind loads and will not reduce generation.
- Floaters filled with water to make them heavier and also sunk in the water, decreasing drag and lift forces by strong winds and also adding to the mechanical strength of the floating structure
- Smaller floating islands up to 600 kWp or so to decrease the mechanical strengths within each floating structure and also to reduce the load on the anchors allowing them to withstand stronger winds. This will result in a more expensive plant though.
- Increased tensile strength of the floating structure modules that are connected to the anchors.
- Use of a wave breaker. This will be placed in front of the FPV plant for wave attenuation. It will be anchored to the seabed. It could be made of large sandbags or other materials produced locally. This type of coastal protection solution is practical and cheap, being widely used around the world, greatly reducing the project costs and having a low environmental impact.

In addition to the above, and based on the thorough risk assessment, risk mitigation strategies have been undertaken, as set out in the following (note, in many cases, lessons are being learnt from the start-up of IAREP I):

| Risk Description | Level | Mitigation Measure |
|---|---|---|

| | | |
|---|---|---|
| **Project implementation capacity**<br><br>Insufficient institutional, procurement, and technical capacity and experience in implementing investment projects causes delays or other implementation challenges. | Medium | The project builds on IAREP I. IAREP I has experienced delays, in part due to Covid. It is expected that lessons have been learnt. Capacity building under IAREP has commenced and is expected to address key capacity issues.<br><br>Institutional capacity building to TEC has been provided and will continue. With regards to procurement, a strategic approach to procurement is being developed for IAREP II, covering potentially activities in both Tuvalu and Kiribati. For example, as part of that, market sounding has taken place and a strategy for identifying qualified bidders developed. Innovative and streamlined processes may be developed.<br><br>Going forward, ADB, the PMU, and the construction supervision consultant will assist the TEC, MTET, and MOF in project implementation, execution, monitoring, and procurement. |
| **Governance**<br>Weak financial management capacity, lack of internal audit function within TEC, and potential misuse of funds | Low-medium | The project builds on IAREP I. IAREP I has experienced delays, in part due to Covid. It is expected that lessons have been learnt. Financial management capacity has not been a major issue in IAREP I. Capacity building under IAREP has commenced and is expected to address key capacity issues.<br><br>An internal audit program of TEC is applied through the utilization of the central internal audit unit and with TEC initiating the process of restating its financial statements with the agreement of its external auditor.<br><br>Looking forward, ADB will have strong oversight during the project, which will include holding biweekly teleconferences and two review missions per year. |

| | | |
|---|---|---|
| **Utility and asset sustainability**<br>Current tariff structure does not provide cost recovery for TEC and requires the Ministry of Finance or external parties to provide funding to TEC.<br><br>There is a related lack of funds and capacity for routine maintenance and for quick recovery after disasters. | Medium | A thorough tariff review has taken place and a pathway to full cost recovery for TEC developed. Major recommendations have been adopted by Cabinet. Outcome 3 will support implementation of the Cabinet decision.<br><br>Government subsidies and tariff levels ensure coverage of basic operation and maintenance costs, debt service, and capital replacement. The TEC will implement the operation and maintenance plan.<br><br>Comprehensive institutional capacity building will be provided.<br><br>Assets will be insured, as will TEC, against disasters and catastrophes. |
| **Insufficient O&M capacity.** Experience with some installed PV in the past on Tuvalu suggests that, in some cases, O&M capacity is insufficient to maintain equipment in strong working order. This could be a particular challenge with floating PV. | Medium | To ensure technical and financial sustainability, the project incorporates lessons learnt from previous solar projects in its design and specifications. For example, it includes support for consulting services for project management and for construction supervision. It also includes a comprehensive and inclusive institutional capacity development program covering technical aspects. Building on IAREP I, great attention will be applied for developing a sustainable approach to O&M. This is a focus of capacity building under Outcome 3. |
| **Climate Change (during project implementation period)** | | |
| Damage to equipment or civil works during project implementation | | ADB and partners have experience implementing civil works projects in Tuvalu and are aware of the measures required and how to mitigate this risk. This builds on experience under IAREP I. Full care through project management will be taken to ensure no damage occurs. |

| | | |
|---|---|---|
| Delays to project activities due to storms or other climate impacts. | | Climate events may lead to late deliveries or the need to halt works for short periods.<br><br>ADB and partners have experience implementing civil works projects in Tuvalu and are aware of the measures required. Further, flexibility will be built into the implementation plan meaning: (i) short delays can be tolerated without leading to overall delays and (ii) flexible sequencing will allow non-affected activities to take place when affected activities are held up. |
| **COVID Pandemic Related Risks:** The global COVID Pandemic led to a series of new risks to be monitored, and mitigated if necessary. Although these appear to be less significant currently, this situation should be monitored and managed. These risks and management measures are summarized in the following: | | |
| Restricted enabling environment or finance, as government prioritises COVID response over energy sector development. | Medium | Government commitment to energy transition (and therefore the overall project goals) remains extremely high and immovable. |
| Implementation delays due to COVID Pandemic. | Low | It is anticipated that the impacts of the pandemic will be finished before the project implementation period. Additional mitigation measures are:<br>? Creating flexibility in the sequencing of project activities where possible;<br>? Through the strategic procurement plan, the project will explore the possibility of using national Tuvalan firms or international firms with local offices in Tuvalu. |
| Limited availability of technical expertise ? due to reduced flight availability to Tuvalu in follow-up to pandemic. | Low | Concerned project activities may be delayed, but this is not considered to be a risk to overall project success. |

Table 13: Risks

However, the Covid pandemic, like all crises, may also provide opportunities for building back better. All such opportunities will be explored and assessed in line with ADB policy. The following table provides the initial opportunity assessment. This will be continually assessed by the ADB (in line with Asia-Pacific wide activities) and by the project management.

| **Opportunity Category** | **Project Activities** |
|---|---|

| | |
|---|---|
| **Social** | The Covid-19 pandemic has served to underline the importance public services. Public understanding of the need for a reliable energy to support all services is higher. This is a good opportunity for investing in renewable energies with public support, including tariff reforms. |
| **Economic/Fiscal** | The economic and fiscal impacts of the pandemic have been very significant, and negative, for Tuvalu. A comprehensive and united effort is required to get the economy and fiscal balances back on track. Initial signs are that communities are motivated to work collectively to achieve these goals. The project will explore potential opportunities. |
| **Communication** | The normalization of online conferencing and communication platforms since early 2020 means that online interaction, online teaching, online capacity building, online meetings and online conferences have become much more commonplace and accepted by a broad range of global stakeholders. This has paved the way for stakeholders to reach a much wider range and bigger number of participants through capacity building and network building activities. The project will optimize these possibilities. The Pacific region covers a very large area and traveling can be is expensive (both in terms of time, monetary and carbon costs). The switch to optimal digital communications can therefore decrease costs and increase overall communications. |
| **Data sharing** | The pandemic affected everyone in the world in one way or another; this has forced millions of people to re-evaluate the way they operate. Without a doubt, this is an opportunity to innovate and grow digitally (new technology, information display, among others). The project will be guided by this. |

Table 14: Covid opportunities assessment.

[1] Using Begg Z., Wandres M., Damlamian H., (2023). COSPPac Wave Climate Reports. Tuvalu, Funafuti. The Pacific Community (SPC ). Available at http://oceanportal.spc.int/portal/app.html#climate

**6. Institutional Arrangement and Coordination**

**Describe the institutional arrangement for project implementation. Elaborate on the planned coordination with other relevant GEF-financed projects and other initiatives.**

Institutional arrangements

GEF funds and ADB co-financing are to be managed by ADB and the Government. All works, goods, and services under the project will be procured by the recipient in accordance with ADB?s Procurement (2017, as amended from time to time).

Institutional arrangements are a continuation of the recently started Phase 1.

The project executing agency is the Ministry of Finance (MOF) of the Government of Tuvalu. TEC is the implementing agency with oversight by MTET. A project management unit (PMU), led by a project manager, and overseen by TEC general manager, will be established.

The National Infrastructure Steering Committee (PSC) provides government oversight, whilst a Project Steering Committee will provide project implementation oversight. PSC comprises the CEOs of MOF, MTEM, and the TEC General Manager.

The PMU will be technically supported by a construction supervision consultant (CSC). In this, a team of PV and BESS, financial, social and environmental safeguards and gender experts will support the PMU and TEC in project management, implementation and construction supervision. Key responsibilities are set out as follows:

| **Implementation organization** | **Management roles and responsibilities** |
|---|---|
| Ministry of Finance (Executing agency, EA) | ? Overall delivery of the project and reporting to Government.<br>? Ensure compliance with grant agreement covenants.<br>? Coordinate with TEC the preparation of withdrawal applications and submit to ADB.<br>? Maintain separate project accounts, have all project accounts audited annually and send to ADB.<br>? Ensure the compilation and presentation of all reporting requirements under the project. |
| TEC/MTET (Implementing agency, IA) | ? Responsible for the overall implementation of the project.<br>? Ensure compliance with the provisions of the Grant and Project Agreements and government policies and guidelines.<br>? Responsible for procurement and services for the project.<br>? Issue contract change orders as appropriate.<br>? Establish and implement the project monitoring and evaluation framework.<br>? In coordination with MOF and assisted by the PMU, will maintain separate project accounts and records by funding source for all expenditures incurred on the project. |
| National Infrastructure Steering Committee | ? Comprising of the CEOs of MOF, MLGA, MTET, MPWIELD, GM of TEC and Directors of Departments of Energy, and Environment.<br>? Chaired by CEO of MTET.<br>? Responsible for providing Government oversight of project and reporting to DCC and Cabinet. |

| | |
|---|---|
| Project Management Unit (with CSC assistance) | ? Responsible for oversight of the implementation of the project, under the direction of the IA, to ensure compliance of contractors with contracts, specifications and management plans.<br>? Prepare reports and supporting information for the EA, IA and Task Force as required.<br>? Ensure readiness of all project sites for contractor including surveyed and staked out sites, any required permits in place and secured lease agreements (if required). |
| ADB | ? Monitor and review overall implementation of project in consultation with EA and IA including project implementation schedule; actions required for summary poverty reduction and social strategy; gender action plan; environmental management plan; project expenditure progress with procurement and disbursement; compliance with grant covenants and likelihood of attaining project outputs and outcome.<br>? Consultant recruitment will be delegated by the EA/IA to ADB following an agreed Matrix of Responsibilities. |

Table 15: Implementing responsibilities

CEOs = chief executive officers, DCC = Development Coordination Committee, GM = General Manager, MLGA = Ministry of Local Government and Agriculture, MPWIE = Ministry of Public Works, Infrastructure and Environment and Lands Development.

Coordination, notably with other relevant GEF-financed projects.

Donor coordination with stakeholders at several levels appears to work well for Tuvalu and several mechanisms are in place, including annual high-level consultation meetings led by Tuvalu, biannual Tuvalu Trust Fund board meetings, and regular inter-donor high level meetings involving ADB, the Governments of Australia and New Zealand, the European Union and the World Bank.

The Tuvalu Task Force (TTF), and its members, that oversees and guides this project, will take the lead in ensuring coordination with all related activities in Tuvalu. Notably, TEC will ensure coordination with all energy sector related initiatives (institutional, capacity building and infrastructure).

ADB will support the TTF with coordination, notably by working with international partners to ensure coordination and synergy, including working with the World Bank, the Government of Australia and the Australian Infrastructure Financing Facility for the Pacific (AIFFP), the concerned UN agencies and international NGOs. ADB coordination will be led through the ADB Tuvalu Country office, with support from ADB technical staff in Fiji and in Manila.

On a day-to-day basis, the PMU will ensure coordination in the implementation of shared and complementary activities.

In addition, coordination will notably be established with the following projects:

| Project | Project aim | Status and coordination points |
|---|---|---|

| | | |
|---|---|---|
| Facilitation of the Achievement of Sustainable National Energy Targets of Tuvalu (FASNETT, GEF/UNDP funded) | FASNETT aims to facilitate the development and utilisation of feasible and renewable energy resources, and the application of energy efficiency technologies. It includes the output ?*Increased application of viable climate resilient renewable energy and energy efficiency technology applications in the country*?. | ? Under implementation.<br>? Activities are faced with delays due to the global COVID pandemic.<br><br>This project is to install 100kw of FPV on the inland Fongafale pond. Lessons will be learnt from that activity. Subsequently, and where possible, joint experts, training, awareness raising will take place. |
| Tuvalu Coastal Action Project (TCAP) (GCF funded) | The Project Objective is to reduce the vulnerability of three islands of Tuvalu to coastal inundation and erosion. This is being achieved through three outputs: (1) strengthening of institutions, human resources, awareness and knowledge for resilient coastal management; (2) Vulnerability of key coastal infrastructure including homes, schools, hospitals and other assets is reduced against wave induced damages in Funafuti, Nanumea and Nanumaga, and; (3) A sustainable financing mechanism established for long-term adaptation efforts | ? Under implementation<br>? Major player in international partnerships to support adaptation of Tuvalu.<br><br>Coordination activities and mechanisms will be developed with the TCAP office in Tuvalu, and the related UNDP office in Fiji. |
| ?Tuvalu: Funafuti Water and Sanitation Project (FWSP)? under the ?Climate Resilient Urban Development in the Pacific?<br><br>(Supported by ADB and GEF/LDCF) | The overall objective of this project is the ?*provision of climate-adapted, resilient, and improved drinking water supply, drainage, and sanitation services improved in Funafuti.?*<br><br>There are four components addressing water supply, sanitation, community awareness and behaviour, and institutional measures and sustainability. : reliable and safe water supply in Funafuti; effective, efficient, and safe sanitation; enhanced awareness of hygiene and water safety issues and sustained improved hygiene behavior, and; water supply and sanitation services on Funafuti are financially and technically sustainable. | ? Approved by GEF.<br>? Due to become operational in Q1/2024.<br><br>The two responsible ADB teams work closely together, in both Manila and Fiji. Where possible, lesson learning and knowledge management will be coordinated, this can notably be with regards to issues such as gender mainstreaming and adapting to climate change. |

Table 16: Related Projects supported by international partners

As highlighted at various points in this proposal, there is a parallel GEF initiative, to be supported by GEF International Waters and ADB and UNEP, with SPREP executing the UNEP components. This is the project:

?Pacific I2I Regional Project: Ocean Health for Ocean Wealth - The Voyage to a Blue Economy for the Blue Pacific Continent?, generally referred to as the ?I2I? project. This is closely related to Outcome 2.

**Coordination on Floating Solar in The Pacific**. ADB has a RE portfolio touching almost all Pacific island nations. FPV may be an appropriate technology for many or all of these. Hence, ADB is supporting the exploration and priming of FPV as an innovative, appropriate technology for the Pacific. In this context, ADB is supporting a regional technical assistance project. In addition to Tuvalu, activities are currently implemented in Kiribati and Tonga, and preparatory activities are underway in the Republic of the Marshall Islands, the Federated States of Micronesia and Cook Islands. In each country, the project supports assessments and road-mapping for FPV, project preparation for FPV projects, and necessary institutional capacity building.

**ADB in Tuvalu.** IAREP I is the first energy sector project for the ADB in Tuvalu, the financing for which is being processed under ADB?s Pacific Renewable Energy Investment Facility. The facility, approved in June 2017, (i) is designed to finance a large number of small-value renewable energy projects in the 11 smaller Pacific island countries,[1] and transform their power subsectors from diesel to sustainable renewable energy generation sources; and (ii) supports sector reform, private sector development, and capacity building.[2] The facility will finance renewable energy projects in the 11 smaller Pacific island countries with an overall estimated cost of $750 million, comprising up to $200 million in ADB financing, an estimated $500 million from cofinancing sources, and an estimated $50 million from government counterpart financing. The Facility focuses on coordination and lesson-sharing and synergies across the 11 Pacific Island States.

Finally, the project also takes place within the framework of the SIDS Accelerated Modalities of Action (SAMOA) Pathway. This aims to address the unique challenges faced by SIDS and to support their development. The ADB fully supports the objectives of the SAMOA Pathway and is involved in supporting SIDS across Asia and the Pacific. Notably, ADB is a solid institutional partner of the Pacific Community (SPC), and the SPC is a regional pillar for SAMOA implementation.

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[1] The 11 countries are the Cook Islands, the Federated States of Micronesia, Kiribati, Nauru, the Marshall Islands, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu. Smaller refers to population.

[2] The facility will benefit the 11 smaller Pacific island economies through (i) an improved balance of trade by reducing fossil fuel imports, (ii) improved energy security, (iii) downward pressure on tariffs, and (iv) and reduced greenhouse gas emissions.

**7. Consistency with National Priorities**

Describe the consistency of the project with national strategies and plans or reports and assesments under relevant conventions from below:

## NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc.

At the regional level, the project is aligned to the regional *Framework for Action on Energy Security in the Pacific* (FAESP) 2010-2020 (prepared by the Secretariat of the Pacific Community and endorsed by Pacific Island leaders). FAESP assessed the threats to achieving energy security in the Pacific. It found that the threats arise from the interaction of a multitude of factors including: fast growing populations without economies to match; remoteness and distances from main centres and supply chain pathways; vulnerability of energy infrastructure to natural disasters such as cyclones, earthquakes, flooding and tsunamis; inability to take advantage of economies of scale due to small populations and limited industrial activity; old and poorly maintained energy infrastructure, such as electricity generation, transmission and distribution systems; lack of technical and safety standards for energy supply, conversion and consumption systems; pricing policies that do not encourage investment in maintenance; and inadequate understanding of the potential of locally available renewable energy sources. These factors are present to varying degrees on Tuvalu, and the project is designed to respond to these threats strategically.

At the national level, the project is fully aligned to national priorities with regards to sustainable development, power supply and climate change, as described in the following sections.

Sustainable development:

Tuvalu?s National Strategy for Sustainable Development 2021-2030 Te Kete identifies 20 National Outcomes covering all aspects of lives, livelihoods, resilience and sustainability. National Outcome 19 is ?Quality and Affordable Energy Supply?. This emphasizes the role to be played by renewables and singles out solar energy as a priority for Funafuti and outer islands.

Energy

Tuvalu?s 2009 *National Energy Policy* aims to promote Renewable Energy resources and cost-effective, equitable, reliable, accessible, affordable, secure, and environmentally sustainable energy systems to improve the well-being of the people of Tuvalu.

The Government of Tuvalu launched the *Enetise Tutumau - The Master Plan for Renewable Electricity and Energy Efficiency in Tuvalu* (TMPREEE) in 2013. This master plan aimed for generation of 100% renewable energy by 2020. Nevertheless, through its First NDC, the government subsequently extended the target date for achieving 100% renewable energy from 2020 to 2025. TMPREEE outlines the way forward to generate electricity from renewable energy and to develop an energy efficiency programme. TMPREEE has two stated goals:

- To generate electricity with 100% renewable energy.
- To increase energy efficiency on Funafuti by 30%.

Floating PV is not mentioned in the masterplan, but solar is a key pillar to reach the 100% RE penetration in the electricity supply.

In April 2016, Tuvalu approved its *Energy Efficiency Act*. The Act promotes energy efficiency, energy conservation and give effects to certain obligations that Tuvalu has under the Climate Change Conventions and relations conventions. It determine standards for minimum energy performance and/or energy labelling for the electrical appliances or products (e.g. refrigerators, air conditioners, lights, etc.).

Although not yet approved, in August 2021 a third draft of Tuvalu?s *Energy Bill* was released. The draft text of the Bill requires that all persons and agencies having responsibilities under the Act apply the ?precautionary approach? when discharging responsibilities or exercising their powers. This requires that, in the event of a threat of damage to Tuvalu?s natural resources or its environment, or a risk to human wellbeing, a ?lack of full scientific certainty regarding the extent of adverse effects of climate change is not

used as a reason for not acting? to prevent or minimise the potential adverse effects or risks. The Bill establishes the Department of Energy, with a dedicated Renewable Energy division and headed by the Director of Energy, within the Ministry responsible for Energy. The department is under the control of the Minister and is the administration, execution, and regulatory agency for the Act (and may have other functions conferred by other acts).

Finally, Tuvalu?s Infrastructure Strategy and Investment Plan (TSIP) 2016?2025 prioritizes A$213 million of investments in maritime transportation, information and communication technology, and renewable energy. The proposed project contributes directly to this.

Climate Change mitigation Tuvalu Climate Change Policy (2012) (?T*e Kaniva?).* This policy prescribes the Government and the people of Tuvalu?s strategic polices for responding to climate change impacts and related disaster risks during the period 2012?2021. The Policy defines seven thematic goals, strategies and desired outcomes. Goal no. 5 is ?Ensuring Energy Security and a Low Carbon Future for Tuvalu?, for which the expected outcome is to ?Realise the target of 100% of electricity generation through renewable energy technologies?. The proposed project contributes directly to this.

As a Non-Annex I Party, Tuvalu has no obligation under the United Nations Framework Convention on Climate Change (UNFCCC) to reduce its emissions of greenhouse gases. Nonetheless, the country has signed and ratified the Kyoto Protocol (16th November 1998) and the Paris Agreement (22th April 2016) and has made significant efforts to date to reduce fossil fuel imports and increase domestic renewable energy use.

Tuvalu?s Second National Communication to UNFCCC (Second NC), through which Tuvalu commits to reducing GHG emissions, despite being historically a micro-emitter (less than 0.000005% of global emissions) and being at the front line of climate change impacts. Specifically, the Second NC sets out the steps that Tuvalu intends to take to reduce GHG emissions, notably: the adoption of policies to guide smart development and strengthening of the economy; identification of areas requiring research, improving education and public awareness of the issues; a move towards renewable energy; and reduction of GHG emissions with 100% renewable energy target by 2020. This proposed project contributes directly to these aims.

Tuvalu submitted their Intended nationally determined contributions (INDC) to the UNFCCC Secretariat on the 27th of November 2015. The country commits to a reduction of emissions of greenhouse gases from the electricity generation sector by 100%, therefore reaching almost zero emissions by 2025. Tuvalu's stated its indicative quantified economy-wide target for a reduction in total emissions of GHGs from the entire sector to 60% below 2010 levels by 2025. These emissions will be further reduced from the other key sectors, agriculture and waste, conditional upon the necessary technology and finance.

Most recently, Tuvalu published *Vaka Fenua o Tuvalu* (National Climate Change Policy), 2021 ? 2030. This includes the following Policy Objective (2.8): To strive for energy security from a sustainable mix of renewable energy sources. This includes three priority actions, as follows:

- 2.8.1 Enhance solar electricity generation and battery storage for all islands;
- 2.8.2 Develop local expertise in the installation, operation, management and maintenance of technically and economically proven technologies for electricity generation ;
- 2.8.3 Explore alternative sources of renewable energy for electricity generation.

Finally, as mentioned previously, the project also takes place within the SIDS Accelerated Modalities of Action (SAMOA) Pathway, to which Tuvalu is committed.

**8. Knowledge Management**

**Elaborate the "Knowledge Management Approach" for the project, including a budget, key deliverables and a timeline, and explain how it will contribute to the project's overall impact.**

The project is piloting a highly innovative technology ? floating PV. This creates several new challenges ? some physical related to the infrastructure, some socio-economic related to the new beneficiaries and new opportunities. It is expected that many lessons will be learnt and knowledge management is very important.

Existing lessons and best practices that informed the project: The project incorporates lessons learnt from previous renewable energy, particular solar PV, projects across the region. These lessons notably relate to its design, the specifications, the needs for capacity building, the approach to community outreach and the need to strengthen the enabling environment.

Learning from relevant projects, programs, initiatives & evaluations**.** The project was identified and concieved, and will be implemented, within the framework of the Pacific Renewables Energy Investment Facility. This Facility is a multi-agency coordination mechanism aimed at improving the delivery of development assistance from donors and development partners to energy infrastructure sector in the Pacific region., The Project has, and will continue to, gain knowledge from that Facility. Further, ADB is investing in sustainable energy in 12 Pacific island states. Total cumulative approvals for energy operations during 2007?2020 reached $945 million in 2020 (this includes significant contributions from development partners, host governments, and (increasingly) from the private sector). During 2007-2020, this helped finance and construct about 94.3 megawatts (MW) of additional installed renewable capacity across the region. Accordingly, this project will learn from the experiences and the network created through this large ADB investment program.

Finally, as mentioned earlier, ADB is currently exploring and facilitating the development of FPV as an innovative, appropriate technology for the Pacific through an ongoing sub-regional technical assistance project. The project is currently undertaking initial design activities in Kiribati, Tonga, Cook Islands, Marshall Islands and the Federated States of Micronesia. This project will facilitate the transfer of knowledge across these countries and associated lesson learning.

Capturing, assessing and documenting information, lessons, best practice & expertise generated during implementation. In-country, the Project PMU will take the lead in collecting information, documenting the project?s success, and sharing knowledge. This will include: collecting information on the performance of the technologies; collecting and documenting information on the impact climate on the project; and publishing a lessons learnt document. Also, in-country, together with TEC and the PMU, the TTF members and ADB will play a leading role in sharing knowledge to all stakeholders in Tuvalu.

Internationally, the above-mentioned Facility, and the ADB renewable energy program in the pacific, will play the leading role in ensuring that the knowledge and lessons generated through this Project are captured and disseminated through direct and indirect measures throughout the Pacific. As appropriate, some lessons will be disseminated more broadly across Asia and to the Indian Ocean.

Tools and methods for knowledge exchange, learning & collaboration**.** In-country, these include (i) the comprehensive and inclusive institutional capacity development program covering technical aspects (photovoltaic and BESS design, construction, testing, commissioning, operation, and maintenance), financial and economic analyses, financial management, environmental and social safeguards, gender, community engagement, procurement, tariff, and governance; and (ii) diverse methods and modalities such as workshops, lectures, hands-on training, certified training, and academic degree scholarships, with special focus on gender and inclusion. Internationally and regionally, knowledge sharing occurs through the technical studies and social media. Other knowledge dissemination mechanisms include (i) participation at ADB?s annual Asia Clean Energy Forum and the Pacific Power Association Conference, and (ii) cooperation with regional stakeholders and regional coordination bodies such as the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE) under the Pacific Community (SPC).

Proposed knowledge outputs to be produced**.** In addition to those mentioned in the points above, one or more ?lessons learnt documents? will be prepared and published.

Finally, from the measures and tools described above, Tuvalu can learn from the success and challenges of other countries, thereby avoiding mistakes and increasing efficiency and sustainability. This relates to both

technologies and also the need for capacity, for public acceptance and for an enabling environment (including promoting private sector investment). Notably, as the level of RE contribution to the grid rises in percentage terms, the management of integration issues becomes more complicated, and it becomes increasingly important to learn lessons. Likewise, after the project, other island states and economies can learn from Tuvalu?s experience.

Communications

The project is supported by several partners, including GEF, ADB, the Irish Government (through its contribution to the ADB Irish Trust Fund) and potentially other governments through contribution to the ADB Urban Resilience Trust Fund (co-financing being sought). All partners recognise the importance of communications and this creates a good opportunity for holistically addressing communications. This will contribute to GEF Communication Policy and notably raising awareness about the GEF and the important global role it plays. In line with this policy:

? As appropriate, activities and products, including relevant, aligned, knowledge management and learning, shall be coordinated with the GEF Communications team to ensure impact and safeguarding of the GEF brand;
? The PMU will include a designated communications focal point
? All outreach material, including publications and digitial communications, will appropriately include the GEF Logo, standard GEF description, links to GEF website and social media

The details of the messages, audience, media etc will be determined during project implementation (Activity 3.5 includes the elaboration and implementation of a communications strategy).

The estimated total costs of specific communications products is in the order of $50,000, with GEF contribution estimated at approximately $10,000.

**9. Monitoring and Evaluation**

**Describe the budgeted M and E plan**

Monitoring, evaluation and reporting for the project will follow ADB?s Evaluation Policy and align with the GEF policy and guidance for both monitoring and evaluation. The Government of Tuvalu is familiar with ADB and GEF processes with respect to M&E and reporting. As indicated in the budget, USD 50,000 has been allocated for GEF M&E costs. This complements a sizeable M+E budget under the various co-financing initiatives.

The PMU, with support from CSC and under the supervision of TEC, will be responsible for project monitoring and reporting. This will include project performance monitoring, compliance monitoring, safeguards monitoring and gender/social dimensions monitoring. The PMU will prepare biannual reports on progress, on the current status of all indicators, on the implementation challenges and on the financial status. The PMU will appoint one staff member as focal point for monitoring and evaluation (M&E). The Tasks include designing and installing the monitoring system, collecting data, preparing progress and evaluation reports, etc. Other team members will support monitoring tasks and funds will be available for workshops, report publishing, as necessary.

In addition, a project completion report will be prepared by the PMU, on the achievement of the project outputs and outcome. This will include individual assessment and evaluation of each output, activities and

achievement of indicators; financial and procurement performance; safeguards performance; social, poverty and gender benefits achieved; lessons learned and best practices; evaluating and quantifying any change in interaction between government agencies and communities; and assessing pathways for scaling up. The government?s project completion report will draw on data collected from surveys, annual knowledge management reviews, and reflections. The final project review will follow submission of government?s project completion report.

To complement the main ADB monitoring, GEF funds will cover the costs of an independent terminal evaluation focussing on GEF and global environment requirements. An estimated 4-6 months input is anticipated, with a total cost to LDCF of $50,000 (see monitoring plan in following table).

| M&E Activity | Description | Responsible Parties | Timeframe | Indicative budget (USD) |
|---|---|---|---|---|
| Inception Workshop (IW) | Report prepared following the IW, which includes:<br>- A detailed workplan and budget for the first year of project implementation,<br>- An overview of the workplan for subsequent years, divided per component, output and activities.<br>- A detailed description of the roles and responsibilities of all project partners, and an organizational chart<br>- Updated Procurement Plan and a M&E Plan, Gender Action Plan<br>- Minutes of the Inception Workshop | Execution: PMU | 1 report to be prepared following the IW, to be shared with participants 4 weeks after the IW (latest) | Incorporated into PMU budget |
| Project Implementation Review (PIR) | Analyzes project performance over the reporting period. Describes constraints experienced in the progress towards results and the reasons. Draws lessons and makes clear recommendations for future orientation in addressing the key problems in the lack of progress.<br>The PIRs shall be documented with the evidence of the achievement of end-of-project targets (as appendices). | Execution: PMU | 1 report to be prepared on an annual basis, to be submitted by January 31st (latest) | All costs incorporated into PMU budget |
| Half-yearly progress report | Part of Asian Development Bank requirements for project monitoring.<br>- Narrative of the activities undertaken during the considered semester<br>- Analyzes project implementation progress over the reporting period.<br>- Describes constraints experienced in the progress towards results and the reasons. | Execution: PMU | half-yearly progress reports for any given year, submitted by January 31 (latest) for period 1st July ? 31st December of previous year | All costs incorporated into PMU budget |

| M&E Activity | Description | Responsible Parties | Timeframe | Indicative budget (USD) |
|---|---|---|---|---|
| Quarterly expenditure reports | Detailed expenditure reports (in excel) broken down per project component and budget line, with explanations and justification of any change | Execution: PMU | Four (4) quarterly expenditure reports for any given year, submitted by January 31, April 30, July 31 and October 31 (latest) | All costs incorporated into PMU budget |
| Co-financing Report | Report on co-financing (cash and/or in-kind) fulfilled contributions from all project partners that provided co-finance letters. | Execution: PMU | 1 annual report from each co-finance partner, and 1 consolidated report, to be submitted by 31 July latest | All costs incorporated into PMU budget |
| Mid term review | At the midpoint, this reviews the progress towards impacts and sustainability of the results, including the contribution to capacity development and the achievement of global environmental goals. Corrections are proposed. | Execution: PMU | Initiated 2 years after activities commence. | GEF: as part of overall budget, up to $30,000 |
| Final Report | The project team will draft and submit a Project Final Report, with other docs (such as the evidence to document the achievement of end-of-project targets).<br>Comprehensive report summarizing all outputs, achievements, lessons learned, objectives met or not achieved structures and systems implemented, etc. Lays out recommendations for any further steps to be taken to ensure the sustainability and replication of project outcomes. | Execution: PMU | Final report to be submitted no later than three (3) months after the technical completion date | All costs incorporated into PMU budget |
| Terminal Evaluation (TE) | Further review the topics covered in the mid-term evaluation.<br>Looks at the impacts and sustainability of the results, including the contribution to capacity development and the achievement of global environmental goals. | Execution: PMU | Can be initiated within six (6) months prior to the project?s technical completion date | GEF: as part of overall budget, up to $20,000 |
| TOTAL M&E COST | | | GEF: US$ 50,000 | |

Table 17: Monitoring Plan

The project results framework (design and monitoring framework) in Annex A will guide monitoring at the overall project level. The following table provides details of the GEF budget for M+E.

| Input | Mid-term evaluation (US$) | Final evaluation (US$) | Total (US$) |
|---|---|---|---|
| International consultant | 20,000 | 30,000 | 50,000 |
| **Total** | 20,000 | 30,000 | 50,000 |

Table 18: M+E Budget (GEF inputs only)

**10. Benefits**

**Describe the socioeconomic benefits to be delivered by the project at the national and local levels, as appropriate. How do these benefits translate in supporting the achievement of global environment benefits (GEF Trust Fund) or adaptation benefits (LDCF/SCCF)?**

Environmental Benefits

As discussed above, the project will lead to the generation of over 2,000 MWh of electricity. Noting that, in the baseline, 3.75 litres of diesel is required to generate 1KWh, this means the project will displace the use of 7.5 million litres of diesel on Funafuti. This will lead to considerable reductions in air pollution on Funafuti, as well as considerable reductions in land pollution from spillages (diesel generation is a main source of pollution). There are also associated reductions in pollution from the shipping required to transport the diesel to Funafuti.

Social and Economic Benefits

The project will have several positive social impacts. A sustainable, accessible energy supply is vital as a basis for socio-economic development. Access to energy allows communities to develop sustainable and resilient livelihoods. For example, sustainable energy supply provides a basis for: (i) reliable water supplies; (ii) reliable education facilities; (iii) reliable health care facilities; (iv) agricultural production and processing; (v) land and marine transport; and (vi) economic activities and innovative technologies. Notably Output 2, through the development of PUE, may lead the way in using energy to for sustainable economic activities.

Further examples of the specific social benefits of FPV include:

? Avoidance of more than 1.2 to 1.8 Ha of land acquisition that could be beneficial for other uses given the low available land are in Funafuti and other regions;

? Water preservation by the FPV to increase household consumption;

? Knowledge sharing with local entities

-

Climate change adaptation

The project significantly reduces the climate risks faced on Funafuti. This is through the following pathways:

Land shortage Until now, all energy infrastructure in Tuvalu has been land-based. The ongoing transition away from fossil-fuel based energy inevitably means developing large amounts of solar PV infrastructure. Traditional, land-based solar PV requires large amounts of horizontal space. Until now, this has been installed primarily on roof tops, however, such options have been almost fully utilized. Climate change induced flooding will greatly exacerbate this shortage of land. The Project, through the introduction of floating solar PV that requires far less land (some land is still required for grid connections, batteries and other small installations), will reduce these CC-induced land availability stresses.

Energy system resilience Energy is an essential sector, and any damage to energy supply inevitably impacts all other sectors, and so increasing the resilience of the energy system to climate is a key climate adaptation measure. Tuvalu, like many Small Island Developing States (SIDS), depends on imported oil products to meet the vast majority of its energy needs. This dependence makes energy supply on Funafuti extremely vulnerable to oil price volatility. To overcome these challenges, the Government has prioritized energy security through investments in renewable energies and energy storage. Through introducing floating solar, this project will increase climate system resilience as follows:

? installing energy infrastructure that is resilient to mean and storm induced sea level rise, as it floats;

? installing PV technology that is less sensitive to rising temperatures on land;

? diversifying away from classic technologies and enabling a decentralization of energy infrastructure;

? increasing overall electricity production capacity and so allowing alternative management systems.

## 11. Environmental and Social Safeguard (ESS) Risks

Provide information on the identified environmental and social risks and potential impacts associated with the project/program based on your organization's ESS systems and procedures

**Overall Project/Program Risk Classification***

| PIF | CEO Endorsement/Approval | MTR | TE |
|---|---|---|---|
| Medium/Moderate | Medium/Moderate | | |

**Measures to address identified risks and impacts**

Elaborate on the types and risk classifications/ratings of any identified environmental and social risks and impacts (considering the GEF ESS Minimum Standards) and any measures undertaken as well as planned management measures to address these risks during implementation.

Environmental and social safeguards are a cornerstone of ADB's support to inclusive economic growth and environmentally sustainable growth. Accordingly, ADB's safeguard policy[1] aims to help developing member countries (DMCs) address environmental and social risks in development projects and minimize and mitigate, if not avoid, adverse project impacts on people and the environment. The Safeguard Policy Statement (2009, amended from time to time) covers environment, involuntary resettlement, and indigenous peoples in a consolidated policy framework. It applies to all ADB-financed projects, including ADB-administered co-financing. The Statement also provides a platform for participation by affected people and other stakeholders in project design and implementation.

Approach. Safeguard instruments have been prepared for the project overall in accordance with ADB?s Safeguard Policy Statement and the Government of the Tuvalu?s laws and regulations which comprise the country safeguards system. For both environment and social safeguards, during implementation, TEC, supported by consultants will undertake the required additional due diligence and oversee the project implementation, and report the same in semi-annual safeguard monitoring reports submitted to MOF and ADB. The monitoring reports will be disclosed.

IAREP2 triggers the three safeguards policies of ADB?s Safeguards Policy Statement 2009 namely the Environment Policy, Involuntary Resettlement (IR) Policy and the Indigenous People?s (IP) Policy. Initial screening assigned the Project Category B for Environment and IR policies respectively, and Category C for IP Policy. Category B denotes a project with potential environmental and social impacts that are less adverse than those of Category A[2] projects. These impacts are site specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category A projects. An Initial Environmental Examination (IEE) report is required (see below).

For the IR policy, a comprehensive due diligence report (DDR) was prepared and is attached as Appendix 6. One finding is that, during construction, a small area of land for the contractor?s laydown, material storage and assembling of PF arrays will be utilized. This will be voluntary. The contractor will negotiate arrangements for any compensation required with affected landowner. After construction, no involuntary land acquisition and physical displacement impacts will result from the project. The floating PV will generate limited economic displacement impacts in the form of some loss of access of some households to lagoon and foreshore areas normally accessible for fishing and gleaning, recreation/swimming, navigation and other purposes. This has been widely consulted, and mitigation options identified. In light of the findings of the DDR (Appendix 6), it is recommended that IAREP 2 be re-classified as Category C for Involuntary Resettlement.

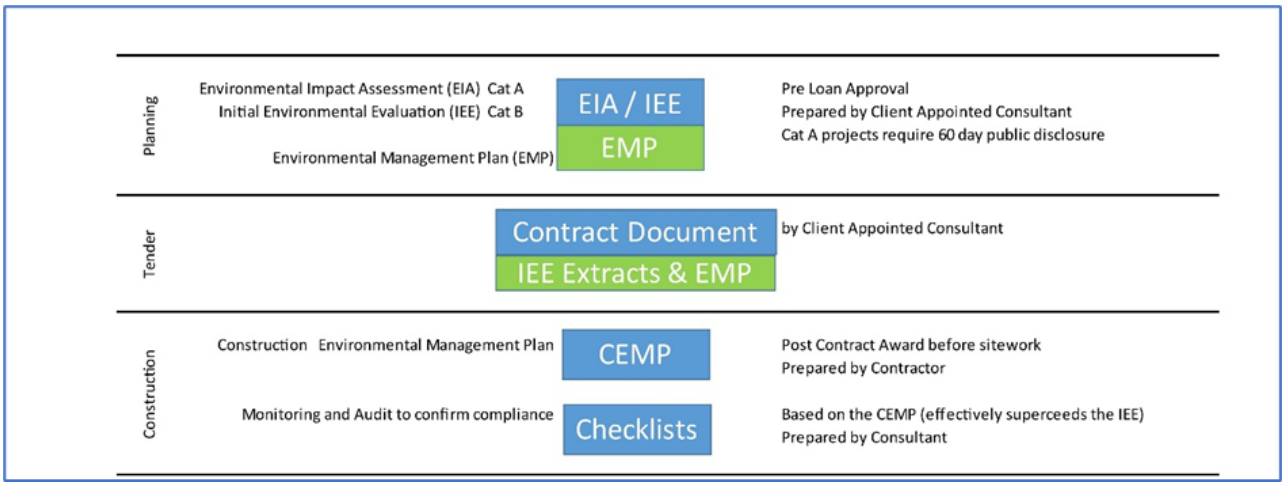
It is noted that for the GEF financed activities, there will be no involuntary land acquisition or resettlement.

The Category C for IPP means there are no significant adverse impacts, reflecting the ethnic and cultural homogeneity of the Tuvalu population and cultural setting. Policy, Category C means no further documentation is required. It will, however, be ensured that local communities receive culturally appropriate benefits, actively participate in the project, and do not suffer any adverse impacts.

Environment[df1]

The project?s environment due diligence process and main findings are presented in Appendix 5:

The key steps and outputs from the process are summarized as:




The EIA and IEE have been completed (drafts). The main findings are (see Appendix 5):

? During construction, the main impacts are caused by solid waste generation and nuisance in the construction yard;

? During operation, the maintenance activities create the most environmental risk;

However,

? during fabrication and deployment, ?no significant impact on ecology? can be expected

? during fabrication and deployment, ?no significant impact on community? can be expected

? during operation, ?no significant impact on ecology? can be expected.

The EMP addresses any residual potential impacts during pre-construction, construction and operation. The recommended environmental mitigation measures will be incorporated into the design of the subprojects. Prior to construction works commencing, the successful construction contractor will prepare a construction EMP (CEMP) based on their methodology and construction approach that will be

reviewed and approved by the Project Management Unit (PMU) (or a specialist consultant engaged on their behalf).

In conclusion, provided that the mitigation measures outlined in the IEE and EMP are appropriately implemented, the subprojects are not expected to have any significant environmental impacts.

Prohibited investment activities**.** Pursuant to ADB?s Safeguard Policy Statement (2009), ADB funds may not be applied to the activities described on the ADB Prohibited Investment Activities List set forth at Appendix 5 of the Safeguard Policy Statement (2009).

Grievance and complaints

A draft Grievance Redress Mechanism (GRM) has been established to address issues and grievances in a timely and effective manner (Appendix 8). The GRM will work within existing legal and cultural frameworks to address concerns and complaints promptly, using an understandable and transparent process that is gender responsive and socially inclusive, and readily accessible at no cost and without retribution. The GRM will be monitored and a summary of grievances filed and resolved will be included in the quarterly progress reports and semi-annual safeguard monitoring reports submitted to ADB.

[1] https://www.adb.org/documents/safeguard-policy-statement

[2] Category A projects are those projects likely to have significant environment and or social impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. (ADB, SPS 2009; p.19)

**Supporting Documents**

Upload available ESS supporting documents.

| Title | Module | Submitted |
|---|---|---|
| **23-06-19 GEF ID 10788 TUV Social safeguards** | **CEO Endorsement ESS** | |
| **23-06-19 GEF ID 10788 TUV Environmental Safeguards** | **CEO Endorsement ESS** | |
| **23-06-19 TUV IAREP II Appendix 2 - CRVA** | **CEO Endorsement ESS** | |
| **23-06-19 TUV IAREP II Appendix 7 (PSA)** | **CEO Endorsement ESS** | |
| **23-06-19 TUV IAREP II Appendix 8 (GRM)** | **CEO Endorsement ESS** | |
| **23-06-19 TUV IAREP II Appendix 6 (DDR)** | **CEO Endorsement ESS** | |
| **23-06-19 TUV IAREP II Appendix 5 (IEE and EMP summary presentation)** | **CEO Endorsement ESS** | |
| **5-10-2023 SPC Wave report** | **CEO Endorsement ESS** | |
| **5-10-2023 Appendix 6 - Social due dilligence report** | **CEO Endorsement ESS** | |

| Title | Module | Submitted |
| --- | --- | --- |
| 5-10-2023 Appendix 5 IEE and EMP | CEO Endorsement ESS | |
| A4 Covid-19 risk assessment | Project PIF ESS | |
| 49450-015 LD 14 CRVA Appendix B PACCSAP | Project PIF ESS | |
| 49450-015 LD 14 CRVA Appendix A - AWARE | Project PIF ESS | |
| 49450-015 LD 14 Climate Change Assessment TUV IAREP | Project PIF ESS | |
| TUV_IAREP_REA_Energy_Solar | Project PIF ESS | |
| IEE TUV IAREP | Project PIF ESS | |
| TUV DDR Social safeguards (conso) | Project PIF ESS | |

## ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found).

**Design and Monitoring Framework (DMF)**

| Results Chain | Performance Indicators with Targets and Baselines[a] | Data Sources and Reporting | Risks |
|---|---|---|---|
| **Outcome**<br>Increased generation and utilization of reliable, resilient and climate-adapted clean energy from renewable energy in Tuvalu | By 2028:<br>a. Increase climate resilient renewable electricity generation in Tuvalu to 52% of generation mix (2019 baseline: 16%)<br>b. Increase generation of solar PV power by 1,280 MWh per year (2019 baseline: 0 MWh)<br>c. Diesel fuel savings of at least 317,000 liters per year in the first year (2019 baseline: 0)<br>d. $CO_2$ emissions avoidance of 2,891 tons in the first year (**note**: this figure includes 1441 from ADB administered projects and 1450 from parallel co-financing). (2019 baseline: 0)<br>e. 0.5 hectares of reef regenerated and 150 meters of coast protected (baseline: 0)<br>f. 2 Electric boats and 1 charging station piloted (baseline: 0)<br>g. Number of beneficiaries: 6,000 (50% female). Total population of Funafuti (baseline is 0). | a-d. MOF, MTET annual reports, TEC generation data, and project completion report | Reduction in diesel use by power sector is offset by increase in other sectors. |

| Results Chain | Performance Indicators with Targets and Baselines[a] | Data Sources and Reporting | Risks |
|---|---|---|---|
| **Outputs**<br>1. Solar photovoltaic system installed on three outer islands | By 2028:<br>1a. at least 44.8 kWp solar PV capacity for Nukulaelae (baseline is 0).<br>1b. at least 78.4 kWp solar PV capacity for Nukufetau (baseline is 0).<br>1c. at least 100.8 kWp solar PV capacity for Nui (baseline is 0).<br>1d. hire at least 25% women among any local workers hired, for construction, administration, maintenance, security, and supervision roles (baseline: 0)<br>1e. Public awareness program on efficient household electricity demand management; and business skills training on income opportunities from electricity supply for women and men developed and potential trainers with at least 50% women trained (baseline: 0) | 1a-e. MTET and TEC annual reports<br>1a-e. Project progress reports<br>1d-f. GAP Progress Report | Bidding packages are unattractive and do not receive sufficient competitive tender offers.<br><br>Counterpart support, performance, and coordination are weak and inadequate<br><br>Implementation delays due to bad weather and unavailability of transport to the outer islands |

| Results Chain | Performance Indicators with Targets and Baselines[a] | Data Sources and Reporting | Risks |
|---|---|---|---|
| 2. Floating solar photovoltaic, sustainable blue economy and productive uses of energy, rooftop solar photovoltaic and battery energy storage system installed on Funafuti | By 2028<br>2a. at least an additional 500 kW rooftop PV commissioned and operational (baseline 0).<br>2b. at least 1 MW /2 MWh BESS commissioned and operational (baseline: 0).<br>2c. hire at least 25% women among any local workers hired, for construction, administration, maintenance, security, and supervision roles (baseline: 0)<br>2d. Public awareness program on efficient household electricity demand management; and business skills training on income opportunities from electricity supply for women and men developed and potential trainers with at least 50% women trained (baseline: 0)<br>2e. At least two electricity demand management public awareness program implemented with at least 50% women participation (baseline 0) and separate business skills trainings for men and women (30 women and 20 men).<br>2f. At least 1250 kW of floating PV commissioned and operational (baseline: 0),<br>2g. At least two electric boats and one charging station procured and operational (baseline: 0)<br>2h Coastal protection, disaster risk reduction measures and reef generation implemented and operational (baseline: 0). | 2a-d. MTET and TEC annual reports<br><br>2a-d. Project progress reports<br><br>2c-e. GAP Progress Report | Bidding packages are unattractive and do not receive sufficient competitive tender offers.<br><br>TEC staff not prepared to operate a modernized power station incorporating automated controls, BESS technology rooftop solar PV, floating solar PV |

| Results Chain | Performance Indicators with Targets and Baselines[a] | Data Sources and Reporting | Risks |
|---|---|---|---|
| 3. Institutional capacity for inclusive and climate adapted renewable energy project development and implementation enhanced | By 2028:<br>3a. at least 2 women provided scholarships on solar and battery related technical courses and subsequently employed at TEC (baseline: 0)<br>3b. TEC percent of women staff increased by 20% (baseline: 10%) i.e. 5 out of 50 women)<br>3c. CSC and PIC with at least 30% women team members mobilized (i.e. 2 out of 6 consultants) (baseline: 0).<br>3d. At least 30 stakeholders, including 9 women, participate in a national workshop including hands-on training on PV and BESS technology and related operation and maintenance (baseline: 0)<br>3e. Gender policy for human resource management for TEC developed (baseline: 0)<br>3f. At least 60 stakeholders, including 25 women, receive hands-on training on FPV and electric vehicles, SBE and PUE technologies and related operation and maintenance (baseline: 0)<br>3g. At least 30 stakeholders, including 15 women, participate in a national workshop on FPV, electric vehicles, SBE and PUE technologies, including operation and maintenance (baseline: 0) | 3a-e. MTET and TEC annual reports<br><br>3a-e. Project progress reports/GAP Progress Report | Insufficient interest in training and programs offered |

## ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF).

At the time of PIF approval:

- all comments from GEF Secretariat had been addressed

- no comments were received from GEF Council.

The following STAP comments have been addressed as noted below:

| PIF Section | STAP Comment | Response |
|---|---|---|
| Project Objective | Suggest rephrasing the objective to make it more clearer. E.g., ?to promote the increased utilization of renewable energy and reduce greenhouse gas emissions in Tuvalu.? | Done |
| Project components | Yes. Component 3 and 4 need to be further developed. | Done<br>PIF Component 3 (Output 3) has been expanded, see description in the text in section 1.a.3.<br><br>PIF Component 4 is Monitoring and Evaluation. This has been detailed in Section 9. |
| 6) global environmental benefits (GEF trust fund) and/or adaptation benefits (LDCF/SCCF) | Yes. Refer to STAP overall assessment for comments on GEBs | More information has been provided on the calculation of avoided GHG emissions.<br><br>However, STAP requested (i) calculation of reduced emissions due to reduced shipping activity (ii) assessing and monitoring of impacts on air, soil and marine environment. Due to complications in project development as a result of the Covid Pandemic, it has not yet been possible to establish a baseline or methodology. |
| **8. Knowledge management.** | Yes ? though as noted there should be linkages to SAMOA Pathway, Island Policy Lab (UNDESA supported) and Island Innovations.<br><br>Please reflect the knowledge management approach within the project components. | Done. Conceptual links to SAMOA are set out in Sections 6 and 7,<br><br>KM is addressed notably through Output 3. This is also detailed in the main text in Section 8. |

## ANNEX C: Status of Utilization of Project Preparation Grant (PPG). (Provide detailed funding amount of the PPG activities financing status in the table below:

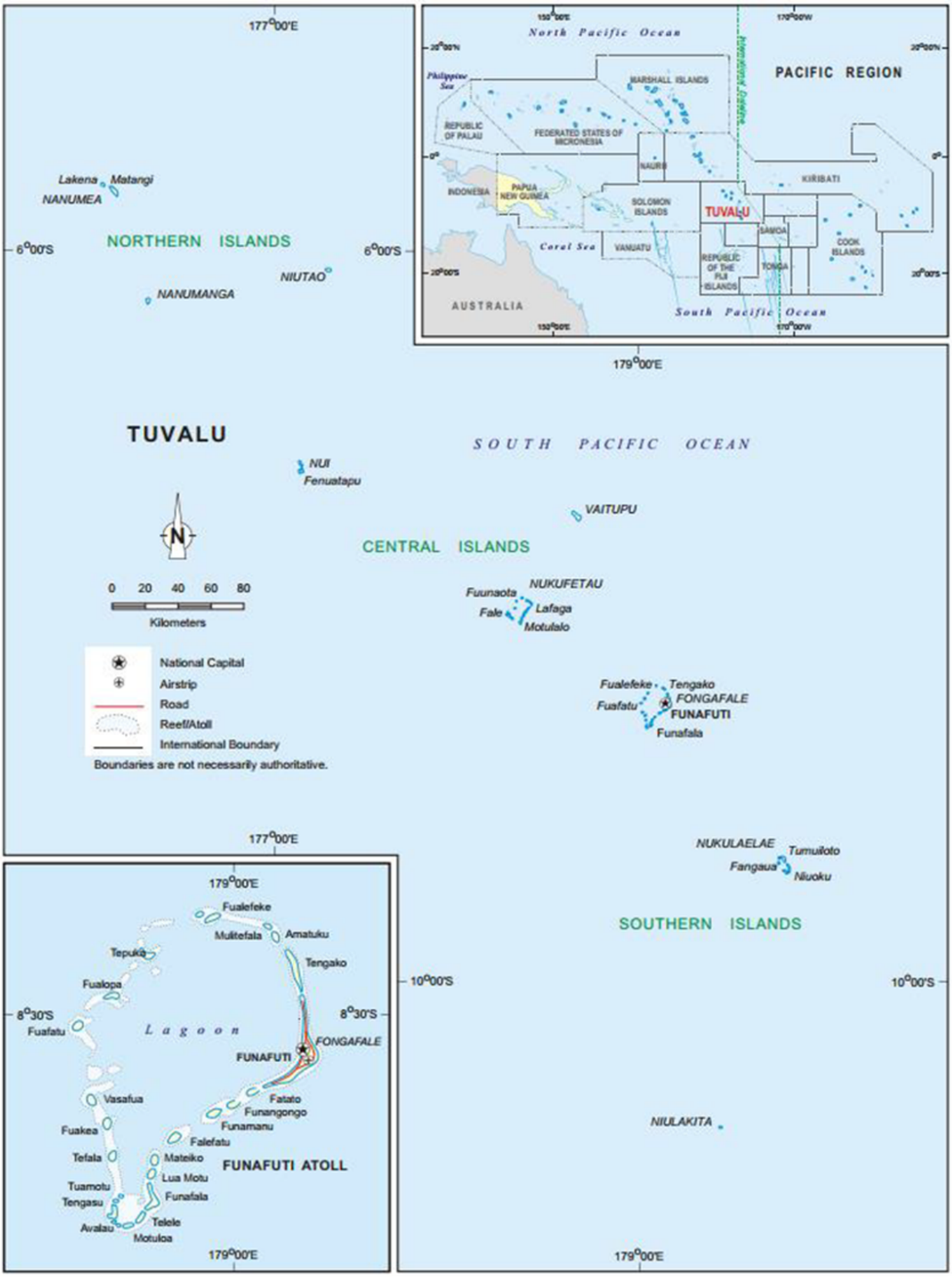
Not applicable

## ANNEX D: Project Map(s) and Coordinates

## Please attach the geographical location of the project area, if possible.

**General**

The project site is the three outer islands (Nukulaelae, Nukufetau and Nui) and Funafuti, Tuvalu, located in the South, Central Pacific. The coordinates for Funafuti are: 08?31?S 179?12?E. The locations of Tuvalu in the Pacific, of Funafuti and the three outer islands are illustrated in the following maps.


177°00'E
Lakena
Matangi
NANUMEA
NORTHERN ISLANDS
6°00'S
NIUTAO
NANUMANGA
PACIFIC REGION
North Pacific Ocean
MARSHALL ISLANDS
REPUBLIC OF PALAU
FEDERATED STATES OF MICRONESIA
NAURU
KIRIBATI
INDONESIA
PAPUA NEW GUINEA
SOLOMON ISLANDS
TUVALU
SAMOA
COOK ISLANDS
Coral Sea
VANUATU
REPUBLIC OF THE FIJI ISLANDS
TONGA
AUSTRALIA
South Pacific Ocean
179°00'E
TUVALU
SOUTH PACIFIC OCEAN
NUI
Fenuatapu
VAITUPU
CENTRAL ISLANDS
NUKUFETAU
Fuunaota
Fale
Lafaga
Motulalo
0 20 40 60 80
Kilometers
National Capital
Airstrip
Road
Reef/Atoll
International Boundary
Boundaries are not necessarily authoritative.
Fualefeke
Tengako
Fuafatu
FONGAFALE
FUNAFUTI
Funafala
177°00'E
179°00'E
Fualefeke
Mulitefala
Amatuku
Tengako
Tepuka
Fualopa
8°30'S
Fuafatu
Lagoon
FONGAFALE
FUNAFUTI
Vasafua
Fatato
Funangongo
Funamanu
Fuakea
Falefatu
Tefala
Mateiko
FUNAFUTI ATOLL
Lua Motu
Tuamotu
Funafala
Tengasu
Avalau
Telele
Motuloa
179°00'E
NUKULAELAE
Tumuiloto
Fangaua
Niuoku
SOUTHERN ISLANDS
10°00'S
NIULAKITA
179°00'E

As mentioned previously, Funafuti atoll is approximately 18 km long and 14 km wide, meaning the lagoon has a surface area of approximately 275 km2. The average depth of the Funafuti lagoon is about 36.5 metres.

On Funafuti, the proposed project will install rooftop PV and floating PV on the lagoon. Note that 1.2 MWp typically occupies 1.2 x (1.2-2) hectares, or at most 2.4 hectares, or 0.024 km2 or at most 0.008% of the lagoon.

The FPV area is to be located near the Princess Margaret hospital, north of Funafuti. This part of the island is where most of the population live with around 4,000 inhabitants, being the largest of Funafuti?s islets and the centre to the major commercial, public and industrial activities, representing the highest energy demand (1,300 kW peak load). Being inside the lagoon, this area is more protected from harsh or extreme weather conditions such as strong winds and cyclones.

There are two sites in the area that can be used to implement the floating PV plant as illustrated in the figure below.

The indicative coordinates are: 8?30'53.1"S 179?11'53.2"E.

Full details of the site are provided in the Feasibility Study in Appendix 1. These include:

? water quality

? bathymetry

? bottom soil

? hydrodynamic ? including wave conditions and currents

? Meteoroligical data ? including solar irradiation, winds, etc

? Benthic data

? UXO issues

? Access to the site from land

? opportunities for power evacuation to grid

? O&M Concerns

Given the nature of the technology, wave and sea conditions are a primary factor in siting and design. Accordingly, specific assessments of wave data and modelling has been developed and obtained, which have been used in the comprehensive climate risk and vulnerability assessment (Appendix 2).

## ANNEX E: Project Budget Table

## Please attach a project budget table.

Note: For civil works, full details of cost estimate are provided in Appendix 1.

| | Output 1 | Output 2 | Output 3 | Output 4 | PMC | M+E | Totals |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **International consultants** | | | | | | | |
| Financial Management Expert | | | 30,000 | | | | 30,000 |
| Community Engagement Expert | | | 30,000 | | | | 30,000 |
| Gender Expert | | | 30,000 | | | | 30,000 |
| Technology trainers | | | 30,000 | | | | 30,000 |
| Energy sector specialist (Tariffs, Law, and Metering) | | | 90,000 | | | | 90,000 |
| Communications expert | | | 25,000 | | | | 25,000 |
| M+E expert | | | | | | 50,000 | 50,000 |
| Sub-total | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **National Consultants** | | | | | | | |
| Community Engagement Expert | | | 5,000 | | | | 5,000 |
| Gender Expert | | | 5,000 | | | | 5,000 |
| Project manager | | | | | 130,000 | | 130,000 |
| Communications expert | | | 10,000 | | | | 10,000 |
| Sub-total | | | | | | | |
| | | | | | | | |
| **Sub contracts** | | | | | | | |
| | | | | | | | |
| **Civil works*** | | | - | | | | |
| Installation of Floating Photovoltaic | 2,302,294 | | | | | | 2,302,294 |
| | | | | | | | - |
| | | | | | | | |
| **Other** | | | | | | | |
| Regional workshop | | | 15,000 | | | | |
| | | | | | | | |
| **TOTALS** | 2,302,294 | - | 270,000 | - | 130,000 | 50,000 | 2,752,294 |

**ANNEX F: (For NGI only) Termsheet**

Instructions. Please submit an finalized termsheet in this section. The NGI Program Call for Proposals provided a template in Annex A of the Call for Proposals that can be used by the Agency. Agencies can use their own termsheets but must add sections on Currency Risk, Co-financing Ratio and Financial Additionality as defined in the template provided in Annex A of the Call for proposals. Termsheets submitted at CEO endorsement stage should include final terms and conditions of the financing.

**ANNEX G: (For NGI only) Reflows**

Instructions. Please submit a reflows table as provided in Annex B of the NGI Program Call for Proposals and the Trustee excel sheet for reflows (as provided by the Secretariat or the Trustee) in the Document Section of the CEO endorsement. The Agencys is required to quantify any expected financial return/gains/interests earned on non-grant instruments that will be transferred to the GEF Trust Fund as noted in the Guidelines on the Project and Program Cycle Policy. Partner Agencies will be required to comply with the reflows procedures established in their respective Financial Procedures Agreement with the GEF Trustee. Agencies are welcomed to provide assumptions that explain expected financial reflow schedules.

Not applicable

**ANNEX H: (For NGI only) Agency Capacity to generate reflows**

Instructions. The GEF Agency submitting the CEO endorsement request is required to respond to any questions raised as part of the PIF review process that required clarifications on the Agency Capacity to manage reflows. This Annex seeks to demonstrate Agencies? capacity and eligibility to administer NGI resources as established in the Guidelines on the Project and Program Cycle Policy, GEF/C.52/Inf.06/Rev.01, June 9, 2017 (Annex 5).

Not applicable