GLOBAL ENVIRONMENT FACILITY
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Increasing Access to Renewable Energy in Tuvalu

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

Taxonomy
SMEs, Private Sector, Individuals/Entrepreneurs, Stakeholders, Technology Transfer, Climate Change Mitigation, Climate Change, Focal Areas, Renewable Energy, Influencing models, Transform policy and regulatory environments, Demonstrate innovative approache, Type of Engagement, Participation, Consultation, Communications, Public Campaigns, Awareness Raising, Local Communities, Beneficiaries, 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, Small Island Developing States, Climate Change Adaptation

Rio Markers
Climate Change Mitigation
Climate Change Mitigation 2

Climate Change Adaptation
Climate Change Adaptation 1

Duration
60 In Months

Agency Fee($)
247,706.00

Submission Date
4/12/2021

A. Indicative Focal/Non-Focal Area Elements

Programming Directions	Trust Fund	GEF Amount($)	Co-Fin Amount($)
CCM-1-4	GET	2,752,294.00	15,480,000.00
	Total Project Cost ($)	**2,752,294.00**	**15,480,000.00**

B. Indicative Project description summary

Project Objective

In Tuvalu, utilization of renewable energy increased and greenhouse gas emissions are reduced

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)
Generation and utilization of renewable energy technologies	Investment	1. Solar photovoltaic system installed on three outer islands	1.1 At least 224 kWp of PV capacity installed on 3 outer islands 1.2 Public and government awareness raising programs	GET		1,760,000.00
Generation and utilization of renewable energy technologies	Investment	2. Solar photovoltaic system and BESS installed on Funafuti island	2.1 At least 1650 kWp of rooftop PV capacity installed (GEF USD500,000) 2.2 At least 750 kWp of Floating PV capacity installed (including climate resilience and cross-sectoral applications such as rainwater collection) (GEF USD 2M) 2.3 At least 2.0 megawatt/4.5 MWh BESS 2.4 Public awareness and demand management programs	GET	2,500,000.00	12,470,000.00
Generation and utilization of renewable energy technologies	Investment	3. Institutional capacity for inclusive renewable energy project development and implementation enhanced	3.1 Scholarship program 3.2 National training program 3.3 Construction Supervision (GEF USD 82,290)	GET	82,294.00	600,000.00

Monitoring and Evaluation	Technical Assistance	4. GEF Monitoring and Evaluation	4. GEF Monitoring and Evaluation conducted	GET	40,000.00	
				Sub Total ($)	**2,622,294.00**	**14,830,000.00**
Project Management Cost (PMC)						
				GET	130,000.00	650,000.00
				Sub Total($)	**130,000.00**	**650,000.00**
				Total Project Cost($)	**2,752,294.00**	**15,480,000.00**

C. Indicative 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($)
GEF Agency	Asian Development Bank	Grant	Investment mobilized	8,000,000.00
Recipient Country Government	Government of Tuvalu	In-kind	Recurrent expenditures	480,000.00
Donor Agency	World Bank	Grant	Investment mobilized	7,000,000.00
			Total Project Cost($)	**15,480,000.00**

Describe how any "Investment Mobilized" was identified

The investment was mobilized through processes related to ADB Country Program Strategy and Country Operational Business Plan (CPBP) development for Tuvalu and Pacific Region.

D. Indicative 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($)
ADB	GET	Tuvalu	Climate Change	CC STAR Allocation	2,752,294	247,706	3,000,000.00
				Total GEF Resources($)	**2,752,294.00**	**247,706.00**	**3,000,000.00**

E. Project Preparation Grant (PPG)

PPG Required **false**

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_2e (direct)	46302	0	0	0
Expected metric tons of CO_2e (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_2e (direct)				
Expected metric tons of CO_2e (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_2e (direct)	46,302			
Expected metric tons of CO_2e (indirect)				
Anticipated start year of accounting	2024			
Duration of accounting	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			

Energy Storage	2.00	

Indicator 11 Number of direct beneficiaries disaggregated by gender as co-benefit of GEF investment

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

Part II. Project Justification

1a. Project Description

1) The Global Environment and Related Problems

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 (km^2) distributed across nine coral atolls. United Nations estimated the total population in Tuvalu in 2017 to be 11,393, with a population growth of around 0.2% during 2010–2015. 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).[1] 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), average altitude of 1.83m above sea level, and 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 the government revenues rely significantly on foreign aid, fees from license fees from foreign fishing vessels and remittances from seafaring Tuvaluans (which 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's economic performance had picked up on the back of several large infrastructure projects and stimulus from high public expenditure. It is estimated that 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 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.

Funafuti is the capital of Tuvalu and is an atoll island. 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/km^2. The 2012 census (the most recent completed) shows a small general decrease in population growth 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.

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 km^2. The average elevation is under 2 meters (m) and the highest point is under 6m. Te Namo lagoon is 18 km long and 14 km wide, 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.

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. The strong seasonal cycle is driven by the strength of the South Pacific Convergence Zone, which is strongest during the wet season. The West Pacific Monsoon can also bring high rainfall to Tuvalu during the wet season.[2]

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,[3] the disaster is estimated to have affected 40 percent of the population and caused damages of around AUD 14.0 million (or a staggering 33.6 percent of 2014 GDP). The infrastructure and housing sectors alone sustained damages of AUD 11.1 million. The economic damages and the cost of recovery mean that many years', if not decades', worth of development was undone in the matter of days.

Climate change will exacerbate the scale of Tuvalu's climate hazards. According to (CSIRO/BOM, 2014)[4], climate change projections for Tuvalu are as follows:

- Average temperatures are projected to rise by up to 2°c by 2050. This will lead to higher mean daily temperatures and higher extreme temperatures. This will affect all human activities, and notably the health and water sectors;
- Annual average rainfall may not change or 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, and the rate of rising will accelerate thereafter. 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 and to water resources, potentially affecting all areas on Funafuti;
- There is great uncertainty regarding droughts. Possibly, the effect of climate change on ENSO could exacerbate droughts and this would significantly affect water sector.

However, more recent data and scientific findings suggests the effects of climate change may be far greater than those set out above and projected in (CSIRO/BOM, 2014). Notably, with regards to sea level rise, recent reports suggest credible scenarios whereby the sea may rise by over 1m before the year 2100. Likewise, recent observations of intensive rainfall across the region suggest intensive rainfalls may increase by up to 50% in intensity within a few years.

As Tuvalu is highly vulnerable to external economic shocks and climate change, climate change cuts across all 12 priority areas of the National Strategy for Sustainable Development 2016 to 2020 (“Te Kakeega III”). Climate change and extreme weather events - such as increased temperatures; reduced solar radiation; and increased frequency and intensity of rainfall and cyclones, storm surges, and tsunamis—pose additional threats to energy infrastructure sustainability. Climate change impacts will worsen 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.

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Greenhouse Gas Emissions and the Energy Sector

Despite its small size, Tuvalu does make 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 Commitments and to its Second National Communications to the UNFCCC, the energy sector is the major contributor to CO2 emissions (100%). The waste sector is the main contributor of CH4 emissions (74.7%) followed by the Agriculture sector (24.7%). On a mass basis, emissions of CO2 are by far the most important. This is largely due to the importance of fossil fuel combustion as a source of CO2. Land-use change and forestry is not an important CO2 source in Tuvalu.

In terms of carbon dioxide equivalent, Tuvalu’s gross aggregated GHG emissions (not including the LUCF sector), across all sectors, totalled 16.95 Gg CO2---e in 2002 and the net GHG emissions (including the LUCF sector) were practically the same figure (16.92 Gg CO2---e). 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 can affect the overall balance of payment as well as GDP. At the business and household level, high fuel prices and fluctuations have a destabilizing effect on businesses and households, limiting expansion opportunities and challenging food security, especially in the most isolated outer islands.

2) Root Causes of Greenhouse Gas Emissions

Current power production

An estimated 98% of households across Tuvalu have access to electricity (2018 figures), and there are no reports of significant shortages or outages. Approximately 18% of the electricity in 2018 was generated from renewable sources. With regards to developing renewable energy (RE), until now, the main focus 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 below).

At the national level, the, demand for electricity is growing rapidly. 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[5]. Funafuti is currently lagging far behind the outer islands in terms of the share of renewable energy 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. Of the 1.8 million litres of fuel imported in 2018, 95% was for use on Funafuti for energy production. Notably, approximately 7-10% of GDP is spent on imported fuel (i.e. around US$2 million depending on oil prices) – thereby making energy the costliest sector of the Tuvalu economy. Also, the energy production sector is a major contributor to Tuvalu's net greenhouse gas emissions.

The peak electricity demand on Funafuti is estimated to be 1.36 megawatt (MW) (2017 figures). 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, meaning the system has no spare capacity. The other two running units are due for major maintenance, which would require the third unit to be brought back online. If simultaneous generator faults or breakdowns occur, then extended system wide outages are inevitable. Anecdotally, 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 around 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 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 illustrates the growth of electricity generation from 2013 – 2017 in Funafuti, separating diesel and renewable sources. Figure 1 illustrates that renewables are currently marginal on Funafuti.

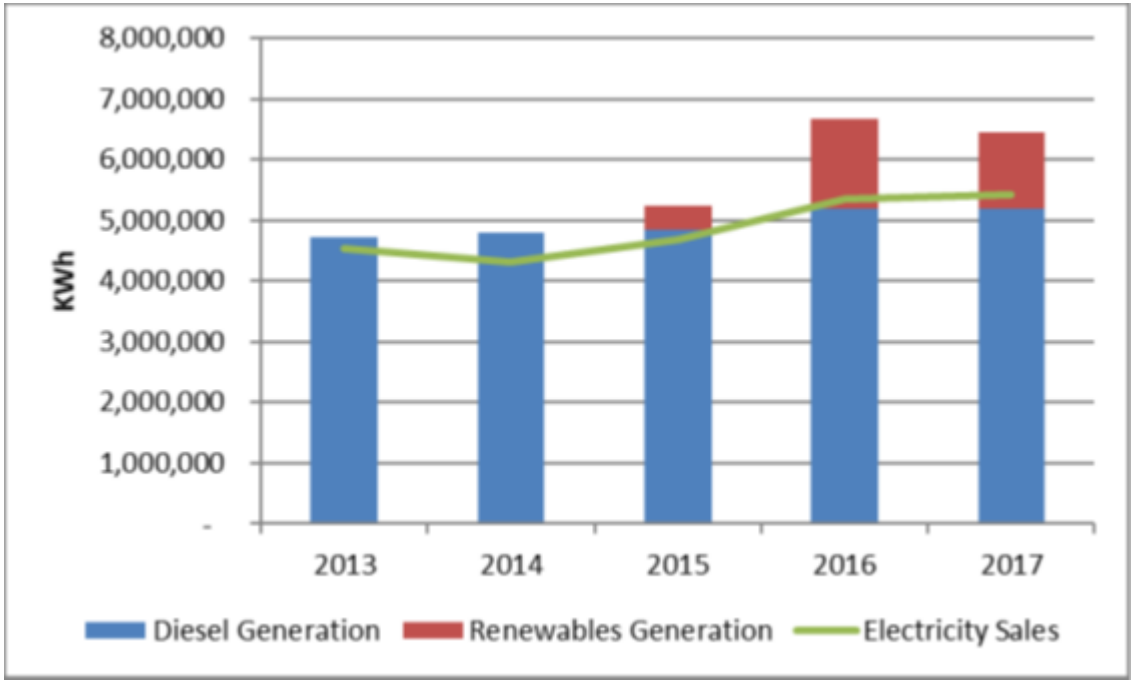

Figure 1: Growth of energy production and sales, Funafuti

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 is currently estimated to AU$ 0.82 (US$0.62 as for 5 March 2021) 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:

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

(ii) Potential high costs and volatility. This affects affordability and financial planning;

(iii) The local pollution generated from the use of diesel;

(iv) Inability to meet commitments to UNFCCC to reduce or eliminate emissions of greenhouse gases.

As stated in Tuvalu's Nationally Determined Contributions (NDC), one of the many constraints to development is Tuvalu's high dependency on imported energy resources, primarily petroleum products. High fuel prices and fluctuations have a destabilizing effect on businesses and households, limiting growth and reducing food security, especially in the most isolated outer islands.

Previous investments in renewable energy

With previous support from international partners, there is currently 735 kWp of installed solar PV capacity that is operational in Funafuti – all land-based or rooftop. The current installed sites are as follows:

(i) 75 kWp at the Princess Margaret Hospital (rooftop);

(ii) 65 kWp of ground mounted PV panels at Public Works Department (PWD) compound;

(iii) 350 kWp integrated into the diesel generation plant;

(iv) 75 kWp at the Marine Warehouse (rooftop);

(v) 130 kWp on Government Offices (rooftop);

(vi) 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.

3) The Solution - Achieving 100% RE Generation for all Tuvalu (the 'Road Map')

In line with national stated objectives and policies (see later sections), Tuvalu aims to reach 100% electricity generation from renewable sources in the near future. This section discusses the steps necessary and the general challenges faced to reach these objectives. This section draws on the analysis and future plan set out in the Tuvalu – Funafuti Road Map (Entura, 2019a).[6]

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*.

Until recently, diesel generators have often been utilised in *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 a low upfront capital cost, and was very attractive in the past when the price of diesel fuel was 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 (mine) 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, transiting their isolated power systems from diesel to renewable energies. This has provided the basis for an uptake of renewable energy in many isolated grids. Initially, in almost all cases, power supplies become **hybrid,** with a mixture of diesel and renewable energy. There is now global experience in developing hybrid and pure RE systems. 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.

That is, when preparing a hybrid power system, it is necessary to not only consider the amount of power required, but also the quality of the power or system reliability. In technical terms, for the system to be reliable, seven basic power system regulation requirements must be met. These requirements are technical and are listed in Table 1.

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

While renewable energy can provide competitively priced real (kW) power (requirement no. 3 in Table 1), it may not be in a position to provide all of the other six basic system reliability requirements. There are two solutions to this. The first is to ensure high levels of diesel are incorporated into the system. The second approach to ensuring that the requirements are constantly met, at higher levels of renewable energy in the power system, is to smoothen the output of renewable energy and maintain power system stability using additional technologies. These **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 journey can be categorized into four stages:

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

With each stage, as more renewable energy is installed into the system, more powerful and more complex enabling technologies are required.

Funafuti: Funafuti Roadmap to 100% Renewable Electricity Production

Based on four stages listed in the above section, Funafuti - with 16% of production from RE – is in the middle of stage 2 or the 'low' RE stage. Hence, in order to reach the objective of 100%, it has to complete stage 2, stage 3, and then stage 4. In addition, as the anticipated demand for electricity on Funafuti is growing, the size of each 'stage' is growing (and standing still would mean receding further from the objective).

Demand. Entura (2019a) prepared demand forecasts for Funafuti (and other islands). 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, this will have to progressively increase to 2.82 MW by 2045 at the latest – as well as fully transitioning to renewables.

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 attractive technologies. 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 at best price.

The benefit of solar PV is 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, locally available and PV is the least cost option for power generation.

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.

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Stages Entura (2019a) established the following road map to 100% renewable energy penetration by 2045 on Funafuti:

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: this includes approved and planned investments (baseline)				
1800	1985	1000/2000	49	33
Stage 2				
1800	4385	2000/3000	60	52
Stage 3				
1800	7635	3000/14000	Approx. 100	86

Table 2: RE on Funafuti - road map stages and milestones

Stage 1 of the Road Map includes significant BESS capacity. The BESS is oversized relative to the renewable energy available and thus enables the future addition of 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 is composed of 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.

From Table 2, 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 MW of solar PV and 3 MW / 14 MWh of BESS;

(iii) the 'final mile' is particularly challenging, and so 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%.

4) Barriers to Achieving 100% Renewable Energy Penetration in Tuvalu and Funafuti

The above analysis suggests that Funafuti faces a unique, but potentially short-lived, opportunity to shift onto a low carbon, highly resilient and renewable energy pathway. This would be transition to a largely PV-only energy production system, with storage. This would massively reduce Tuvalu's GHG emissions, as well as generating other development benefits through energy independence and creation of a sustainable power sector.

This section lists and introduces the barriers to rolling out solar PV on Funafuti.

Land. The most significant challenge to implementing the Road Map is identifying sites which 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 on its development. Energy competes with other sectors, such as agriculture, commerce, water supply 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, equipment.

The estimated area requirements for each stage are as follows:

	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 3: Required areas for road map stages

As free space and land is at a premium, the areas listed in Table 3 are not easily available. For this reason, floating PV (FPV) is being considered as an alternative. This would mean the installation of the PV Panels on wetlands near the airport or on Te Namo Lagoon. The lagoon, in particular, is large, shallow and relatively calm, and appears to provide a good option. The relative strengths of FPV, and the specific barriers facing the roll-out of this innovative technology on Tuvalu, are discussed later in this section.

Technological challenges. As set out in the roadmap, new technologies are required to control and optimise performance of the system, and the specific 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;

(v) protection discrimination and functions are proven adequate.

Step by step, in line with the system growth, new 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, the electricity distribution system is likely to require re-assessment. The system is considered adequate to accommodate the Stage 1 and system growth in the near term. However, this will require reassessment, and probably upgrading, at some point before stage 2 is completed, most likely with regards to cabling capacity and power flow. This will depend on the specific project connection points and sizing of generation technology, which is not yet known. For example, it is anticipated that for each larger RE generation project site, a new 11kV connection point will be required.

Human and institutional capacity. With the new technologies, new technical skills and capacity will be required to manage, maintain and repair the system and the equipment. The details of this need 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 small island. This equates to a transitional development project of a scale not previously seen in the densely populated island of Funafuti. There will potentially be many losers and winners. For example, the greatly reduced import of diesel will lead to increased costs of diesel, potentially affecting transport and fisheries sector. Some businesses will benefit, others will lose. 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 roll out of the new technologies.

Finance. Total funding costs for completing stages 2 and 3 is estimated at US$21.1 million. That is currently far beyond the scope of the government or other potential investors. Further, TEC has operated at a loss since 2013. According to Entura (2019a), there are two main reasons for the continued losses at TEC. The tariff has remained unchanged since it was legislated in January 2008, and does not recover costs. The second reason is the accounting treatment of the grant funded renewable assets, where TEC has fully written-off these investments on the grounds of impairment, although the assets continue to be in use and generate revenue through reduced fuel costs.[7]

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; and (v) can reduce levels of algal growth in water.[8] 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. Although growing rapidly, as of June 2020, global installed FPV capacity was 1.8 GW, out of a global installed cumulative PV capacity of over 505 GW. I.e., approximately 0.36% of PV installed globally is floating. As a new technology, it's roll-out on Funafuti will face some specific barriers:

(i) Understanding and effectively managing the potential environmental impacts on the marine/lagoon environment, including of reduction of light reaching water/lagoon floor;

(ii) 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);

(iii) Increased cleaning and maintenance, which may require access by boats and divers;

(iv) Potential cultural resistance to infrastructure on the lagoon, which has notably traditionally been used for leisure and fishing;

(v) Potential increased 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 the individual capacity required to install and set up;

(vi) Increased possibility of soiling by birds.

5) the baseline scenario and any associated baseline projects

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. The outer islands are now approaching 100% renewable penetration (with the exceptions of Nui, Nukulaelae and Nukufetau – see below). 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 three diesel units, if all operating, can generate up to a combined 1800kW.

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. If successful, this activity will (i) demonstrate the potential of floating PV (ii) lead to a better understanding of the approach to rolling out floating PV and (iii) build individual capacity to install and operate floating PV. This initiative has been approved and has secured financing but, as of yet, installation has not commenced – at least in part due to travel and mobility restrictions associated with the novel coronavirus disease (COVID-19) pandemic.

If investments do not proceed beyond the above baseline, additional diesel generation will be required in 2023 and then again in 2033.[9] Given the short timeframe, and the current status of TEC's financial position which does not have any 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).

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 Roadmap and laying the basis for completing stage 3. The push for floating solar addresses the key constraints in land and rooftop space availability for achieving the PV target for stage 2.

To reach this goal, the project will specifically deliver 3 Outcomes: (i) on three remote islands, RE penetration is taken to over 90%; (ii) on Funafuti, RE penetration is taken to 40-50%, and associated enabling activities are undertaken, and: (iii) on Funafuti, capacity and support for RE sustained deployment is established. The project will also 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 integrated solutions to provide additional co-benefits beyond clean electricity supply and GHG emissions avoidance.

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 including installing physical infrastructure (notably BESS, rooftop PV and FPV), capacity building, institutional strengthening and developing the enabling environment for RE.

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

The figure below further illustrates the project's preliminary theory of change.

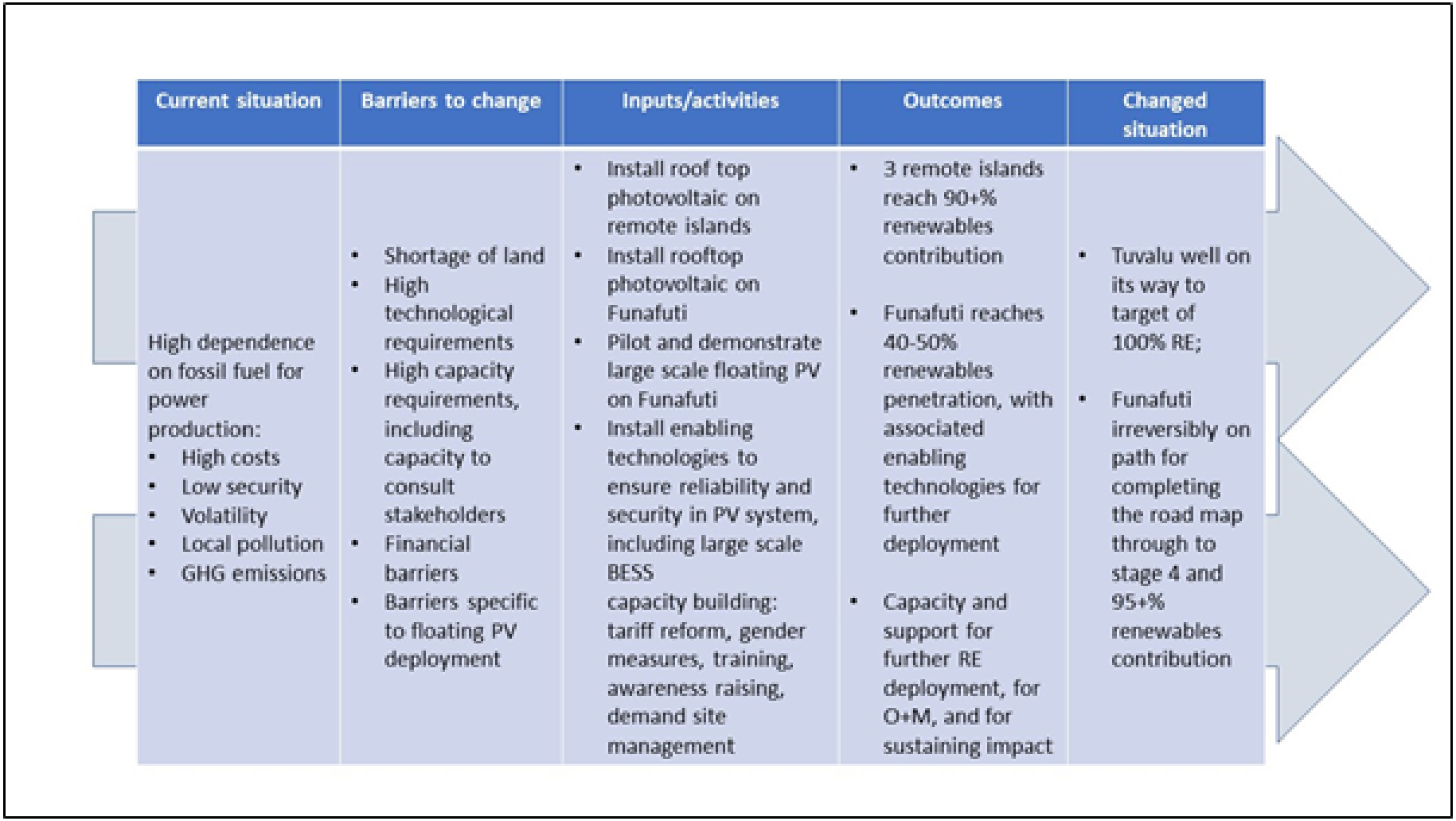

Figure 2: Preliminary Theory of Change

Objective and Outcomes

The Project Objective is, for Tuvalu, the reduction of greenhouse gas emissions and the increased utilization of renewable energy. This is to be achieved by three Outcomes (or Outputs in ADB terminology), i.e.:

(i) Outcome 1. Solar photovoltaic system installed on three outer islands;

(ii) Outcome 2. Solar photovoltaic system and BESS installed on Funafuti;

(iii) Outcome 3. Institutional capacity for inclusive renewable energy project development and implementation enhanced.

ADB has already committed to a Phase 1 financing of this project, Tuvalu: *Increasing Access to Renewable Energy Project* (IAREP). Under this existing commitment, ADB and Government are to finance the installation of 500 kWp rooftop solar PV and 1000 kW/3542 kWh BESS on Funafuti. The Phase 1 project also supports the installation of 224 kW of ground-mounted PV on the outer islands of Nukufetau, Nukulaelae and Nui.

In addition, the World Bank (through the Tuvalu: Energy Sector Development Project) 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 ADB core funds, ADB is proposing to implement a second Phase 2 of the IAREP project. Phase 2 will finance, for Funafuti, a further 400 kWp rooftop solar PV and 750 of floating solar PV.

The approved ADB investment (Phase 1), the WB commitment, and the proposed Phase 2 (financed by ADB and requested from GEF) supported investments are all described in the following sections.

Outcome 1: Solar photovoltaic system installed on three outer islands

Note: This Outcome is financed entirely by the ADB baseline co-financing IARE Project (Phase 1).

This Outcome concerns the three outer-islands of Nui, Nukufetau and Nukulaelae. Two Outputs will be supported:

Output 1.1 At least 224 kWp of PV Capacity Instlaled on 3 Outer islands.

Power systems were originally built with diesel only generation and simple low-voltage (LV) distribution systems. Starting 2015, an EU funded project aimed to reduce dependence on diesel generation and installed hybrid solar/battery power systems, adjacent to the existing diesel power stations.

The aim of the current proposed project is to increase the renewable energy contribution on each of these three islands to, or beyond, the government's 90% target.

The current power system situation is as follows:

Island	Diesel generator capacity (kVA/kW)	PV Capacity (kWp DC)	Battery capacity (kWh)
Nukulaelae	114/90	456	576
Nukufetau	164/130	87	1008
Nui	164/130	77	864

Table 4: Energy supply, outer islands (Nukulaelae, Nukufetau and Nui)

Entura (2019a) and Entura (2019b)[10] analysed current performance, condition of the existing equipment, population growth and forecasted the following electricity demand for 2021:

Island	Existing Demand from Billing data (kWh/year)	Annual growth rate (%)	Dist. losses (%)	Energy Efficiencies (%)	New water pumps and appliances (%)	Annual generation requirement (kWh/year)	Average daily generation requirement (kWh/day)
Nukulaelae	n/a	n/a	n/a	n/a	n/a	75,592	207
Nukufetau	142,222	0	10	-4	4	156,664	429
Nui	130,458	0	10	-4	4	143,504	393

Table 5: Projected energy demand, outer islands (Nukulaelae, Nukufetau and Nui)

The analysis determined that, beyond 2021 "*As a result of the balancing effect of the population movement trends, economic fortunes, recent demand trends, and from discussions with TEC, it has been assumed that growth in electricity demand will be negligible on the outer islands for the project lifetimes*" Hence the demands in Table 5 are considered to apply throughout the period 2021 – 2040. This assumption has been applied as the basis for system design and sizing.

Based on the above, the project will install the following generation capacity (and associated equipment and infrastructure).

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, 10 m 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.).

In addition to the solar arrays, some additional equipment will be 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 as necessary. This consists of:

(i) System balancing (all sites);

(ii) Ancillaries and design (all sites);

(iii) New diesel powerhouse (Nukulaelae only);

(iv) Distribution upgrades (all sites).

The total budget for this equipment and infrastructure under this Outcome (excluding duties and contingencies) is as follows:

Item	Cost US$		
	Nukulaelae	Nukufetau	Nui
Solar PV supply and in stallation (see details in Table 6)	112,400	196,700	252,800
Balance of System	77,300	67,300	67,300
Ancillaries and design	91,000	91,000	46,000
New diesel powerhou se	150,000	-	-
Distribution upgrades	10,000	10,000	10,000
Developer margin (2 0%)	88,140	73,000	75,220
Subtotal	**528,840**	**438,000**	**451,320**

Table 7: Project inputs and estimated budget, outer islands (Nukulaelae, Nukufetau and Nui)

Output 1.2: Public and Government Awareness-raising Programs Initiated

In addition, under Outcome 1, on the outer islands, the following capacity building measures are to be supported:

(i) Public awareness program on efficient household electricity demand management;

(ii) Business skills training on income opportunities from electricity supply for women and men (at least 50% women);

(iii) At least two electricity demand management public awareness programs implemented with at least 50% participation of women;

(iv) Separate business skills trainings for men and women.

Outcome 2: Solar photovoltaic system and BESS installed on Funafuti

Note: This Outcome is financed jointly by the ADB baseline co-financing (IAREP Phase 1), World Bank co-financing, and the ADB/GEF financing (IAREP phase 2).

Box: Current power system on Funafuti

The existing Fongafale power system on Funafuti Island consists of 3 x 600kW diesel generation at TEC, with SMA 'fuel saver' control system, and 735 kWp of installed, operational solar PV capacity. The diesel u nits are aging and not highly reliable.

The system has an SMA 'fuel saver' control system installed that applies an effective limit on solar PV out put of 415 kW.

Forecasted demand for Funafuti

2019b included a detailed analysis of demand (undertaken in 2017), taking into account current customer billing, annual population growth, system losses, system efficiencies and economic growth. The analysis determined that:

(i) For year 2017, annual generation requirement is: 6,668 MWh/year;

(ii) For year 2017, daily generation requirement is 18,268 kWh/day;

(iii) An annual growth rate of 3%/year in required generation.

This leads to the following graphic of total demand on Funafuti:

Figure: Projected electricity demand for Funafuti.

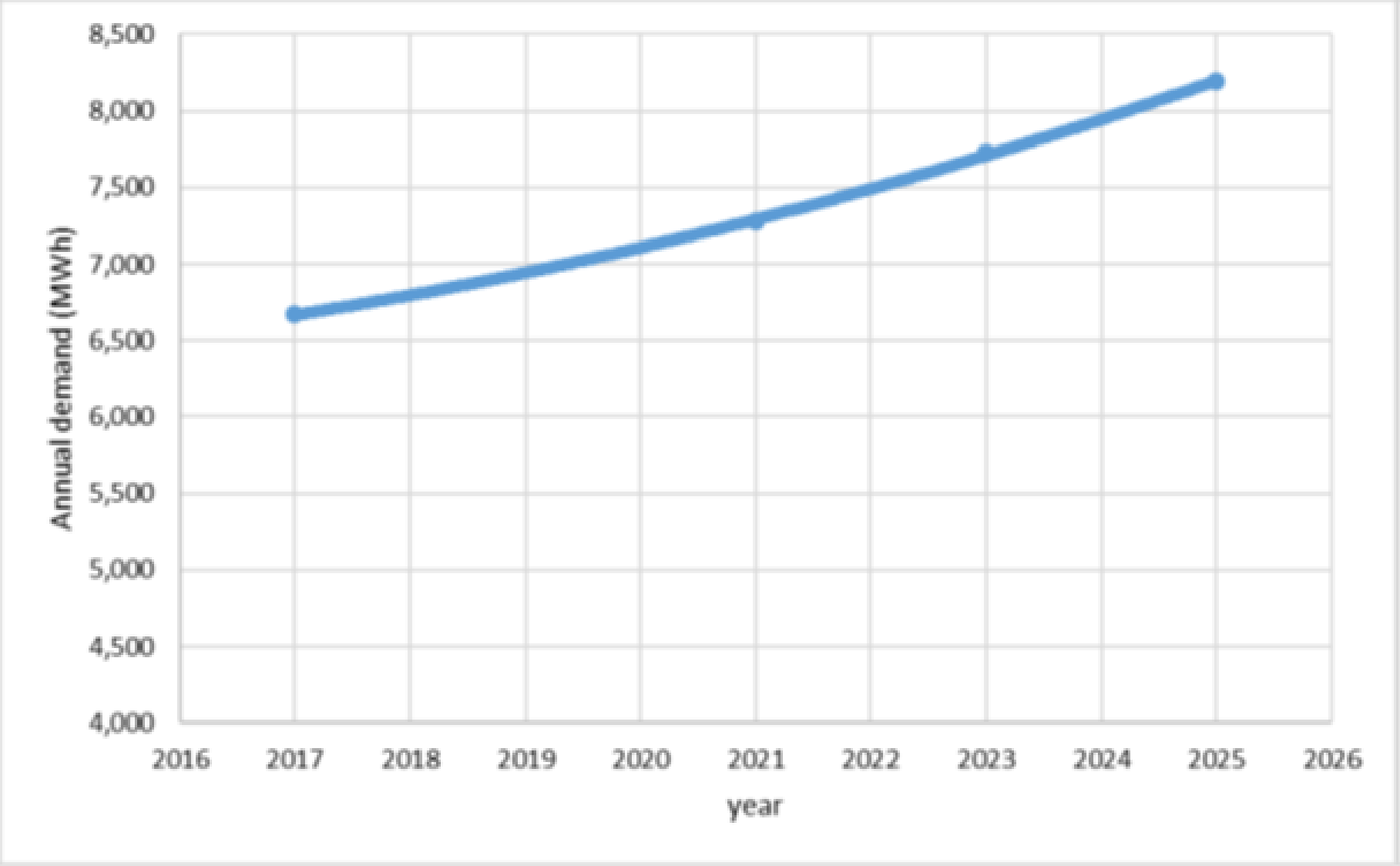

Figure3: Projected electricity demand for Funafuti

Proposed Project Interventions

The Box above describes the current power production system on Funafuti and the projected demands. In order to help Funafuti meet these demands, and reduce GHG emissions, there will be 4 outputs under this Outcome (provided collectively by the various inputs to the alternative project):

Output 2.1: At least 1650 kWp of Rooftop/Ground-mounted PV Capacity Installed

Output 2.2: At least 750 kWp of Floating PV Capacity Installed

Output 2.3: At least 2 Megawatt/4.5 MWh BESS

Output 2.4: Public Awareness and Demand Management Programs Conducted

-

The Box above describes the **total** electricity demand for Funafuti. Completing all stages of the Road Map would lead to renewable energies meeting approximately 100% of total demand.

As discussed in earlier sections, and as listed in Table 2, in order to transition fully to RE and meet this growing demand, and so implement the roadmap 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).

This proposed project, with support from GEF, World Bank (*Tuvalu Energy Sector Development Project*[11]) and ADB, intends to make a significant contribution to meeting total demand by providing photovoltaic generation capacity, battery energy storage systems, and the necessary enabling technologies and capacity building. The following will be provided on Funafuti:

	World Bank/ESDP	IAREP Phase 1 (ADB)	IAREP Phase 2 (GEF/ADB)	Totals
Rooftop and ground-mounted PV (MW)	0.75	0.5	0.4	1.65
Floating PV (MW)	0	0	0.75	0.75
BESS (MW/MWh)	1 / 1	1 / 3.5	0	2 / 4.5

A total of 2.4 MW of PV generation capacity will be installed, along with 2 MW / 4.5 MWh of battery energy storage (BESS) capacity. This is sufficient battery storage to complement installed generation capacity and installs all the battery storage required under Stage 2 of the Road map.

More details are provided in the following paragraphs:

IAREP Phases 1 and 2 – Rooftop PV A total of 900kWp (at least) of rooftop PV will be installed on Funafuti under IAREP Phase 1 and Phase 2.

Entura 2019a undertook an initial assessment of potential rooftop sites across the island of Funafuti, assessing more than 20 potential sites, using multi-criteria analysis. The details and maps of the location of the potential sites are provided in Annex D.

As a result of this analysis, sites for the first 600 kWp of production have been preliminarily selected. Entura (2019b) provides full details of the technical assessment, required infrastructure, technologies, specifications, drawings, sitings, etc for these sites. These pre-selected sites are presented in Table 8 below.

Site	Selected PV capacity (kWp)
Princess Margaret Hospital	259
Waste sorting building	25
Civil Servant Buildings	192
Govt. office building carparks	30
Airport terminal building	168

Table 8: Summarizing selected (preliminary) Rooftop PV for in itial 600kWp

The siting of the additional sites for the subsequent 300kWp (or more) are to be selected from the sites presented in Annex D, and based on the analysis in Entura (2019a)

World Bank – Ground-mounted PV. The World Bank Tuvalu Energy Sector Development Project will install 750 kW of solar PV at the northern end of Funafuti on the top of the waste disposal area.

IAREP Phase 2 Floating PV. At least 750 kWp of floating PV will be installed at one site on Te Namo lagoon.

The project aims to demonstrate and build expertise on the floating solar photovoltaic (FPV) technology through (i) installation of at least 750 kWp of FPV plus value-added co-benefits, and (ii) institutional capacity in designing, constructing and operating FPV systems. The floating system will likely be connected to nearby existing substations. The project site will not be within or near any environmentally sensitive or highly populated areas and will have little or no adverse environmental and social impacts.

Floating PV is a rapidly evolving technology set, and the optimal technology type will be selected based on the assessment (see Annex E - adapted from Entura 2019a), a consideration of latest technological developments, and suitability to the project site. The types of technology to be considered include:

(i) Larger pontoon floating structures;

(ii) Small modular floating structures;

(iii) Circular floater/membrane array systems;

(iv) Raised fixed structures;

(v) Tensile solar structures

After assessment, a choice will be made between metal structures (more resilient, more costly) and high density poly-ethylene (HDPE) structures.

World Bank and IAREP (Phase 1) - BESS

(i) The World Bank Tuvalu Energy Sector Development Project will install 1 MW/1 MWh of BESS;

(ii) IAREP, Phase 1, will install 1 MW / 3.5 MWh of BESS.

The above will, based on latest calculations, actually complete Stage 2 battery storage requirements. There are several requirements on this BESS technology:

(i) The battery shall be capable of increasing the energy storage capacity, without any requirement to increase its inverter capacity;

(ii) 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;

(iii) The inverter must be able to moderate reactive power to support the loads on the grid;

(iv) 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;

(v) The battery cells and power conversion system will need to be modular, and typically small unit size / weight to assist with transport and logistics;

(vi) 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;

(vii) High cycle life and tolerance to low states of discharge are also important to minimise lifetime O&M costs (particularly battery replacement);

(viii) 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;

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

(x) Flooding/inundation risk is to be managed through the detailed design process with equipment lay-outs elevated to levels above anticipated storm events.

It is proposed to install all the BESS – both World Bank and IAREP (ADB) 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.).

Other: in addition to the generation and storage infrastructure, the World Bank ESDP also includes policy support, studies, increased energy efficiency for example through the financing of prepayment meters, and some support to the outer islands. This project also includes: (i) Installation of a satellite-based communications system to enable the Tuvalu Energy Corporation (TEC) to remotely monitor, control, and improve the operation and maintenance of the power system and enhance customer service. This will require support from external contractors and advisors; and (ii) a program of activities designed to enhance the capacity of TEC and other government staff for project implementation. These activities include coordination, administration, technical operation, procurement, financial management, environmental and social management, monitoring, evaluation, and reporting.

For Outcome 2, the total budget for the equipment, technology and infrastructure (excluding taxes and contingency) is estimated as follow:

Item	IAREP Phase 2 (GEF and ADB) (US$ million)	IAREP Phase 1 (ADB) (US$ million) (includes taxes & conting encies)	World Bank
Rooftop/mounted PV	0.5*	1.2 (approx.)	to be determined
Floating PV	3.33*	0	0
BESS	0	2.94 (approx.)	to be determined
Totals	3.83	4.14	7.0
Table 9: Outcome 2, Project inputs and estimated budget, Funafuti			

*** Important notes:**

(i)Typically, FPV units are costlier than rooftop PV units. However, important savings are also made on land acquisition, land preparation costs, and the units are more productive. Typically, globally, the purchasing costs per unit of FPV are 1-5 – 3 the costs of rooftop, and this ratio is falling. In this table a conservative ratio of 3.2 has been is selected, although there is reason to believe it will be lower, and it will be possible to install more than 750kWp of FPV. The installation will also include climate resilience and cross-sectoral solutions such as rainwater collection system from the solar arrays.

(ii) These estimated costs include the following sub-items: new PV capacity, new inverter capacity, transformer, balance of system, ancillaries and design, distribution upgrades, developer margin, physical contingencies.

Full details of required technology specifications are provided by Entura (2019a and 2019b).

In addition, under Outcome 2, with support from ADB and GEF, the following gender sensitive capacity building measures are to be supported (covering outer islands and Funafuti):

(i) Public awareness program on efficient household electricity demand management;

(ii) Business skills training on income opportunities from electricity supply for women and men (at least 50% women);

(iii) At least two electricity demand management public awareness programs implemented with at least 50% participation of women;

(iv) Separate business skills trainings for men and women.

Outcome 3: Institutional capacity for inclusive renewable energy project development and implementation enhanced

-

Note: This Outcome is financed primarily by the ADB baseline co-financing project (Phase 1), with some strategic input from the GEF financing.

The Outputs are:

Output 3.1: Scholarship Program Delivered

Output 3.2: National Training Program Implemented

Output 3.3: Construction Works Supervised

This includes the following activities:

(i) Design and implementation of a capacity building program for TEC staff, likely to include a small overseas scholarship program (for 2 women) and national training;

(ii) Design and implementation of basic education and awareness campaign;

(iii) Hands-on training in solar photovoltaic and BESS design, construction, operation, and maintenance.

Outcome 4: GEF Monitoring and Evaluation

During project preparation, a M&E Plan will be prepared. This will be aligned with GEF Monitoring Policy and Evaluation Policy respectively, as well as requirements of ADB's Independent Evaluation Department (IED).

Output 4.1 GEF Monitoring and Evaluation conducted

See M&E section below. Total M+E costs are estimated at US$ 40,000 to cover Mid-Term Review and Termination Evaluations (reference Table B).

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*.

Notably, in line with this objective, this project has the following characteristics:

(i) It will directly contribute to the transformation of the energy sector, accelerating Funafuti from stage 1 to stage 2 of the RE roadmap;

(ii) It will 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;

(iii) Ensures enabling – 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 and moving PV to a scale and firmly on the roadmap towards the ultimate stage 3.

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

In line with Multilateral Development Bank guidance on counting climate finance[12], 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 be considered 'additional'. The details and GEF contributions are provided in the following table:

Outcome	Total costs (US$, millions)			
	Baseline	Alternative (financed by ADB, Government, World Bank and GEF)	GEF (from the alternative)	GEF (as a %ge of the alternative)
1. Solar photovoltaic system installed on three outer islands	-	1.76	0	0
2. Solar photovoltaic system and BESS installed on Funafuti island	FASNETT: $0.6	14.97	2.5	17
3. Institutional capacity for inclusive renewable energy project development and implementation enhanced	-	0.67	0.07	10
M+E of global environment	0	0.05	0.05	100
PMC	0	0.78	0.13	17
Totals	$0.6	18.23	2.75	15

Table 10: estimated incremental costs analysis

As seen from above table, GEF contributes 15% of alternative project costs, with co-financing covering 85% of the alternative project costs.

Global Environmental Benefits (GEBs)

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. IAREP (Phases 1 and 2), and World Bank ESDP, will install generation capacity, and will provide enabling technical solutions (e.g. BESS, etc) 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.

This project will finance (at least) 1873kWp of rooftop and ground-mounted PV and (at least) 750 kWp of floating PV. A first order, conservative method is used to estimate avoided CO2e emissions. This is based on a comparison of with/without project scenarios, and based on the following assumptions:

(i) In the baseline, 3.75 litres of diesel fuel are consumed to generate 1 kWh;

(ii) 1 litre of diesel fuel consumed generates 2.68 kg CO_2e (conversion factor);

(iii) PV Plant load factor[13] is 17%, for rooftop, ground-mounted and FPV;

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

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

Based on the above,

	First year	Annualized average	25-year aggregate
kWh generated by PV	3.396 million	3.2 million	79.996 million
Diesel fuel saved (liters)	905,599	853,290	21,332,248
GHG emissions avoided (tonnes)	2,427	2,287	57,170
Note: rounding errors			

Table 11: estimated GHG avoided emissions

As a conservative estimate, the project avoids 2,427 tonnes of CO_2e emissions in the first year, an annualized average of 2,287 tonnes of CO_2e over 25 years, and an aggregate 57,170 tonnes of CO_2e over the 25 years.

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.

Co-Benefits

In addition to the above reduction in GHG emissions, the project and implementation of the Funafuti RE road map should have the following additional benefits:

- Reduced air and soil pollution, due to reduce use of fossil fuel burning. This may have measurable impacts on health of local residents;
- Reduced marine pollution, due to (i) reduce transport of fossil fuel (and risk of spills) and (ii) reduced leakage from thermal plants to local marine areas. In both cases this will reduce negative impacts on marine biodiversity and ecosystems;
- Increased stability and sustainability in energy sector, leading to reduced pressures on balance of payments and imports, thereby freeing government funds for investment in social and economic capital – with potential spill-on positives for health and education sectors;
- Increased food and water security. PV use less water (for cleaning, maintenance and cooling) than traditional thermal plants. And FPV systems can be combined with food production systems, thereby contributing to food production.

Details of these to be developed during full project preparation.

Innovation, 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 are:

First, RE remains quite innovative in the Pacific and in Tuvalu, with only a relatively short history and still low generation capacity levels. The transition through stages 1, 2 and 3 of the Road Map, with 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.

Second, floating PV technology remains innovative at the global level, accounting for around 0.36% 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.

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

Sustainability

The GoT commitment is reflected in its adoption of 100% RE targets by 2020 (since revised to 2025).

The IAREP direclty supports 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, of tarifs and an increase in energy security, all strong incentives for government and popular support. By directly contributing 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:

(i) Support ongoing efforts to increase TEC revenue generation. The ongoing tariff review will lead to proposed measures for increased revenue for TEC, who will then be enabled to ensure operations, maintenance and expansion. Increased revenue will also provide incentives to TEC to maintain a high level of service;

(ii) Support efforts to lower costs. Increased efficiency (through the smart management systems and improved technologies) will lead to less cost per 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;

(iii) Help enhance coordination across actors and actions. The road map provides a strong coordination tool. This project directly supports the road map, thereby ensuring that the actions of all partners are coordinated. This will also contribute to lowered costs and increased incentives to maintain a high level of performance;

(iv) Capacity building. The project includes several capacity building and training programs, covering technological issues (managing and operating the new technologies), management capacity, revenue enhancement, equipment operations and maintenance (O+M), etc. These include an on-the-job training 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.

(v) 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. 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 proposed project (and other partners), through the tariff review and institutional analyses, aims to determine financially viable models through which TEC can finance O+M and basic investments, at least.

Potential for scaling up

IAREP takes place in the mid-stages of the 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.

More strategically, the project will develop and demonstrate the use of floating PV on lagoon in the Pacific. This is a technologically 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. Hence, ADB, with its RE portfolio touching almost all Pacific SIDS is looking to actively prime the development of FPV as an innovative, appropriate technology for the Pacific. In this context, ADB is supporting a sub-regional technical assistance project. In addition to Tuvalu, initial activities are currently implemented in Kiribati and Tonga. In each country, the project supports assessments and road-mapping for FPV, project preparation for FPV projects, and necessary institutional capacity building. Positive lessons will be replicated in other countries subsequently.

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

[2] Tuvalu's Second National Communication to UNFCCC, Government of Tuvalu, 2015

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

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

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

[6] The "Tuvalu - Funafuti road map", prepared for the Government of Tuvalu and ADB under TA9242

[7] Instead, the correct accounting treatment would have been to capitalize and depreciate the assets while at the same time amortizing the grant as deferred revenue to profit.

[8] 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.

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

[10] Entura 2019. Tuvalu Renewable Energy Project – Feasibility Report. Prepared for Government of Tuvalu and ADB (Entura, 2019b).

[11] Restructuring paper on a proposed restructuring of energy sector development project (dated July 2020)

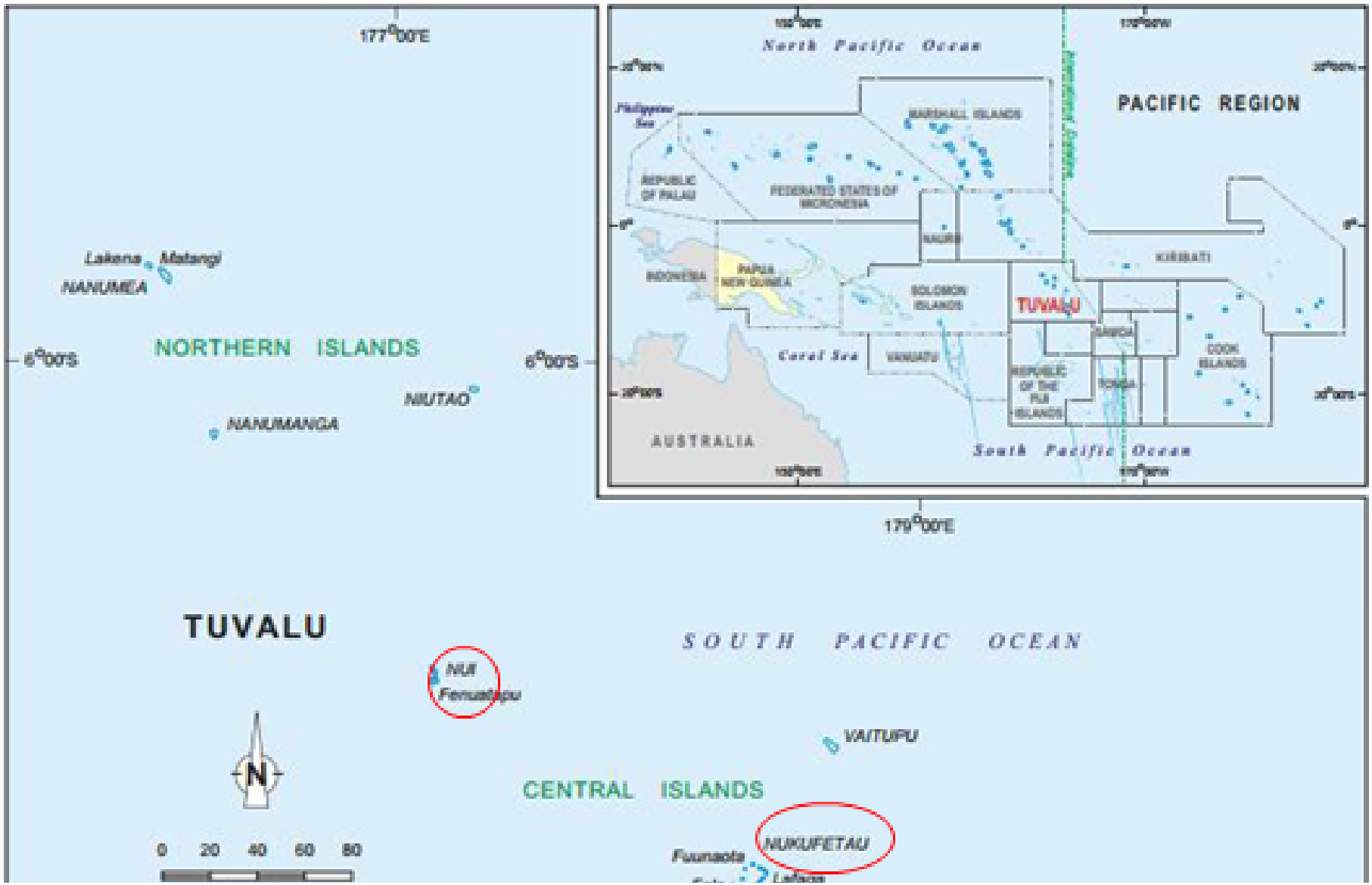
[12] See, for example, "Common Principles for Climate Mitigation Finance Tracking", World Bank (https://www.worldbank.org/content/dam/Worldbank/document/Climate/common-principles-for-climate-mitigation-finance-tracking.pdf)

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

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 following maps.



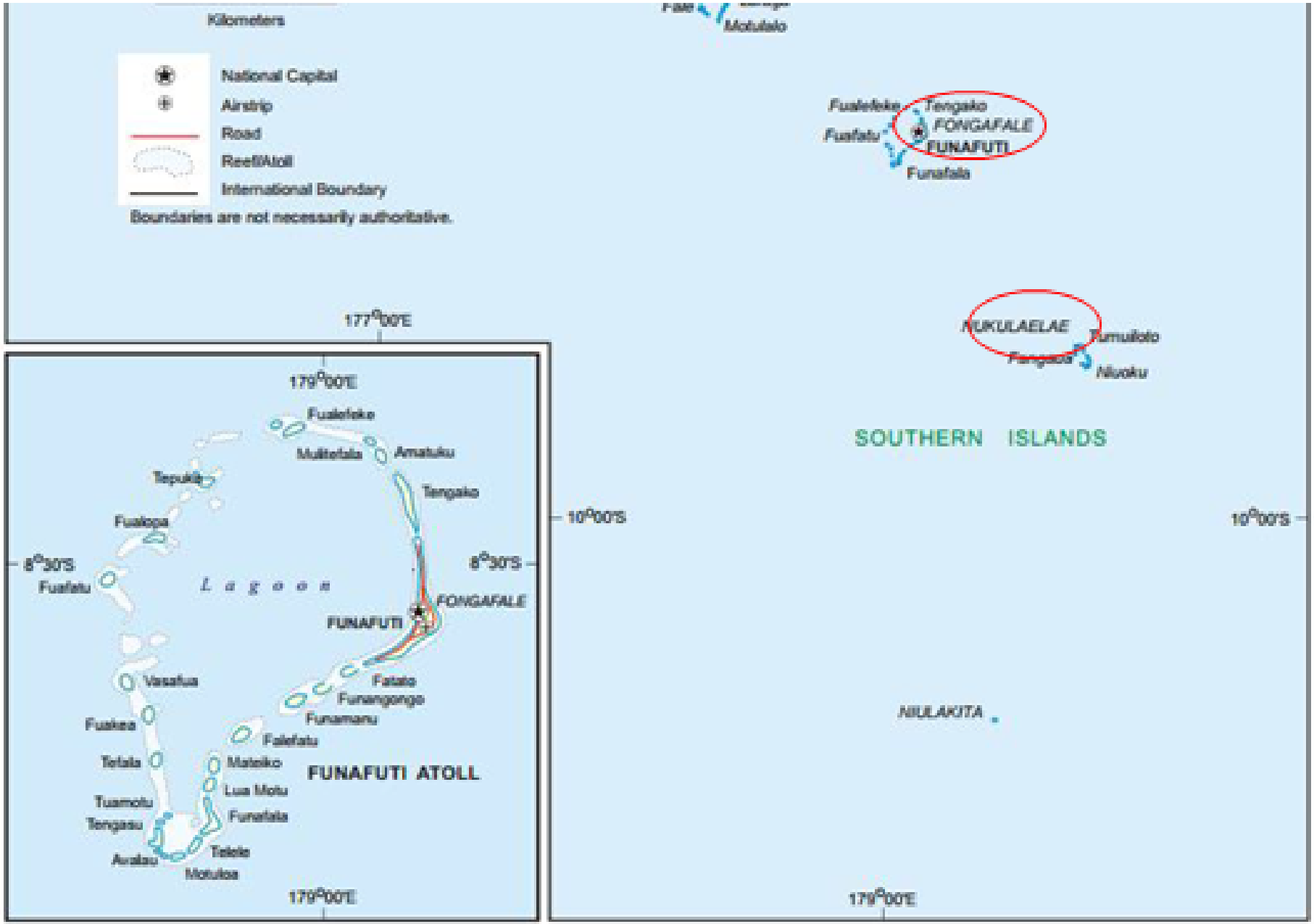


Figure 4: Location of project sites

As mentioned previously, Funafuti atoll is approximately 18 km long and 14 km wide, meaning the lagoon has a surface area of approximately 275 km^2. 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 0.45 MWp typically occupies 0.45 x (1.2-2) hectares, or at most 0.9 hectares, or 0.009 km^2 or at most 0.003% of the lagoon.

The following images (Figure 5) illustrate the likely location and size of the floating solar PV panels, the rooftop PV and the BESS.

Satellite image of Funafuti Atol

Approximate location of potential site for floating PV, on Te Namo lagoon.

Figure 5: Proposed location of rooftop PV and BESS on Funafuti

2. Stakeholders

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

Indigenous Peoples and Local Communities Yes

Civil Society Organizations Yes

Private Sector Entities

If none of the above, please explain why:

In addition, provide indicative information on how stakeholders, including civil society and indigenous peoples, will be engaged in the project preparation, and their respective roles and means of engagement

Approach. ADB and GEF require projects to engage in, and to carefully document, meaningful consultation with stakeholders. ADB defines "meaningful consultation" as a process that:

(i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle;

(ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people;

(iii) is undertaken in an atmosphere free of intimidation or coercion;

(iv) is gender inclusive and responsive and tailored to the needs of disadvantaged and vulnerable groups; and

(v) 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.

Achievements so far Until now, as part of the process to prepare the phase I IAREP project, the project design team has consulted all major stakeholders. This includes staff and officers of TEC, other offices of the national and atoll governments, the national women's NGO, and the potentially affected landowners. This included the Kaupule (community chiefs) and representatives of the Funafuti Native Lands Trust Board. The team visited all subproject sites and met with local stakeholders.

Key findings So far, all stakeholders are supportive of 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. An outline communications plan covering Phase 1 has been prepared (see Annex F).

Consultation during future project development and implementation: A full stakeholder assessment is to be undertaken related to proposed GEF supported activities. This shall be prior to any substantive planning, decisions or to any infrastructure activities. This will lead to an updated stakeholder engagement plan, in line with ADB procedures (and to be available prior to GEF approval of the project).

Key activities planned as part of the stakeholder engagement strategy include:

(i) Conduct a stakeholder analysis to identify and map key stakeholders (including local and international NGOs), their level of influence, communication dynamics and their stake, interest and positions on project issues considering stakeholders' inputs into the analysis. Conduct communication-based assessments determining: (a) each stakeholder's communication requirements and project information needs; (b) their needs and interests in participating in consultations; and (c) the most appropriate channels to engage them. The assessment will also determine the capacity of the project management unit (see below) to implement communication activities; and will also include a review of previous communication activities and identify any gaps that need to be addressed in succeeding communication activities.

(ii) Based on the stakeholder analysis and communication-based assessments, develop the communication strategy. The strategy will include, but not be limited to: (a) how information will be shared and disseminated with both external and internal stakeholders; (b) an outline of proposed participation channels, consultation activities and the role of project grievance mechanisms; a disclosure plan detailing how information is best shared with each stakeholder, especially NGOs, and in what forms. The consultant will ensure that the strategy and all planned activities are in accordance with and meet Government's communication policies and ADB's Public Communications Policy and related procedures and guidelines.

(iii) Implement key components of the communications strategy. For example, it is expected that the PMU and the implementation contractor will consult with and advise target communities regarding implementation work. The implementation contractor will also work with and through the Tuvalu National Council of Women and with the government's Gender Affairs and Culture Department to design and implement a public awareness and education program for households on electricity demand management. TEC, PMU and any consultants will consult with GoT regarding any potential changes to electricity tariff structure and/or rates and will take direction from GoT regarding any public consultation process to be carried out regarding any such changes.

Indigenous people (IP). In line with ADB Safeguard policy, IPs are (amongst others essential criteria) groups that are culturally, economically, socially, or politically separate from those of the dominant society and culture. The people living on Funafuti are overwhelmingly ethnic Tuvaluans - hence there are no indigenous peoples affected by this project.

One potential impact of increased RE production is that Tuvalu will decrease its bulk purchases of diesel, meaning that unit diesel costs on Tuvalu may rise. This may impact stakeholders that are dependent on diesel, such as shipping and fisheries sectors. This will be assessed.

[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.

Annex F – Stakeholder Communication Plan (for Phase 1 only)

STAKEHOLDER COMMUNICATION AND PARTICIPATION PLAN

No.	Objectives	Target Stakeholders	Messages Agenda	Means of Communication	Schedule/ Frequency	Responsible Agencies/Groups	Resources	Reporting
PHASE 1: OUTER ISLANDS CONSTRUCTION								
1.	Inform island residents about construction contractor and about construction programme, schedule, logistics, and outcome.	Island *kaupule* and other residents.	Project construction program, schedule, and outcome.	Email to island TEC staff and to *Ofisa Kaupule*. *Kaupule* then inform other residents by notice on bulletin board and other standard procedures.	Once in Q1 2020	PMU, Ministry of Home Affairs and Rural Development, island TEC staff, island *Ofisa Kaupule*.	Email documents.	Island *Ofisa Kaupule* report back to PMU by email.
2.	Arrange for temporary use of local building(s) and land(s) for storing construction materials and equipment and for project staff housing. Arrange any support services for construction contractor staff.	Island *kaupule* and other residentssaf.	Solicit and confirm supporting arrangements.	Email to island TEC staff and to *Ofisa Kaupule*. *Kaupule* then discuss with other residents as necessary.	Once in Q1 2020	PMU, implementation contractor, Ministry of Home Affairs and Rural Development, island TEC staff, island *Ofisa Kaupule*.	Email documents.	Island *Ofisa Kaupule* email report back to PMU and PMU to implementation contractor.
3.	Public awareness of EMP monitoring and GRM.	Island *kaupule* and other	EMP monitoring and GRM procedures.	Public consultation with island TEC staff and *Ofisa Kaupul*	Once in Q1 2020	Implementation contractor.	Printed handouts and posters.	EMP and GRM records and reports.

		residents.		*e* then with community.				
4.	Ribbon cutting ceremony.	Island community.	Summary of work done and outcome.	Public ceremony.	Once in Q2 2020 and Q3 2020	Implementation contractor, *Ofisa Kaupule*, and island TEC staff.	Ceremony.	Implementation contractor and TEC.
PHASE 1: OUTER ISLANDS OPERATIONS AND MAINTENANCE								
1.	Customer and local TEC staff feedback and error reports.	TEC customers and local staff.	Feedback and error reports.	Verbal to local TEC staff, written reports by email to PMU.	As necessary	Local TEC staff, PMU, and implementation contractor.	Pencil and paper and electronic records and reports.	Local TEC staff report to PMU, and PMU reports to implementation contractor regarding any warranty work.
PHASE 2 – FUNAFUTI CONSTRUCTION								
1.	Inform Funafuti residents about construction contractor and construction programme, schedule, and outcome.	TEC customers.	Project construction program, schedule, and outcome.	TEC and GOT notices.	Once in Q1 2021	PMU.	Public radio and notice boards.	PMU quarterly report.
2.	Funafuti ribbon cuting ceremony.	Island community.	Summary of work done and outcome.	Public ceremony and local radio news report.	Once in Q4 2021	TEC and GOT.	Ceremony.	PMU quarterly report.
PHASE 2 – FUNAFUTI OPERATIONS AND MAINTENANCE								
1.	Customer and local TEC staff feedback and error reports.	TEC customers and local staff.	Feedback and error reports.	Verbal to local TEC staff, written reports to PMU and to implementation contractor.	As necessary	Local TEC staff, PMU, and implementation contractor.	Pencil and paper and electronic records and reports.	PMU reports to implementation contractor regarding any warranty.

ADB = Asian Development Bank, EMP = environmental management plan, GRM = Grievance Redress Mechanism, PMU = project management unit, Q = quarter.

3. Gender Equality and Women's Empowerment

Briefly include below any gender dimensions relevant to the project, and any plans to address gender in project design (e.g. gender analysis).

The strategy for ensuring gender equity and women's empowerment will build on the work achieved and ongoing under the preparations of ADB Phase 1 project. In order to prepare that project, working closely with Gender Affairs and Culture Department, a gender assessment was undertaken and a gender action plan (GAP) covering Phase 1 prepared (see Annex G).

Direct results of that assessment are:

(i) The government agreed to undertake a periodic gender-sensitive review of tariffs and fees, including an assessment of their impact on low-income households. The first such review will be supported by the project;

(ii) All project outputs incorporate gender mainstreaming and corresponding performance indicators, and these targets are detailed in the design and monitoring framework;

(iii) The project is categorized as *effective gender mainstreaming*;[1]

(iv) The project notably aligns with ADB's Strategy 2030 operational priorities including 'accelerating progress in gender equality'.

The proposed project tentatively has the following gender related targets (as set out in the gender action plan): (i) arranging stakeholder consultations to achieve 50% participation of women overall; (ii) if local workers are hired, having a target of at least 25% female local workers overall for construction, administration, maintenance, security, and supervision; (iii) developing and implementing formal TEC human resource gender policies, including equal pay for equal work between men and women by the end of 2020; (iv) funding and awarding at least two academic and/or training scholarships of up to 2 years each for two Tuvalu women and then hiring them on graduation to technical positions in the TEC; (v) developing a household electricity demand management public awareness program; (vi) training women and men on business skills and carrying out the program nationally, beginning in Funafuti, with presenters, 50% of whom are female, trained to present courses to outer islands; (vii) ensuring a gender-sensitive tariff review of residential accounts with analysis and recommendations on subsidies and tariffs to support low-income households, including households headed by women; and (viii) initiating the implementation plan of the inclusive, gender-responsive, cost-recovery tariff review recommendations. A gender policy for human resource management for TEC will be developed in consultation with Tuvalu National Council of Women.

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.

In the preparation of the Phase 2 to be co-financed by GEF, an updated gender assessment will be prepared, and an updated gender action plan. This will be undertaken in accordance with guidelines provided in ADB's Handbook on Poverty and Social Analysis (2012). It is anticipated to have similar approaches and activities as the identified for Phase 1.

[1] By definition, the project is assigned EGM classification if the project outcome is not gender equality or women's empowerment, but project outputs are designed to directly improve women's access to social services, and/or economic and financial resources and opportunities, and/or basic rural and urban infrastructure, and/or enhancing voices and rights, which contribute to gender equality and women's empowerment.

[1] Implementation contractor to propose strategy on proactively seeking women local workers in bid documents.

[2] Include separate, secure and private room for women staff, including sanitation facilities with easy and well-lit access.

[3] These activities will have collaboration with the Gender Affairs Department and with their Communication and Campaign Officer as the focal point.

[4] Gender Affairs Department will participate and undertake sessions on gender issues in Tuvalu.

[5] These activities will have collaboration with the Gender Affairs Department and with their Communication and Campaign Officer as the focal point.

[6] Policy will explore gender-responsive provisions in human resource management, such as (i) measure to be adopted for hiring and grooming female staff in the organization; (ii) maternity leave benefits; and (iii) measures to combat sexual harassment at workplace.

Annex G – Gender Action Plan (for Phase 1 only)

GENDER ACTION PLAN

Outputs	Design Features and Targets	Timeline	Responsibility
Output 1: Solar photovoltaic system installed on three outer islands.	a. During implementation, arrange public awareness and stakeholder consultations on project activities. Target: 50% women (baseline: 0).	Q1 2020–Q2 2021	CSC, PMU, and contractor
	b. During implementation, ensure participation of women for the construction, administration, maintenance, security, and supervision roles. Target: 25% women (baseline: 0).[1]	Q1 2020–Q2 2021	Contractors
	c. Conduct at least two awareness and training for all project staff and contract workers on HIV/AIDS and gender issues prior to or upon mobilization (baseline: 0).	Q1–Q2 2020	Contractors
	d. Ensure equal pay for equal work between women and men contract workers.	Q1–Q2 2020	Contractors

	e. Provide safe and suitable accommodation and facilities for all project staff.[2]	Q1 2020–Q2 2021	TEC and PMU
	f. Develop (i) public awareness program on efficient household electricity demand management; and (ii) business skills training on income opportunities from electricity supply. Target: 50% women (baseline: 0).[3]	Q1 2020	CSC with and through Tuvalu National Council of Women.
	g. Carry out (i) at least two electricity demand management public awareness programs. Target: 50% women (baseline: 0) and (ii) separate business skills trainings for men and women Target : At least 20 women and 10 men.	Q1 2020–Q3 2020	CSC with and through Tuvalu National Council of Women
Output 2: Solar photovoltaic and battery energy storage system installed on Funafuti.	a. During implementation, arrange public awareness and stakeholder consultations. Target: 50% women (baseline: 0).	Q1–Q4 2020	CSC, PMU and Contractor
	b. During implementation, ensure participation of women for the construction, administration, maintenance, security, and supervision roles. Target: 25% women (baseline: 0) (footnote 12).	Q1–Q4 2020	Contractors
	c. Conduct at least two awareness and training for all project staff and contract workers on HIV/AIDS and gender issues prior to or upon mobilization.[4]	Q1 2020	Contractors
	d. Ensure equal pay for equal work between women and men contract workers.	Q1 2020	Contractors
	e. Provide safe and suitable accommodation and facilities for all project staff	Q1 2020	Contractors and PMU
	f. Develop (i) public awareness program on efficient household electricity demand management; and (ii) business skills training on income opportunities from electricity supply. Target: 50% women (baseline: 0)[5]	Q1 2020	CSC with and through Tuvalu National Council of Women.
	g. Carry out (i) at least two electricity demand management public awareness program. Target: 50% women (baseline 0) and (ii) separate business skills trainings for men and women. Target: 30 women and 20 men. (baseline: 0)	Q1 2020–Q3 2020	CSC with and through Tuvalu National Council of Women.
Output 3: Institutional capacity for inclusive renewable energy project development and implementation enhanced.	a. Site safety induction for all relevant TEC, contractor and its engaged local workers and PMU staff to include a component on gender awareness (baseline: 0).	Q1 2020–Q1 2021	CSC and Contractor.
	b. Number of TEC women staff increased by 20% (baseline: 10% i.e. 5 women out of 50 staff)	by Q4 2021	TEC
	c. Number of women CSC team member mobilized by 30% (2 out of 6 consultants)	Q1 2020	TEC
	d. Fund, advertise, and award academic and/or practical training scholarships of u	Q4 2019	TEC and GOT

	p to two years each for two Tuvalu women and hire them on graduation to relevant technical positions in TEC. Target: 2 (baseline: 0).		
	e. Trainings provided on renewable energy project management, financial and procurement, governance, tariff design, construction, operations and maintenance, environment and gender/social safeguards to relevant government agencies with participation from all women staff working in these fields (5 women in TEC; 2 women in DoE; 2 women from MoF; 2 from Gender Affairs Department)	Q4 2019	CSC
	f. Organize national workshop on photovoltaic and BESS technology and related operation and maintenance for 30 participants. Target: 9 women (baseline: 0)	Q2 2020	CSC, TEC and PMU
	g. Develop a formal gender policy for human resource management for TEC in consultation with Tuvalu National Council of Women.[6]	Q1–Q2 2020	CSC and TEC.
	h. Ensure a gender-sensitive tariff review of residential accounts with analysis and recommendations on subsidies and tariffs to increase the use of labor-saving appliances and tools among low income households.	Q1 2020	CSC, GOT, TEC

ADB = Asian Development Bank, CSC = construction supervision consultant, GAP = gender action plan, GOT = Government of Tuvalu, PMU = project management unit, and TEC = Tuvalu Electricity Corporation.

Source: ADB

[1] Implementation contractor to propose strategy on proactively seeking women local workers in bid documents.

[2] Include separate, secure and private room for women staff, including sanitation facilities with easy and well-lit access.

[3] These activities will have collaboration with the Gender Affairs Department and with their Communication and Campaign Officer as the focal point.

[4] Gender Affairs Department will participate and undertake sessions on gender issues in Tuvalu.

[5] These activities will have collaboration with the Gender Affairs Department and with their Communication and Campaign Officer as the focal point.

[6] Policy will explore gender-responsive provisions in human resource management, such as (i) measure to be adopted for hiring and grooming female staff in the organization; (ii) maternity leave benefits; and (iii) measures to combat sexual harassment at workplace.

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; No

improving women's participation and decision-making; and/or Yes

generating socio-economic benefits or services for women. Yes

Will the project’s results framework or logical framework include gender-sensitive indicators?

Yes

4. Private sector engagement

Will there be private sector engagement in the project?

Yes

Please briefly explain the rationale behind your answer.

The economy of Tuvalu is highly vulnerable to external shocks and income volatility due to its geographical remoteness, dependence on imports, reliance on revenue from overseas remittance, and exposure to climate risks. Private sector growth is constrained by the small-scale of the economy; the high costs of doing business; and the country's widely dispersed population. Hence, the public sector dominates, and accounts for 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 proposed project will take several measures to specifically promote the private sector. These may include:

(i) Through the project, private sector operators may be engaged in the provision of capacity building to TEC and other key government agencies. The aim is to transfer private sector modalities and values to Tuvalu public sector stakeholders;

(ii) The Government is committed to exploring measures to attract future private sector co-financing to utilities development, and the project will support this;

(iii) A key project objective is to make power supply financially viable, which can lay a basis for private sector involvement in the sector in the future. The project efforts to improve management and governance will also contribute to these strategies.

With regards to future private sector investments in the energy sector, it is noted that even in comparison to other small Pacific island states, Tuvalu's economy is dominated by the public sector. Private sector interest in investing in the energy sector has until now therefore been extremely low. However, ongoing initiatives supported by ADB (IAREP Phase 1, and the Pacific Renewable Energy Investment Facility) are assessing the barriers to private sector investments, and then will prepare a pathway to private sector investment, and will support overall sector reform that should facilitate private sector involvement. Specifically, that ongoing technical assistance will assess the private sector appetite for investment in FPV, solar powered water supply, alternative fuels and electric mobility, and develop potential business models that cover public-private partnerships and independent power producers.

5. Risks to Achieving Project Objectives

Indicate risks, including climate change, potential social and environmental risks that might prevent the Project objectives from being achieved, and, if possible, propose measures that address these risks to be further developed during the Project design (table format acceptable)

The key risks and mitigating measures are summarized in the following table. This will be validated and updated during final design of GEF supported measures.

Risk	Mitigation measure
Project implementation capacity Insufficient institutional, procurement, and technical capacity and experience in implementing investment projects causes delays or other implementation challenges.	ADB, the PMU, and the construction supervision consultant will assist the TEC, MTET, and MOF in project implementation, execution, monitoring, and procurement. Institutional capacity building will be provided. Market sounding will be conducted to gauge and widen market interest before tendering.
Governance Weak financial management capacity, lack of internal audit function within TEC, and potential misuse of funds	ADB will have strong oversight during the project, which will include holding biweekly teleconferences and two review missions per year. An internal audit program for the TEC will be 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.
Utility and asset sustainability Current tariff structure does not provide cost recovery for TEC and requires the Ministry of Finance or external parties to provide funding for TEC to remain liquid.	The Government of Tuvalu, through the MOF will undertake a review of the tariff structure and implement a plan to progressively increase tariffs towards full cost recovery. Tariff revision is covenanted.

Climate risk screening: Documentation has been

Lack of funds and capacity for routine maintenance and for quick recovery after disasters	The government will ensure minimum tariff levels to ensure coverage of basic operation and maintenance costs, debt service, and capital replacement. The TEC will implement the operation and maintenance plan. Comprehensive institutional capacity building will be provided. The TEC (in coordination with the MOF) will set up a self-insurance fund. The MOF will ensure that the fund is financed such that funds are available when needed (rather than it being a pure bookkeeping exercise).
Unrealized project financial and economic benefits Because of lack of or delayed additional investments in solar capacity to fully utilize the battery capacity	The government is actively seeking financing from ADB and other donors for additional solar installation on Funafuti. ADB supports this exercise.
Climate risk exposure The technology is to be exposed to climate risks, notably storms, waves and sea level rise. These are to become greater with climate change.	The project design will include a full climate risk assessment, accounting for climate change.
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.	To ensure technical and financial sustainability, the project will incorporate lessons learnt from previous solar projects in its design and specifications. It will include support for consulting services for project management and for construction supervision. It will also include a comprehensive and inclusive institutional capacity development program covering technical aspects.
COVID Pandemic Related Risks: The global COVID Pandemic leads to a series of new risks to be monitored, and mitigated if necessary. These are summarized in the following:	
Delayed implementation, as is being experienced by existing projects.	This may lead to delayed outputs, but this is not considered to be a risk to overall project success.

Limited availability of technical expertise - this may be increasing limited as currently travel to Tuvalu is not possible, as for most countries in the region.	Concerned project activities will therefore be delayed, but this is not considered to be a risk to overall project success.
Limits on stakeholder engagement process, as mobility and interactions may be limited by the pandemic.	Currently it is anticipated that this will lead to delays, not changes, in stakeholder engagement. And so this is not considered to be a risk to overall project success.

Table 12: Initial risk assessment

Restricted enabling environment or finance, as government prioritises COVID response over energy sector development.	Government commitment to energy transition and overall project goals remains extremely high and immovable.

attached.

Environment and social safeguards. The project will adhere to the GEF Minimum Standards for Environment and Social Safeguards, as well as ADB's Safeguard Policy Statement.

Due diligence of the IAREP Phase 1 has been undertaken. Social safeguards were rated as low (category C). The Due Diligence Report is attached for reference. For environment, a Rapid Environmental Assessment (REA) and an Initial Environmental Examination (IEE) have been conducted 1 (both attached). As a result, the project is classified as medium risk (Category B) - due to the expected small, site-specific impacts during construction.

For the proposed Phase 2, a full assessment of safeguards will be undertaken in line with ADB's Safeguard Policy. Most likely, the ratings will be the same as Phase 1. However, should the site selected for the floating PV lie on privately owned lagoon (i.e. near shore), this would lead to a classification for social safeguards as medium (Category B).

Annex H – Covid-19 Risk Assessment

TUVALU: INCREASING ACCESS TO RENEWABLE ENERGY PROJECT

COVID-19 RISK ASSESMENT

FEBRUARY 2021

This document has been prepared to assess the risk to the health and safety of workers (TEC Staff, Contractors, PMU, Consultants), as well as communities living near or affected by the Tuvalu IAREP. This risk assessment will be used to inform contractors (including any sub-contractors and/or equipment suppliers) and consultants so that they can update their respective health and safety plans (HSP) and emergency response plans (ERP) as necessary. The

HSP and ERP are standard elements of the environmental management plan (EMP), and these need to be updated to address COVID-19 health risks.

The global COVID-19 outbreak was first detected in January 2020, with it officially declared a pandemic by the World Health Organisation on March 12 2020. The first cases of COVID-19 were detected in Fiji in March 2020. The Governor General of Tuvalu declared a State of Emergency on March 20 2020 and immediately closed the Tuvalu borders to international flights and shipping.

The Government of Tuvalu formed a National COVID-19 Taskforce on March 2 2020. The Task Force is responsible for reporting to the Parliament on a number of areas that are impacted by the pandemic, or that require actions to manage possible scenarios that may occur during the pandemic.

Critically, a COVID-19 Alert Level and Response Plan has been devised and implemented. The Response Plan has 4 levels of increasing alert levels based on where cases of COVID-19 are detected geographically to Tuvalu. There are 4 subsequent levels of decreasing risk as the pandemic recedes through until Level 0 when the World Health Organisation declares the pandemic finished.

The risk assessment and mitigation measures required are to remain in place until one of the following occurs:

1. WHO declares the pandemic finished
2. Government of Tuvalu declares that COVID-19 restrictions need not apply to the project
3. The project is completed and the defect and liability period commences

Entry to Tuvalu

As of February 2021 the Tuvalu borders remain closed to international air travel, and limited to entry by sea borne supply vessels only.

It is anticipated that the borders to Tuvalu will open during 2021 however there is likely to remain stringent conditions on those people seeking to enter the country including Contractors, Sub-contractors and Consultants working on the Tuvalu IAREP.

Thus, whilst there remains a risk of an International traveller bringing COVID-19 to Tuvalu the following measures should be applied prior to entry into country:

Minimise the number of travellers into the country

a. Identify essential and non-essential workers and only allow essential workers to travel in country

b. Reduce the number of trips in and out of the country by extending the length of time of in country visits where possible.

2. When entering the country, follow all Government of Tuvalu isolation and quarantine requirements prior to entry and during initial period in country. This may also include requirements of other countries if transiting through multiple countries to get to Tuvalu.

Site work

Once in country (and out of isolation or quarantine if required) site safe working procedures should be implemented to minimise the risk of transmission between workers, and also with the community around project sites. Such safe working measures may include:

Restrict access to the site to the fewest people necessary

a. Split shifts into AM and PM

b. Reduce the number of site meetings and have them off-site and remotely where possible using phone or video conferencing

2. Apply social distancing between workers on site including assessments of maximum capacity of zones within the project site.

a. Limit physical interactions between workers, workers and clients, and workers and the community including deliveries

b. Create specific walkways through the site(s)

c. Stagger meal times and other breaks to limit worker congregation

d. Avoid queues at hoists/lifts

e. Place signage to remind workers of social distancing requirements

3. Perform regular site cleaning using detergent or disinfectant:

a. Frequently touched surfaces of the project site including plant, equipment, lifts, hoists, handrails and doors

b. Site amenities including lunch break areas, site offices, change rooms, toilets, showers, water tanks/coolers

c. Workers should be trained to clean plant or equipment immediately after use.

d. The person performing the cleaning should wear gloves and use an alcohol based hand sanitiser before and after wearing gloves.

e. Gloves and sanitiser should be made available throughout the site(s)

4. Enforce worker hygiene including
    a. covering coughs and sneezes with an elbow or a tissue
    b. disposing of tissues properly
    c. washing hands often with soap and water, including before and after eating and after going to the toilet
    d. using alcohol-based hand sanitisers
    e. cleaning and disinfecting surfaces
    f. washing body hair and clothes thoroughly every day
    g. staying more than 1.5 metres away from others, and
    h. staying home if sick.
    i. avoid touching their face
    j. avoid handshakes or any other close physical contact
    k. refrain from spitting at all times, and
    l. put cigarette butts in the bin.
5. Keep workers informed about the risks of exposure to COVID-19 and where required, workers should be trained in infection control.
6. Consult and communicate with workers
    a. Workers should be provided with clear guidance of their expectations when working in country including
        i. When to stay away from the workplace
        ii. What action to take if they become unwell
        iii. What symptoms to be concerned about
    b. Provide workers with a point of contact to discuss their concerns nd to access support if required.

Biodiversity. The FPV are to be installed in the lagoon and so special attention is to be made to ensure that there is no negative impact on aquatic flora and fauna. Previous results suggest that the only possible negative impacts are due to the reduced levels of light reaching the water underneath and the lagoon floor. The IEE to be undertaken for Phase 2 will assess this, and ensure that no valuable or vulnerable ecosystem is to be affected, notably by ensuring the site

selection is suitable. Finally, this project is implemented within the framework of ADB's Pacific Renewable Energy Investment Facility (see below). All such projects have to be category C or B - no category A projects are eligible. This further ensures that there will be significant adverse environmental impacts that are irreversible, diverse, or unprecedented.

COVID-19 Pandemic Since September 2020, there are no commercial flights to/from Tuvalu and the borders are closed to all non-nationals/residents. Arrivals/departures from Tuvalu are highly regulated. This strict measure has so far ensured that zero cases of COVID have been confirmed on Tuvalu.

Based on the Covid-19 specific risk assessment (see Annex H), measures will be taken to reduce the health risks to project staff and stakeholders.

Although it is recognised that, within the GEF portfolio, climate change mitigation projects may offer fewer opportunities related to Covid than natural resource projects, an initial opportunity assessment for the project has been undertaken. This will be detailed out during full design. The design will: (i) establish the changes induced by the COVID pandemic on Tuvalu and the updated status; (ii) identify pathways in Tuvalu towards building green recovery and overall resilience, emerging from the COVID Pandemic; (iii) explore linkages with the emerging private sector on Tuvalu; (iv) define possibilities for mutual support between the project and post-COVID green recovery/resilience strategies; and (v) substituting transportation with information technologies in communications and service delivery, for example using video communications rather than face-to-face meetings, in order to reduce costs and allow engagement with a broader audience.

Climate Change As mentioned above, the technology is to be exposed to climate risks, in particular the floating PV, which is to be exposed to storms, tropical cyclones, waves, storm surges and sea level rise. These risks are to become greater with climate change. However, it is to be noted that the FPV is to be installed on the lagoon and close to the coast. This is a marine area that naturally enjoys a high level of protection from extreme events, notably waves are low, winds are mitigated, and even extreme tides and surges are buffered. Hence, it is considered unlikely that this will lead to significant additional costs or provisions.

6. Coordination

Outline the institutional structure of the project including monitoring and evaluation coordination at the project level. Describe possible coordination with other relevant GEF-financed projects and other initiatives.

Execution, Implementation and Management.

ADB is the designated GEF Agency and is the leading co-financier. Consequently, all works, goods, and services under the project will be procured by the recipient in accordance with ADB's Procurement Guidelines (2015, as amended from time to time) and ADB's Guidelines on the Use of Consultants (2013, as amended from time to time). The implementation arrangements for the GEF funds are to be as for ADB funds. These are summarized in the following passages.

The Ministry of Finance (MoF) has the following responsibilities for all ADB managed funds in Tuvalu[1]: i) overall delivery of the project and reporting to Government; ii) ensuring compliance with grant agreement covenants; iii) coordinating with implementing partners on the preparation of withdrawal applications and submitting to ADB; iv) maintaining separate project accounts, and to have all project accounts audited annually and sending to ADB, and; v) ensuring the compilation and presentation of all reporting requirements under the project.

The project GEF Executing Entity is the Tuvalu Electricity Corporation (TEC, under the Ministry of Transport, Energy and Tourism, or MTET)[2]. The Tuvalu Electricity Corporation (TEC) was established, incorporated, and constituted under the Electricity Act of 1991 and began operations in December 1991 (it was previously known as the Tuvalu Electricity Authority). The TEC is governed by the requirements of the Public Enterprise Act 2009, and board members are appointed by the government. The powers, function, and duties of the corporation under the Electricity Act are for the provision and maintenance of a power supply that is financially viable, economically sound, and consistent with the required standards of safety, security, and quality. The corporation is entrusted with enforcing the Electricity Act and regulations, setting standards, and examining and registering electricians. TEC is a state-owned enterprise, a vertically integrated electricity utility operating in the capital of Funafuti and the outer islands of Nukulaelae, Nukufetau, Nui, Nuitao, Vaitupu, Nanumaga and Nanumea.

As GEF Executing Entity, the TEC is responsible for: i) the overall implementation / delivery of the project; ii) ensuring compliance with the provisions of the Grant and Project Agreements and government policies and guidelines; iii) procurement and services for the project; iv) issuing contract change orders as appropriate; and v) establishing and implementing the project monitoring and evaluation framework.

Further, the government has established the Tuvalu Task Force (TTF), comprising of the CEOs of MOF, MTET, also of the Ministries of Public Works, the Ministry of Local Government and Agriculture, and the General Manager of TEC and the Directors of the Departments of Energy and Environment. The TTF is responsible for providing Government oversight over the project and reporting to Cabinet.

The Government is to establish the Project Management Unit (PMU). The PMU is to be responsible for day to day operations and delivery of the project, under the direction of the TEC, to ensure compliance of contractors with contracts, specifications and management plans. The PMU also prepares reports and supporting information for the MOF, TEC and Task Force as required. It ensures the readiness of all project sites for contractor including surveyed and staked out sites, any required permits in place and secured lease agreements (if required).

Coordination with ongoing and planned projects, including GEF 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, Australia, New Zealand, the European Union, and the World Bank.

The TTF, and its members, which 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.

The ADB and GEF supported activities are to be implemented in close consultation with the Tuvalu: Energy Sector Development Project (World Bank funded). This project shares the same government supervisory body, and the PMUs will be very close, if not combined. Close coordination has already been established between ADB and WB.

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

Project	Project aim	Status and coordination points
Facilitation of th	FASNETT aims to facilitate the development and utilisation of feasible and renewable ene	- Under implementation.

e Achievement of Sustainable National Energy Targets of Tuvalu (FASNETT, GEF/UNDP funded)	rgy 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*".	- Activities are faced with considerable delays due to the global COVID pandemic. 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 - Major player in international partnerships to support adaptation of Tuvalu. Coordination activities and mechanisms will be developed with the TCAP office in Tuvalu, and the related UNDP office in Fiji.
"Tuvalu Integrated Urban Resilience Project" under the "Climate Resilient Urban Development in the Pacific" (Proposed for funding by ADB and GEF/LDCF – pending submission/approval)	The overall objective of this project is tentatively "*the urban community on Funafuti is resilient and has access to fully climate resilient sanitation services*". There are to be, tentatively, four components: 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.	- As part of a regional program, the GEF/LDCF PFD has been approved; - This child project was originally to be submitted to GEF before end- December 2020. A one-year extension has since been granted, due primarily to COVID related delays. 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 13: Related Projects supported by international partners

Coordination on Floating Solar in The Pacific. ADB has a RE portfolio touching almost all Pacific SIDS. FPV may be an appropriate technology for many or all of these. Hence, ADB is looking to actively explore and prime the development of FPV as an innovative, appropriate technology for the Pacific. In this context, ADB is supporting a sub-regional technical assistance project. In addition to Tuvalu, activities are currently implemented in Kiribati and Tonga. In each country, the project supports assessments and road-mapping for FPV, project preparation for FPV projects, and necessary institutional capacity building. These activities are supporting development and detailed design of the current proposed project to GEF.

ADB in Tuvalu. This 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,[3] and transform their power subsectors from diesel to sustainable renewable energy generation sources; and (ii) supports sector reform, private sector development, and capacity building.[4] 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.

[1] In ADB terminology, MoF is the Executing Agency

[2] In ADB terminology, TEC is the Implementing Agency

[3] 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.

[4] 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

Is the Project consistent with the National Strategies and plans or reports and assesments under relevant conventions?

Yes

If yes, which ones and how: 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: The *National Strategy for Sustainable Development, 2016 – 2020* (NSSD or *Te Kakeega III)* guides all development on Tuvalu. The NSSD places a strong emphasis sustainable energy development. One of the strategic goals is "*provide efficient, high quality infrastructure and support service*", for which a key performance indicator is '*power production by renewable energy'*. The key strategy is to develop photovoltaics, and this project contributes to that.

Power supply: Tuvalu, like many Pacific Nations, has traditionally relied on imported fossil fuels for electricity generation. This has recently led to the development of policies aimed specifically at reducing the reliance on fossil fuels. This will set an example on mitigating climate change, as well as having the added benefits of reducing the cost of generation, and improving security of supply. In Tuvalu, this is articulated in the 2009 *National Energy Policy.* The goal of that policy is to promote the use of 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 proposed project contributes to that.

Building on that policy, the Government of Tuvalu "*Enetise Tutumau*" - the *Master Plan for Renewable Electricity and Energy Efficiency in Tuvalu,* in 2013. This plan aimed to generate 100% renewable energy by 2020 and to increase energy efficiency by 30%. The Government has subsequently extended the target date for achieving 100% renewable energy from 2020 to 2025. 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 both the energy master plan and the infrastructure strategy.

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.

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.

Finally, in its Nationally Determined Contributions (NDC), Tuvalu commits to reducing by 100% emissions of greenhouse gases from the electricity generation (power) sector, i.e. almost zero emissions by 2025. The NDC also recognizes that one of many constraints to development is Tuvalu's high dependency on imported energy resources, primarily petroleum products. The NDC sets out a strategy to overcome these challenges, meet these goals. This notably includes the deployment of large scale solar photovoltaic panels and associated storage and enabling technologies, on Funafuti, and the specific use of floating solar PV.

8. Knowledge Management

Outline the knowledge management approach for the Project, including, if any, plans for the Project to learn from other relevant Projects and initiatives, to assess and document in a user-friendly form, and share these experiences and expertise with relevant stakeholders.

A detailed knowledge and learning strategy will be prepared for the Request for CEO Endorsement (CER). Outlined below are some possible elements of the strategy:

i) **Overview of existing lessons and best practice that inform the project concept**: 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.

ii) **Plans to learn 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. That project initially addresses activities in Kiribati and Tonga as well as Tuvalu. This project will facilitate the transfer of knowledge across these countries and associated lesson learning.

iii) **Proposed processes to capture, assess and document info, 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.

iv) **Proposed tools and methods for knowledge exchange, learning & collaboration.** In-country, these will 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) other various 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 will occur through the technical studies and social media. Other knowledge dissemination mechanisms will 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).

5. **Proposed knowledge outputs to be produced and shared with stakeholders.** In addition to those mentioned in the points above, one or more 'lessons learned documents' will be prepared and published.

6. **A discussion on how knowledge and learning will contribute to overall project/program impact and sustainability**. 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.

7. **Plans for strategic communications.** The outline communications plan covering Phase 1 is in Annex F. This will be elaborated for Phase 2, including necessary strategic communications. Finally, the above-mentioned Facility is supported by a regional ADB technical assitance (TA) project. That Facility promotes the sharing of technical and managerial lessons learnt between SIDS, who are often experiencing similar technical and management issues related to upscaling and integrating renewable energy on small grids. This knowledge will be shared between participating SIDS, and further across the Pacific region.

9) Monitoring and Evaluation Plan and Budget:

During project preparation, a M&E Plan will be prepared. This will be aligned with GEF Monitoring Policy and Evaluation Policy respectively, as well as requirements of ADB's Independent Evaluation Department (IED).

Total M+E costs are estimated at US$ 40,000 to cover Mid-Term Review and Termination Evaluations (reference Table B).

9. 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			

Measures to address identified risks and impacts

Provide preliminary information on the types and levels of risk classifications/ratings of any identified environmental and social risks and potential impacts associated with the project (considering the GEF ESS Minimum Standards) and describe measures to address these risks during the project design.

Environment and social safeguards. The project will adhere to the GEF Minimum Standards for Environment and Social Safeguards, as well as ADB's Safeguard Policy Statement.

Due diligence of the IAREP Phase 1 has been undertaken. Social safeguards were rated as low (category C). The Due Diligence Report is attached for reference. For environment, a Rapid Environmental Assessment (REA) and an Initial Environmental Examination (IEE) have been conducted 1 (both attached). As a result, the project is classified as medium risk (Category B) - due to the expected small, site-specific impacts during construction.

For the proposed Phase 2, a full assessment of safeguards will be undertaken in line with ADB's Safeguard Policy. Most likely, the ratings will be the same as Phase 1. However, should the site selected for the floating PV lie on privately owned lagoon (i.e. near shore), this would lead to a classification for social safeguards as medium (Category B).

Supporting Documents

Upload available ESS supporting documents.

Title	Submitted
A4 Covid-19 risk assessment	
49450-015 LD 14 CRVA Appendix B PACCSAP	
49450-015 LD 14 CRVA Appendix A - AWARE	
49450-015 LD 14 Climate Change Assessment TUV IAREP	
TUV_IAREP_REA_Energy_Solar	
IEE TUV IAREP	
TUV DDR Social safeguards (conso)	

Part III: Approval/Endorsement By GEF Operational Focal Point(S) And GEF Agency(ies)

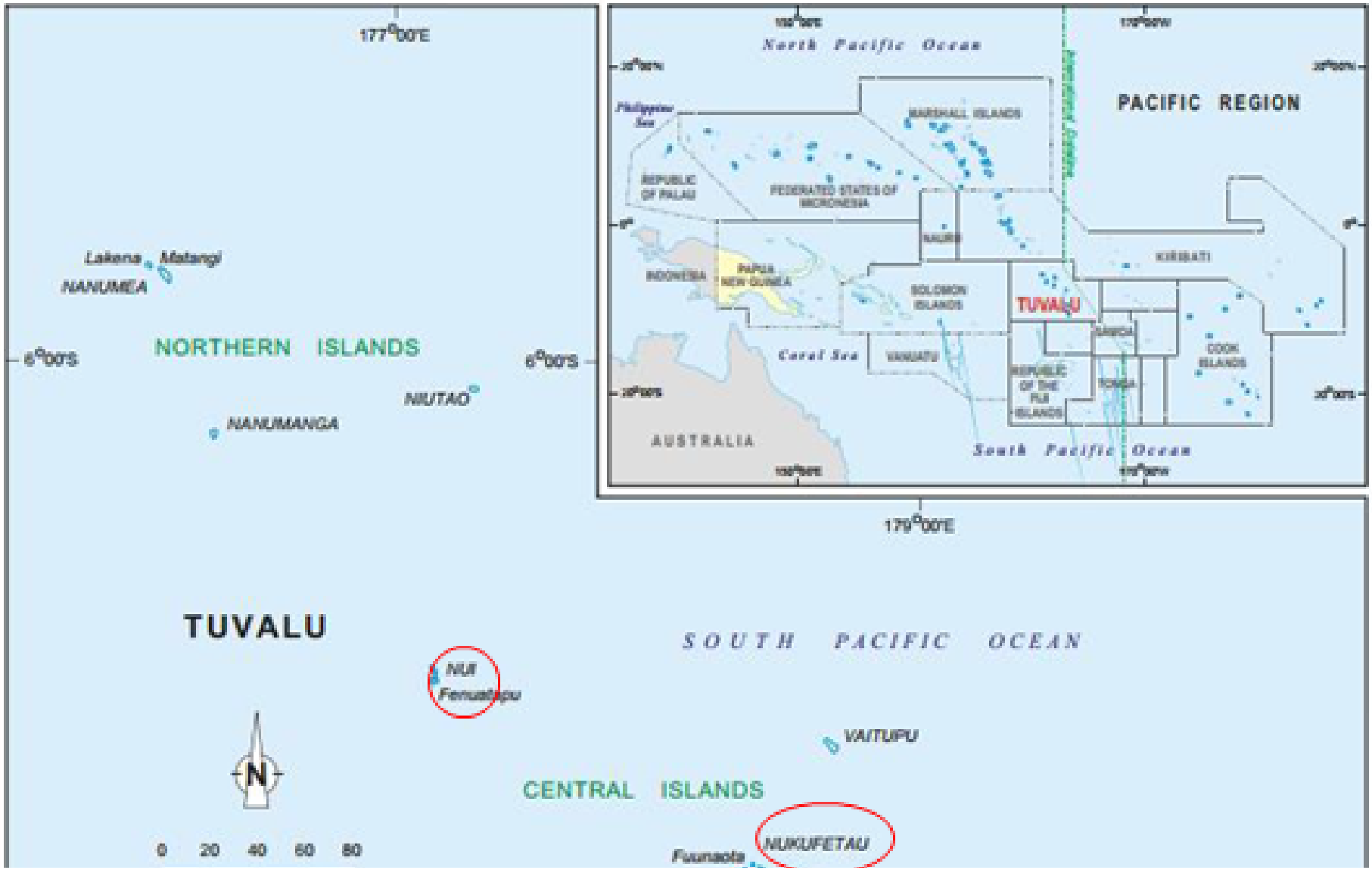
A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT (S) ON BEHALF OF THE GOVERNMENT(S): (Please attach the Operational Focal Point endorsement letter with this template).

Name	Position	Ministry	Date
Tilia Tima	Director of Environment (AG)	Department of Environment Government Building	3/23/2021

ANNEX A: Project Map and Geographic Coordinates

Please provide geo-referenced information and map where the project intervention takes 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 following maps.



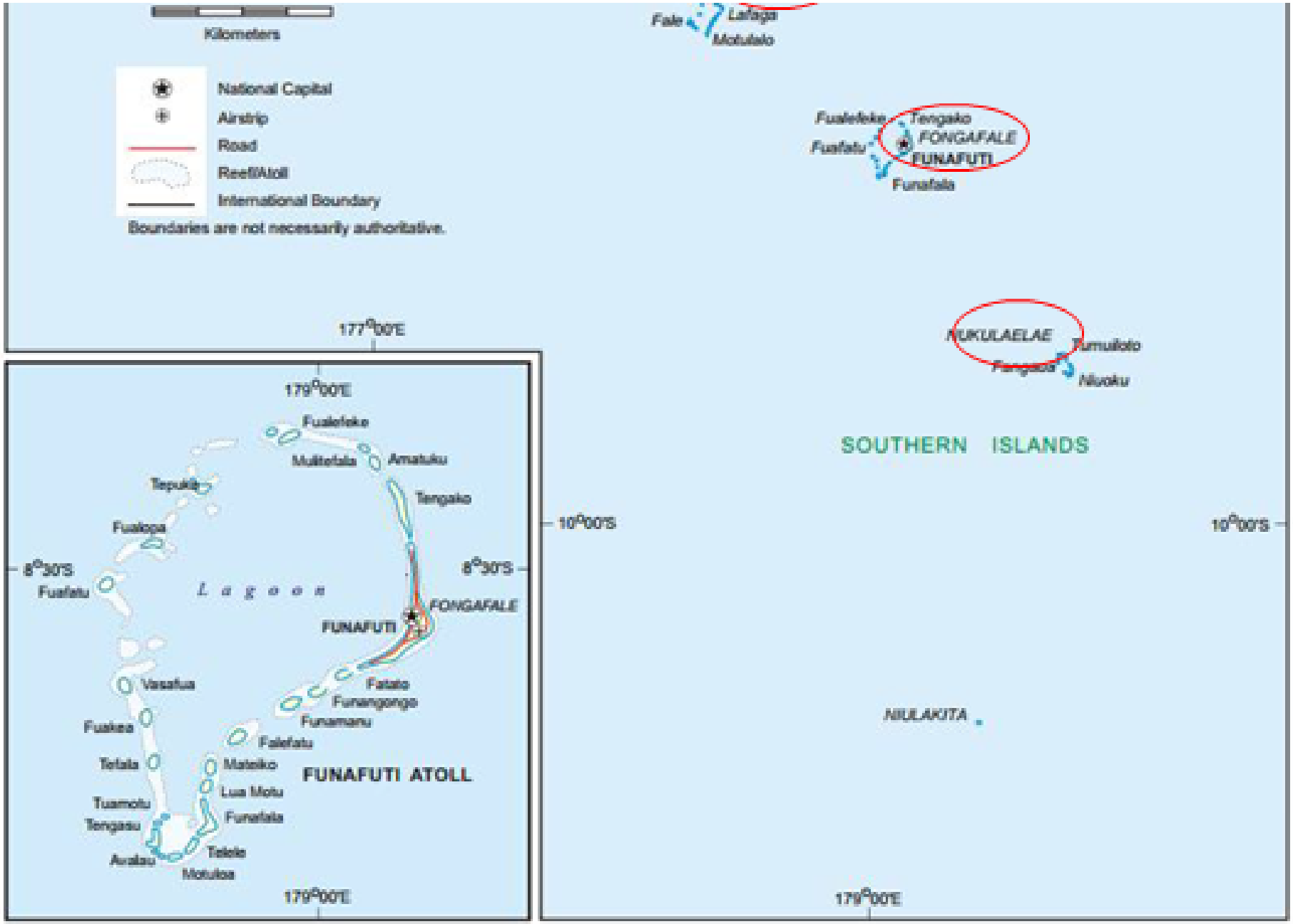


Figure 4. Location of project sites

As mentioned previously, Funafuti atoll is approximately 18 km long and 14 km wide, meaning the lagoon has a surface area of approximately 275 km^2. 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 0.45 MWp typically occupies 0.45 x (1.2-2) hectares, or at most 0.9 hectares, or 0.009 km^2 or at most 0.003% of the lagoon.

The following images (figure 5) illustrate the likely location and size of the floating solar PV panels, the rooftop PV and the BESS.

Satellite image of Funafuti Atol

Approximate location of potential site for floating PV, on Te Namo lagoon.

Figure 5: Proposed location of rooftop PV and BESS on Funafuti