Funding Proposal

FP090: Tonga Renewable Energy Project under the Pacific Islands Renewable Energy Investment Program

Tonga | Asian Development Bank (ADB) | Decision B.21/34

28 November 2018

GREEN CLIMATE FUND

GREEN CLIMATE FUND

Funding Proposal

Version 1.1

The Green Climate Fund (GCF) is seeking high-quality funding proposals.

Accredited entities are expected to develop their funding proposals, in close consultation with the relevant national designated authority, with due consideration of the GCF's Investment Framework and Results Management Framework. The funding proposals should demonstrate how the proposed projects or programmes will perform against the investment criteria and achieve part or all of the strategic impact results.

Project/Programme Title:	Tonga Renewable Energy Project (under the Pacific Islands Renewable Energy Investment Program)
Country/Region:	Kingdom of Tonga
Accredited Entity:	Asian Development Bank
Date of Submission:	18 August 2017

Contents

Note to accredited entities on the use of the funding proposal template

- Sections **A, B, D, E** and **H** of the funding proposal require detailed inputs from the accredited entity. For all other sections, including the Appraisal Summary in section F, accredited entities have discretion in how they wish to present the information. Accredited entities can either directly incorporate information into this proposal, or provide summary information in the proposal with cross-reference to other project documents such as project appraisal document.
- The total number of pages for the funding proposal (excluding annexes) is expected not to exceed 50.

Please submit the completed form to:

fundingproposal@gcfund.org

A.1. Brief Project / Programme Information			
A.1.1. Project / programme title		Tonga Renewable Energy Project (TREP)	
A.1.2. Project or programme		Project	
A.1.3. Country (ies) / region		Kingdom of Tonga (Tonga)	
A.1.4. National designated authority (ies)		Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications (MEIDECC)	
A.1.5. Accredited entity		Asian Development Bank (ADB)	
A.1.5.a. Access modality		☐ Direct ☒ International	
A.1.6. Executing entity / beneficiary		Executing Entities: Ministry of Finance and National Planning (MFNP), MEIDECC, Tonga Power Limited (TPL) Beneficiary: Government of Tonga – represented by MFNP	
A.1.7. Project size category (Total investment, million USD)		☐ Micro (≤10) X Medium (50<x≤250)	☐ Small (10<x≤50) ☐ Large (>250)
A.1.8. Mitigation / adaptation focus		☒ Mitigation (with the anticipated Adaption co-benefits) ☐ Adaptation ☐ Cross-cutting	
A.1.9. Date of submission		18 August 2017	
A.1.10. Project contact details	Contact person, position	Mr. Woo Yul Lee, Energy Specialist	
	Organization	Asian Development Bank (ADB)	
	Email address	wylee@adb.org	
	Telephone number	(63) 2 683 1803	
	Mailing address	6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines	

A.1.11. Results areas *(mark all that apply)*

Reduced emissions from:

- ☒ Energy access and power generation
  (E.g. on-grid, micro-grid or off-grid solar, wind, geothermal, etc.)
- ☐ Low emission transport
  (E.g. high-speed rail, rapid bus system, etc.)
- ☐ Buildings, cities and industries and appliances
  (E.g. new and retrofitted energy-efficient buildings, energy-efficient equipment for companies and supply chain management, etc.)
- ☐ Forestry and land use
  (E.g. forest conservation and management, agroforestry, agricultural irrigation, water treatment and management, etc.)

Increased resilience of:

- ☒ Most vulnerable people and communities
  (E.g. mitigation of operational risk associated with climate change – diversification of supply sources and supply chain management, relocation of manufacturing facilities and warehouses, etc.)
- ☐ Health and well-being, and food and water security
  (E.g. climate-resilient crops, efficient irrigation systems, etc.)
- ☒ Infrastructure and built environment
  (E.g. sea walls, resilient road networks, etc.)
- ☐ Ecosystem and ecosystem services
  (E.g. ecosystem conservation and management, ecotourism, etc.)

A.2. Project / Programme Executive Summary (max 300 words)

Please provide a brief description of the proposed project/programme, including the objectives and primary measurable benefits (see investment criteria in section E). The detailed description can be elaborated in section C.

The Kingdom of Tonga (Tonga) is a small island developing state consisting of 177 islands with a total area of 748 km^2. Tonga's population is approximately 103,000, of which almost three-quarters live in the island of Tongatapu. Tonga is extremely remote from all markets and most resources. Until recently, Tonga depended almost entirely on imported diesel (around 90%) to generate its electricity. This led to climate change concerns and also created a high dependency on imported fuels, which caused limited electricity consumption because of high electricity costs. Tonga has a large potential for renewable energy, notably from solar, wind and biomass. However, financial, technical and other barriers have constrained the development of renewable energies. In response, the Government of Tonga (GOT) issued the Renewable Energy Act in 2008 and then formulated the Tonga Energy Road Map, 2010 – 2020 (TERM). Tonga's Nationally Determined Contributions (NDC) include the following generation (supply side) targets:

- by 2020, 50% of all electricity to be generated from renewables; and
- by 2030, 70% of all electricity to be generated from renewables.

GOT has been implementing the TERM in a phase manner as shown in Figure 1.

Figure 1: The Three Phases of TERM

Tonga's 50% Renewable Energy Target by 2020

Phase 1 (2014-2019)

Outer Island Renewable Energy Project [OIREP] (RE plants on 9 outer islands + power distribution network upgrades) funded by

- ADB Loan: $2.50M
- ADB Grant: 11.44 M
- Government of Australia Grant: $6.72 million
- European Union: $3.57 million
- Second Danish Cooperation Fund for Renewable Energy and Energy Efficiency for Rural Areas: $0.75M
- Global Environment Facility Grant: $2.64 M
- Government of Tonga: $1.57 million

Total: $29.19 M

Phase 2 (2017-2019)

- 1 Solar IPP: ~ $5.0 M
- 2 Wind Farms to be funded by JICA and Government of China : $10-15M
- **Total: $15~20 M**

Phase 3 (2018-2020)

Tonga renewable energy project (TREP):

- Green Climate Fund Grant: $29.90M
- ADB Grant: $12.20M
- Government of Australia Grant $2.50M
- Tonga Power Limited: $3.00 million
- Government of Tonga: $5.60 million

Total: $53.20 M

✓ 4MW Solar PV farms and 3.8MW wind farm to be developed by IPPs
✓ Potential contribution from Government of NZ for wind IPP (to be confirmed)
✓ Potential Biomass Plant _Funding sought

Tonga's Energy Efficiency Target (Reduction of Power Grid Losses to 9%) by 2020

Completed

1. Cyclone Ian Recovery Project to rehabilitate TPL's power grid on Haápai (completed in 2015).

- ADB Grant: $ 2.0 M
- Tonga Power Limited: $0.5M

2. Tongatapu – Tonga Village Network Upgrade Project (completed in 2015).

- Government of New Zealand Grant: $ 35 M

Total: $37.5 M

Ongoing

1. **'Eua – part of OIREP (to be completed in 2018).**
2. **Vava'u– part of OIREP (to be completed in 2019).**

2. Tongatapu – Smart Metering Project (completed in 2018).

- Government of New Zealand Grant: $ 0.6 M
- TPL: $3.0M

Total: $3.6 M

Planned (Beyond 2020)

1. **Nukuálofa Network Upgrade Project**
   - ADB Grant: $ 6.8 M
   - Government of New Zealand: $8.0M
2. **Battery Energy Storage System - part of TREP**

3. Energy Efficiency Programs for residential and commercial customers

- Tonga Power Limited: $0.5M/yr

Total: $14.8 M (excluding TPL's annual contribution)

Source: Government of Tonga and Tonga Power Limited

The first two phases of TERM are under implementation. When these phases are complete, approximately 27% of Tonga's electricity will be generated from renewable energies. Building on this, the proposed project – the Tonga Renewable Energy Project (TREP) to be funded in part by the Green Climate Fund (GCF) – will be the major force to implement TERM Phase 3, thereby helping Tonga meet its NDC targets.

To also improve the demand side management of electricity, GOT has aimed to improve energy efficiency through reduction of electricity line losses to 9 percent by 2020 (from a baseline of 18 percent in 2010) under its NDC. To achieve this target, GOT and TPL have implemented and currently implement the following completed and planned energy efficiency activities (see Figures 1 and 4):

- Power distribution network upgrades under the Tonga Village Network Upgrade Project on Tongatapau (completed);
- Power distribution network upgrades under the Outer Islands Renewable Energy Project (OIREP) on Ha'apai (completed), 'Eua (completed) and Vava'u (on-going);
- Power distribution network upgrades under the Nuku'alofa Network Upgrade Project on Tongatapau (planned); and
- Others (e.g. Smart meter installation, Interconnection Upgrades and Energy Efficiency Programmes for residential and commercial customers, etc) (on-going).

Impact potential. The impact of TREP will be a transformational shift away from the traditional reliance on fossil fuels toward a greater emphasis on climate-resilient renewable energy systems coupled with battery energy storage system (BESS) and reduced GHG emissions as well as promotion of more private section investments into renewable energy development. To achieve this, TREP will:

- Install multiple units of BESS with a preliminary capacity of 10.1 MW/19.9 MWh to overcome the technical barrier to greater renewable energy integration to the grid and therefore unlock private sector investment into renewable energy development, which will enable installation of about 7.8 MW of grid-connected renewable energy (4 MW solar PV and 3.8 MW wind power) generation capacity on Tongatapu (man island) to be financed by independent power producers (IPPs) (see Output 1 of Section C.3.);[1]

- Install about 1.15 MW of renewable energy generation capacity in the outer islands coupled with the associated BESS with a preliminary capacity of 1.40 MWh (see Output 2 of Section C.3.);

- Build a mini-grid system in the outer islands to bring electricity generated from renewable energy-based hybrid system including the associated BESS with a preliminary capacity of 0.90 MWh to consumers (see Output 3 of Section C.3.);

- Improve capacity of GOT and TPL on (i) developing renewable energy system including BESS; (ii) undertaking operation and maintenance; (iii) setting off-take tariffs for power purchase agreements for private sector funded investments; and (iv) improving both gender and community engagement (see Output 4 of Section C.3.);

- Make a major contribution to Tonga's NDC target of generating 50% of electricity from renewables by 2020 and help Tonga build momentum to reach 70% by 2030. TREP-financed generation technologies in the outer islands will directly generate about 3% of additional clean electricity. BESS to be installed under TREP will enable an increase in renewable energy generation by about 7.8 MW (4 MW solar PV and 3.8 MW wind power to be funded by the private sector), which will enable Tonga to increase their renewable energy penetration by 24% without negatively affecting the grid. Moreover, BESS system on Tongatapu will help TPL meet government's NDC target of reducing electricity line losses to 9 percent by 2020 (from a baseline of 18 percent in 2010).;

[1] Tonga Power Limited (TPL) has successfully sourced, structured and negotiated the first independent power producer (IPP) for a 2 MW solar PV farm, which is currently in operation. Additional IPPs in the pipeline include: (i) option for additional 4 MW (2 lots of 2 MW) of IPP solar through the current power purchase agreement; and (ii) the Government of New Zealand (MFAT) has committed NZ$5.0 million to support a 2.2 MW wind IPP project, which both MFAT and TPL have just started identifying the IPP. However, both solar and wind IPPs are subject to installation of any form of storage to be grant funded by development partners like GCF.

- (Mitigation) - Lead to 13,616 tonnes of reduced CO_2 emissions per year, or 340,395 tonnes over the project's 25-year project lifespan; and

- (Adaptation) - Incorporate climate proofing into technical design.

Paradigm shift potential. TREP has been designed to

(i) help rapidly move Tonga from its current energy pathway that is almost entirely (about 90%) dependent on imported fossil fuels for power generation to a pathway using clean and renewable energy resources that is low-carbon and climate resilient;

(ii) provide enabling technical solutions (e.g. BESS, etc) and capacity building for promoting more private sector investments on renewables, which will help Tonga meet its 50% renewable energy target by 2020 and build momentum to reach 70% by 2030. For instance, without the proposed BESS under TREP, planned solar PV and wind farms to be developed by IPPs would not be realized, because TPL's grid cannot fully observe intermittent electricity generated from those renewable energy generation facilities. Moreover, the capacity building component of TREP will support potential IPP transactions and areas for IPP involvement (e.g. drafting and/or reviewing PPAs to be entered into with IPPs);

(iii) help TPL operate and maintain all the grant-funded BESS and renewable energy generation assets on a more commercially oriented way by ensuring through a legal agreement that physical assets financed under TREP are: (a) transferred to TPL and recorded as assets owned by TPL; (b) treated as an increase in the GOT's equity in TPL for accounting purposes; and (c) depreciated on TPL's balance sheet according to an appropriate depreciation schedule for the relevant asset classes as part of TPL's regulated asset base for determination of TPL's costs and revenue requirements;

(iv) increase a level of energy access to marginalized populations in the outer islands where this is currently low. Moreover, the poor who live in the outer-islands can access the modern electricity for a longer period per day instead of the limited energy access generated from individual solar home systems (SHSs), which could lead to development of new business opportunities; and

(v) provide more opportunities for women and local communities involved in the whole project life cycle.

Financing. As presented in Table 1, the proposed financing is a combination of grants from GCF, ADB and the Government of Australia, and contributions from Tonga Power Limited (TPL) and GOT. The indicative financing plan for TREP is presented in Table 1:

Table 1: Indicative Financing Plan

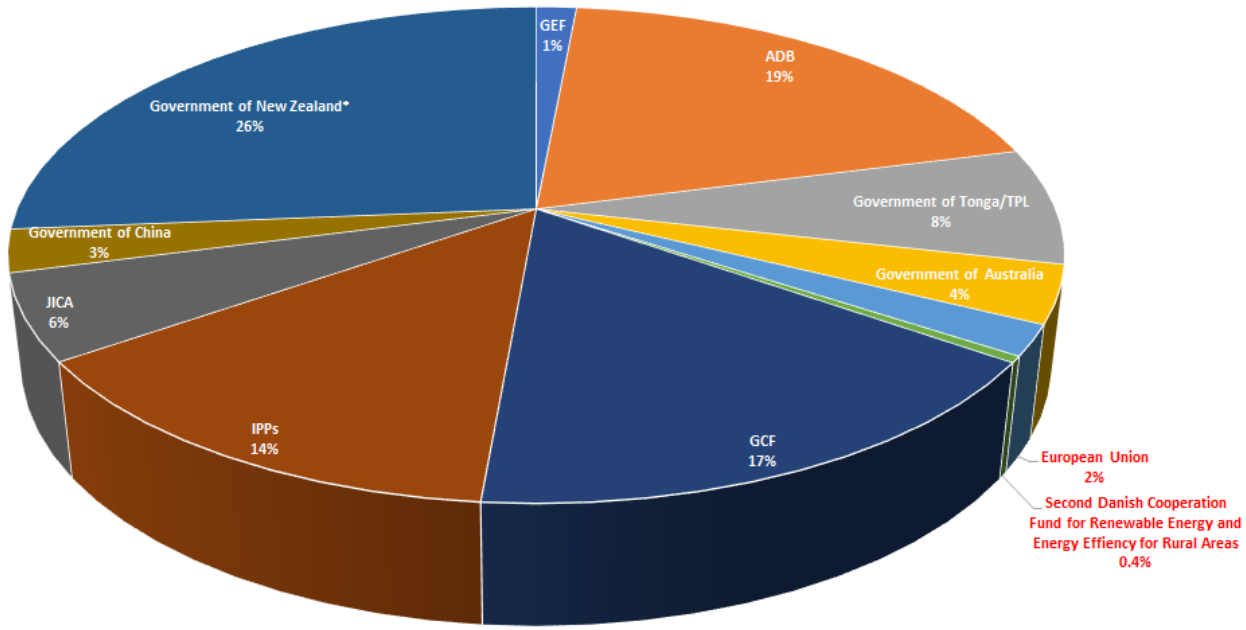
Source	Net Amount ($ million)	%
Green Climate Fund (Grant) [a]	29.90	56.2
Asian Development Bank (Grant)	12.20	23.0
Government of Australia (Grant) [b]	2.50	4.7
Tonga Power Limited [c]	3.00	5.6
Government of Tonga [d]	5.60	10.5
Total	**53.20**	**100.0**

[a] Administered by the Asian Development Bank (ADB). This amount will not be used to cover ADB's administration fee, audit cost or bank charges.
[b] Administered by ADB. This amount includes ADB's administration fee, audit cost, and bank charges to the extent that these items are not covered by the interest and investment income earned on this grant, or any additional grant contribution by the Government of Australia.
[c] Tonga Power Limited will pay for land acquisitions including compensation to land owners for components 1-5 (see Table 3), and other project management and administrative costs.
[d] The Government of Tonga will pay duties and taxes.
Source: Government of Tonga, Tonga Power Limited, Government of Australia and ADB

GOT has very limited revenue sources, and no means of increasing revenue to finance the TERM Phase 3 investments. Attracting private sector interest to Tonga is not easy, and commercial financing is limited. BESS is not considered suitable as a stand-alone private sector investment as the power utility needs to operate the system to ensure power quality is maintained from multiple independent suppliers. Moreover, small-scale renewable energy projects in the outer islands are also not attractive to the private sector. GCF is uniquely positioned to introduce financing at scale to overcome the initial renewable energy investment hurdle (diesel generators are inexpensive to buy and expensive to operate, while renewable energy has a high up-front investment hurdle but are inexpensive to operate). Therefore, the Government of Tonga (GOT) requests grant financing for this proposal.

The requested $29.9 million GCF grant would account for about 56% of the estimated total investment for TREP (Phase 3 of TERM). However, by the virtue of previous and ongoing efforts of other development partners including ADB under Tonga's programmatic (in a phase manner) approach including the supply side management, the requested GCF grant would account for about 17% of the estimated total investment to achieve the overall TERM (Phases 1-3) and energy efficiency targets (see Figures 1 and 4).

Figure 2: Investment Contribution for TERM (50% Renewable Energy) and Energy Efficiency Targets (reduction of electricity line losses to 9 percent) by Financier



Source: Government of Tonga and Tonga Power Limited
* To be confirmed

A.3. Project/Programme Milestone

Expected approval from accredited entity's Board (if applicable)	01/12/2018
Expected financial close (if applicable)	31/12/2022
Estimated implementation start and end date	Start: 01/02/2019 End: 30/06/2022
Project/programme lifespan	25 years

B.1. Description of Financial Elements of the Project / Programme

Investment Program

The financing plan for TREP is presented in Table 2 below. Annex 3 contains the letters of confirmation/commitment from all co-financiers.

Table 2: Indicative Financing Plan

Source	Net Amount ($ million)	%
Green Climate Fund (Grant) [a]	29.90	56.2
Asian Development Bank (Grant)	12.20	23.0
Government of Australia (Grant) [b]	2.50	4.7
Tonga Power Limited [c]	3.00	5.6
Government of Tonga [d]	5.60	10.5
Total	**53.20**	**100.0**

[a] Administered by the Asian Development Bank (ADB). This amount will not be used to cover ADB's administration fee, audit cost or bank charges.
[b] Administered by ADB. This amount includes ADB's administration fee, audit cost, and bank charges to the extent that these items are not covered by the interest and investment income earned on this grant, or any additional grant contribution by the Government of Australia.
[c] Tonga Power Limited will pay for land acquisitions including compensation to land owners for components 1-5 (see Table 3), and other project management and administrative costs.
[d] The Government of Tonga will pay duties and taxes.
Source: Government of Tonga, Tonga Power Limited, Government of Australia and ADB

Tonga is a small island developing state (SIDS) and is highly vulnerable to external economic shocks and climate change. The small size of the economy, the remoteness from partners and markets, and the limited opportunities for economic diversification mean it cannot access commercial credit on favorable terms. Considering this, GOT requests grant financing for this proposal, in addition to the rationale outlined below:

- **Vulnerability.** In the 2016 update of the World Risk Index, Tonga again is ranked as second most vulnerable country worldwide. Further, although not considered to be in a fragile and conflict-affected situation (FCAS), Tonga and other Pacific island countries meet some of the criteria for FCAS classification.
- **Foreign exchange risk.** As of June 2016, over 90% of the total public debt stock was denominated in foreign currency, leaving Tonga highly exposed to exchange rate risks.
- **Need for socially equitable tariffs.** Electricity tariffs are already very high in Tonga[2] and government social policy precludes increasing them. Based on analysis undertaken by Tonga Power Limited (TPL) - the sole state -owned power utility - utilizing grants instead of loans for TREP could lead to up to 18.6% of a reduction in tariffs to consumers, thereby helping to meet social objectives.
- **External debt distress.** As per the 2017 Article IV Consultation—Press Release and the Staff Report for Tonga released by the International Monetary Fund (IMF) in January 2018, Tonga's Debt Sustainability Analysis (DSA) raises its risk of external debt distress from 'Moderate' to 'High' (see Annex 9), because of future potential costs of natural disasters. As a result, Tonga is only eligible to receive 100% grants from many development partners, including ADB. Given this, Tonga will not be in a position to enter into agreements that increase its debt.
- **Debt to equity ratio.** TPL has a prudent 40% debt-to-equity ratio (debt ratio) threshold. Current projections for total TPL debt at the end of June 2017 were T$31.2 million. TPL's debt ratio has already exceeded the 40% threshold. Further borrowing for TREP would push TPL's debt ratio well beyond its debt sustainability levels (up to about 67%).

The estimated cost breakdown by component and sub-project is presented in Table 3.

[2] For instance, the electricity tariff in March /April in 2018 was about 36.0 US cents per kWh.

Table 3: Project Scope and Base Cost

Components	RE Capacity	BESS Capacity	Amount ($ million)	Funding Sources
Base Cost[a]				
Output 1: BESS on Tongatapu				
1 BESS at Fahefa solar PV plant	-	0.7 MW / 0.35 MWh	1.84	ADB Grant
BESS at Matafonua solar PV plant	-	0.7 MW / 0.35 MWh	1.84	ADB Grant
2 BESS at Niutoua wind farm	-	1.8 MW / 0.9 MWh	4.74	ADB Grant
3 Multiple unit of BESS	-	6.9 MW / 18.30 MWh	18.16	GCF Grant
Output 2: Grid-connected Renewable Energy Generation on 'Eua and Vava'u islands				
4 Solar PV Farm with BESS in 'Eua	0.35 MW	0.9 MWh	2.57	GCF Grant
5 Solar PV Farm with BESS in Vava'u	0.3 MW	0.5 MWh	2.20	GCF Grant
Output 3: Renewable-Based Hybrid Systems and Mini-Grids on Outer-Islands				
6 Solar/Battery Hybrid + New Mini-grid				
O'ua	58 kW	109 kWh	0.77	GCF (about 58%) &ADB (about 42%) Grants
Tungua	84 kW	160 kWh	0.86	
Kotu	69 kW	130 kWh	0.73	
Mo'unga'one	35 kW	66 kWh	0.48	
7 Niuafo'ou	0.25 MW	0.404 MWh	4.26	
Output 4: Capacity Building and Project Management Support				
8 Construction Supervision and Capacity Building			2.00	ADB (about 21%) &GOA (about 73%) Grants
9 Project Management Support			1.15	
Base Cost Total			**41.60**	
Other Costs [b]			2.25	TPL
Contingencies			3.22	ADB (about 4%) & GCF (about 96%) Grants
Land Acquisitions			0.53	TPL
Taxes and Duties			5.60	GOT
Total			**53.20**	

BESS = battery energy storage system, GOA = Government of Australia, GOT = Government of Tonga, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic, RE = renewable Energy, TPL = Tonga Power Limited.

[a] The Base Cost which will be funded by ADB, GCF and GOA grants includes packages to be procured in accordance with ADB's Procurement Guidelines.

[b] TPL will pay it for land acquisition including compensation to land owners for components 1-5 (see Table 3), and other project management and administrative costs including project management and control, land clearance and road access, and integration support.

Source: Government of Tonga and Tonga Power Limited.

The financial model for TREP is included in the Feasibility Study Report, attached as Annex 2.

B.2. Project Financing Information

	Financial Instrument	Amount	Currency	Tenor	Pricing
(a) Total project financing	**(a) = (b) + (c)**	53.20[3]	million USD ($)		
(b) GCF financing to recipient	(i) Senior Loans	……	Options	( ) years	( ) %
	(ii) Subordinated Loans	……	Options	( ) years	( ) %
		……	Options		( ) % IRR

[3] Including GOT's contribution in form of duties and taxes exemption.

	(iii) Equity (iv) Guarantees (v) Reimbursable grants * (vi) Grants *	…… …… …… 29.90	Options Options million USD ($)		
	Justification for grant is provided in Section F.1.				
	Total requested (i+ii+iii+iv+v+vi)	29.90	million USD ($)		

	Financial Instrument	Amount	Currency	Name of Institution	Tenor	Pricing	Seniority
	Grant Grant Grant	3.00 2.50 12.20	USD	TPL Government of Australia ADB			Options Options Options Options
	Lead financing institution: Asian Development Bank						
(c) Co-financing to recipient	In addition to the above co-financers, the Government of Tonga will pay duties and taxes of about $5.60 million through exemption. ADB succeeded in mobilizing a grant of $2.50 million equivalent from the Government of Australia as direct co-financing to the GCF investment. Moreover, GOT and TPL have mobilized an indirect co-financing grant of NZ$5.0 million from the Government of New Zealand to support a 2.2 MW wind IPP project, which will benefit from the associated BESS to be funded under TREP. (see Component #2 of Table 3). ADB will continue its efforts to mobilize additional co-financing even during the TREP implementation ADB will provide a grant of $12.20 million under TREP (Phase 3 of TERM), which accounts for about 23.0% of the total TREP investment need. However, ADB alone provides $13.94 million, mobilizes and administers co-financing of $15.97 million from several bilateral/multilateral development partners including the European union, the Government of Denmark and the Government of Australia as well as GEF under Phases 1 and 2 of TERM, which accounts for about 50% of the estimated total investment to achieve the overall TERM (Phases 1-3) target (see Figures 1 and 2). In addition to the supply side support, ADB, other development partners (e.g. the Government of Australia and the Government of New Zealand) and Tonga Power Limited have provided grants of about $41.1 million so far and plan to provide grants of about $14.8 million beyond 2020.						

B.3. Financial Markets Overview (if applicable)

How market price or expected commercial rate return was (non-concessional) determined?

The proposed investment will be 100% grant financed. The financial viability was determined through a comparison of the weighted average cost of capital (WACC) and the financial internal rate of return (FIRR). TPL's corporate financial projection following project implementation is prepared. – see Annex 2D.

Please provide an overview of the size of total banking assets, debt capital markets and equity capital markets which could be tapped to finance the proposed project/programme.

Not applicable

Please provide an overview of market rates (i.e. 1-year T-Bill, 5-year government bond, 5-year corporate bond (specify credit rating) and 5-year syndicate loan.

Not applicable

Provide examples or information on comparable transactions.

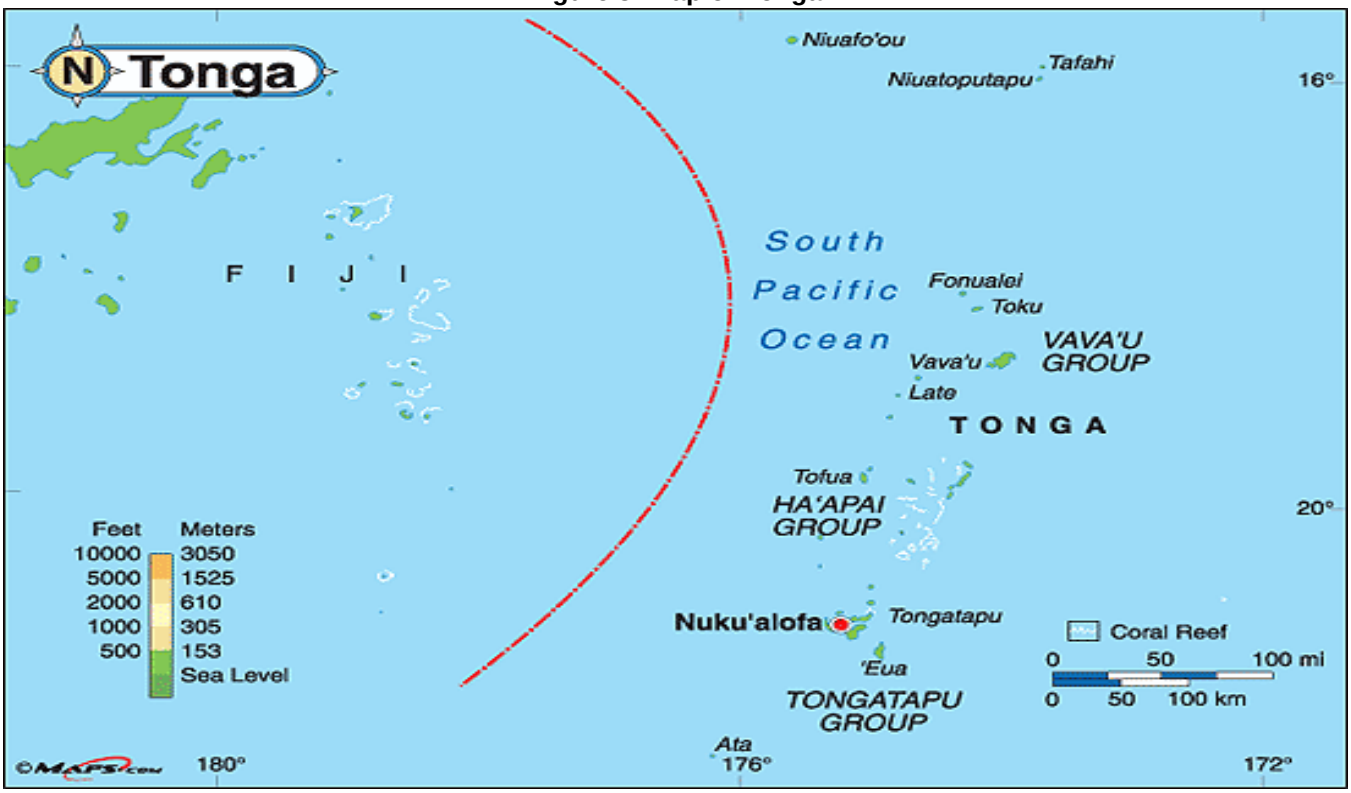
Not applicable

C.1. Strategic Context

Please describe relevant national, sub-national, regional, global, political, and/or economic factors that help to contextualize the proposal, including existing national and sector policies and strategies.

The Kingdom of Tonga (Tonga) is a small island developing state (SIDS) consisting of 177 islands with a total area of 748 km^2 divided into the following four island groups: Tongatapu, Ha'apai, Vava'u and Niuas. 36 of Tonga's islands are inhabited and the total population is estimated at 103,000[4]. Approximately 75% of the population live in Tongatapu, the main island and the location of the capital, Nuku'alofa. The entire country is considered remote from most markets, lying in the Pacific approximately 1,000 km from Fiji and over 4,000 km from New Zealand.

Figure 3: Map of Tonga



Source: http://www.maps.com

In Tonga, 89% of households have access to electricity, rising to 97% in urban areas. Like many other small Pacific islands, Tonga's electricity production relied almost exclusively on diesel generation. Until recently, over 95% of electricity in Tonga was generated using imported diesel fuel. For example, in 2012 (the latest year with complete figures), an estimated 15 million liters of diesel were consumed to generate electricity at a cost equivalent to approximately 10% of total gross domestic product and 15% of national imports.

[4] Tonga, Department of Statistics, Preliminary Census Data, 2016

As illustrated throughout this report, this has the following negative implications: high greenhouse gas (GHG) emissions, high electricity production costs and tariffs, high input price volatility, high dependency on imports, and localized pollution. For example, the electricity tariff peaked in September 2008 at $0.4513 / kWh, and again in July 2011 at $0.4336 / kWh and then slowly dropping to $0.3673 / kWh in March 2017 due to fluctuation in global fuel prices.

Recognizing this contribution to GHG emissions, Tonga's Nationally Determined Contributions (NDC) includes the following targets:

- by 2020, 50% of all electricity to be generated from renewables. Since around 2010, GOT and TPL have focused on many outer islands, which require much higher unit system costs and takes longer for implementation, most entirely supported by various development partners.

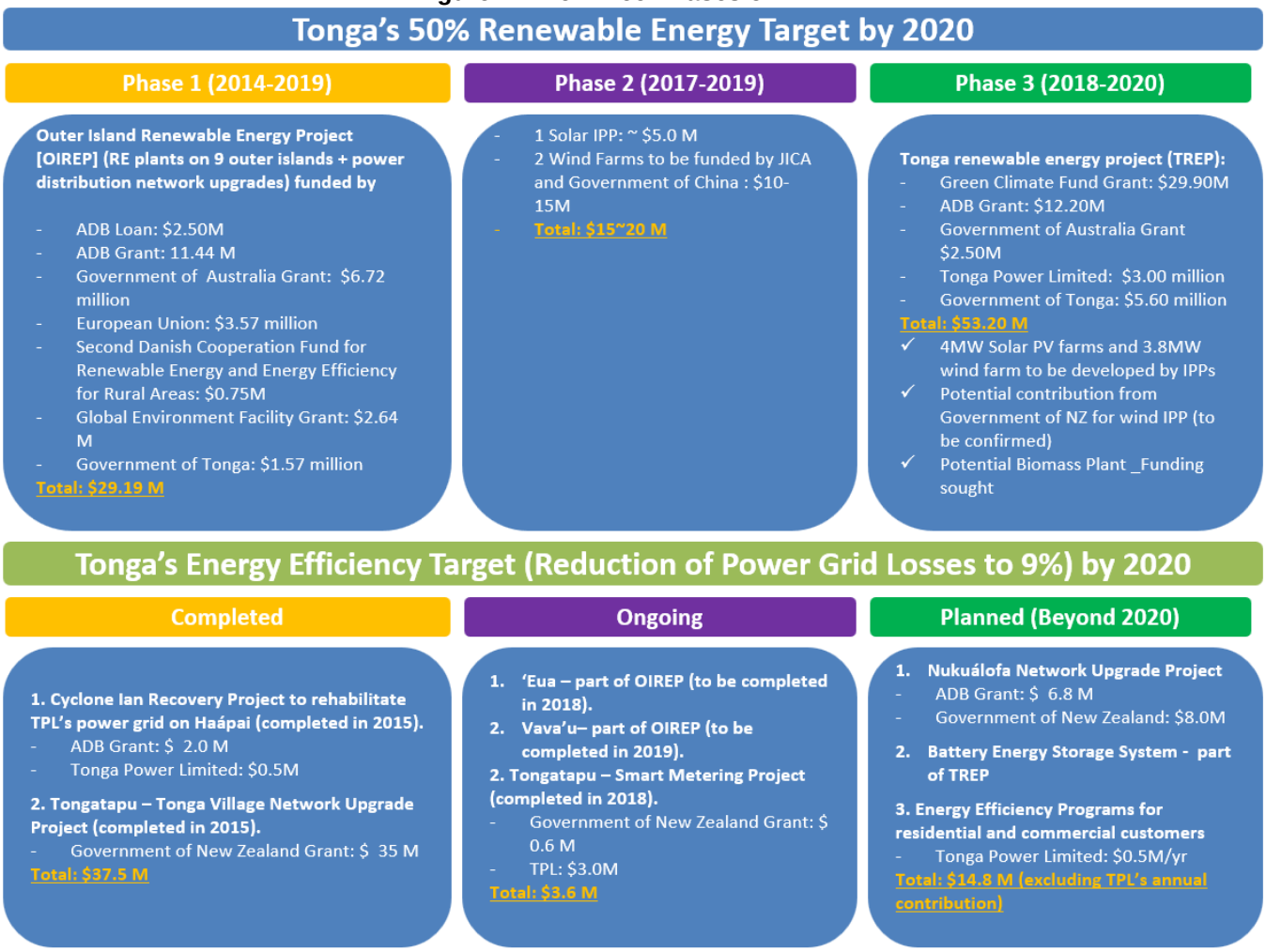
- by 2030, 70% of all electricity to be generated from renewables. GOT and TPL will focus a few main islands, mainly Tongatapu, which is the largest demand center. However, as a renewable energy penetration rate reaches above 50%, a comprehensive storage plan would be of the essence, which is currently being prepared by TPL (partially under TREP). During the period of 2020-2030, GOT and TPL will focus on improving grid and networks. Supporting equipment (to be financed by public funding) must able to absorb these penetrations without permanent damage to the grid, while increasing the RE penetration (to be funded by private sector) to addition 20%. GOT and TPL have no plan to install any new diesel generators after 2020; and

- By 2020, as part of GOT's demand side management efforts electricity line losses to be reduced to 9% (from a baseline of 18 percent in 2010).

Moreover, the poor who live in the outer islands (O'ua with 36 customers; Tungua with 53, Kotu with 43; Mo'unga'one with 22) currently access the electricity generated from solar home systems (SHSs) for limited periods during the day. Existing SHSs are mostly in varying degrees of disrepair. Any "Alternating Power (AC)" power currently on these islands is generated from household-sized fossil fuel generators.

To address the challenges of (i) climate change, (ii) energy security, and (ii) energy access, GOT issued the Renewable Energy Act in 2008. A transition to renewable energy has been a stated national priority ever since. Further, in 2009, GOT issued the Tonga Energy Road Map, 2010 – 2020 (TERM). Figure 4 illustrates how efforts to reach the target are being implemented in three phases for the supply side and for the demand side during the same period:

Figure 4: The Three Phases of TERM



Source: Government of Tonga and Tonga Power Limited

- **Phase 1 (2014 – 2019).** The Outer Island Renewable Energy Project (OIREP), supported by several development partners. OIREP outcomes are: (i) optimized use of on-grid and off-grid generation systems, and (ii) increased consumer access to electricity generated by solar power. OIREP outputs include: (i) the construction and installation of solar power systems including some smart meters with a total capacity of 1.32 MWp on 9 outer islands, (ii) the transfer of operation and maintenance knowledge, and (iii) rehabilitation of the existing grid network near the solar power generation systems on the islands of 'Eua and Vava'u. This enabled Tonga to shift from 0% to approximately 11% generation from renewables.[5]

- **Phase 2 (2017 – 2019).** This includes a pilot solar farm to be funded and built by an independent power producer (IPP), and utility-scale wind farms in Tonga to be funded by the Japan International Cooperation Agency (JICA) and the Government of China, with a total investment of $15 to 20 million. Completion should take Tonga to generating about 27% of its electricity from renewables.

Phases 1 and 2 have generated lessons and have, to some extent, covered the easier investments. However, electricity generated from those renewable energy assets only account for approximately 27% of electricity generation. If Tonga is to reach its NDC targets, a rapid upscaling of investment in renewables is necessary. This is to be achieved through Phase 3, with essential GCF support to TREP.

[5] Including a few existing small-scale renewable energy facilities.

For the outer islands, the ongoing OIREP is currently implementing five mini-grids on neighboring islands. Since these mini grids are similar in size to what is proposed under this project, the lessons learned from the OIREP could be brought into the proposed GCF project (TREP), thus reducing risk and lead times while helping to ensure project outcomes and objectives at no additional cost.

- **Phase 3 (2018 – 2020).** TREP is the main component of Phase 3. Two small-scale solar PV plants (total of 0.75MWp) coupled with BESS are expected to be constructed on 'Eua and Vava'u. TREP will also support Tonga to meet its renewable energy targets by installing BESS, subsequently enabling increased integration of intermittent renewable energy (4 MW solar PV farms and 3.8 MW wind farm) to be developed by the private sector on Tongatapu (the largest demand center). The importance of BESS cannot be over-empathized. For instance, without the proposed BESS under TREP taken in place, planned solar PV and wind farms to be developed by independent power producers (IPPs) would not be realized, because TPL's grid cannot fully observe intermittent electricity generated from those renewable energy generation facilities. Under TREP, renewable energy-based hybrid mini-grid system will also be installed on five outer islands not covered through ongoing OIREP (Phase 1). Discussions are ongoing with the Government of New Zealand's Ministry of Foreign Affairs and Trade (MFAT) with regards to a potential contribution to wind farms to be delivered by a private independent power producer (IPP). Moreover, as an integral part of Phase 3, GOT (with support from development partners) is planning solar PV plants to be developed by IPPs (funding being sought– see footnote 1). Phase 3 completion will ensure that Tonga generates over 50% or more of its electricity from renewables and build momentum to reach 70% by 2030.

To also improve the demand side management of electricity, GOT has aimed to improve energy efficiency through reduction of electricity line losses to 9 percent by 2020 (from a baseline of 18 percent in 2010) under its NDC. To achieve this target, GOT and TPL have implemented and currently implement the following completed and planned energy efficiency activities (see Figures 1 and 4):

- Power distribution network upgrades under the Tonga Village Network Upgrade Project on Tongatapau (completed);
- Power distribution network upgrades under the Outer Islands Renewable Energy Project (OIREP) on Ha'apai (completed), 'Eua (completed) and Vava'u (on-going);
- Power distribution network upgrades under the Nuku'alofa Network Upgrade Project on Tongatapau (planned); and
- Others (e.g. Smart meter installation, Interconnection Upgrades and Energy Efficiency Programmes for residential and commercial customers, etc) (on-going).

Table 4 shows the anticipated impact of each phase to the renewable energy penetration by 2020.

Table 4: Anticipated Impact of Each Phase to Renewable Energy Penetration*

		TPL Grid				Non TPL-Grid		
	Phase	Tongatapu	'Eua	Vava'u	Ha'apai	Outer Islands	Total	%
	Grand Total Consumption (kWh)	**54,215,438**	**1,791,133**	**6,148,000**	**1,553,085**	**2,292,344**	**66,000,000**	**100%**
	Conventional (kWh)	23,549,038	978,333	5,000,000	699,435	252,297	30,479,103	46%
Phase 1	OIREP RE+ BESS (kWh)	-	301,800	-	837,650	747,596	1,887,046	3%
	Existing RE + BESS (kWh)	4,000,000	-	710,000	16,000	550,946	5,276,946	8%
Phase 2	Ongoing and Upcoming RE +BESS (kWh)	10,840,000	-	-	-	15,885	10,855,885	16%
Phase 3	TREP RE + BESS including IPPs (kWh)	15,826,400	511,000	438,000	-	725,620	17,501,020	27%

Total	**Total RE + BESS (kWh)**	**30,666,400**	**812,800**	**1,148,000**	**853,650**	**2,040,047**	**35,520,897**	-
	RE Penetration (%) per Island	57%	45%	19%	55%	89%	54%	

BESS = battery energy storage system, kWh = kilowatt-hour, OIREP = Outer Island Renewable Energy Project, RE = renewable energy, TPL = Tonga Power Limited, TREP = Tonga Renewable Energy Project.
* Excludes electricity generation from both wind farm and biomass plant to be funded by NZ-MFAT and potential IPP.
Source: Government of Tonga and Tonga Power Limited

This proposed Tonga Renewable Energy Project (TREP) is the second project to be submitted under the *Pacific Islands Renewable Energy Investment Program* (PIREIP, FP036). PIREIP will help seven Pacific island countries transition to a renewable energy future. PIREIP's objective is to transform energy use and electricity production sectors across the Pacific to low carbon, climate resilient pathways. PIREIP's outcome will be expanded access to clean, resilient and affordable energy.

Under PIREIP, the December 2016 GCF Board meeting also approved a grant of $12 million for battery energy storage system (BESS) in the Cook Islands and a grant of $5 million for regional capacity building and sector reform. The Independent Technical Advisory Panel (ITAP) of the GCF indicated its support for the PIREIP at its meeting in December 2016. It noted:

- PIREIP's potential catalytic effect for private sector investment,
- its holistic approach involving energy policy development and sector reforms and on the-ground interventions,
- the economies of scale in the program approach,
- the high level of national and regional support and relevance to meeting countries' renewable energy strategies and sustainable development goals,
- the opportunities to apply lessons learned in new subprojects, and
- its potential for replicability in other regions.

C.2. Project / Programme Objective against Baseline

Describe the baseline scenario (i.e. emissions baseline, climate vulnerability baseline, key barriers, challenges and/or policies) and the outcomes and the impact that the project/programme will aim to achieve in improving the baseline scenario.

Current Generation of Electricity

Tonga is highly dependent on diesel for energy and electricity generation. Tonga has an ambitious national target to achieve 50% renewable energy generation by 2020 and an additional target in its NDC to have 70% of electricity generated from renewable sources by 2030.

Tonga's current installed generation and storage capacity is listed in Table 5. Overall installed capacity is 20.2 MW, 3.7 MW (or 18%) of which, is solar PV. There is an additional 1.2 MW of battery energy storage systems (BESS).

Table 5: Current Status of Generation and Storage Capacities in Project Area

Location	Grid Status	Description	Conventional Capacity (MW)	RE Capacity (MW)	BESS Capacity (MW)
Tongatapu	TPL Grid (11 kV)	Popua Power Station 6 x 1.4 MW and 2 x 2.8 MW Diesel	14.0		
		Popua (Maama Mai) PV plant		1.3	0.5
		Vaini Solar Plant		1.0	0.5
		Distributed PV +1 x 11 kW Wind ~ 30 sites across Tongatapu		0.5	
Eua		Power station 2 x 186 kW Diesel	0.37		

	TPL Grid (Medium Voltage)	PV Plant (no storage)		0.2	
Vava'u	TPL Grid (Medium Voltage))	Taumu'aloto power station 2 x 600 kW, 1 x 300 kW and 2 x 186 kW Diesel La'a Lahi Solar Facility PV and VRLA batteries	1.87	0.42	0.2
Nomuka (Ha'apai)	Non TPL Grid (6.6 kV)	Power station 1 x 37 kW and 1 x 55 kW Gensets	0.092 kW	0.070	
Ha'afeva (Ha'apai)	Non TPL Grid (6.6 kV)	Power station 1 x 37kW and 1 x 27 kW Gensets	0.064 kW	0.070	
Ha'ano (Ha'apai)	Non TPL Grid (6.6 kV)	Power station 1 x 37 kW and 1 x 27 kW Gensets	0.064 kW	0.070	
Uiha (Ha'apai)	Non TPL Grid (6.6 kV)	Power station 1 x 37 kW and 1 x 55 kW Gensets	0.092 kW	0.070	
Other islands (Ha'apai)	Off grid	Household generators and solar home systems (SHS)	Very low	Negligible	
Niuafo'ou (Niuas)	Off Grid	Small SHS in most houses + 32 small portable gensets (2.5 kW)			
TOTAL			**16.55**	**3.7**	**1.2**

BESS = battery energy storage system, kV = kilovolt, kW = kilowatt, MW = megawatt, PV = Photovoltaic, RE = renewable energy, SHS = solar home system, TPL = Tonga Power Limited, VRLA = valve-regulated lead-acid.
Source: Government of Tonga and Tonga Power Limited.

Most installed capacity – conventional, solar and BESS – is on Tongatapu, the main island and main grid. The other capacity is on separate mini-grids or household systems across many islands. The generation of electricity from solar PV is limited by: (i) the fact that solar PV electricity is not always available when needed (especially after sunset, despite battery storage); and (ii) the distribution of generators across the islands cannot always perfectly match the demand on the islands. Hence, in 2017, only about 11% of electricity consumption was being met by renewables.

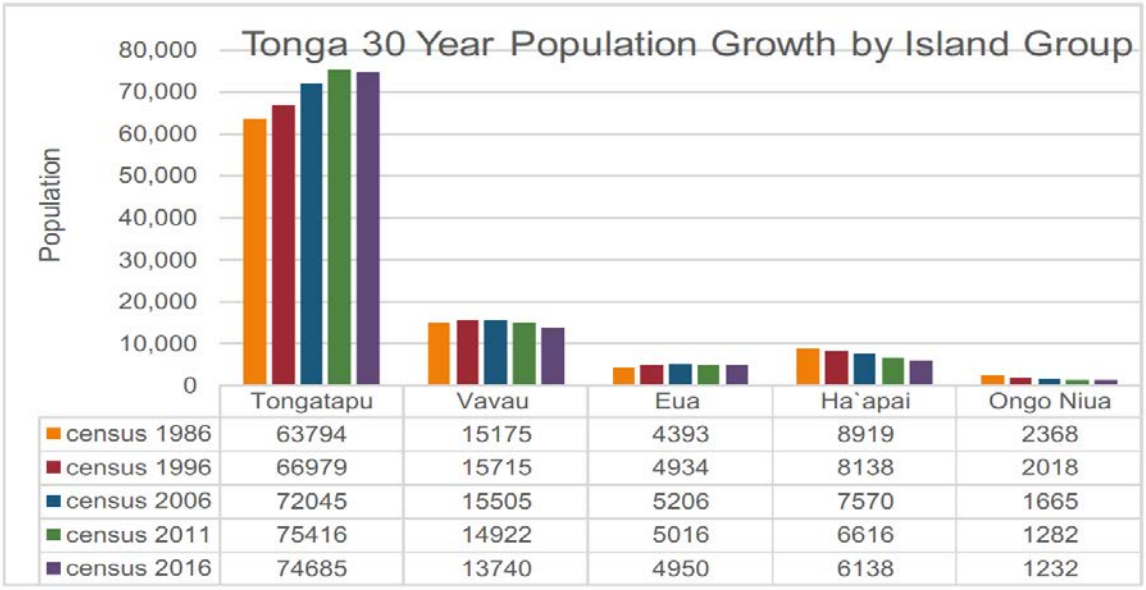
For Tonga as a whole, electricity consumption in 2012 was 52.4 GWh. Most realistic scenarios (see Annex 2) are that consumption will rise to 66 GWh by 2020 and 107 GWh by 2030.[6] GOT and TPL are striving to lower generation and network management costs, and work with retail and commercial consumers to improve the electricity efficiency by the following measures; (i) investing on energy saving devices such as LED lighting and more efficient HVAC; (ii) reducing electricity by managing lighting, equipment, machinery and HVAC usage; and (iii) smoothing the uptake and shedding of electricity usage during the two main peak periods.

Electricity Demand in the Baseline

Demographics. Population is an important factor driving electricity demand. Typically, a rising population results in rising demand. As seen in Figure 5, the population of Tongatapu grew over previous decades before falling slightly since 2011, whereas the population on the other island groups has shown a stronger decline trend over several decades.

Figure 5: Population and Demographics on Tonga, 1986 - 2016

[6] It's estimated in consideration of both ongoing and planned energy efficiency measures (see Figures 1 and 4), including (i) BESS under TREP; (ii) distribution network upgrades under the Tonga Village Network Upgrade Project on Tongatapau and OIREP on Ha'apai, 'Eua and Vava'u; (iii) Others (e.g. Smart meter installation, Interconnection Upgrades and Energy Efficiency Programmes for residential and commercial customers, etc)



	Tongatapu	Vavau	Eua	Ha`apai	Ongo Niua
census 1986	63794	15175	4393	8919	2368
census 1996	66979	15715	4934	8138	2018
census 2006	72045	15505	5206	7570	1665
census 2011	75416	14922	5016	6616	1282
census 2016	74685	13740	4950	6138	1232

Source: PI Berlin 2017

Other factors driving demand. In addition to population, many other factors impact electricity demands, including: population distribution, seasonal visitors (from Australia, New Zealand and the Unites States, etc.), reliability of supply, community aspirations, the cost of electricity, the affordability to pay for electricity; and the development of livelihoods and industries that require electrical power. For example, for Vava'u, between 2014 and 2016, although the population declined slightly, electricity consumption grew by approximately 20% (see Figure 6).[7]

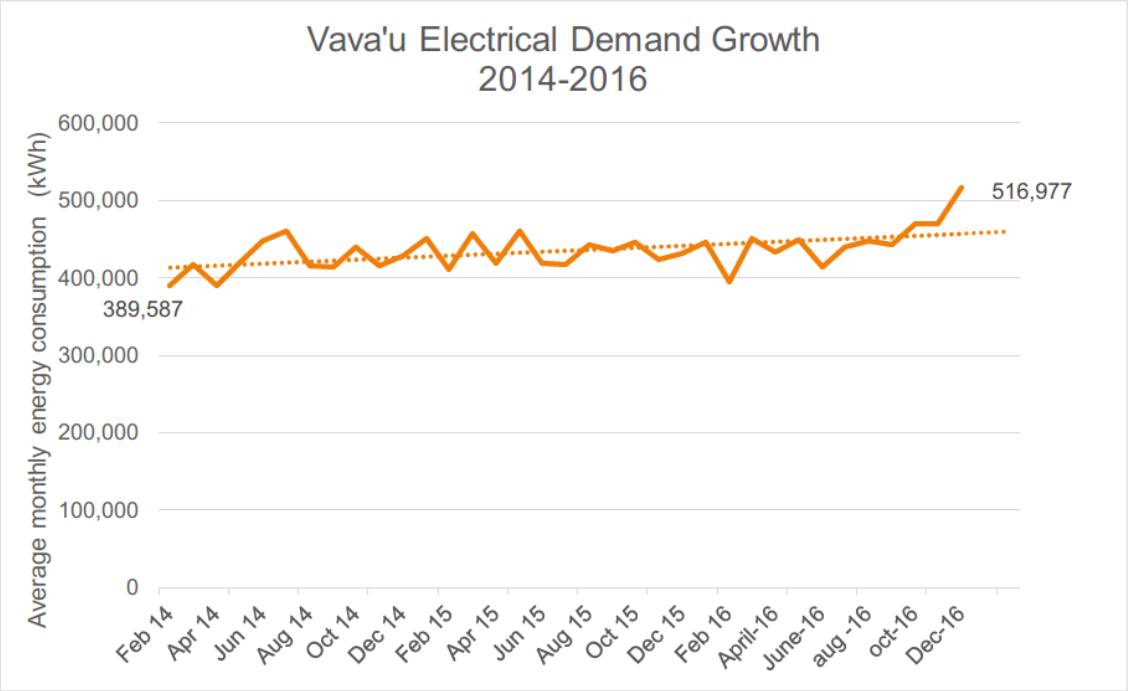
It appears likely that, in the baseline, over the coming period years:

- There is most likely an unmet demand for electricity, at least on some islands, and possibly even on Tongatapu; and
- The population will decline slowly on the outer islands, but the demand for electricity is likely to grow on many islands, and most notably on Tongatapu.

In the baseline, currently about 89% of electricity generation is from diesel generators, which leads to greenhouse gas emissions and the many other environmental and economic challenges associated with diesel generation.

[7] Source: Feasibility study

Figure 6: Electricity Demand on Vava'u, 2014 - 2016



Source: PI Berlin 2017

Barriers to Achieving Targets of 50% and 70% renewable energy generation by 2020 and 2030 and Mitigation Measures under TREP

In recent years, like other Pacific SIDSs, Tonga has gained experience in integrating small amounts of intermittent renewable energy into its grids. In the baseline, Tonga has in place many of the elements to rapidly transform to a low-carbon, renewable-based energy sector. These include:

- The government is strongly committed;
- The awareness and understanding of climate change, both mitigation and adaptation, have grown rapidly in recent years;
- The country shows a relatively small papulation and electricity demand;
- Tonga has gained some relevant experience, for example with solar PV and BESS, and has started the process to develop capacity and to generate data and understanding;
- Several development partners are currently strongly supporting this process, including ADB, World Bank, Australia, China, European Union, European Investment Bank, Japan, New Zealand and the United Arab Emirates; and
- As the process to transform to renewables is still in the early stages, it is still possible to influence the process and ensure it delivers optimally on a range of benefits, not only energy security, but also on minimizing GHG emissions, affordability, ensuring climate resilience, and maximizing social access.

The above factors suggest that Tonga faces a unique, and potentially short-lived, opportunity to shift onto a low carbon, resilient, socially equitable and economically efficient pathway for their energy sectors. However, in the baseline, there are several barriers to the rapid uptake of renewable energies and the proposed approaches under TREP to be grant-funded by GCF will help Tonga overcome those barriers as shown below:

Table 6: Key Barriers to Achieve GOT's Renewable Energy Target and Mitigation Measures under TREP

Type of Barrier	Barrier Description	Mitigation Measures
Technical	At the current low levels of intermittent renewable energy (wind power and solar PV), it is relatively straightforward to integrate new generation capacity onto the existing grid, which is designed for diesel. However, as generation increases towards the proposed renewable energy targets, this integration will become increasingly challenging, and will require storage to manage transient supply, upgraded equipment and operating systems to manage dispatches and distribution, and increased capacity to manage multi-generational grids.	The proposed BESS under TREP will provide load shifting [8] to offset renewable generation and grid-stabilization[9] to manage the impact of fluctuations in the generation on the grid, so as to increase absorption capacities of Tonga Power Limited (TPL). Consequently, it will allow GOT and TPL to connect about 24% additional intermittent electricity generated from renewable energy facilities to be developed by IPPs without negatively affecting the grid.
Financial	Rapidly transforming the sector requires substantial investments in a short period. The ability of Tonga to access public and private financing for such investments is limited. The available resources are insufficient to finance the structural shift from diesel generation to renewable energy. Especially, both GOT and TPL have very limited debt-bearing capacity.	The full grants from GCF, ADB and the Government of Australia will help GOT achieve its renewable energy target by 2020 (50%) and 2030 (70%) and increase modern electricity access of the poor in the outer islands without negatively affecting debt stresses of both GOT and TPL.
Limited Private Sector Involvement	Investors are often deterred by small project size, poor financial returns on investments, lack of previous experience and perceived risk, and incomplete data sets and analysis.	The proposed BESS under TREP will help TPL tender sizable renewable projects, which can attract more renewable energy IPPs by reducing the off-take risk. The full grant financing under TREP will help TPL reduce the consumer tariff, which will give TPL more room to negotiate tariffs with IPPs.
Weak Capacity of GOT & TPL Staff	Although Tonga has made great progress in establishing governance and management capacity, some gaps do remain. These are mostly managerial and technical, although some policy capacity may be needed. As with many countries in the Pacific, TPL has suffered from a drain of qualified personnel. Until now, it has been possible to fill gaps by using 'generalist' staff – staff with experience in basic power systems but with limited experience in the design/implementation of major or complex projects, but as the system becomes more complex, this will not be possible.	Given the limited capacity of GOT and TPL, TERM has been implementing, and TREP expects to be implemented in a phase approach. Under TREP, both project management consultants (PMC) and construction supervision consultants (CSC) will be recruited to fill this capacity gap. The operation and maintenance (O&M) manual will be prepared by turnkey contractor to help GOT and TPL undertake O&M of the funded renewable energy and BESS assets including training sessions.
Insufficient Time Left until 2020	Less than 3 years left to achieve 50% target by 2020, given the timelines for construction of RE installations, capacities of technicians & government staff, development absorption capacities, etc.	Project start-up activities will begin immediately following project. To expedite procurement and implement processes, advance procurement actions will be undertaken. ADB has already recruited the project management consulting firm who can assist GOT and TPL in preparing bidding documents for all the components to be funded under TREP.
Insufficient policy, regulatory frameworks to achieve the RE targets	TERM needs to be updated beyond 2020 (until 2030). Policy and regulatory reform may need to be reformed.	The GCF approved a grant of $5 million of the regional capacity technical assistance (TA) approved in December 2016 (FP036). Moreover, GCF may provide additional about $1million for Readiness and Preparatory Support to Tonga. The proposed policy works are expected to be carried out under both regional TA (under FP036) and Readiness and Preparatory Support to Tonga.

[8] Load shifting is where (renewable) energy is stored for relatively long periods, for use when generation is not available. Typically, in the case of solar PV systems, this relates the daily cycle of charging during daylight and discharging overnight. Many grid stabilization systems also store energy; however, these may store energy from milliseconds to a few minutes, whereas load shifting is optimized for storing energy for several hours (or even days).

[9] Measures typically start with a control system for managing the scheduling and operation of subsystems and power flows and can add a range of technologies such as high power batteries, flywheels (synchronous converters, diesel uninterruptable power supplies), and resistors / load banks to reduce reliance on diesel generators.

Climate and Geohazard Vulnerability. Like other countries in the Pacific, Tonga is highly exposed to climate and geohazard threats and these are projected to increase with climate change. This increases the level of risk associated with infrastructure investments and also increases the cost of investments. In the baseline, the response is to climate proof existing infrastructure on a subproject by subproject basis. However, as climate change occurs, there will be a need to go beyond basic climate proofing and develop new approaches and/or technologies that are climate resilient. To address this risk, the selection of equipment will be carefully analyzed based on best engineering practices. The design will incorporate adequate climate proofing and geohazard -preventive measures to lessen the potential negative impacts of extreme weather events throughout the project life cycle. For instance, the BESS installation will be comprised of containerized BESS units (likely four 40 ft. ISO shipping containers). All components procured will be suitable for tropical marine and coastal environments, preferably preassembled and resistant to corrosion as practicable and can withstand extreme weather events. For instance, the mini-grid would be buried underground (if feasible after detailed geotechnical investigation) to improve cyclone resilience and safety. The O&M manuals to be prepared by turnkey contractors will include some climate proofing and geohazard preventive measures.

TREP Objective and Outcome to Achieve In Improving the Baseline Scenario.

As part of the PIRIEP, TREP's objective is to shift electricity production in Tonga onto a low carbon, climate resilient pathway. TREP's outcome is expanded access to clean, resilient and affordable energy for the population in Tonga.

TREP will allow Tonga to exceed its NDC target of generating 50% of electricity from renewables by 2020 and help Tonga build momentum to reach 70% by 2030. TREP-financed generation technologies on 'Eua and Vava'u will directly generate about 3% of additional clean electricity. BESS to be installed under TREP will allow an increase in renewable energy generation by about 7.8 MW (4 MW solar PV and 3.8 MW wind power to be funded by the private sector), which will enable Tonga to increase their renewable energy penetration by 24% without negatively affecting the grid.

Specifically, TREP will allow Tonga to: (i) replace electricity currently generated by using about 3.8 million litres of diesel by electricity generated using solar PV and wind power, which can be connected to the grid by virtue of BESS; (ii) meet the current and growing demand for electricity with solar PV and wind power generation technologies; and (iii) provide necessary grid management and distribution capacity, notably: BESS, strengthening the grid installation and absorption capacity. TREP will allow GOT and TPL to install and ensure the sustainable operation of the following renewable energy generation and energy storage facilities:

Table 7: Renewable Energy Technologies and BESS under TREP

Location	PV	Wind	BESS	Cumulative RE Penetration after TREP (kWh basis)[10]
Tongatapu	4.00 MW*	3.8 MW*	10.1 MW / 19.9 MWh	
'Eua	0.35 MW	-	0.9 MWh	
Vava'u	0.30 MW	-	0.5 MWh	54%
Outer Islands**	0.50 MW	-	0.9 MWh	
Totals	**5.15 MW**	**3.8 MW***	**10.1 MW / 22.2 MWh**	

BESS = battery energy storage system, kWh = kilowatt-hour, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic, RE = renewable energy, TREP = Tonga Renewable Energy Project.
Source: Government of Tonga and Tonga Power Limited.
* These renewable energy generation facilities are expected to be developed by IPPs.
** The last official census in Tonga in 2006 highlights a trend of slightly decreasing population in the outer islands, but those islands show relatively large seasonal variations in electricity consumption. That is why the proposed renewable energy based hybrid system is beneficial to meet the seasonal peak-loads.

The TREP Approach

The TREP approach has the following three components: (i) electricity generation from the most feasible renewable resources in Tonga; (ii) upgrading grid technologies and management to adapt to new electricity sources; and (iii) adding a large BESS capacity to ensure that the intermittent electricity generated from solar PV and wind power can be stored and used overnight without negatively affecting TPL's grids. These three components are introduced in the following sections, and full details are provided in Annex 2.

[10] Based on information and calculations provided in the Feasibility Study (Annex 2A) and associated documents.

Electricity generation from renewable sources. Apart from diesel, the most attractive electricity generation technologies on Tonga are solar, wind and, to a lesser extent, biomass.
Table assesses each of these against key investment criteria in the Tonga context.

Table 8: Comparison of Potential Generation Technologies Against Key Investment Criteria

Criteria	Resource and Generation Technology			
	Biodiesel	**Diesel**	**Solar PV**	**Wind**
Maturity	High	High	High	High
Resource availability (local)	Minimal	None	High	Medium
Energy security and independence	Minimal	Negative	High	High
Direct cost of generation	High	High	Low / declining	Low / declining
Modularity	Medium	Medium	High	Medium
Complexity, including maintenance requirements	Medium	Medium	Low	Medium
Intermittency -storage requirements	None	None	High	Low-medium
Space requirements	Low-medium	Low	High	Medium
Renewable resource	Yes	No	Yes	Yes
Environmental and social aspects	Impacts related to feedstock and land use constraints	Harmful stack emissions, risks of fuel spills	Minimal issues	Cyclone-proof mounting required

Source: ADB's feasibility study report.

All the generation technologies considered in
Table 8 are *modular* in nature, and can therefore be constructed and commissioned relatively quickly, as and when needed. In terms of costs, those for fuel and biodiesel equipment are not expected to decline in the near term.[11] Overall, biomass resources are limited but could make a modest contribution, e.g., through biomass cogeneration, waste-to-energy, and possibly coconut biodiesel. With regards to wind technology, the costs are expected to decline moderately in the future. The costs for solar PV have been and are expected to decline, as global manufacturing capacity continues to increase rapidly. Likewise, battery costs are declining rapidly at the global level and this is expected to continue. Other renewable resources were considered, as follows: ocean energy technologies – these are not attractive due to high capital costs; and hydro-power – not available on Tonga. The feasibility assessment (Annex 2A) confirmed that wind power and solar PV are the most suitable for Tonga.

As stated previously, the most realistic scenario is that consumption will rise to 66 GWh by 2020, based on constant demand growth. This increase could be met by solar PV and wind power as follows:

- Solar PV - assuming 4 hours per day (1,460 hours per year) at rated capacity, 66 GWh would require 45.2 MWp of solar PV. Further, assuming a maximum of 3 hectares (Ha) per MW, a total land area of 135.6 Ha would be required. This is less than 1% of total land area of Tonga.
- Wind - assuming 6 hours per day (2,190 hours per year) at rated capacity, 66 GWh per year would require 30 MW of wind power, again feasible in Tonga.

Based on the Feasibility Study (see Annex 2), the optimal approach is a combination of solar and wind. On Tongatapu, a combination of solar PV and wind power is optimal. It is noted that wind monitoring conducted on Tongatapu indicated some complementarity with solar PV, i.e. at night-time, when the solar output is zero, wind provides generation potential.

[11] Biodiesel is generally priced at parity with conventional diesel, so no cost savings are expected although pollutant emissions are relatively lower than petroleum-based diesel. Advanced fuel-water emulsions may also be an option to further reduce diesel consumption and reduce stack emissions.

Solar PV will be used on the outer islands.[12] Moreover, see below appropriate amounts of BESS will be used to ensure optimality, mostly on Tongatapu.

Upgrading grid technologies and management to adapt to new electricity sources. The supply of significant levels of intermittent electricity generated by solar PV and wind power may affect the grid, notably creating instability. Several grid related issues must be resolved to avoid such negative impacts. Based on the Feasibility Study (Annex 2), Table 9 assesses various enabling technologies for each concerned issue.

Table 9: Enabling Technologies for High-Level Renewable Energy Penetration to Grid

Grid Issues/Power System Requirement	Enabling Technologies					
	Forecasting	**Dump load**	**Dynamic resistor**	**DUPS, Synchronous Condensers**	**Battery storage systems**	**Advanced Long-term time shifting**
Voltage control				✓	✓	✓
Frequency control			✓		✓	✓
Real power (kW)					✓	✓
Reactive power (kVAR)				✓	✓	✓
Inertia				✓		✓
Fault currents				✓		✓
Spinning reserve	✓	✓	✓		✓	✓
Time shift / night time power					✓	✓
Environmental and social safeguards aspects	Minimal – weather sensors and software	Minimal	Minimal	Minimal – can be installed inside the fence at existing diesel power plants	Minimal – batteries are enclosed in standard shipping containers	Modest footprint for compressed air storage and hydrogen
Comments						
Appropriate control system is required to integrate and manage generation and all other augmentation and storage options	Integrated with controller, provides time to manage spinning reserve in conjunction with renewable energy output. Relatively low-cost.	Able to dump excess renewable generation, and bring it back on-line on command	Integrated control system enables high frequency variation of resistance and hence load and setting system frequency	Provides inertia and fault current when main diesel generators are shut down. These technologies will likely be necessary to ensure stable operation and design lifetime of diesel units.	Battery technology selection needs to be optimized for (i) grid stability, and for (ii) load shifting, i.e., 2 different types of batteries will be required.	Modular compressed air systems are still pre-commercial. Hydrogen is commercially available but unfavourable with respect to "round-trip" efficiency

DUPS = dial-up power switch, kVAR = unit of reactive power, kW = kilowatt
Source: ADB's feasibility study report.

Under TREP, both mini-grid and renewable energy-based hybrid system will be constructed in the outer-islands, which will improve electrical safety by replacing old, unsafe and inefficient privately-owned gen-sets with a new, safer and more efficient RE system.

Battery Energy Storage Systems (BESS). Solar PV and wind power are both intermittent sources of electricity. They generate electricity when it is not needed, and they cannot reliably generate at times that it is needed. The variability of output from both solar PV and wind power will require energy storage for load-shifting as well as grid stability. Energy storage systems (ESS) can store electricity generated at periods of low demand and supply it to the grid at high demand

[12] In the future, systematic wind monitoring will be undertaken on outer islands to determine wind viability.

periods. ESS will allow variable output from both solar PV and wind power to be delivered to the grid as "firm" energy. Thus, ESS will help TPL: (i) maintain grid stability, (ii) optimize energy delivery, and (iii) facilitate increasing renewable generation connected to the TPL grid.

Given the relative environmental sensitivities, gestation periods, and ease of installation, battery energy storage system (BESS) is a preferred option over other enabling technologies indicated in Table 9. Further, installed and levelized costs of BESS are expected to rapidly decline (along with solar PV). BESS has evolved rapidly in recent years and are now routinely being deployed for grid stability and bulk power management across the world. Moreover, BESS provides modularity and can be tailored to the specific needs in Tonga. BESS can also be readily integrated with solar PV and wind power to provide reliable energy outputs to the grid. Without the proposed BESS under TREP, planned solar PV and wind farms to be developed by IPPs would not be realized, because TPL's grid cannot fully observe intermittent electricity generated from those renewable energy generation facilities.

C.3. Project / Programme Description

TREP will assist Tonga to transition from diesel generation to renewable energy generation. The supported investments include but are not limited to: i) renewable energy generation (grid-connected solar PV and small-scale solar- hybrid systems); ii) BESS; iii) power distribution network (mini-grid); and iv) energy access investments. TREP will also support community engagement and communication, capacity building, project management, energy efficiency and mobilizing private sector investment.

TREP will have the following four outputs:

Output 1: Battery Energy Storage Systems (BESS) on Tongatapu
1.1: Installing multiple units of BESS with a total installed capacity of 10.1 MW/19.9MWh to complement the renewable energy systems[13]

Output 2: Grid-connected Renewable Energy Generation on 'Eua and Vava'u islands
2.1: Installing the on-grid solar PV plants coupled with small BESS on 'Eua and Vava'u

Output 3: Renewable-Based Hybrid Systems and Mini-Grids on Outer-Islands
3.1: Installing mini-grid renewable-based hybrid systems coupled with small-scale BESS in five outer islands which includes installation of the mini-grid

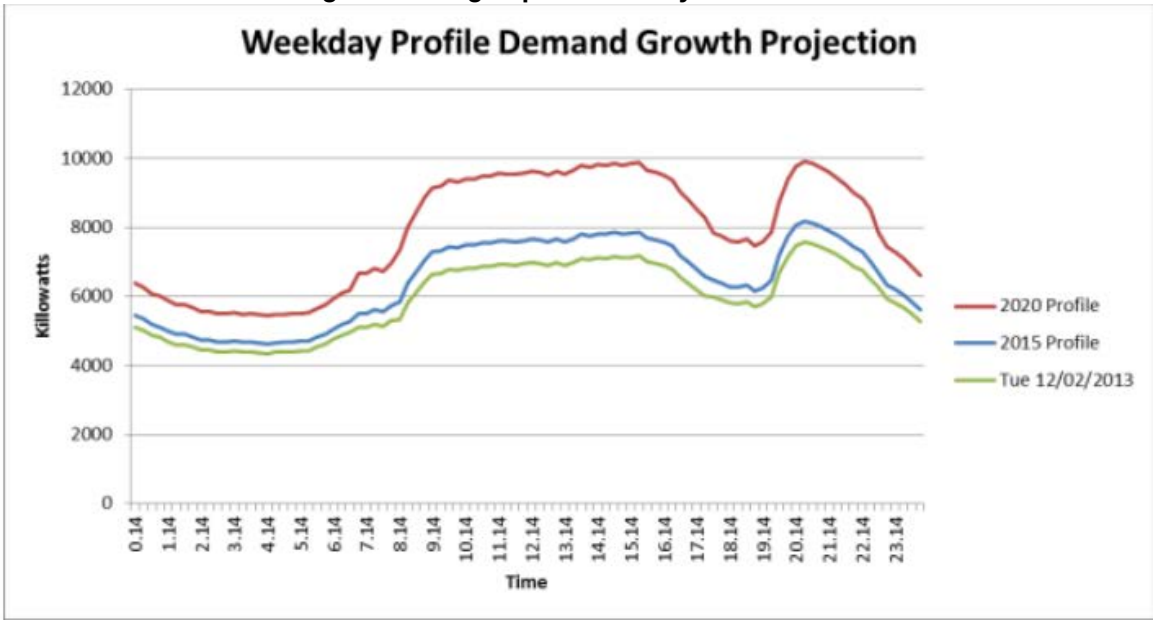
Output 4: Capacity Building[14] and Project Management Support
4.1: Improved capacity to assess renewable energy technologies and set off-take tariffs for power purchase agreements for private sector funded investments
4.2: Developed capacity of executing entities to manage assets and undertake operations and maintenance and improve community engagement
4.3: Executing entities supported to provide project management in line with international standards and best-practices
4.4: Experts' support on both design and procurement activities, construction supervision, and development of operations and maintenance manuals

Output 1: Battery Energy Storage Systems (BESS) on Tongatapu

Tongatapu is the main island of Tonga, the seat of GOT, and home to about 75% of the population. The Tongatapu grid has by far the largest load. In 2015, this typically ranged from 4-8 MW (see Figure 7) during each day. The peak load is forecasted to reach approximately 11 MW by the year 2020. The entire island is serviced by an 11 kV distribution network that is owned and operated by TPL.

[13] These renewable energy generation facilities are expected to be funded by IPPs.
[14] More detailed capacity building plan is Annex 13.

Figure 7: Tongatapu - Weekday Load Profile



Source: ADB's feasibility study report.

Currently, the main power plant is at Popua. It currently has 14 MW of installed diesel generation capacity. This consists of two MAK generators of 2.8 MW each and 6 Caterpillar 3,516 units of 1.4 MW each. The Caterpillar generators are scheduled to be decommissioned in 2020. However, if they are not replaced, in the baseline the decommissioning is likely to be postponed and their lifetime extended.

In addition, Tongatapu currently also has two solar PV plants: 1.3 MW at Maama Mai and 1 MW at Vaina. These have the necessary BESS to provide grid stability and smooth out the solar PV output (but not suitable for long-term storage or load shifting). There is also an estimated 0.5 MW of solar PV in distributed small solar home systems (SHS) and commercial building installations – not grid-connected.

In addition to the above existing installations, the baseline includes two generation assets under construction: (i) Niutoua Wind Farm (with support from JICA) for 1.3 MW; and (ii) the Zhuhai Singyes solar PV park – an IPP with a scheduled 2 MW of installed capacity. Finally, the baseline includes a planned 1.5 MW Wind Farm, also at Niutoa, to be supported by a grant from the Government of People's Republic of China (PRC).

Output 1 of TREP includes installation of multiple units of BESS with a total preliminary capacity of 10.1 MW and 19.9 MWh on Tongatapu. The proposed BESS will enable 4.0 MW of additional solar PV generation and 3.8 MW of additional wind generation on Tongatapu to be developed by IPPs, as shown in Table 10.

Table 10: Output 1 Sub-Project on Tongatapu and its Indirect Benefits

	Sub-projects	Capital cost ($ million) *	Installed capacity (MW)	Associated BESS (MW/MWh)	Annual generation (kWh/yr)	Fuel savings (liters/yr)	Avoided emissions (tons/yr)
1	multiple units of stand-alone BESS	18.16	-	6.9 / 18.3	-	-	-
	Associated BESS in Fahefa solar PV plant	1.84	2.0*	0.7 / 0.35	2,961,600	731,259	2,272
2	Associated BESS in Matafonua solar PV plant	1.84	2.0*	0.7 / 0.35	2,961,600	731,259	2,272

3	Associated BESS in Niutoua wind farm	4.74	3.8*	1.8 / 0.9	9,986,400	2,377,714	7,769
	TOTAL	**26.58**	**7.8***	**10.1 / 19.9**	**15,826,400**	**3,819,690**	**12,313**

BESS = battery energy storage system, MW = megawatt, MWh = megawatt-hour, kWh = kilowatt-hour, PV = photovoltaic.
* Capital costs only include the BESS components. TPL may consider installing BESSs in a phase manner to take advantage of the rapidly declining cost of battery energy storage technologies, which will be firmed up at both detailed design and procurement stages.
**These renewable energy generation facilities are expected to be funded by IPPs.

The overall transformation that this will facilitate on Tongatapu is illustrated in Table 11.

Table 11: Overall Renewable Energy Transformation on Tongatapu

Assets	Generation Capacity	BESS Capacity
Existing		
Popua Diesel Station 14 MW		
MAK: 2 x 2.8 MW	5.6 MW	
Caterpillar 6 x 1.4	8.4 MW	
Maama Mai solar PV	1.3 MW	0.5 MW
Vaini solar PV	1 MW	0.5 MW
Subtotal	**16.3 MW**	
Under Construction		
Niuotoa Wind Farm (JICA)	1.3 MW	
Zhuhai Singyes solar PV (IPP)	2 MW	0.7 MW / 0.35 MWh
Subtotal	**3.3 MW**	
Proposed TREP		
BESS at Fahefa solar PV plant	2 MW	0.7 MW / 0.35 MWh
BESS at Matafonua solar PV plant	2 MW	0.7 MW / 0.35 MWh
BESS at Niuotoa wind farm (TREP – ADB GCF)	3.8 MW	1.8 MW / 0.9 MWh
Niuotoa wind farm (PRC)	1.5 MW	
Multiple units of BESS		6.9 MW / 18.30 MWh
Subtotal	**9.3 MW**	
TOTAL	**28.9 MW**	
Grid mix with all new assets: 14 MW diesel + 6.6 MW wind + 8.3 MW solar		
Grid mix after retirement of Caterpillar units: 5.6 MW diesel + 6.6 MW wind + 8.3 MW solar		

ADB = Asian Development Bank, BESS = battery energy storage system, GCF = Green Climate Fund, IPP = independent power producer, JICA = Japan International Cooperation Agency, MW = megawatt, MWh = megawatt-hour, PRC = People's Republic of China, PV photovoltaic, TREP = Tonga Renewable Energy Project.
Source: ADB and government assets based on the various assessments listed in Section 2.

In summary, TREP will facilitate a transformation of the installed capacity on Tongatapu from 19.3 MW, with diesel accounting for about 73% to 28.9 MW (and significant BESS support), with diesel accounting for about 49%. In terms of annual electricity generated, TREP will lead to diesel being reduced from 39.4 GWh to 24.1 GWh, or from 70% to 46% (see Annex 2 for details of the calculation).

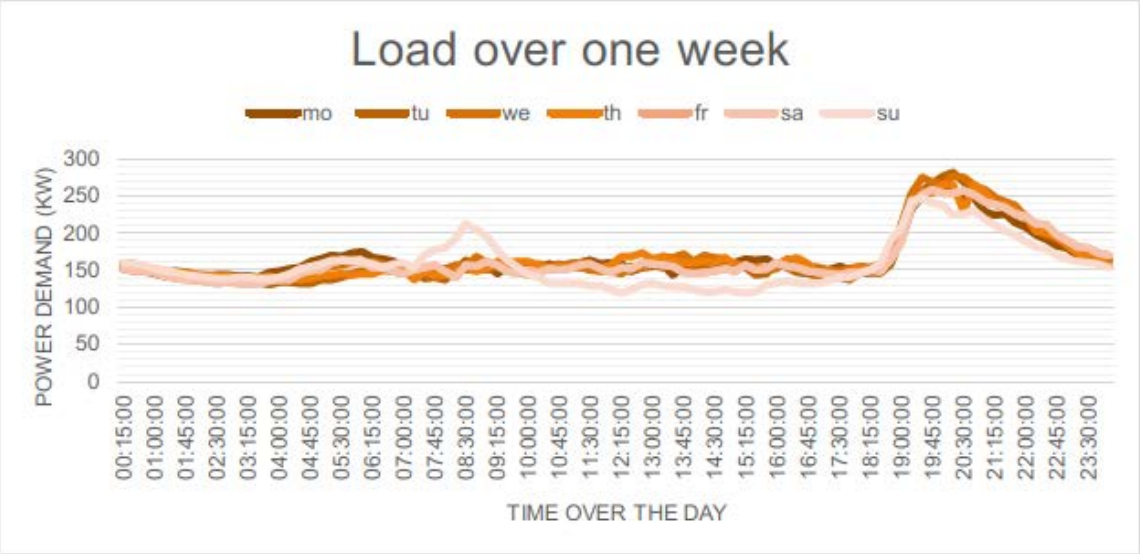
The proposed Output 1 under TREP will lead to 10.1 MW / 19.9 MWh of BESS, ensuring that renewable energy can be stored when produced to be used when needed (load shifting). It will also enable an additional 7.8 MW of solar PV and wind power capacity to be connected to the grid, which will be funded by IPPs without negatively affecting the grid. The Feasibility Study (Main Report, Annex 2A), provides detailed information on:

- the selection of the mixture of technologies;
- the criteria for site selection and a map of the sites;
- the technologies considered and the selection criteria; and
- the forecasted loading and generation amounts.

Output 2: Grid-Connected Renewable Energy Generation on 'Eua and Vava'u Islands

'Eua is a relatively small island located southeast of Tongatapu with a population of just over 4,950 and 1,107 electricity customers. Figure 8 shows the average daily load profile for the community, which averages around 150 kW and peaks at over 280 kW in the evenings.

Figure 8: Load on 'Eua Grid

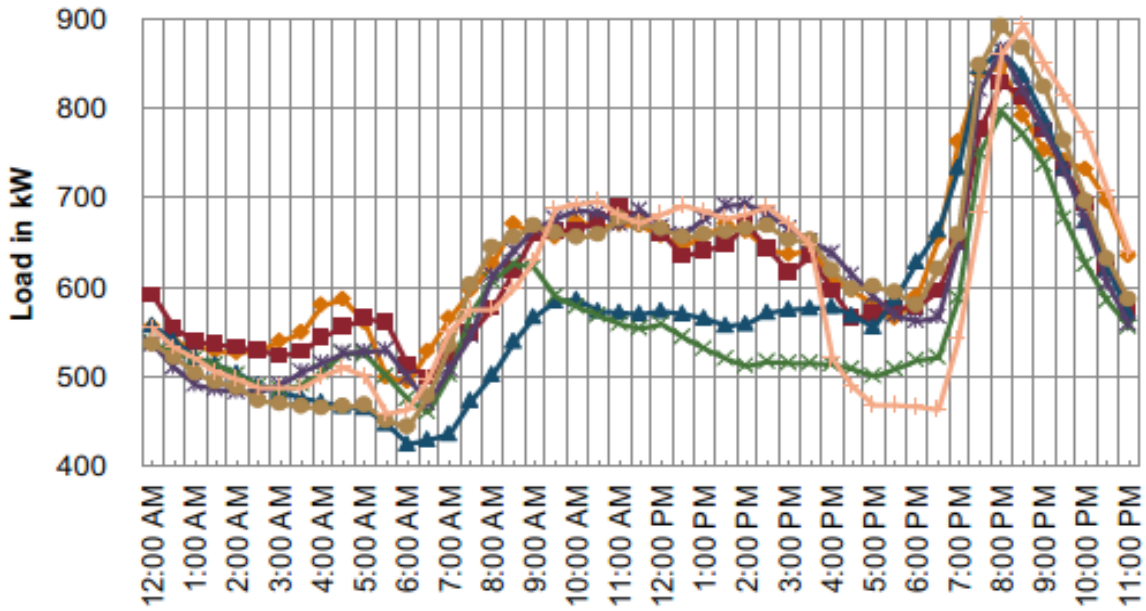


Source: ADB's feasibility study report (PI-Berlin 2017).

The 'Eua baseline consists of the two existing 186 kW Diesel Gensets. These provide power to the community via an existing 11 kV distribution network. In addition, a 200 kWp PV plant (without BESS) was installed (commissioned in early 2017) under OIREP. In the baseline, with support from the ongoing OIREP project, 100% of the existing distribution network will be rehabilitated. This makes the grid more robust and helps reduce losses.

Vava'u has the second largest electricity grid in Tonga. It is located approximately 300 km north of Tongatapu and has a population of approximately 15,000 (the equivalent of 3,300 electricity consumers). The average monthly consumption is 350 MWh, with average load of approximately 600 kW. The load peaks at approximately 1 MW (see Figure 9).

Figure 9: Loading on Vava'u Grid



Source: ADB's feasibility study report (PI-Berlin 2017).

In the baseline, the electricity on Vava'u is supplied by the Taumu'aloto power station. This consists of: (i) 5 diesel generators with a total installed capacity of 1.87 MW; and (ii) a 420 kW solar PV plant. All generated power is currently distributed across the island via the 6.6 kV network. In the baseline, with support from the ongoing OIREP project, 60% of the existing distribution network will be rehabilitated. This makes the grid more robust and helps reduce losses. The grid upgrade also enables the grid to absorb more intermittent electricity and facilitates the distribution of electricity from remotely located generators (e.g. wind turbines). It also makes the grid significantly more cyclone resilient.

On 'Eua and Vava'u, TREP will support the following two sub-projects under Output 2, with GCF support:

Table 12: Output 2 Sub-Projects on 'Eua and Vava'u

	Sub-projects	Capital cost ($ million)	Installed Solar Capacity (MW)	BESS Capacity (MWh)	Annual generation (kWh/yr)	Fuel savings (liters/yr)	Avoided emissions (tons/yr)
4	Solar PV Farm with BESS in 'Eua	2.57	0.35	0.9	511,000	155,855	398
5	Solar PV Farm with BESS in Vava'u	2.20	0.30	0.5	438,000	127,020	341

BESS = battery energy storage system, kWh = kilowatt-hour, MW = megawatt, MWh = megawatt-hour, PV = photovoltaic.

In summary, over the two grids, TREP will facilitate a transformation of the installed electricity generation capacity mix from 2.86 MW (with diesel accounting for over 78%) to 3.51 MW (with diesel accounting for less than 64%). TREP will also provide the necessary BESS to ensure grid stability, but not for load shifting. The new solar PV will replace substantial amounts of the existing diesel generated electricity, which will however remain available for emergencies and exceptional night time peak loads. In terms of generation, diesel generated electricity will be reduced from 7.0 GWh per year to 6.0 GWh per year, or from 87% to 75% of overall electricity generated.

The Feasibility Study Report (Main Report, Annex 2A) provides information on the technologies selected and the proposed locations, and a map.

Output 3: Renewable-Based Hybrid Systems and Mini-Grids on Outer-Islands

The majority of outer islands have a relatively small population and have limited infrastructure. Some islands (Eua, Lifuka, Vava'u, O'ua, Tungua, Kotu, Mo'unga'one and Niuafo'ou) have small diesel powered mini-grids and distribution networks. The others rely only on outdated SHS or small portable generators that are managed at the household level. This limits access to electricity, is unreliable and leads to very high access costs.

Output 3 focuses on five of these outer islands which currently have no central generation capacity and no distribution network and source electricity from a mix of aging SHS and small portable petrol and diesel generators. Under Output 3, TREP will install renewable energy-based hybrid systems and mini-grids to assure a safe and secure source of electricity on five outer islands. Table 13 provides a summary of the baseline and with project scenarios on the five concerned islands.

Table 13: Output 3 - Renewable Energy Transformation on Five Outer Islands

Island (Island group)	Population (approx.)	Baseline situation	Output 3 TREP investment	Specifications PV/BESS
O'ua (Ha'apai)	116	• Limited access to electricity - no grid; • Reliance on existing (and outdated) SHS and locally funded and operated portable petrol and diesel generators; • High costs - effective cost of fuel up to $1.60/liter.	Four centralized power system: PV/ Battery hybrid systems (one on each island) and four new distribution networks (or mini-grids).	58 kW / 109 kWh
Tungua (Ha'apai)	187			85 kW / 160 kWh
Kotu (Ha'apai)	200			69 kW / 130 kWh
Mo'unga'one (Ha'apai)	63			35 kW / 66 kWh
Niuafo'ou (Niuas)	493	• As above; • Population distributed across 4 villages.	Centralized power system: Solar PV/Battery hybrid system.	PV: 250 kW BESS: 404 kWh
TOTALS	**1,059**			497 kW / 869 kWh

BESS = battery energy storage system, kW = kilowatt, kWh = kilowatt-hour, PV = photovoltaic, TREP = Tonga Renewable Energy Project.
Source: ADB's feasibility study report (PI-Berlin 2017).

In summary, TREP will install 497 kW of renewable energy generation capacity on these outer islands. The installed BESS will be 869 kWh. The Feasibility Study Report (Main Report, Annex 2A) provides additional information on the islands, the details of the technologies selected and the proposed locations, with maps. This will be provided through two sub-projects as detailed in Table 14.

Table 14: Output 3 - Summary of Outer Islands Investments

	Sub-projects	Capital cost ($ million)	Installed Solar Capacity (kW)	BESS Capacity (kWh)	Annual generation (kWh/yr)	Fuel savings (liters/yr)	Avoided emissions (tons/yr)
6	4 outer islands of Ha'apai + mini-grids	2.84	247	465	360,620	115,398	281
7	Niuafo'ou + mini-grids	4.26	250	404	365,000	116,800	284

kW = kilowatt, kWh = kilowatt-hour.
Source: ADB's feasibility study report (PI-Berlin 2017).

These systems are designed to meet the following needs and criteria:

- The provision of electricity via a grid or distribution network.
- The renewable energy contribution is at least 95%. The remoteness of these islands and the relatively high costs of installing power systems makes this necessary. The hybrid diesel, although more expensive to install, provide an acceptable level of energy security.
- Under normal operating conditions, the solar PV provide all electricity, hence there should be sufficient BESS for load shifting (in addition to ensuring grid stability and smoothing).
- The necessary technical capacity to ensure operation & maintenance, administrative support and technical support. This capacity is to be based locally. It will ensure a reliable performance over the technology's lifetime.
- The provision of a continuous electricity supply, 24 hours a day, 7 days a week.

It is further noted that the modern, efficient power system and the reduced electricity tariff may provide an incentive for the population to remain on the islands and reduce migration from these islands. It is, however, acknowledged that this alone is unlikely to reverse emigration from the outer islands.

Output 4: Capacity Building and Project Management

This Output will develop the capacity to design, install, commission and run the renewable energy systems and BESS including lessons learned from the similar projects such as OIREP in Tonga, and the Cook Islands project funded by GCF (FP036) and the Global Environment Facility (GEF). This Output will also include:

- Developing the capacity of decision-makers and technical experts to (i) assess the technical and economic feasibility of renewable energy technologies; and (ii) undertake environmental and social assessments and design appropriate response measures;
- Providing support on (i) basic design; (ii) procurement; and (ii) construction supervision of solar PV system, mini-grids and BESS;
- Developing the capacity of decision-makers and technical experts to determine off-take tariffs for power purchase agreements, and so facilitate future private sector funded investments; and
- Developing the capacity of managers and technical experts in the two executing entities (TPL and MEIDECC) to manage assets and to undertake appropriate climate-resilience and operations and maintenance measures.

This Output will also include significant capacity building on gender issues. Under the gender action plan (GAP, see details later in this document), capacity building programs will be implemented including business training on potential solar-power related business opportunities and women's employment at sites. A Social Development and Gender Specialist will be engaged to assist all executing entities in implementing and monitoring the Gender Action Plan and providing capacity building activities. Annex 7 – Procurement Plan includes detailed terms of references for consulting services.

Under PIREIP (FP036), the following sector reform components are implemented for Tonga:[15]

- Sector planning (renewable energy roadmaps and grid integration studies);
- TPL reform and capacity building;
- Tariff review and reform;
- Review and revision of regulatory and policy frameworks; and
- Promotion of greater private sector participation by identifying opportunities for independent power providers (IPP's), providing transaction advice for public-private partnership and designing guarantee products.

[15] The proposed scopes will be covered by the regional capacity technical assistance ($5.0 million grant) under FP036 and Readiness and Preparatory Support ($1.0 million grant) both to be funded by GCF.

Summary of Sub-Projects and Investments

Table 15: Summary of Cost Estimates, Scope of TREP Sub-Projects, and Avoided Emissions

Sub-projects	Capital cost ($ million) **	Annual generation (kWh/yr)	Fuel savings (liters/yr)	Avoided emissions (tons/yr)
Output 1: BESS on Tongatapu				
1 Multiple units of BESS	18.16	-	-	-
2 Associated BESS in Fahefa solar PV plant*	1.84	2,961,600	731,259	2,272
Associated BESS Matafonua solar PV plant*	1.84	2,961,600	731,259	2,272
3 Associated BESS Niutoua wind farm*	4.74	9,986,400	2,377,714	7,769
Output 2: Grid-connected Renewable Energy Generation on 'Eua and Vava'u islands				
4 Solar PV Farm with BESS in 'Eua	2.57	511,000	155,855	398
5 Solar PV Farm with BESS in Vava'u	2.20	438,000	127,020	341
Output 3: Renewable-Based Hybrid Systems and Mini-Grids on Outer-Islands				
6 Centralized Solar PV/Battery hybrid systems and mini-grids on 4 outer islands of Ha'apai	2.84	360,620	115,398	211
7 Centralized Solar PV/Battery hybrid systems and mini-grids on Niuafo'ou	4.26	365,000	116,800	284
Sub totals	**38.45**	**17,501,020**	**4,355,305**	**13,616**
Output 4: Capacity Building and Project Management				
8. Construction Supervision and Capacity Building	2.00			
9. Project Management Support	1.15			
10. Other Costs***	2.25			
Contingency	3.22			
Land acquisition	0.53			
Taxes and duties	5.60			
Grand Total	**53.20**	**17,501,020**	**4,355,305**	**13,616**

BESS = battery energy storage system, kWh = kilowatt-hour, PV = photovoltaic, TREP = Tonga Renewable Energy Project.

* These renewable energy generation facilities are expected to be funded by IPPs, that will be facilitated by the availability of battery storage in the Tongatapu grid.

** Capital costs only include the BESS components.

*** TPL will pay for land acquisitions including compensation to land owners for components 1-5 (see Table 3), and other project management and administrative costs including project management and control, land clearance and road access, and integration support.

Source: ADB's feasibility study report.

C.4. Background Information on Project / Programme Sponsor (Executing Entity)

Describe the quality of the management team, overall strategy and financial profile of the Sponsor (Executing Entity) and how it will support the project/programme in terms of equity investment, management, operations, production and marketing.

The Government of Tonga (GOT) will be the grant beneficiary, represented by the Ministry of Finance and National Planning (MFNP). The project executing entities will be (i) the MFNP for the overall project implementation, especially for disbursement of funds; (ii) Tonga Power Limited (TPL) for Outputs 1 and 2; (iii) and the Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications (MEIDECC) for Output 3. TPL and MEIDECC will be joint executing entities for Output 4 (Project Management Capacity Building). A project steering committee has already been established to support TREP. A project management unit (PMU) will be established to implement the project under MEIDECC.

TPL is a government-owned, vertically integrated public enterprise under the oversight of the Ministry of Public Enterprises and the cabinet. TPL has the concession for and operates four independent grids for on-grid electricity services. These are on the main island of Tongatapu, and main islands of the Vava'u, Ha'apai, and Eua island groups, where it generates, distributes, and retails electricity, and provides O&M services. The Energy Department (ED) under MEIDECC is the primary institutional body responsible for policy formulation, as well as for implementation of rural

electrification and demand management projects for off-grid electricity services. All executing entities have the mandate and authority to implement the activities foreseen under this project, and they have significant experience in these areas.

C.5. Market Overview (if applicable)

Describe the market for the product(s) or services including the historical data and forecasts. Describe the competitive environment including the list of competitors with market shares and customer base and key differentiating factors (if applicable). Provide pricing structures, price controls, subsidies available and government involvement (if any).

Market Regulation and Actors

The Electricity Act of 2007 is the legislation governing the electricity sector and establishes the Electricity Commission as the independent electricity sector regulator, consisting of not less than three and not more than five members. The Electricity Act of 2007 outlines the important role of the Commission in regulating the generation and selling of electricity and establishes the role of the concession contract/agreement in delivering electricity. In addition, the Act provides the authority for the Ministry of Finance and National Planning (MFNP) to be a party of the concession contract between the Commission and the Concessionaire, and to establish regulations to ensure effective management of the electricity utility. The Concession agreement outlines a utility's operations in comprehensive detail, including how the tariffs are calculated. The Government of Tonga also issued the Renewable Energy Act in 2008. Transition to renewable energy has been a national priority ever since. In 2009, the Tonga Energy Road Map, 2010 – 2020 (TERM) established the target of generating 50% of all electricity from renewables by 2020.

The responsibility for providing Alternating Current (AC) electricity services rests solely with TPL. TPL has legal rights under the concession contract to pass through fuel costs to consumers and charge an inflation-indexed non-fuel tariff. The non-fuel tariff covers agreed operational costs, business overheads, interest payments, depreciation and an allowed return on investment, which provides retained earnings for future capital expenditure and/or shareholder dividend payment.

For mini-grid and off-grid services, ED of the MEIDECC is the primary institutional unit. It is not regulated by the government, but it acts under the policy and planning provided by MEIDECC, MFNP and the Prime Minister's office. In addition, the Ha'apai, and Vava'u outer island groups have individual mini-grid and specific off-grid project management structures. Ha'apai (its outer-islands) has electricity co-operative societies (ECOS) to provide the day-to-day operations, maintenance and administration of their diesel powered mini-grids. Finally, some of the remote outer islands (e.g. Niuafo'ou and Niuatoputapu) have specific arrangements for managing their solar home systems (SHS) and small diesel generator sets. A long-term O&M contract is expected to be made between GOT and TPL for those outer islands to be funded under TREP.

All assets under Outputs 1 [BESS] and 2 [On-grid RE] will be operated and maintained by TPL. Mini-grid system under Output 3 will be operated by each island's ECOS who will provide the day-to-day operations, maintenance and administration. For Output 3, GOT will contract TPL under the government's budget for periodic and preventive O&M and to illustrate a permanent and durable commitment to the long-term maintenance of the outer island energy assets.

Market Scale

As of early 2017, system capacity had increased to 20.25 MW, of which 3.7 MW was solar photovoltaic (PV). 1.2 MW of battery energy storage system (BESS) has also been installed, mainly for grid stability. In 2016 (the latest year for which information is available), peak demand was about 11.1 MW and total diesel consumption was about 13 million liters. For the year ending June 2016, total generation (diesel plus renewables) in all four islands groups was approximately 60 GWh, an increase from 55.4 GWh over the previous 12-month period. Out of total power generated, 53.3 GWh were billed to customers: parasitic and line losses were 1.4 GWh and 4.9 GWh respectively. The overall system losses were reduced to 11.09 % at end of December 2016.

Tariffs and Fuel Price Volatility

Fuel costs can vary significantly with the international market and it is this variability that the Government wants to address with improved system operation and the introduction of renewable energy. Petroleum dependency makes Tonga highly

vulnerable to oil price shocks, affecting the affordability of food, goods, electricity and transportation. This variability is one motivation for the Government wanting to transition to renewable energy. Until now, about 90% of Tonga's overall grid connected electricity supply is met by diesel generation. The fuel costs are passed through to end-users of electricity. For example, the average retail electricity tariff peaked in September 2008 at $0.4513 / kWh and in July 2011 at $0.4336 / kWh. It had declined to $0.3673 / kWh in March 2017. The tariff structure was changed in 2009 and a "one tariff for all" regulation introduced, meaning tariffs are consistent across all the four island groups. Recently, 'lifeline' tariffs for the first 100 kWh of residential consumption were introduced.

Table 16 summarizes tariffs in March and April and shows the impacts of these lifeline discounts.[16]

Table 16: Residential Tariffs Effective April 2017 (US$ / kWh), Showing Impact of 'Lifeline Discounts

Tariff Component	March 2017	Adjustment	Lifeline Discount	New Tariff – April 2017
Non-fuel	0.2040	0	0	0.0204
Fuel	0.1778	+0.013	- 0.0730	0.1180
Total for first 100 kWh	0.3819			0.3220
Non-fuel	0.2040	0	0	0.0204
Fuel	0.1778	+0.013	0	0.1778
Total for above 100 kWh	0.3819			0.3948

kWh = kilowatt-hour, US = United States.
Source: http://matangitonga.to/2017/03/31/tonga-power-offers-lifeline-tariff-reductions-vulnerable-customers

C.6. Regulation, Taxation and Insurance (if applicable)

Provide details of government licenses or permits required for implementing and operating the project/programme, the issuing authority, and the date of issue or expected date of issue. Describe applicable taxes and foreign exchange regulations. Provide details on insurance policies related to project/programme.

Permits

TPL and MEIDECC are responsible for operating electricity generation and transmission facilities on the islands – TPL for Outputs 1 and 2 islands and MEIDECC for Output 3 islands –where the proposed TREP subprojects will be located. MEIDECC and TPL have authorities to obtain all necessary permits and licenses (e.g. EIA, Lands, Fire etc.) for project development under TREP. MEIDECC and TPL have been implementing similar projects for many years and in the past have efficiently obtained all necessary permits and licenses without causing any major delays or other costs. All the necessary electrical and civil permits and licenses (Australia/New Zealand standards) will be obtained by contractors, which will be part of requirements in the bidding documents. ADB will ensure through grant covenants that both MEIDECC and TPL obtain and maintain all necessary permits and licenses for the implementation of TREP.

Insurance

The budget includes all insurance costs associated with contractors and construction. This includes (i) professional indemnity insurance for design and supervision consultants covering detailed engineering designs and construction supervision, (ii) insurance for contractors works and equipment (All Risks Insurance Policy), and (iii) third party insurance covering injury to persons and damage to property outside of the contractor's responsibility.

Taxation

[16] The Electricity Regulator will be involved in tariff setting and advisory service in the structure of TREP, drafting the PPA, selection of IPP, IPP due diligence, legal framework, construction and operation of TREP.

ADB and GCF (administered by ADB) financed projects in Tonga are tax exempt. As per the Electricity Amendment Act (2010), all plant and machinery required for setting up a power plant in Tonga are exempt from all kinds of taxes and duties. There are no regulations affecting the import of foreign currency as applicable under this project.

C.7. Institutional / Implementation Arrangements

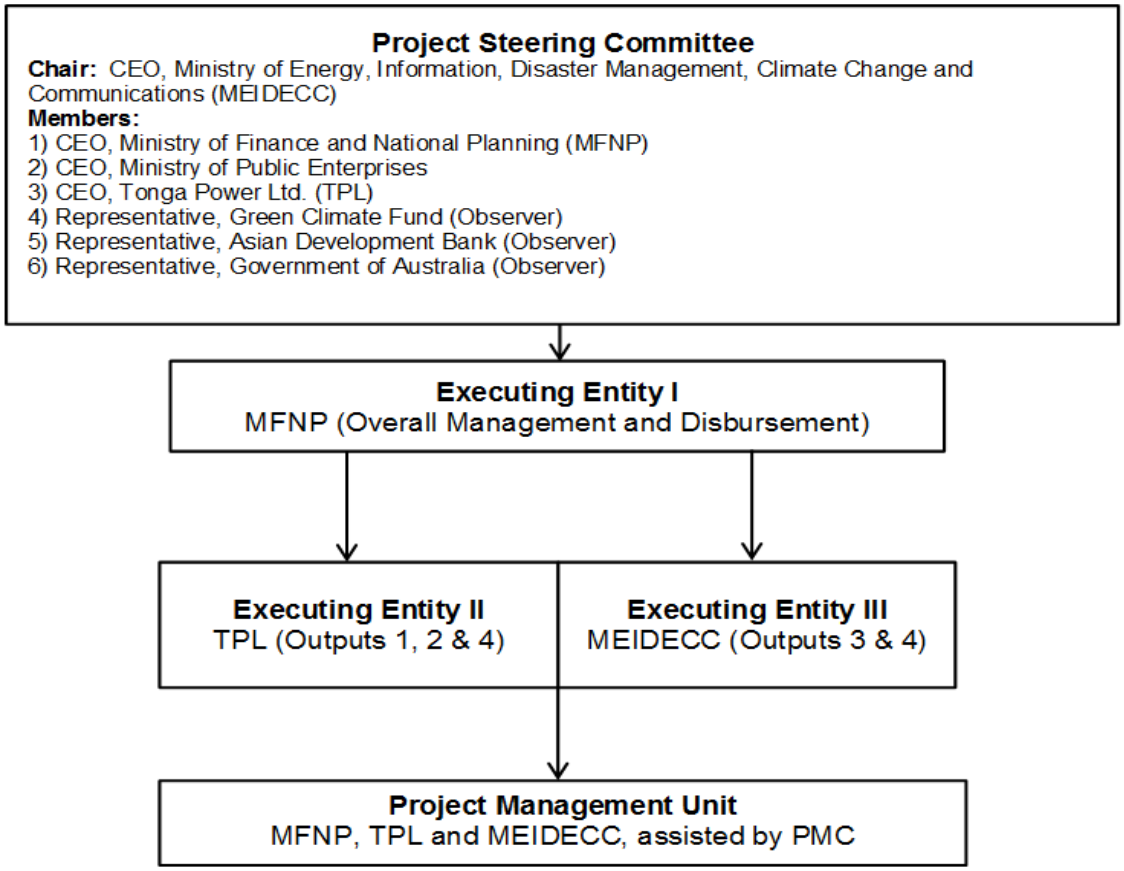
Please describe in detail the governance structure of the project/programme, including but not limited to the organization structure, roles and responsibilities of the project/programme management unit, steering committee, executing entities and so on, as well as the flow of funds structure. Also describe which of these structures are already in place and which are still pending. For the pending ones, please specify the requirements to establish them.

Governance and Implementation Arrangements

The Government of Tonga will be the grant beneficiary, represented by the Ministry of Finance and National Planning (MFNP). Under the direction of the MEIDECC Minister, a Project Steering Committee (PSC) will be established. The CEO of the MEIDECC will chair the PSC. The PSC members are: CEO of Ministry of Public Enterprises (MPE); CEO of Ministry of Finance and National Planning (MFNP); Head of the ED; CEO of TPL; ADB representative, and; Australian High Commission (AHC) representative.

The project executing entities will be (i) the MFNP for the overall project implementation, especially for disbursement of funds; (ii) Tonga Power Limited (TPL) for Outputs 1 and 2; (iii) and the Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications (MEIDECC) for Output 3. TPL and MEIDECC will be joint executing entities for Output 4 (Project Management Capacity Building). The PMU established in MEIDECC under the ongoing OIREP will also be the TREP-PMU. Figure 10 illustrates the project organizational arrangements.

Figure 10: TREP Organizational Arrangements



Source: ADB's feasibility study report.

Table 17 summarizes the roles and responsibilities of the agencies involved in management and implementation. The Accredited Entity, ADB, and GCF shall enter into a funded activity agreement (FAA) after approval of (i) this funding proposal by the GCF Board; and (ii) the administration of the GCF grant by the ADB Board. After the FAA is signed by both ADB and GCF, ADB will enter into a Grant (subsidiary) Agreement with MFNP and a Project (subsidiary) Agreements with TPL. A representative from each co-financier would be allowed to participate in PSC meetings as observer.

Table 17: Summarizing TREP Management and Implementation Roles and Responsibilities

Agency	Roles
Project Steering Committee (PSC)	• Oversees project implementation and make key decisions such as the selection of turnkey contractors* and consultants as well as approval of key documents such as operation and maintenance manuals, etc; • Monitors project progress; • Resolves any obstacles or impediments to implementation; • Guides the executing entities (MFNP, MEIDECC and TPL); and • Provides coordination on policy issues.
Executing Entity (MFNP)	• Enters into a Grant (subsidiary) Agreement (GA) with ADB; • Represents the government as a grant recipient as per the GA between GOT and ADB; • Facilitates negotiation, signing, and execution of the project financing agreements with ADB and other co-financier (Government of Australia); • Reviews and approves the project's procurement actions, in coordination with two executing entities - MEIDECC and TPL; • Submits withdrawal applications to ADB; and • Expedites implementation and minimizes cost by ensuring necessary counterpart funds are available on time; reviewing invoices and payments to contractors, consultants, and other service providers; and monitoring project progress and instructing MEIDECC and TPL to take corrective actions to prevent significant variations and deviations from schedules and budgets.
Executing Entities (TPL and MEIDECC): • TPL for Outputs 1 and 2 • MEIDECC for Output 3 • TPL and MEIDECC jointly for Output 4	• Enters into a Project (subsidiary) Agreement (PA) with ADB;[17] • Coordinates with ADB on all project management activities (including community engagements); • With the support of the PMU, manages and monitors project implementation activities, ensuring compliance with the government and ADB's requirements, especially ADB's Procurement Guidelines and Safeguards Statements; • Manage contractors, consultants and suppliers; • arrange PSC meetings as necessary and at least quarterly; • Reviews monthly progress reports that PMU prepares and endorses and submits to the PSC; • Supervises PMU in providing government counterpart assistance; • With the support of PMU, coordinates with and supervises design and supervision consultants; • Facilitates the coordination with government agencies necessary to prepare and implement the project; • Oversees reporting and monitoring of project performance, including preparation of monthly and quarterly project progress reports; • Review operation and maintenance manuals prepared by turnkey contractors and submit those manuals to PSC. • Oversees and approves, for submission to higher authorities', all contract administration matters, in close coordination with PMU; and • Assists ADB during project review missions.
Project Management Unit	• Perform day-to-day management work during project preparation, implementation and supervision periods;

	• Coordinate with government agencies and other involved parties for project implementation; • Communicate and coordinate with ADB for project management and implementation Report project implementation progress and compliance monitoring to ADB; • Engage project management consulting services; • Engage external resettlement, environmental and social monitors; • On behalf of the executing entities, review and submit bidding documents, bid evaluation reports, and other necessary documentation for ADB approval; • Submit withdrawal applications to the MFNP; • Submit required annual audit reports and financial statements of project account to ADB complying with international accounting standards; • Ensure compliance with ADB safeguard policies; • Carry-out the procurement for infrastructure, social housing, public space; and • Undertake day-to-day construction supervision.
Accredited Entity: ADB	• Carry out the obligations set out in the AMA and the FAA for TREP; • Oversees the project (preparation and implementation) as per both GA and PA signed between GOT and ADB (GA) and TPL and ADB (PA); • Administers grants from ADB, GCF and DFAT to GOT; • Administers the co-finance resources from DFAT in accordance with the pertinent co-financing agreement; • Administers the co-finance resources from the GCF in accordance with the FAA; • Monitors project implementation arrangements, disbursement, procurement, consultant selection, and reporting; • Monitors schedules of activities, including funds flow; • Reviews compliance with agreed procurement procedures; • Reviews compliance with grant covenants; • Monitors effectiveness of safeguard procedures; • Analyses the outcome of the capacity building and training programs; • Monitors conformity with ADB anti-corruption policies; • Undertakes periodic review missions; • Undertakes a joint midterm review mission; • Undertakes project completion report; and • Independent Evaluation Department (of ADB) validates project completion report and has option to conduct an evaluation.

ADB = Asian Development Bank, AMA = Accreditation Master Agreement, DFAT = Department of Foreign Affairs and Trade, FAA = Funded Activity Agreement, GA = Grant Agreement, GCF = Green Climate Fund, GOT = Government of Tonga, MEIDECC = Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications, MFNP = Ministry of Finance and National Planning, PA = Project Agreement, PSC = project steering committee, PMU = project management unit, TPL = Tonga Power Limited, TREP = Tonga Renewable Energy Project.

* Turnkey contractors will be selected in accordance with ADB's Procurement Guidelines, particularly following User's Guide to Procurement of Plant: Design, Supply, and Installation (https://www.adb.org/sites/default/files/institutional-document/32833/sbd-plant-users-guide.pdf).

The PMU will provide the project management services to all executing entities. An Environment and Social Unit (ESU) will be formed by the PMU and will be tasked with all social and environmental monitoring and reporting for TREP. This will include regular environmental audits for all construction activities, as well as monitoring of all project activities in relation to resettlement and gender. The PMU will be staffed by (but not limited to) the following: a Project Manager; On-grid Team Leader; Off-grid Team Leader; Administrative Officer; Financial and Procurement officer; and Environment and Social Safeguards Officer. Under Output 4, both project management consulting (PMC) and construction supervision consulting (CSC) services will be mobilized and, financed under TREP, to support PMU operations and support the

[17] ADB shall enter into a Project Agreement only with TPL for the implementation of the project. No agreement will be concluded between ADB and MEIDECC, as MEIDECC is a government agency.

capacity building activities. These organizational arrangements are designed to ensure optimal technology transfer and capacity development of MEIDECC, TPL staff and staff of other Tongan stakeholders.

Disbursements Arrangements

The grant proceeds will be disbursed in accordance with ADB's Loan Disbursement Handbook (2015, as amended from time to time) and the detailed arrangements agreed upon between the government and ADB. With support from both PMC and CSC, the PMU will coordinate internally within MEIDECC and TPL to arrange allocation of counterpart funds for individual projects. The PMU will be responsible for collecting supporting documents, preparing withdrawal applications and submitting to MFNP, who in turn will be responsible for screening withdrawal applications and submitting to ADB. The GCF will transfer the proceeds of the grant to the accredited entity, ADB ("Grant Account"), in amounts and installments as detailed in the following schedule:

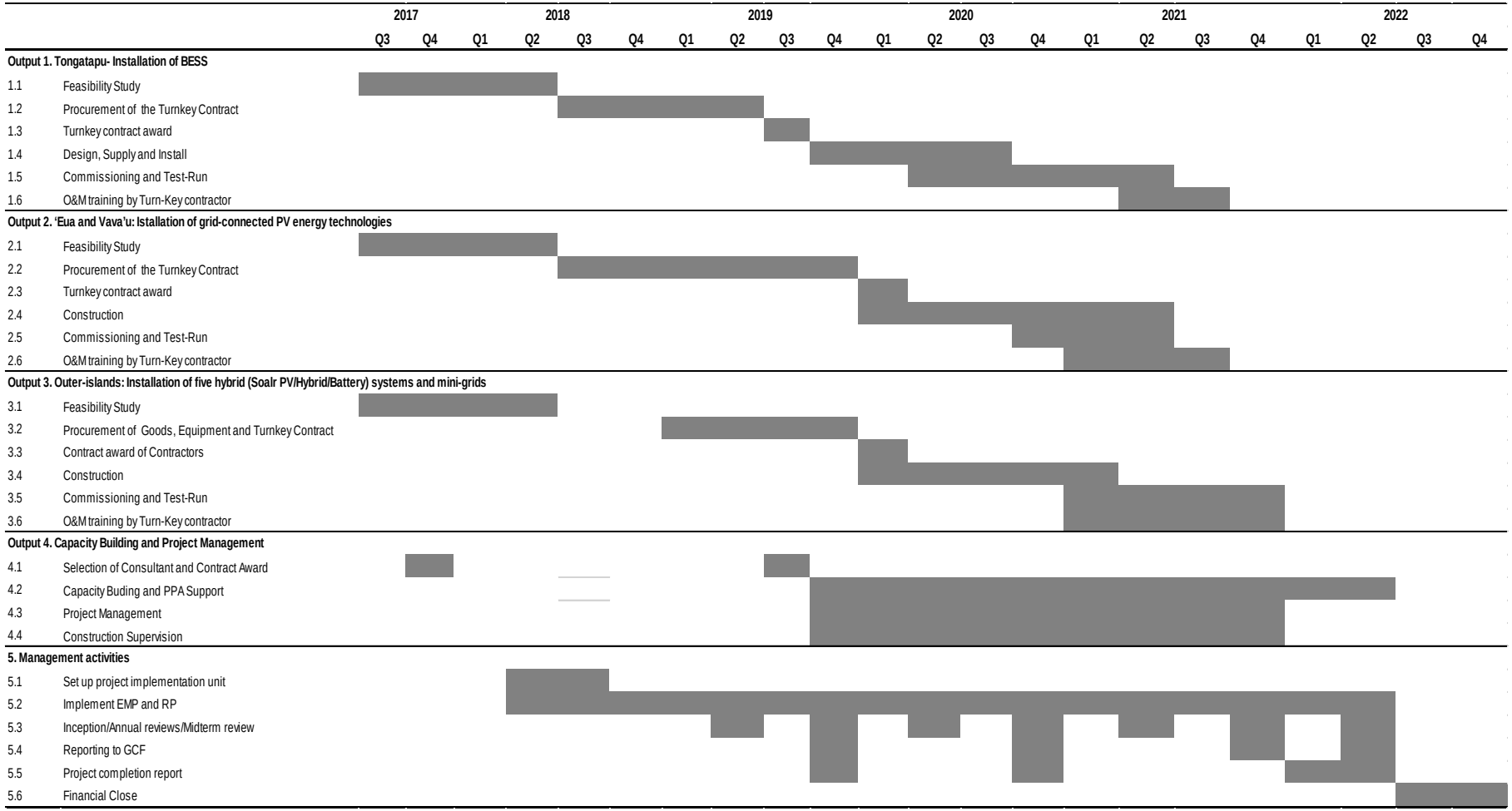
Installment	Date	Amount (USD)
#1	Q1 2019	$4,059,000
#2	Q1 2020	$20,265,000
#3	Q1 2021	$5,576,000
	Total	**$29,900,000**

Describe operational arrangements with key contractual agreements following the completion of construction. If applicable, provide the credit analysis of key counterparties of key contractual agreements and/or structural mitigants to cover the counterparty risks.

PMC/CSC and turnkey contractors will prepare the operations and maintenance program manual and will provide capacity building on asset management and operations and maintenance covering all solar PV generation and BESS technologies. GOT will separately issue a contract to TPL to undertake O&M. This also illustrates the Government's permanent and durable commitment to maintenance of the outer island energy assets, and also supports sustainability (see later section on sustainability).

C.8. Timetable of Project/Programme Implementation

Please provide a project/programme implementation timetable in section I (Annexes). The table below is for illustrative purposes. If the table format below is used, please refer to the activities as numbered in Section H. In the case of outputs, please mark when all the required activities will be completed.



D.1 Value Added for GCF Involvement

Please specify why the GCF involvement is critical for the project/programme, in consideration of other alternatives.

GCF involvement in financing TREP is critical for the following reasons:

- **Pacific Islands Renewable Energy Investment Program.** TREP takes place within the framework of the *Pacific Islands Renewable Energy Program* (PIRIEP) that is supported in principle by the GCF. The first PIRIEP sub-project for the Cook Islands was approved by GCF in December 2016. Continuing funding support of GCF to the Pacific under PIRIEP is beneficial not only to Tonga, but it will create momentum for the Pacific region to address dual challenges of climate change and energy security by transforming from diesel dependent economies towards low carbon economies.

- **Lack of available financing.** The Government of Tonga, through its NDC, is committed to generating 50% of its electricity from renewable resources by 2020 and aims for 70% by 2030. To date, Tonga has managed to achieve only 11%, a figure likely to rise to around 20% in the baseline. The financing required to transition Tonga's energy infrastructure asset base from diesel to renewable energy significantly exceeds available sovereign financing sources through traditional multilateral and bilateral sources. Moreover, attracting private sector interest to Tonga is not easy, and commercial financing is limited. BESS is not considered suitable as a stand-alone private sector investment as the power utility needs to operate the system to ensure power quality is maintained from multiple independent suppliers. In addition, small-scale renewable energy projects in the outer islands are also not attractive to the private sector. GCF is uniquely positioned to introduce financing at scale to overcome the initial renewable energy investment hurdle (diesel generators are inexpensive to buy and expensive to operate, while renewable energy has a high up-front investment hurdle but are inexpensive to operate). Without GCF, Tonga is unlikely to access sufficient financing to reach their renewable energy targets and will take an extended period. Consequently, Tonga will continue to rely on fossil fuels for power generation.

- **Restrictions on accessing debt finance.** Like many of other SIDSs in the Pacific, Tonga has a history of debt distress and a relatively weak economy, so the country is unable to attract sovereign debt. As per the 2017 Article IV Consultation—Press Release and the Staff Report for Tonga released by the International Monetary Fund (IMF) in January 2018, Tonga is recommended moving from "Moderate" category to "High" Distress (see Annex 9), which means that Tonga will be eligible for full grants starting in 2018 from many development partners including ADB. Additionally, due to the national debt headroom limitation, Tonga is unable to borrow to support large renewable energy infrastructure development like TREP. GOT has been therefore reliant on relatively small amounts of external grant financing for infrastructure development such as Phase 1 and Phase 2 of TERM (see Figures 1 and 4), which is generally inadequate and sporadic in nature, which makes sector planning difficult. Without grant support from GCF, Tonga will be unable to access sufficient funding to transition to renewable energy.

- **Community Service Obligations.** Output 3 of TREP, the energy access component (solar mini-grids, hybrid grids solar home system and grid expansion), is beneficial from a social perspective and has a strong economic rationale. However, these systems are rarely financially viable. Thus, such activities are generally funded through community service obligations, rather than by corporatized power utilities. Due to budget limitations for the SIDS, the energy access components are unlikely to be funded and are therefore reliant on GCF grant support.

- **Synergy between TREP and Power Sector Reform.** In December 2016, the GCF Board approved a grant of $5 million for regional capacity building and power sector reform under PIRIEP (FP036). ADB as the accredited entity is currently preparing a regional capacity building technical assistance. Both GCF's funding support on renewable energy infrastructure development through TREP and regional capacity building effort on power sector reform will bring together a significant synergy.

- **Gender Action Plan.** The GCF is the first climate fund to have taken gender into account in its operationalization from the outset, even before it adopted a dedicated gender policy and gender action plan in March 2015. The GCF already stated its commitment to a gender-sensitive approach in its governing instrument, making it integral to its mission. A project-specific gender action plan has been prepared for TREP, which will actively promote

the involvement of women in employment, such as hiring women in local construction contracts and female participation in training rolled out during project implementation.

- **Innovative Technology Promotion and Knowledge Sharing.** Firstly, BESS is not considered suitable as a stand-alone private sector investment and due to ongoing restrictions in sovereign and commercial financing, investment in BESS requires GCF support. Secondly, the combination of utility-scale solar PV and wind power, both to be developed by IPPs and BESS and funded by GCF on Tongatapu, will be the single largest system of its kind to be built in the single island in the Pacific region. It will also possibly be the largest such system in any SIDS. Thus, it will require full integration with the larger control system for the whole of the Tongatapu Island electricity generation and transmission network. Managing high renewable energy penetration without negatively affecting the grid and installing renewable energy-based hybrid system in the isolated island setting can be tested under TREP with the GCF grant support. Any gained knowledge from TREP can be shared with other SIDSs, and TREP could be replicated on other SIDSs facing similar challenges.

D.2. Exit Strategy

Please explain how the project/programme sustainability will be ensured in the long run, after the project/programme is implemented with support from the GCF and other sources, taking into consideration the long-term financial viability demonstrated in E.6.3. This should include a description of strategies for longer term maintenance of physical assets (if applicable).

TREP will support Tonga's transition from diesel generation to sustainable power generation based on renewable energy. The transition is considered sustainable due to the following:

- Renewable energy on all grids will be least cost compared to diesel, and given the decline in cost of renewable energy, it is considered unlikely Tonga will revert to diesel generation.

- All assets will be incorporated into the asset base of TPL and MEIDECC, operated and managed through legally-binding agreement between ADB and TPL/MEIDECC. It will help TPL - especially as Tonga's only government-owned power utility- operate and maintain all the grant-funded BESS and renewable energy generation assets on a more commercially oriented way by ensuring through a legal agreement that physical assets financed under TREP are: (a) transferred to TPL and recorded as assets owned by TPL; (b) treated as an increase in the GOT's equity in TPL for accounting purposes; and (c) depreciated on TPL's balance sheet according to an appropriate depreciation schedule for the relevant asset classes as part of TPL's regulated asset base for determination of TPL's costs and revenue requirements.

- Both TPL and MEIDECC have adequate management capacity and a tariff regime sufficient for full cost recovery, which allows for adequate operation and maintenance.

- Once the initial funding barriers to renewable energy are addressed by the grant from GCF and the transition to renewable energy is largely complete, it is expected that financing of upgrades or refurbishments of renewable energy assets will be covered by operational budgets of GOT and TPL.

- Under the ongoing outer island renewable energy (OIREP) project, GOT will contract TPL under the government's budget for O&M and to illustrate a permanent and durable commitment to the long-term maintenance of the outer island energy assets. Establishing an appropriate O&M contract[18] is essential to address sustainability risks and concerns for the significant capital investments proposed under TREP. Under OIREP, a detailed O&M business model is being prepared. The O&M business model will be reviewed annually to ensure that issues and feedback are considered for improvements.

- Communities have been closely engaged since a project preparatory and basic design stage. Close community engagement will enhance a project ownership.

[18] ADB will demand the Government of Tonga (GOT) to include (an) O&M related covenant(s) in the grant agreement to be made between ADB and GOT.

- GOT is working toward reviewing and developing a coherent and robust National Energy Framework Bill. The Tonga Energy Efficiency Master Plan will set clear direction based on the need to address climate change and security of energy supply, supported by market instruments that encourage incentives to attract private sector investments in renewable energy.

- Battery storage is required to allow increased integration of renewable energy, particularly from the private sector. Once the additional renewable energy is constructed, TPL will become reliant on battery storage for a significant proportion of its revenue, and therefore has a strong incentive for operating and maintaining battery storage.

- Finally, TREP is fully supported by the Government of Tonga at the highest level. TREP is a central and pivotal component of TERM, and the Government of Tonga has established a high-level Taskforce to implement TERM. This taskforce is chaired by the Prime Minister. Without the proposed BESS under TREP taken in place, planned solar PV and wind farms to be developed by independent power producers (IPPs) would not be realized, because TPL's grid cannot fully observe intermittent electricity generated from those renewable energy generation facilities.

In this section, the accredited entity is expected to provide a brief description of the expected performance of the proposed project/programme against each of the Fund's six investment criteria. Activity-specific sub-criteria and indicative assessment factors, which can be found in the Fund's Investment Framework, should be addressed where relevant and applicable. This section should tie into any request for concessionality made in section B.2.

E.1. Impact Potential

Potential of the project/programme to contribute to the achievement of the Fund's objectives and result areas

E.1.1. Mitigation / adaptation impact potential

Specify the mitigation and/or adaptation impact, taking into account the relevant and applicable sub-criteria and assessment factors in the Fund's investment framework.

Mitigation. TREP's 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 in 18. Further details of the methodology and assumptions for calculating CO_2 emissions are provided in the sections below.

Table 18: Estimated Reduction of Annual GHG Emissions by TREP

Island (group)	Annual power generation from RE provided and caused by TREP (GWh)	Annul diesel use displaced due to TREP RE ('000 liters)	Annual CO_2 Emission reduced (tonnes)
Tongatapu	15.826*	3,820	12,313*
'Eua	0.511	156	398
Vava'u	0.438	127	341
Outer islands	0.726	232	565
Totals	**17.501**	**4,335**	**13,616**

GHG = greenhouse gas, GWh = gigawatt-hour, CO_2 = Carbon Dioxide, TREP = Tonga Renewable Energy Project.
* These are expected to be achieved by solar PV and wind IPPs, which will happen because of BESS to be funded by GCF.

TREP will lead to an estimated 13,616 tonnes of reduced CO_2 emissions per annum, which, over the project's 25-year lifespan, will lead to a total of 340,395 tonnes of reduced CO_2 emissions.

TREP will play a major role in addressing multiple challenges Tonga faces with: (i) climate change with frequent extreme weather events; (ii) energy security because of a high dependency on diesel; and (iii) low access to 'modern' electricity in outer islands. The momentum and scale of renewables, the experience and capacity acquired, the lowered

risks, the awareness raised and the reduced barriers through TREP all make a return to fossil fuels extremely unlikely, effectively 'locking out' fossil fuels in the future.

Notably, TREP will directly and indirectly lead to the following:

- Approximately 95,000 people on Tongatapu, 'Eua and Vava'u benefitting from clean, reliable and affordable electricity supplies, of which at least 50% is generated from renewable energy technologies;
- A total of about 1,059 people on the outer islands on Ha'apai and Niuas benefitting from a longer, reliable, modern electricity supply at a lower cost;
- Installation of 8.95 of MW renewable electricity generation capacity[19] and a complementary 10.1 MW / 22.2 MWh of BESS, providing about 17.5 GWh of annual electricity generation from renewables;[20]
- Direct and indirect (by IPPs) investments that provide about 27% of that electricity from renewable sources. This will lead to a situation where renewables are supplying at least 50% of Tonga's electricity, as opposed to the current level of 11%; and
- In addition, although not included in the formal calculations, TREP will also lead to reduced shipping and therefore reduced emissions from shipping, especially to isolated outer islands.

Contribution to the National Renewable Energy Target. Before TREP, both Phases 1 and 2 under TERM (see Figure 1) are expected to deliver up to 27% electricity from renewable energies. BESS to be installed under TREP will allow an increase in renewable energy generation by about 7.8 MW (4 MW solar PV and 3.8 MW wind power to be financed by the private sector), which will enable Tonga to increase their renewable energy penetration by 24% without negatively affecting the grid and curtailment. In addition, TREP-financed generation technologies in the outer islands will directly generate about 3% of additional clean electricity. By increasing the contribution of renewable energy by 27% (added to the exiting 27%), TREP will allow Tonga to exceed its NDC target of generating 50% of electricity from renewables by 2020. In doing so, it will also help Tonga build momentum to reach its target of 70% by 2030.

Contribution to Resilience and Climate Change Adaptation. TREP will generally contribute to the climate resilience of the population on Tongatapu, 'Eua, Vava'u and Ha'apai. By providing a sustainable, reliable, and independent energy source, TREP will help establish resilient lives and livelihoods on those islands. For instance, locals will have access to full household electricity services (refrigeration, washing machine, TV, radio, internet etc.), as opposed to only lighting which is the current case. This will enable locals to connect to the outside world and empower them to build their own business to help improve their livelihoods. This will also increase possibilities for cyclone and disaster warning. This is notably the case for O'ua, Tungua, Kotu and Mo'unga'one (all part of the Ha'apai island group) and Niuafo'ou (Niuas island group). These are small and remote island groups relying on maritime transport for their diesel imports, which can be increasingly disrupted with climate change. These small islands also face environmental issues from damaged batteries used by existing outdated solar home systems (that only provide light). These islands are relatively small in land size and batteries have recently become an environmental and health issue for these islands. The GCF project will remove these batteries from these islands and replace the existing fragmented solar home systems with solar PV mini-grid, which will reduce acid spillage from these batteries and provide more consistent electricity supply to consumers.

The selection of equipment has been carefully analyzed based on best engineering practices. The equipment is specifically designed for hard marine environments and remote island conditions. The equipment will incorporate adequate climate-proofing measures to increase resilience to climate and disaster risks throughout the project lifecycle. The BESS installation will comprise containerized BESS units (likely four 40 ft. ISO shipping containers). All components procured will be suitable for tropical marine and coastal environments, preferably pre-assembled and resistant to corrosion as practicable and can withstand extreme weather events. The mini-grid would also be buried underground to improve cyclone resilience and safety. Finally, the proposed O&M service to be provided by TPL on outer islands will enhance the long-term sustainability of all the funded assets under TREP.

[19] About 7.8MW renewable energy generation capacity is expected to be financed by IPPs, which is not part of the TREP financing plan.

[20] About 15.826 GWh of annual electricity generation is expected to be achieved by solar PV and wind IPPs, which will happen because of BESS to be funded by GCF.

E.1.2. Key impact potential indicator

Provide specific numerical values for the indicators below.

GCF core indicators	*Expected tonnes of carbon dioxide equivalent (t CO_2 eq) to be reduced or avoided (Mitigation only)*	*Annual*	13,616 t CO_{2eq}
		Lifetime	340,395 t CO_{2eq}
	• *Expected total number of direct and indirect beneficiaries, disaggregated by gender (reduced vulnerability or increased resilience);* • *Number of beneficiaries relative to total population, disaggregated by gender (adaptation only)*	*Total*	Estimated 96, 000 beneficiaries
		Percentage (%)	49.7% female and 50.3% male
Other relevant indicators	*As above*		

Describe the detailed methodology used for calculating the indicators above.

The determination of GHG emission reductions from solar PV and wind power generators, which will happen because of BESS to be funded by GCF, are based on parameters, factors and assumptions described in Annex 12.

TREP will lead to 13,616 tonnes of reduced CO_2 emissions per annum[21], which, over the project's 25-year lifespan, would add up to a total of 340,395 tonnes of reduced CO_2 emissions. TREP will reduce global emissions by an estimated 340,395 t CO^2_e for a total GCF investment of $29.90 million at a cost of $87.8 per t CO^2_e. This compares favourably to the Cook Islands BESS project approved under the Regional Program at GCF 15th board meeting (with a rate of $167 per t CO^2_e,), and the recent solar power development project in the Solomon Islands (with a rate of $724 per t CO^2_e). (See Section E.6)

The methodology does not account for positive carbon emission reductions due to the reduced amount of shipping activity. As a result of TREP, there will be less need for shipping to transport diesel to Tonga and to the Outer Islands.

E.2. Paradigm Shift Potential

Degree to which the proposed activity can catalyze impact beyond a one-off project/programme investment

E.2.1. Potential for scaling up and replication (Provide a numerical multiple and supporting rationale)

Describe how the proposed project/programme's expected contributions to global low-carbon and/or climate-resilient development pathways could be scaled-up and replicated including a description of the steps necessary to accomplish it.

The dominance of energy as a GHG emitting sector underscores Tonga's current reliance on imported oil, which supplies all transport fuel, much of the energy for water pumping, and about 90% of grid-supplied electricity. Consequently, the Tongan economy and electricity consumers have been exposed to high and volatile electricity prices linked to oil prices over the last fifteen years. This is more acute than some other larger Pacific island countries, as Tonga does not have hydropower potential.

[21] About 12,313 tonnes of CO_2 emissions are expected to be achieved by IPPs, which will happen because of BESS to be funded by GCF.

Meanwhile, the increasing frequency of strong destructive tropical cyclones has affected Tonga's development with damages on average costing 20% of GDP. Extensive coastal erosions across the country have prompted the Government of Tonga to direct over 30% of mobilized development assistance to address this issue over the past six years, and lack of climate proofing investments further risks Government's poverty alleviation commitments and national development.

To address dual challenges of climate change and energy security, Tonga introduced a new paradigm by setting ambitious targets under its NDC; (i) 50% and 70% of electricity generation from renewable sources by 2020 and 2030; (ii) reduction of electricity line losses to 9 percent by 2020 (from a baseline of 18 percent in 2010). Tonga's NDCs raise its ambition to contribute towards a robust and ambitious legally binding COP21 climate change agreement.

Firstly, TREP has been designed to help Tonga achieve this paradigm shift, in order to rapidly move the country from its current energy pathway that is almost entirely (about 90%) dependent on imported fossil fuels, to a lower carbon and more climate resilient pathway. TREP will also help provide greatly increased levels of access to marginalized populations in outer islands, where this is currently low. For instance, TREP-financed generation technologies will directly generate about 3% of additional clean electricity.

Secondly, a large scale of BESS to be funded by GCF will allow an increase in renewable energy penetration by 24% without negatively affecting the grid and curtailment. Any significant further development of renewable contribution to the electricity sector in Tonga will require BESS. Without the BESS, the grid has reached its capacity, and no further investment – public or private – would make sense. TREP will install BESS and thereby enable additional electricity providers to sell to the grid on a commercial basis. Hence, installing BESS will create a more attractive context for private sector investment by reducing off-take risk. That is, GCF and public funds are used to install BESS, thereby helping to attract private sector investment. As a result, TREP will not only make a major contribution to Tonga's NDC target of generating 50% of electricity from renewables by 2020, it will also help Tonga lay the foundation to reach 70% by 2030 and to meet another NDC target of reduction of electricity line losses to 9 percent by 2020 (from a baseline of 18 percent in 2010).

Lastly, TPL like many other power utilities in the Pacific has not been allowed to pass through their generation assets grant-financed by many development partners to consumers and charge a tariff. It has weakened TPL's capacity to properly maintain those assets, consequently has threaten the overall sustainability of those assets. All assets to be funded under TREP will be incorporated into the asset base of TPL, operated and managed through legally-binding agreement. It will help TPL - Tonga's only government-owned power utility- operate and maintain all the grant-funded BESS and renewable energy generation assets on a more commercially oriented way by ensuring through a legal agreement that physical assets financed under TREP are: (a) transferred to TPL and recorded as assets owned by TPL; (b) treated as an increase in the GOT's equity in TPL for accounting purposes; and (c) depreciated on TPL's balance sheet according to an appropriate depreciation schedule for the relevant asset classes as part of TPL's regulated asset base for determination of TPL's costs and revenue requirements.

Figure 11: Theory of Change

Activities →	Products →	Results →	Impacts
Output 1: Battery Energy Storage Systems (BESS) on Tongatapu	- Multiple units of BESS installed - A total preliminary BESS capacity of about 10.1 MW/19.9MWh	- About 3 renewable energy generation facilities to be financed by IPPs will be built - About 340,395 tCO_{2eq} will be reduced throughout the lifespan (25 years). - Approximately, 27% of Tonga's electricity will be generated from renewable energies – Earnings/saving from energy produced/saved in sub-projects financed - About 3 PPAs are expected to be signed - All the grant-funded BESS and renewable energy generation assets on a more commercially oriented way. - Both PPA and O&M trainings are delivered to the Executing Entities	- Energy security and climate mitigation are enhanced. - 50% RE target are achieved, and momentum to reach 70% RE by 2030 are built. - Enabling technologies like BESS to attract more private sectors are demonstrated. - Tonga's emission intensity from power generation decreased due to a higher share of RE in the generation mix. - Overall sustainability grant-financed assets are enhanced. - Overall capacity of Tonga and TPL to attract more private sectors are enhanced.
Output 2: Grid-connected Renewable Energy Generation on 'Eua and Vava'u islands	- 0.35MW solar PV plant plus 0.9MWh BESS on 'Eua - 0.3MW solar PV plant plus 0.5MWh BESS on Vava'u		
Output 3: Renewable-Based Hybrid Systems and Mini-Grids on Outer-Islands	- A total of 0.49 MW solar PV plants plus 0.9MWh BESS in 5 outer-islands.		
Output 4: Capacity Building and Project Management Support	- Power purchase agreements for private sector funded investments - O&M training workshops and manuals - Project management and construction supervision support		

Source: Asian Development Bank

E.2.2. Potential for knowledge and learning

Describe how the project/programme contributes to the creation or strengthening of knowledge, collective learning processes, or institutions.

There is a lot of commonality across Pacific island countries with regards to renewable energy opportunities, barriers and solutions. The approach of using renewable energy technologies to create modern power sectors in remote island areas is of interest across the Pacific, to SIDS across the world, and even to remote island communities in medium and high development countries. Any gained knowledge from TREP can be shared with other SIDSs and TREP can be replicated on other SIDSs facing similar challenges.

TREP takes place within PIRIEP (FP036). Lessons and experience from TREP will have an impact across the Pacific region, facilitating and paving the way for replicating and upscaling public and private sector investments.

Under PIRIEP (FP036), the first project approved (in December 2016) was the Cook Islands project with a focus on BESS. Tonga will learn from the Cook Island experience with developing BESS. This includes lessons on the institutional and capacity support mechanisms. Under PIRIEP, further projects are being developed in the Federated States of Micronesia, Nauru, Papua New Guinea, Republic of Marshal Islands and Samoa. On the other hand, these

countries in the Pacific will learn from Tonga in regard to BESS, solar PV and wind power technology development, and also institutional and capacity support mechanisms. Notably, many Pacific countries will be interested to learn how Tonga has provided access to reliable, sustainable energy to remote communities on outer islands. Specifically, lessons will be shared from Tonga on the operational know-how and soft measures used to address the particular challenges associated with rapid, increasing shares of renewables in small developing island context.

Moreover, more advance and sustainable accounting practices of TPL for all grant funded generation assets will provide lessons that can be shared with other power utilities in the Pacific. This sharing of lessons learned

- the creation of knowledge products (website, lesson learnt files, guidance documents and/or scientific papers), which can be presented at ADB's annual Asia Clean Energy Forum and the Pacific Power Association Conference;
- the provision of opportunities for inter-island visits to observe successes and lesson learnt including knowledge sharing workshops; and
- cooperation with regional stakeholders and regional coordination bodies.

E.2.3. Contribution to the creation of an enabling environment

Describe how proposed measures will create conditions that are conducive to effective and sustained participation of private and public sector actors in low-carbon and/or resilient development that go beyond the program.

Tonga has already taken steps to strengthen its enabling environment for energy production, starting in 2008 with the Renewable Energy Act and the preparation of the TERM in 2009. Notably, TERM included comprehensive measures to update policy, legal, regulatory arrangements. This has been largely implemented with the support of development partners, including actions under Phases 1 and 2 described in Figure above. GOT has also demonstrated strong governance in establishing regulatory systems which have provided adequate revenue generation for operation and maintenance of power sector assets. Finally, TPL and MEIDECC have demonstrated strong internal capacity for operating and maintaining power assets over an extended period.

The enabling environment will be continuously assessed, including under (i) this proposed TREP project (Output 4); (ii) PIRIEP ($5 million regional technical assistance [FP036]); and (iii) Readiness and Preparatory Support, and as necessary recommendations will be made, and support given.

Building on the above policy and institutional capacity, TREP will further strengthen the enabling environment to attract additional public and private finance as follows:

- **Raising awareness and confidence in renewables**: by demonstrating the success and co-benefits of renewables, this will raise awareness across the board on the benefits of renewables, amongst policy-makers and investors;
- **Individual capacity building:** by providing training and on-the-job experience in TPL and MEIDECC, this will lead to a strong cadre of personnel able to facilitate successful investments in renewable energies;
- **Installing BESS**. BESS is a necessary foundational investment that paves the way for commercial, private investment in solar PV and wind power. For instance, without the proposed BESS under TREP taken in place, planned solar PV and wind farms to be developed by independent power producers (IPPs) would not be realized, because TPL's grid cannot fully observe intermittent electricity generated from those renewable energy generation facilities.; and
- **Preparing IPP involvement**. TREP will support potential IPP transactions and areas for IPP involvement (e.g. drafting and/or reviewing PPAs to be entered with IPPs).

Describe how the proposal contributes to innovation, market development and transformation. Examples include:

- *Introducing and demonstrating a new market or a new technology in a country or a region*
- *Using innovative funding scheme such as initial public offerings and/or bond markets for projects/programme*

TREP includes several innovative technologies and approaches. Most are innovative for the region, while some are innovative at a global level. These include:

- **Battery storage at scale.** This is new to Tonga and in the region and relatively new globally. There is still much to be learned in terms of appropriate technologies, performance, integration into transmission networks, operation and maintenance, etc. Moreover, TREP will be the first project in Tonga to install two different forms of BESS in terms of functionality: (i) load shifting to offset renewable generation at the planned RE facilities in Tongatapu; and (ii) grid-stabilization to manage the impact of fluctuations in the generation on the grid, so as to permit more renewable energy generation to be integrated while maintaining power quality and system reliability. Lessons should be learned from this innovative combination of two battery functions.

- **Integrated approach.** Under Output 1, TREP will lead to installing three renewable energy technologies onto one relatively small grid: wind power, solar PV and BESS. This will provide TPL the experience in designing both RE and BESS systems using the most cost effective and fully integrated approaches and developing management systems to integrate renewable and intermittent energies into the grid.

- **O&M contract in the outer islands.** As part of government's community service obligation, a long-term O&M contract is expected to be made between GOT and TPL for those outer islands to be funded under TREP, which will ensure the long-term sustainability of the funded assets in the outer islands. Under the O&M contract, TPL will train local communities for daily O&M, especially disasters maintenance.

- **Gender training.** TREP will make extensive efforts to involve women in project activities and so to ensure gender mainstreaming into energy development plans. For instance, under the ongoing OIREP, TPL has successfully brought to the project sites, 8 women out of 15 trained workers. Four of these women previously completed and are currently taking the same tasks on Ha'apai, 'Eua and Vava'u under another project funded by ADB. TPL's effort may create a long-term employment opportunity for these female workers under TREP.

- **More commercially oriented accounting practices and tariff-setting.** All assets to be funded under TREP will be incorporated into the asset base of TPL, operated and managed through legally-binding agreement. It will help TPL - Tonga's only government-owned power utility- operate and maintain all the grant-funded BESS and renewable energy generation assets on a more commercially oriented way by ensuring through a legal agreement that physical assets financed under TREP are: (a) transferred to TPL and recorded as assets owned by TPL; (b) treated as an increase in the GOT's equity in TPL for accounting purposes; and (c) depreciated on TPL's balance sheet according to an appropriate depreciation schedule for the relevant asset classes as part of TPL's regulated asset base for determination of TPL's costs and revenue requirements.

E.2.4. Contribution to regulatory framework and policies

Describe how the project/programme strengthens the national / local regulatory or legal frameworks to systematically drive investment in low-emission technologies or activities, promote development of additional low-emission policies, and/or improve climate-responsive planning and development.

Tonga has already undertaken significant sector reform in recent years, with support from ADB and other partners. However, three innovative aspects under TREP may lead to a need for new regulation or legislation, especially to attract more private sector investment after TREP and beyond 2020. These are: (i) the introduction of large-scale BESS; (ii) the need to fully climate proof all investments and all physical infrastructure; and (iii) the integration of diverse renewable energy technologies (i.e. solar, wind, storage). MEIDECC, TPL, ADB and PMU will monitor this situation and initiate measures as necessary. Especially, more sustainable O&M arrangement for renewable energy generation assets to be located in the outer islands is required, which can be assisted under (i) this proposed TREP project (Output 4); (ii) PIRIEP ($5 million regional technical assistance [FP036]); and (iii) Readiness and Preparatory Support.

PIRIEP (FP036 includes a $5 million technical assistance package that will support, where necessary, sector reform activities. Depending on the country level needs, these activities may include the following:

- Sector planning (roadmaps and grid integration studies);
- Power utility management reform and capacity building;
- Tariff review and reform;
- Review and revision of regulatory and policy frameworks, if necessary; and
- Promote private sector by identifying opportunities for independent power providers (IPP's), providing transaction advice and designing guarantee products.

PIRIEP (FP036 includes a $5 million technical assistance package that will support, where necessary, sector reform activities. Depending on the country level needs, these activities may include the following:

The Readiness and Preparatory Support to be funded by Tonga will support the development of the following guidelines and policies that will build a sustainable bankable OISES business for off-grid systems:

- Robust operational and management model for the outer island rural electrification society (OISES);
- Sustainable and Bankable Business Model for OISES;
- Robust Asset Maintenance Policies for OISES; and
- Climate and Natural Disaster Proofing Guideline of OISES.

E.3. Sustainable Development Potential

Wider benefits and priorities

E.3.1. Environmental, social and economic co-benefits, including gender-sensitive development impact

Development, Social and Gender Benefits

TREP will allow Tonga to increase the renewable energy penetration to the national electricity generation mix up to about 54%. Moreover, TREP will provide access to reliable and sustainable energy (Output 4) that is essential for development, as illustrated through the following examples:

Economic co-benefits. The anticipated economic co-benefits from the program include the following:

- Improved access to and reliability of power supply (Outputs 4) will help local businesses, especially in the outer islands;

- Downward pressure on tariffs will support business activity, including household income generation and small local businesses. It is noted that some residential supply is subsidized, but this does not apply to electricity supply to enterprises and businesses;
- Reduced expenditure on fuel imports will reduce pressure on the national budget, releasing funds for other economic investments;
- Increased national energy security creates a better environment for business development;
- Entrepreneurial opportunities relate to renewable energy; and
- Improved and clean energy supply notably benefits the tourism sector.

Environmental co-benefits. The anticipated environmental co-benefits from the program include the following:

- Reduction in local air pollution and noise impacts on local communities from closing down or reducing the use of diesel generated electricity;
- Reduction in the use of diesel will lower risk of fuel spills and land/water contamination (both at sea when transporting the fuel (including waste oil) and on land when stored or being used);
- Less damage from the misuse of batteries. In the past, many of the small islands have faced environment degradation due to mishandling of old and damaged lead acid batteries used with outdated SHSs. In some places, this is becoming a serious issue. TREP will remove these batteries from these islands and replaced the existing fragmented solar home systems with clean solar PV mini-grid. Batteries will be centralized and properly managed;
- Introduction of systematic use of environmental safeguard policies will have a positive influence on development on the islands; and
- Encourage and empower local businesses and community groups to mainstream environment standards to local development plans.

For further information on the environmental context, and the benefits to be achieved through this project, the risks created by this project and how they are to be addressed, see Section F.3 and the Feasibility Study in Annex 2 (Annex 2C: Initial Environmental Examinations).

Social co-benefits. The anticipated social co-benefits from the program include the following:

- Improved reliability of power supply on some grids will support household income generating activities;
- Improved affordability of power supply will reduce household expenditure on energy, releasing income for other essentials such as education and food;
- Notably, on outer islands, increased access to electricity will result in significant social benefits: including improved education, income generation at household levels, reduced household expenditure on kerosene, lowered fire risk from kerosene lighting, and reduced fuel wood consumption; and
- Improved lighting means more time for community meetings, meaning improved conflict resolution. It is observed that afternoon/night time meetings tend to involve majority of the community members to discuss issues and come to a consensus.

Gender co-benefits. The anticipated gender co-benefits from the program include the following:

- Improved community lighting leads to increase safety, and notably women are more confident to attend social gatherings;
- Improved household access to electricity disproportionally benefits women;
- Lower cost to electricity disproportionally benefits women;
- Improved lighting leads to increased security and safety for children and women, and this may lead to reduced child and women abuse; and
- TREP will make extensive efforts to involve women in project activities and so to ensure gender mainstreaming into energy development plans. For instance, under the ongoing OIREP, TPL has successfully brought to the project sites, 8 women out of 15 trained workers. Four of these women previously completed the same tasks

on Ha'apai under another project funded by ADB. TPL's effort may create a long-term employment opportunity for these female workers under TREP.

For further information on the development and social context, and the benefits to be achieved through this project, see the Feasibility Study in Annex 2 (Annex 2B: Poverty, Social and Gender Assessment).

E.4. Needs of the Recipient

Vulnerability and financing needs of the beneficiary country and population

E.4.1. Vulnerability of country and beneficiary groups (Adaptation only)

Describe the scale and intensity of vulnerability of the country and beneficiary groups, and elaborate how the project/*programme addresses the issue (e.g. the level of exposure to climate risks for beneficiary country and groups, overall income level, etc).*

Not applicable (adaptation only)

E.4.2. Financial, economic, social and institutional needs

Describe how the project/programme addresses the following needs:
- *Economic and social development level of the country and the affected population*

Addressing Economic and Social Development

As a small island economy and lower middle-income country, Tonga is geographically isolated and has limited human resources. Its economy is dependent on imports, but exports are low. Like other Pacific island countries, it is highly vulnerable to external economic shocks as well as natural disasters. Tonga has mostly experienced low and volatile growth, and its economy is dominated by the service sector and by the public sector. High levels of remittances are necessary to boost the economy and household revenue.

About 22.5% of Tonga's population are considered to live in poverty (2009).[22] This figure has been rising in recent years. Moreover, Tonga has not met the MDG targets for poverty. Although there is no absolute poverty in Tonga, due in part to a high level of remittances, and to subsistence farming and fishing, there is a high level of income disparity. Notably, per capita revenue on Tongatapu is approximately 15% above the national GDP per capita, while on outer islands it is approximately 40% below the national average.[23] Further, female headed households account for 24.6% of those falling below the Basic Needs Poverty Line, and 29.5% of children living in female headed households are in households below the Basic Needs Poverty Line.[24]

The Tonga Strategic Development Framework II (2015-2025) (TSDF II) sets out to address these poverty and socio-economic challenges. One of the main strategies of TSDF II is to increase energy access, including through TERM. Hence, TREP will make a direct contribution to TSDF II's socio-economic goals. Notably, by establishing energy security, and the use of modern, resilient, appropriate energy technologies, TREP contributes to establishing a climate resilient energy sector in Tonga, which is a necessary basis for all socioeconomic, climate resilient development.

TREP (Output 3) will allow outer islanders of Tonga to enjoy the greater access to the modern AC electricity for a longer period per day. The poor on many outer islands rely on outdated SHS or small portable generators that are managed at the household level. This limits access to electricity, is unreliable and leads to very high access costs. Rural women in Tonga perform multiple roles often with limited resources and challenging work environments, such as lack of access to electricity. The provision of an affordable, reliable power supply to beneficiary households will enable

[22] Asian Development Bank (2016). *Basic 2016 Statistics: Economic Research and Regional Cooperation Department*. Manila: ADB Development Economics and Indicators Division, p. 2.
[23] Government of Tonga (2015). *Millennium Development Goals Final Report*. Nuku'alofa, p.30.
[24] Government of Tonga (2015). *Tonga Strategic Development Framework, 2015–2025*. Nuku'alofa, p.30.

women to perform their roles more efficiently. Moreover, it will also enable school children to study during night time. Outer islanders of Tonga will also have greater access.

For further information on the development and social context, see the Feasibility Study in Annex 2 (Annex 2B: Poverty, Social and Gender Assessment).

Absence of alternative sources of financing (e.g. fiscal or balance of payment gap that prevents from addressing the needs of the country; and lack of depth and history in the local capital market)

As with most Pacific SIDSs, the small population, remoteness, limited economic diversity and low involvement of the private sector means that the Pacific SIDS have limited access to finance - both public and private. Access to private sector finance for innovative investments is particularly limited, as the perceived risks are generally high.

The possibility of increased public sector financial support to renewables was considered as an alternative to accessing GCF funds. However, GOT has very limited revenue sources, and no means of increasing revenue to finance the TERM Phase III investments. Further, given the current debt position, GOT has limited room to borrow – even highly concessional - to finance investments in the energy sector. GOT would not be able to materialize TREP without GCF's grant support.

Specifically, TPL has a prudent 40% debt-to-equity ratio (debt ratio) threshold.[25] According to the Pacific Power Association Benchmarking Study 2016 TPL ranked 4th on the highest Debt to Equity Ratio comparison on 26th member countries around the pacific region. Current projections for total TPL debt at end of June 2017 are T$31.2 million. As indicated in Table 19, TPL's debt ratio has already exceeded the 40% threshold. Further borrowing for TREP would push TPL's debt ratio well beyond its debt sustainability levels (up to about 67%). The second column in Table 19 illustrates how TPL's debt situation would be affected if TREP was to be 50% loan. Finally, it should be noted that TPL passes on all cost to customers, hence the cost of returning to sustainable debt levels would be borne by the people of Tonga, and would particularly impact the poor and the aspiring entrepreneurs.

Table 19: TPL Debt Situation

Ratios	Jun 2017 (estimated)	Loan/Grant 50:50 for TREP
Loan as a % of Total Sources of Funds	24%	45%
Loan as a % of Total Debt	44%	67%
Debt Ratio	55%	67%

TPL = Tonga Power Limited, TREP = Tonga Renewable Energy Project.

Need for strengthening institutions and implementation capacity

Tonga has benefitted from several projects in recent years to build institutional, governance, management and technical capacity related to renewable energies. TREP will focus specifically on technical and implementation capacity building to allow TPL and MEIDECC to manage the transition to higher integration of renewable energy, while institutional are expected to be strengthened through the regional capacity technical assistance ($5.0 million grant) under FP036 and Readiness and Preparatory Support ($1.0 million grant) both to be funded by GCF.

E.5. Country Ownership

Beneficiary country (ies) ownership of, and capacity to implement, a funded project or programme

E.5.1. Existence of a national climate strategy and coherence with existing plans and policies, including NAMAs, NAPAs and NAPs

[25] The TPL Board mandates the level of Debt to Equity be held at around 40%, so TPL can pay down its debt and not become insolvent.

Please describe how the project/programme contributes to country's identified priorities for low-emission and climate-resilient development, and the degree to which the activity is supported by a country's enabling policy and institutional framework, or includes policy or institutional changes.

Energy policy and interventions in Tonga are partly driven by regional level initiatives and accords. This project in part responds to the regional Framework for Action on Energy Security in the Pacific (FAESP) 2010-2020, as endorsed by all Pacific Island leaders in 2010. 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 centers 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, etc. PIREIP was set up as a response to FAESP.

However, Tonga, through TERM, was a key driver of the above regional developments. In many ways, Tonga was ahead of other countries in the region, and the Tonga government played a key role in driving FAESP.

Energy security, renewable energy and TREP are all among the highest priorities of GOT and stakeholders. This is stated clearly in TERM, in Tonga's Second National Communication to the UNFCCC and in the Tonga NDC to UNFCCC (the Paris Agreements). These policy documents and commitments specify the objective of having 50% of electricity generated from renewable energy sources by 2020.

Further, the present GOT, on taking office in December 2014, stated that access to affordable and reliable sources of energy is crucial to sustainable livelihoods in Tonga's scattered islands. This reflects the strategies and goals of TSDF II. Tonga is also committed to making progress towards the Sustainable Development Goals, and as seen in the previous section, TREP will help to reach all social, economic and environmental goals.

E.5.2. Capacity of accredited entities and executing entities to deliver

Please describe experience and track record of the accredited entity and executing entities with respect to the activities that they are expected to undertake in the proposed project/programme.

Asian Development Bank (ADB). ADB is the accredited entity. ADB is a multilateral development financial institution that provides loans, grants and technical assistance to its developing member countries. ADB is composed of 67 members, 48 of which are from the Asia and Pacific region. ADB's clients are its member governments, who are also its shareholders. In addition, ADB provides direct assistance to private enterprises of developing member countries through equity investments and loans. In 2016, ADB loan and grant approvals to developing member countries amounted to $17.8 billion, and total co-financing mobilized, with donor support, amounted to $13.9 billion, bringing total sovereign operations to $31.7 billion in 2016. Non-sovereign operations for the same year amounted to $2.5 billion. In 2016, ADB approved $4.4 billion in climate finance, and of this the energy sector accounted for 59% or $2.6 billion, including approximately $31 million in technical assistance. Investments in mitigation amounted to $2.1 billion or 80% of energy climate change investments. These figures demonstrate that ADB has the experience to support projects such as TREP.

ADB was the first multilateral development bank to be accredited to the GCF, and the first accredited entity to mobilize GCF funding to the Pacific region (Fiji, Nauru and the Cook Islands). ADB has the largest energy sector portfolio amongst development partners in the Pacific, covering electricity generation, transmission and distribution. Currently, the regional energy portfolio consists of 14 projects in 8 countries for a total investment of over $350 million. ADB has been operating in Tonga since 1972 and has provided the country with $168.5 million in loans, grants, and technical assistance.

The Government of Tonga (GOT) will be the grant beneficiary. The project executing entities will be (i) the Ministry of Finance and National Planning (MFNP) for the overall project implementation, especially for disbursement of funds; (ii)

Tonga Power Limited (TPL) for Outputs 1 and 2; (iii) and the Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications (MEIDECC) for Output 3. TPL and MEIDECC will be joint executing entities for Output 4 (Project Management Capacity Building). A project steering committee has already been established to support TREP. The PMU will be established to implement the project under MEIDECC. A project steering committee has already been established to support TREP. See Section C.4 for information on its capacity to execute the project.

E.5.3. Engagement with NDAs, civil society organizations and other relevant stakeholders

Please provide a full description of the steps taken to ensure country ownership, including the engagement with NDAs on the funding proposal and the no-objection letter.

The TERM Taskforce has played a key role in the development of TREP and in ensuring its alignment to national priorities and programs. notably:

- the MEIDECC Minister has played a strong role in coordination;
- MEIDECC and TPL have been strongly engaged, supporting data collection and analysis, and mobilizing co-financing from international partners; and
- The GCF National Designated Authority (NDA), under MEIDECC, has been regularly involved in planning discussions and has closely followed project development. The 'No Objection' letter is included in Annex 1.

Due to the above, TREP enjoys broad support and understanding from national level agencies and concerned bodies.

Please also specify the multi-stakeholder engagement plan and the consultations that were conducted when this proposal was developed.

The identification and design of TREP was accomplished through a consultation process that led to TERM in 2009. Subsequently, at the national level, detailed consultations occurred and continue with concerned government departments (MFNP, MEIDECC and TPL), the accredited entity (ADB), and with potential partners (JICA, Government of China, Government of Australia and Government of New Zealand).

With regards to each sub-project under TREP, feasibility studies have been prepared for the separate investments in Tongatapu, 'Eua, Vava'u and the outer islands. The process to prepare these included on the ground consultations with potential beneficiaries, land-owners and affected parties. More details are provided in the reports referred to in Annex 2 (Feasibility Study: Main Report). In addition, during the preparation of the Initial Environment Evaluation (IEE), further consultations were held with community stakeholders – a total of about 100 persons were consulted during that process.

During implementation, the PMU will monitor and ensure that poor households and women are fully consulted; that there are activities to raise gender awareness with target groups; that poor household and women participate as possible in related contracts. PMU will oversee the collection of disaggregated data for poor households and gender, for monitoring and evaluation purposes.

The population in the project area comprises the mainstream population of Tonga, especially in outer islands. TREP is not expected to affect any distinct and vulnerable group of indigenous peoples as defined under ADB's Safeguard Policy Statement (2009). The project team will consider engaging with a Civil Society Organization, if necessary, in the further project design making process.

E.6. Efficiency and Effectiveness

Economic and, if appropriate, financial soundness of the project/programme

E.6.1. Cost-effectiveness and efficiency

Describe how the financial structure is adequate and reasonable in order to achieve the proposal's objectives, including addressing existing bottlenecks and/or barriers; providing the least concessionality; and without crowding out private and other public investment.

The proposed financial structure – full grant - is considered reasonable to meet the TREP's objectives of increased renewable energy integration. Tonga's ability to borrow is very limited, hence loans must be limited. As per the Preliminary Staff Concluding Statement of the 2017 Article IV Mission approved by IMF's Board in January 2018, its DSA raises Tonga's risk of external debt distress from 'Moderate' to 'High', because of future potential costs of natural disasters. This will allow Tonga to become eligible to receive 100% grants from many development partners, including ADB. Therefore, it is not considered reasonable for GCF to extend loans to Tonga.

While public sector grant financing has supported the majority of renewable energy investments to date in Tonga, there is insufficient public-sector financing, either grant or concessional lending, to implement the TERM, especially if the timeframes are respected. Therefore, TREP will not crowd out public sector financing. For reasons discussed in previous sections, the investments included in TREP are not considered suitable for private sector investment, and therefore TREP will also not crowd out private sector financing. Co-financers, ADB and the Government of Australia, also consider providing full grants for TREP.

A good example of the above is the need for BESS. Any significant further development of renewable contribution to the electricity sector in Tonga will require BESS. Without the BESS, the grid has reached its capacity, and no further investment – public or private – would make sense. TREP will install BESS and thereby enable additional electricity providers to sell to the grid on a commercial basis. Hence, installing BESS will create a more attractive context for private sector investment by reducing off-take risk. That is, GCF and public funds are used to install BESS, thereby helping to attract private sector investment. The proposed battery storage is not considered suitable for private sector investment. In addition, small-scale renewable energy projects in the outer islands are also not attractive to the private sector. The proposed GCF financing will therefore not displace private sector financing.

Please describe the efficiency and effectiveness, taking into account the total project financing and the mitigation/ adaptation impact that the project/programme aims to achieve, and explain how this compares to an appropriate benchmark. For mitigation, please make a reference to E.6.5 (core indicator for the cost per tCO2eq).

The mitigation benefits are set out in the previous section, E.1. The benefits per $ invested by GCF compare favorably with other projects in this region. It is recognized that the Pacific is an expensive region, due to high transport costs and low population densities.

TREP will lead to 13,616 tonnes of reduced CO_2 emissions per annum, which, over the project's 25-year lifespan, would add up to a total of 340,395 tonnes of reduced CO_2 emissions. In summary:

- Total project cost: $53.20 million
- Requested GCF amount: $29.90 million
- Expected annual tCO_{2e} reductions: 13,616
- Estimated lifetime tCO_{2e} reductions (25 year): 340,395
- Estimated GCF cost per tCO_{2e} reduction: $87.8 / ton

TREP will reduce global emissions by an estimated 340,395 t CO^2_e for a total GCF investment of $29.90 million at a cost of $87.8 per t CO^2_e. This compares favourably to the Cook Islands BESS project approved under the Regional Program at GCF 15th board meeting (with a rate of $167 per t CO^2_e,), and the recent solar power development project in the Solomon Islands (with a rate of $724 per t CO^2_e).

E.6.2. Co-financing, leveraging and mobilized long-term investments (mitigation only)

Please provide the co-financing ratio (total amount of co-financing divided by the Fund's investment in the project/programme) and/or the potential to catalyze indirect/long-term low emission investment.

During the preparation of this proposal, the Government of Tonga has been very active mobilizing resources to parallel investments in support of TREP. It has notably secured the following parallel and associated financing:

- $5 million from JICA for a utility scale wind farm on Tongatapu;
- $2 million from the Government of China to provide 1.5 MW of wind energy;
- About $23 million from IPPs to develop 4 MWp solar PV plants and 3.8 MW wind farm; and
- Discussions are ongoing with the Government of New Zealand for investment in wind power on Tongatapu, possibly through an IPP. MFAT has indicated an interest to contribute NZ$ 5 million.

It is unlikely that the above parallel financing would been mobilized if TREP was not being prepared, especially BESS. The above parallel financing results in great part from the momentum gathering around TREP and demonstrates that TREP creates conditions that attract financing. The above parallel financing amounts to approximately $10-15 million. Directly, TREP has the following financing:

Table 20: Indicative Financing Plan

Source	Net Amount ($ million)	%
Green Climate Fund (Grant) [a]	29.90	56.2
Asian Development Bank (Grant)	12.20	23.0
Government of Australia (Grant) [b]	2.50	4.7
Tonga Power Limited [c]	3.00	5.6
Government of Tonga [d]	5.60	10.5
Total	**53.20**	**100.0**

[a] Administered by the Asian Development Bank (ADB). This amount will not be used to cover ADB's administration fee, audit cost or bank charges.
[b] Administered by ADB. This amount includes ADB's administration fee, audit cost, and bank charges to the extent that these items are not covered by the interest and investment income earned on this grant, or any additional grant contribution by the Government of Australia.
[c] Tonga Power Limited will pay for land acquisitions including compensation to land owners for components 1-5 (see Table 3), and other project management and administrative costs.
[d] The Government of Tonga will pay duties and taxes.
Source: Government of Tonga, Tonga Power Limited, Government of Australia and ADB

The proposed GCF investment is $ 29.9 million that is 56.2 % of the overall investment. Total leveraged co-financing for the project is $38.2 million.[26]

E.6.3. Financial viability

Please specify the expected economic and financial rate of return with and without the Fund's support, based on the analysis conducted in F.1.

TREP is deemed financial and economically viable as shown in Table 21.

Table 21: Summary Financial and Economic Viabilities of TREP

Financial and Economic Indicators	Results
Weighted Average Cost of Capital (WACC)	4.9%
Financial Internal Rate of Return (FIRR)	9.2%
Financial Net Present Value (FNPV, million))	$25.4

[26] It includes the anticipated private sector investment caused by the proposed BESS to be funded under TREP.

Economic internal rate of return (EIRR)	10.1%
Project's overall economic net present value (ENPV, million)	$22.1

TREP = Tonga Renewable Energy Project.

The detailed analysis is provided in Section F.1, and in annex 2A.

Please describe financial viability in the long run beyond the Fund intervention.

TREP is considered financially viable as the derived financial internal rate of return (9.2%) is greater than the weighted average cost of capital (4.9%) only under the 100% GCF grant scenario. TREP is also economically viable as the economic internal rate of return (10.1%) is greater than the economic discount rate of 6.0%.[27] Further, sensitivity analysis shows that the overall project is financially and economically feasible and generally resilient to impacts of adverse scenarios under several realistic scenarios.

Please describe the GCF's financial exit strategy in case of private sector operations (e.g. IPOs, trade sales, etc.).

Not applicable

E.6.4 Application of best practices

Please explain how best available technologies and practices are considered and applied. If applicable, specify the innovations/modifications/adjustments that are made based on industry best practices.

The project design process has been supported by leading international experts on renewable energy technologies with experience in Tonga and other Pacific countries. This has ensured that the design incorporates best international practices and will be implemented using best practices.

The competitive bidding process will be used to ensure the most robust and hazard-resistant, and the latest technologies and practices are procured through this project. Through the bidding process, GOT, TPL and ADB will specify the required results and will specify the required social, economic and environmental parameters. The contractors bidding will be responsible for identifying and proposing the best technologies to meet those specifications at the lowest cost. Given the rapidly evolving nature of renewable energy technologies, this will also ensure that the latest technologies are obtained. This will also ensure value for money and maximized benefits from recent price reductions. The PMU, supported by ADB and GOT, will closely scrutinize the bids to ensure that all specifications are appropriately met and that technologies and practices are optimized.

The specific 'best practice' technology and implementation arrangements have been included in both design and implementation as set out in the Feasibility Study (Annex 2A, Main Report), these are:

- **Battery energy storage systems (BESS).** Energy storage is a rapidly evolving field. The Feasibility Study determined that battery storage is the least cost storage solution amongst several considered storage options. The proposed BESS systems can be grouped into two groups with different characteristics and technical issues; (i) integral (associated) BESS (to be funded by GCF) to be connected to the solar PV and wind farms (to be funded by IPPs) for providing grid-stability and instantaneous response; and (ii) a stand-alone BESS (indicatively one unit for grid-stability and two units for load-shifting). However, the precise technology to be deployed at the site (i.e. battery type) will be left to the bidding contractors to propose based on specifications in the bidding documents.
- **O&M contract in the outer islands.** As part of government's community service obligation, a long-term O&M contract is expected to be made between GOT and TPL for those outer islands to be funded under TREP,

[27] ADB's *Revised Guidelines for the Economic Analysis of Projects* provides justification for applying a lower discount rate of 6% as the minimum required EIRR for projects that generate environmental benefits (e.g., pollution control), such as the TREP. This accounts for the long-term impacts of environmental protection.

which will ensure the long-term sustainability of the funded assets in the outer islands. Under the O&M contract, TPL will train local communities for daily O&M, especially disasters maintenance.

- **Gender training.** TREP will make extensive efforts to involve women in project activities and so to ensure gender mainstreaming into energy development plans. For instance, under the ongoing OIREP, TPL has successfully brought to the project sites, 8 women out of 15 trained workers. Four of these women previously completed the same tasks on Ha'apai under another project funded by ADB. TPL's effort may create a long-term employment opportunity for these female workers under TREP.
- **More commercially oriented accounting practices and tariff-setting.** All assets to be funded under TREP will be incorporated into the asset base of TPL, operated and managed through legally-binding agreement. It will help TPL - Tonga's one and only government-owned power utility- operate and maintain all the grant-funded BESS and renewable energy generation assets on a more commercially oriented way by ensuring through a legal agreement that physical assets financed under TREP are: (a) transferred to TPL and recorded as assets owned by TPL; (b) treated as an increase in the GOT's equity in TPL for accounting purposes; and (c) depreciated on TPL's balance sheet according to an appropriate depreciation schedule for the relevant asset classes as part of TPL's regulated asset base for determination of TPL's costs and revenue requirements.

E.6.5. Key efficiency and effectiveness indicators

GCF core indicators

Estimated cost per t CO^2_e., defined as total investment cost / expected lifetime emission reductions (mitigation only)

(a) Total project financing	$53.20 million
(b) Requested GCF amount	$29.90 million
(c) Expected lifetime emission reductions overtime	340,395 t CO^2eq.
(d) Estimated cost per t CO^2 eq. (d = a / c)	US$156.2 / t CO^2 eq.
(e) Estimated GCF cost per t CO^2 eq. removed (e = b / c)	US$87.8 / t CO^2 eq.

For the methodology to determine (c), see section E.1.2 above. (d) and (e) are determined using (c).

Please describe how the indicator values compare to the appropriate benchmarks established in a comparable context.

Emission reduction costs can only be meaningfully compared with another SIDS, in particular Pacific SIDS. This compares favourably to the Cook Islands BESS project approved under this Regional Program at GCF 15th board meeting with a rate of $167 per tCO_{2e}, and the recent solar power development project in the Solomon Islands that yielded a cost of $724 per tCO_{2e}.

Expected volume of finance to be leveraged by the proposed project/programme and as a result of the Fund's financing, disaggregated by public and private sources (mitigation only)

TREP has leveraged $38.2 million in public and private sector investments. Government and TPL is continuing to mobilize investment financing from international development partners.

With support from both the TREP PMU and the regional PRIEF PMU, Government of Tonga and TPL will explore measures to attract future private sector co-financing, engage in dialogue with potential investors and facilitate private sector investment.

Describe the detailed methodology used for calculating the indicators above. Please describe how the indicator values compare to the appropriate benchmarks established in a comparable context.

No appropriate benchmarks were identified in the Pacific, or similar regions.

Other relevant indicators (e.g. estimated cost per co-benefit generated as a result of the project/programme)	Not Applicable

F.1. Economic and Financial Analysis

Please provide the narrative and rationale for the detailed economic and financial analysis (including the financial model, taking into consideration the information provided in section E.6.3).

Economic and Financial Assessments

As stated above, TREP is financially viable as the derived financial internal rate of return (9.2%) is greater than the weighted average cost of capital (4.9%) as shown in Table 22.

Table 22: Summary Financial and Economic Viabilities of TREP

Financial Indicators	**WACC**	**FIRR**	**FNPV**
	4.9%	9.2%	$25,401,892
Economic Indicators	**Discount Rate**	**EIRR**	**FNPV**
	6.0%	10.1%	$22,149,103.9

ENPV = economic net present value, EIRR = economic internal rate of return, FNPV = financial net present value, FIRR = financial internal rate of return, WACC = weighted average cost of capital.
Source: ADB's estimates.

TREP is also economically viable as the economic internal rate of return (10.1%) is greater than the economic discount rate of 6.00%. Further, sensitivity analysis shows that the overall project is financially and economically feasible under several realistic scenarios. Full details of the calculations and all tables are provided in Feasibility Study (Annex 2D, Financial Assessment and Annex 2E, Economic Assessment)

Based on the above analysis, please provide economic and financial justification (both qualitative and quantitative) for the concessionality that GCF provides, with a reference to the financial structure proposed in section B.2.

TPL works on full cost recovery basis, and although there are some government subsidies to the poorest consumers, the electricity tariffs reflect TPLs production costs (including TPL's reinvestment, O&M and allowed profits). Hence, should production costs decline, tariffs will also decline. Until now, the heavy dependence on diesel, whose price fluctuates and can be costly, combined with the high costs of shipping the fuel to Tonga, has led to high electricity tariffs in Tonga, even relative to most of its Pacific island peers. Over most previous years, the average electricity tariff in Tonga has been greater than most Pacific islands countries.[28] Hence, the concessionality of GCF assistance (grant) will be passed directly on to electricity consumers, with positive spillover effects on economic activity and general well-being.

Tonga's small size, remoteness, and high vulnerability to external economic shocks and climate change combine to effectively decrease its attractiveness for commercial financing, except on highly unfavorable terms. Further, ss per the 2017 Article IV Consultation—Press Release and the Staff Report for Tonga released by the International Monetary Fund (IMF) in January 2018, its DSA raises Tonga's risk of external debt distress from 'Moderate' to 'High', because of future potential costs of natural disasters. This will allow Tonga to become eligible to receive 100% grants from many development partners, including ADB. Development assistance (full grants) is therefore critical if Tonga is to achieve its commitments to the Paris Agreement. TPL's current debt ratio has already exceeded the 40% threshold. Further borrowing for TREP would push TPL's debt ratio well beyond its debt sustainability levels (up to about 67%), which will negatively effect on TPL's overall solvency.

[28] data provided by TPL.

Grant financing from the GCF would allow TPL to proceed with its ambitious shift toward renewables while at the same time retaining space for reducing electricity tariffs. Finally, the BESS and the off-grid renewable energy technologies are not attractive for private sector investment under current conditions.

Concessionality is also supported by the fact that the project's net benefits to the broader economy outweigh estimated financial gains for TPL (as evidenced by the estimated EIRR being greater than the FIRR). Grant funding is therefore justified as it will accelerate the switch to renewable energy and lead to economic and social gains.

F.2. Technical Evaluation

Please provide an assessment from the technical perspective. If a particular technological solution has been chosen, describe why it is the most appropriate for this project/programme.

The proposed technical solutions were selected based on previous experience (notably with OIREP) and the assessment of best international practices (see the feasibility studies). This included use of the following assessment tools:

- demand forecasts and grid integration modelling to determine equipment sizing and timing of investment;
- availability forecasts for energy resources; and
- least cost analyses.

The four most promising electricity generation technologies – diesel, biodiesel, solar PV and wind power - were assessed (see Annex 2A). The following selection criteria were applied: (i) maturity of the technology; (ii) resource availability; (iii) contribution to energy security and independence; (iv) generation costs; (v) modularity; (vi) complexity, including for maintenance; (vii) intermittency and storage requirements; (viii) space requirements; and (ix) environmental and social aspects as presented in Table 23.

Table 23: Generation Options

Criteria	Resource and Generation Technology			
	Biodiesel	**Diesel**	**Solar photovoltaic**	**Wind**
Maturity	High	High	High	High
Resource availability (local)	Minimal	None	Medium	Medium
Energy security and independence	Minimal	Negative	High	High
Direct cost of generation	High	High	Low / declining	Low / declining
Modularity	Medium	Medium	High	Medium
Complexity, including maintenance requirements	Medium	Medium	Low	Medium
Intermittency -storage requirements	None	None	High	Low-medium
Space requirements	Low-medium	Low	High	Medium
Renewable resource	Yes	No	Yes	Yes
Environmental and social aspects	Impacts related to feedstock and land use constraints	Harmful stack emissions, risks of fuel spills	Minimal issues	Cyclone-proof mounting required

Note: Coconut biodiesel is a possible option for displacing petroleum diesel but has not been identified as a priority for development.

The two most suitable generation technologies were found to be solar PV and wind power, in combination with BESS. The assessment also recommended combination ratios of solar PV and wind power and these have been followed. The 'modularity' of this approach was a critical factor. This modularity means that Tonga can upscale in line with needs and resources, and it can purchase technology when required, and as prices fall and technology improves.

Solar PV and wind power are intermittent resources and do not always provide energy at time of peak demand. This presents technical challenges with respect to predicting power and energy output reliably and ensuring supply meets demand. Hence, energy storage systems are required on Tongatapu and on the outer islands. Energy storage is required for load-shifting (i.e. storing energy over the medium-term for use when demand outstrips supply, e.g. at night for solar PV electricity) and grid stability (i.e. managing micro and short-terms shifts in energy available due to continuous change in wind and solar conditions). Nine technologies for energy storage were assessed using the following criteria: (i) grid stabilization capacity; (ii) load shifting capacity; (iii) maturity of the technology; (iv) energy storage density; (v) energy storage capacity; and (vi) cost.

Costs for wind power are expected to decline moderately. Solar PV is expected to continue declining as global manufacturing capacity increases rapidly. Solar PV and wind are the only options which are promising with respect to reducing cost of supply and tariffs.

Energy storage systems (ESS) are critical to achieving the 50% RE target especially in Tongatapu and present a relatively large capital expense. Table 24 presents an overview of ESS options which are available in the global market and could be potential options for consideration in Tonga. Figure 12 illustrates the key applications, power ratings, discharge durations, and typical system sizes for various ESS. For power quality and grid stability, high power (expressed in kW or MW) systems are needed, while high energy (expressed in MWh) are needed for load shifting and bulk power management.

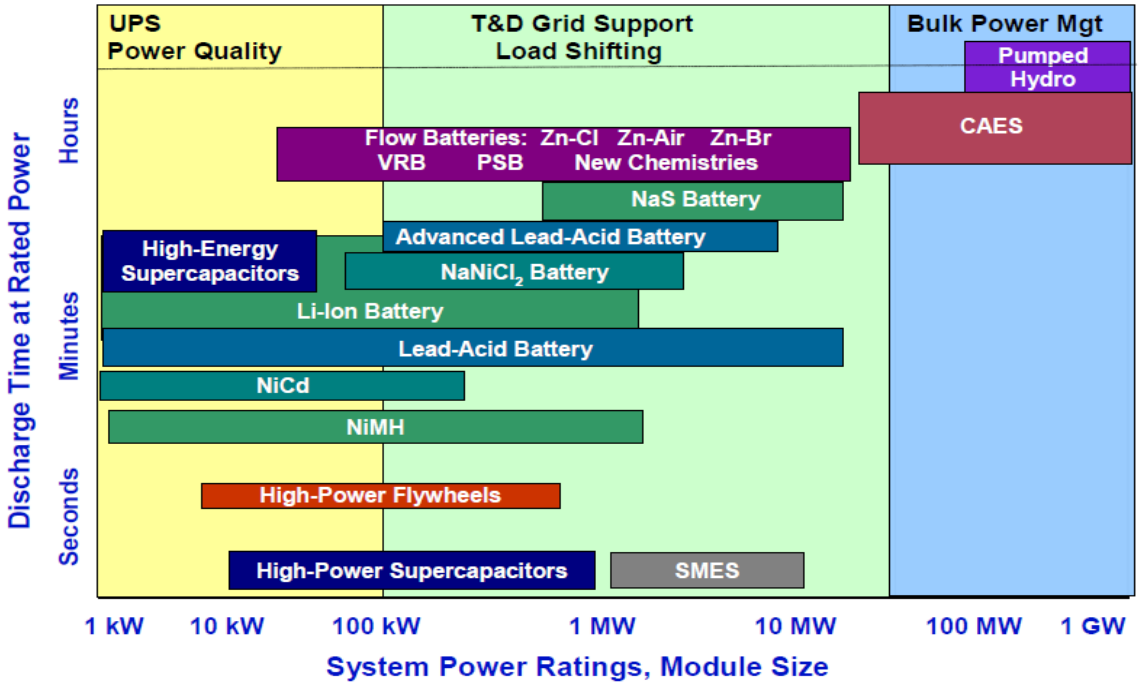
Table 24: Potential Energy Storage System (ESS) Options

	Grid Stabilization	Load Shifting	Technology Maturity	Energy Density	Energy Capacity	Cost
Advanced Lead-acid	No	Yes	High	Low	High	High
Lithium ion	Yes	Yes	High	High	High	Medium-High
Re-dox flow	Yes*	Yes	Medium-High	Medium	High	Medium-High
Zinc-air	No	Yes	Low-Medium	High	High	Low
Sodium Sulfur	No	Yes	High	High	High	High
Super capacitor	Yes	No	Medium-High	High	Low	Very High
Flywheel	Yes	No	Medium-High	High	Low	Very High
Compressed air energy storage	Early commercial deployment	Yes	Emerging – high	Low	High	Low-Medium
Hydrogen fuel cell	Early commercial deployment	Yes	High	Low	High	High

Note: * Lower efficiency when used in grid stabilization than used for load shifting

Figure 12 shows that BESS can provide grid stability and load shifting at the scales required in Tonga.

Figure 12: Power rating and discharge duration for ESS



Source: Sandia National Laboratories (2017)
Note: horizontal axis is logarithmic.

The Feasibility Study (Annex 2A: Main Report), provides the technical rationale for technologies, an assessment of their economic and financial feasibility, as well as social and environmental impacts.

F.3. Environmental, Social Assessment, including Gender Considerations

Describe the main outcome of the environment and social impact assessment. Specify the Environmental and Social Management Plan, and how the project/programme will avoid or mitigate negative impacts at each stage (e.g. preparation, implementation and operation), in accordance with the Fund's Environmental and Social Safeguard (ESS) standard. Also describe how the gender aspect is considered in accordance with the Fund's Gender Policy and Action Plan.

TREP is classified as category B for environment and land acquisition and category C for indigenous peoples per ADB's Safeguard Policy Statement (2009). Initial environmental examinations and resettlement plans were prepared in accordance with ADB's Safeguard Policy Statement 2009 (SPS). No significant environmental impacts will result from the implementation of TREP. No subproject under TREP is expected to involve physical displacement or relocation of people. No distinct and vulnerable indigenous peoples will be affected. All the activities under TREP will be implemented in a culturally appropriate and participatory manner.

The poverty, social and gender assessment (PSGA, see Annex 2B) assesses the social impacts of TREP and sets out necessary response measures and actions plans to mitigate negative impacts and optimize. A Gender Action Plan (GAP) has been prepared (see Annex 2F).

Implementation of the GAP will ensure that TREP optimises women's access to resilient energy supplies, and therefore boosts productive activities among women, including income-generating activities. Further, under the GAP, capacity building programs will be implemented including training on potential solar-power related business opportunities and women's employment at sites. Women are also expected to benefit from improved access to social services such as

health facilities and water from resilient energy supply as they bear the responsibility of caring for their family. The GAP notably includes the following key performance targets and activities:

- All community consultations will have a target of at least 50% female participation;
- The provision of separate toilet and sanitation facilities for men and women. Ensuring women-friendly design by providing reliable water supply, proper lock and lighting;
- Requiring contractors to hire at least 20% women in both technical or non-technical work;
- Enhancing community electric societies' management capacities through facilitation of inclusion of at least 30% women;
- Provide yearly business-skills training on income opportunities from increased electricity supply with 50% women participation at each site;
- Conduct at least 2 consumers' training on power budget management with a minimum of 30% female participation for each TREP community prior to project implementation;
- Include training on intra-household decision-making and sharing household labor and financial access and control with indicators built into the monitoring and evaluation framework to track women's and men's perceptions and behavior on economic and personal empowerment measures before, and after business skills trainings;
- All MEIDECC, TPL and contractors will receive awareness session on sexual harassment. The contractors will submit to TPL a policy against sexual harassment to be implemented during the entire project duration; and
- Train all executing entities in collecting gender disaggregated data and to include this data in the progress, monitoring and evaluation reports.

A Social Development and Gender Specialist will be engaged to assist all executing entities in implementing and monitoring the Gender Action Plan and providing capacity building activities. All the safeguards due diligence including the GAP are included in Annex 2.

F.4. Financial Management and Procurement

Describe the project/programme's financial management and procurement, including financial accounting, disbursement methods and auditing.

Financial Management

Tonga has made solid progress in improving public financial management since achieving internal self-governance in 1984, particularly in government financial accounting and reporting. Public finance legislative frameworks are judged to be reasonably sound.

The present financial management of TPL was assessed using ADB's financial management assessment (FMA) questionnaire and interviews. The responses by TPL to the questionnaire revealed that TPL has defined policies and procedures in place for accounting, budgeting, and auditing activities. As per the FMA questionnaire, TPL maintains records of fixed assets with yearly physical inspections, including an inventory. TPL also has adequate internal controls, including internal audit and risk committee. The existing organizational structure of the Finance and Accounts Department in charge of financial management is adequate. Key findings of the financial management assessment undertaken for the TPL are as described in Table 25.

Table 25: Summary of Financial Management Assessment of TPL

Particulars		Conclusion
A.	Funds Flow Arrangement	Funds flow arrangements are reliable, predictable and secure. TPL has enough capability to smoothly work under the proposed investment program.
B.	Staffing	TPL delegates will compose the PMU to conduct all project relevant activities. TPL have financial staff to manage projects according to ADB financial management procedures.

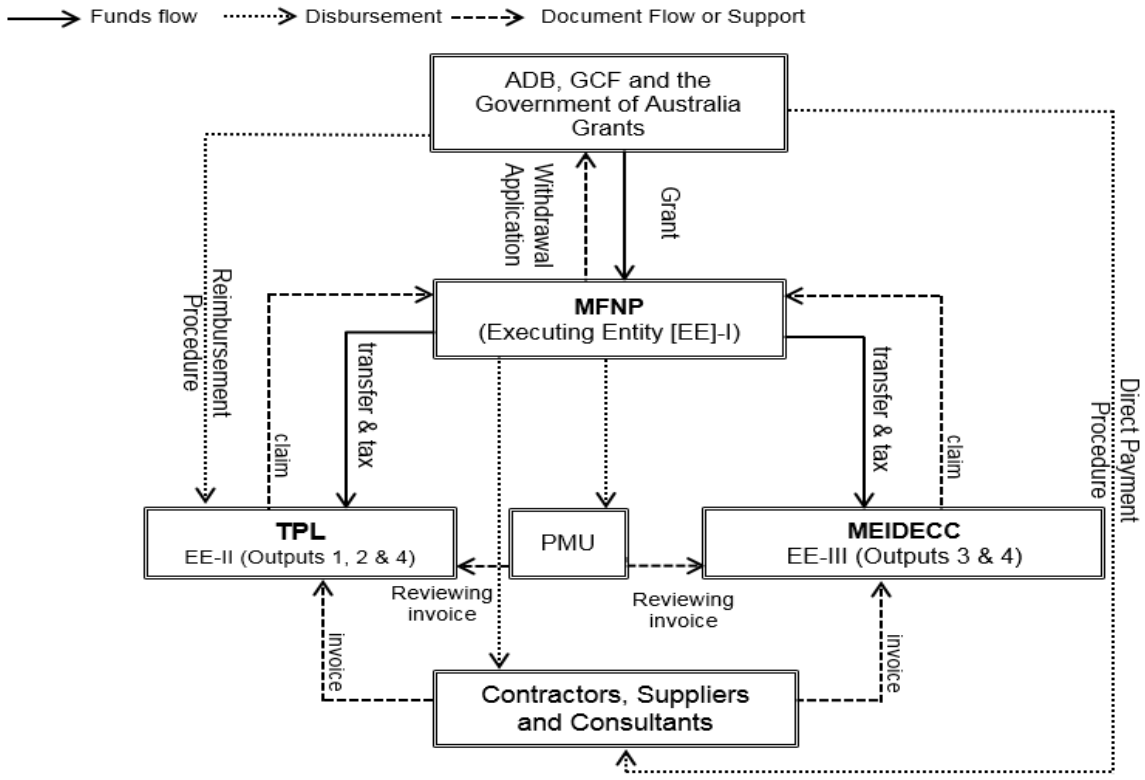
C.	Accounting Policies and Procedures	The TPL's accounting policy is based on the IFRS.
D.	Internal and External Audits	There is an internal audit and risk committee within the TPL. As per the recommendation of the audit and risk committee, the Board outsources internal audit to different auditing firms depending on scope and expertise. The TPL was audited by PWC, an independent external auditor, on an annual basis for the last 3 years. In the following years, KPMG shall be the external auditor for TPL.
E.	Reporting and Monitoring	Financial statements are prepared for the entity in accordance with IFRS, Company Act, 1995 and Public Enterprises Act, 2002.
F.	Information systems	At TPL, the financial management system is computerized, which suits well with the project requirements and procedures.

IFRS = International Financial Reporting Standards, PMU = project management unit, TPL = Tonga Power Limited.

Disbursement, Accounting and Auditing

Disbursement. The loan and grant proceeds including ADB administered co-financings will be disbursed in accordance with ADB's Loan Disbursement Handbook (2015, as amended from time to time), and detailed arrangements agreed upon between the government and ADB. Online training for project staff on disbursement policies and procedures is available at: http://wpqr4.adb.org/disbursement_elearning. All disbursements under government financing will be carried out in accordance with regulations of the government and ADB. Only direct payment and reimbursement procedures will be used under TREP. To facilitate cash flow during project implementation, MFNP, the project sponsor, will approve withdrawal applications coming from the PMU, assisted by PMC and CSC, and submit them to ADB for direct payment for all goods, works and consultancy services of the project. Before submission of the first withdrawal application, the executing entities should submit to ADB sufficient evidence of the authority of the person(s) who will sign the withdrawal applications on behalf of the executing entities, together with the authenticated specimen signatures of each authorized person.

Figure 13: Fund Flow Diagram



Source: Asian Development Bank

Accounting. The TPL/MEIDECC, in coordination with MFNP and assisted by the PMU, will maintain separate project accounts and records by funding source for all expenditures incurred on the project. Project accounts will follow international accounting principles and practices, in line with the NZ-originated Generally Accepted Accounting Practices (GAAP) accounting standard and adhere to sound financial management requirements during the implementation of the proposed project. The TPL/MEIDECC will maintain separate project records and accounts adequate to identify the: (i) goods and services financed from grant proceeds; (ii) financing resources received; (iii) expenditures incurred on each procurement contract related to each Output (TPL for Outputs 1, 2 and 4, and MEIDECC for Outputs 3 and 4); and (iv) counterpart and co-financer funds received and expended.

Auditing. The TPL/MEIDECC, in coordination with MFNP and assisted by the PMU, will ensure that the detailed consolidated project documentation is audited in accordance with International Standards on Auditing and in accordance with the government's audit regulations by an auditor acceptable to ADB. The audited accounts including , certified true copies of audited project documents, auditors' reports and separate opinions on the use of the grant proceeds and compliance with the financial covenants of the grant agreements will be submitted by the PMU (with assistance from PMC/CSC) in English language to ADB in any event not later than 6 months after the end of each related fiscal year (year ending June 30). Public disclosure of the project financial statements, including the audit report on the project financial statements, will be guided by ADB's Public Communications Policy (2011). After review, ADB will disclose the project financial statements for the project and the opinion of the auditors on the financial statements within 30 days of the date of their receipt by posting them on ADB's website. The Audit Management Letter will not be disclosed. The role of the internal audit is to evaluate and improve the effectiveness of internal control, mitigate management risks and ensure efficient governance control process.

Procurement and Consulting Services

For all procurement processes, the government has requested ADB to assist in procuring all project goods, works and services and to recruit related project management consultants (PMC) and construction supervision consultants (CSC). Procurement of goods, works and related services under the project will be processed through TPL and MEIDECC, oversight and approval by ADB and will be carried out in accordance with ADB's Procurement Guidelines (2015, as amended from time to time). For this purpose, TPL and MEIDECC, with the assistance from PMU, will prepare technical specifications and bidding documents per ADB's own format, and prepare bidding evaluation forms. TPL and MEIDECC will recruit both PMC/CSC through firms in accordance with ADB's Guidelines on the Use of Consultants (2015, as amended from time to time).

Both TPL and MEIDECC have extensive experience in procuring various types of goods, works, plants and related services as well as consulting services in accordance with ADB's Procurement Guidelines (2015, as amended from time to time). They also have successfully implemented similar projects funded and administered by ADB.

G.1. Risk Assessment Summary

Please provide a summary of main risk factors. Detailed description of risk factors and mitigation measures can be elaborated in G.2.

The main risk factors identified for TREP include (i) more frequent or intense tropical cyclones or other natural hazards in the future may damage project infrastructure, (ii) poor coordination between all executing entities and the agencies with oversight roles may inhibit effective implementation, (iii) future falls in diesel prices, (iv) delays in procurement and start-up may delay implementation, (v) land acquisition and procurement issues cause delays, (vi) the new government has been recently formed, (vii) IPP investors may not be timely emerged; and (viii) the proposed technology solution may underperform. The risk factors and proposed mitigation measures are detailed below.

Due to the current weak financial situation of both GOT and TPL, full grants from development partners including GCF, ADB and the Government of Australia would be of the essence.

G.2. Risk Factors and Mitigation Measures

Please describe financial, technical and operational, social and environmental and other risks that might prevent the project/programme objectives from being achieved. Also describe the proposed risk mitigation measures.

Selected Risk Factor 1			
Description	Risk category	Level of impact	Probability of risk occurring
More frequent or intense tropical cyclones or other natural hazards in the future may damage project infrastructure.	Other	Medium (5.1-20% of project value)	Medium
Mitigation Measure(s)			
TREP will ensure that infrastructure investments meet standards for cyclone and earthquake resilience.			
Selected Risk Factor 2			
Description	Risk category	Level of impact	Probability of risk occurring
Poor coordination between all executing entities and the agencies with oversight roles may inhibit effective implementation	Technical and operational	Low (<5% of project value)	Low
Mitigation Measure(s)			
A detailed Project Administration Manual will be prepared by ADB setting out the reporting, monitoring and evaluation activities, responsibilities and budget to be complied by all executing entities and project sponsor. It will help all executing entities implement TREP in accordance with ADB's guidelines. Moreover, ADB will ensure that ADB as the accredited entity will regularly follow its project implementation processes and guidelines including reporting obligations under the AMA, and any additional terms that may be agreed in the FAA.			
Selected Risk Factor 3			
Description	Risk category	Level of impact	Probability of risk occurring
Future falls in diesel prices: If the price of diesel falls significantly, it may undermine the competitiveness of renewable energy technologies over the short term.	Financial	Low (<5% of project value)	Medium
Mitigation Measure(s)			
If diesel prices sharply decline, the competitiveness of renewable energy would be reduced. It should be noted however, that Tonga's commitment to renewable energy transition is based on a number of factors, including increased energy security, stability, independence and improved local environment. These should be sufficient to ensure that any impacts on the overall project performance of a drop-in diesel price is low or very low. The situation will be monitored.			
Selected Risk Factor 4			
Description	Risk category	Level of impact	Probability of risk occurring
Delays in procurement and start-up may delay implementation	Technical and operational	Low (<5% of project value)	Medium
Mitigation Measure(s)			
Project start-up activities will begin immediately following project approval to enable timely detailed design, preparation of bid documents, and the tendering and award of contracts. Advance contracting will be undertaken for goods and services that are expected to be procured through the national competitive bidding method. A realistic timeline has been prepared, and these factors fed into the financial and economic assessments.			

Selected Risk Factor 5			
Description	Risk category	Level of impact	Probability of risk occurring
Implementation is delayed due to delays in procurement and land acquisition.	Technical and operational	Medium (5.1-20% of project value)	Low
Mitigation Measure(s)			
During ADB's due diligence process, the candidate sub-project sites have been already identified. For Outputs 1 and 2, TPL already owns or leases the required lands. For Output 3, MEIDECC have already consulted the owners of lands. The Resettlement Plan has been prepared and it will be implemented in accordance with ADB's Safeguards Policy Statement (2009) – refer to Annex 2G.			
Selected Risk Factor 6			
Description	Risk category	Level of impact	Probability of risk occurring
The new government has been recently formed	Other	High (>20% of project value)	Low
Mitigation Measure(s)			
ADB's programing team will confirm new government's strategic priority in energy sector. The new government will most likely put its efforts to meet the current RE target of 50% and 70% by 2020 and 2030.			
Selected Risk Factor 7			
Description	Risk category	Level of impact	Probability of risk occurring
IPP investors may not be timely emerged	Financial	Medium (5.1-20% of project value)	Low
Mitigation Measure(s)			
TPL has successfully sourced, structured and negotiated the first independent power producer(IPP) for a 2 MW solar PV farm, which is currently in operation. Additional IPPs in the pipeline include: (i) Option for additional 4 MW (2 lots of 2 MW) of IPP solar through the current power purchase agreement; and (ii) the Government of New Zealand (MFAT) has committed NZ$5.0 million to support a 2.2 MW wind IPP project, which both MFAT and TPL have just started identifying the IPP. However, both solar and wind IPPs are subject to installation of any form of storage to be grant funded by development partners like GCF.			
Selected Risk Factor 8			
Description	Risk category	Level of impact	Probability of risk occurring
The proposed technology solution may underperform	Technical and operational	Medium (5.1-20% of project value)	Low
Mitigation Measure(s)			
ADB and TPL/MEIDECC will engage experienced turnkey contractors who have proven track records. The project management consulting (PMC)firm who has extensive experience in assisting designing and procurement activities, especially for project located in small islands has already been recruited in meeting the requirements of TPL and operating in identical conditions. TPL to ensure proper operation and maintenance over the life of BESS shall reserve a certain amount of revenue for upcoming operation and maintenance costs.			
Other Potential Risks in the Horizon			

Please describe other potential issues which will be monitored as "emerging risks" during the life of the projects (i.e., issues that have not yet raised to the level of "risk factor" but which will need monitoring). This could include issues related to external stakeholders such as project beneficiaries or the pool of potential contractors.

None identified.

H.1. Logic Framework

Please specify the logic framework in accordance with the GCF's Performance Measurement Framework under the Results Management Framework.

H.1.1. Paradigm Shift Objectives and Impacts at the Fund level[29]

Paradigm shift objectives	
Shift to low-emission sustainable development pathways	TREP has been designed to help rapidly move Tonga from its current energy pathway that is almost entirely (about 90%) dependent on imported fossil fuels for power generation to a pathway using clean and renewable energy resources that is low-carbon and climate resilient. TREP will also provide enabling technical solutions (e.g. BESS, etc.) and capacity building for promoting more private sector investments on renewables, which will help Tonga meet its 50% renewable energy target by 2020 and build momentum to reach 70% by 2030. TREP will also increase a level of energy access to marginalized populations in the outer islands where this is currently low.
Increased climate-resilient sustainable development	As climate change occurs, there will be a need to go beyond basic climate proofing and develop new approaches and/or technologies that are climate resilient. To address this risk, the selection of equipment will be carefully analyzed based on best engineering practices. The design will incorporate adequate climate proofing and geohazard-preventive measures to lessen the potential negative impacts of extreme weather events throughout the project life cycle.

Expected Result	**Indicator**	**Means of Verification (MoV)**	**Baseline**	Target		Assumptions
				Mid-term (if applicable)	Final	
Fund-level impacts						
M1.0 Reduced emissions through increased low-emission energy access and power generation	M1.1 Tons of carbon dioxide equivalent (t CO2 eq) reduced or avoided from gender sensitive energy access and power generation	Project reports	0	Not applicable (N/A)	340,395 (for 25 years)	About 307,823 t CO_2 eq is expected to be reduced by IPPs, which will happen because of BESS to be funded by GCF. Increased diesel generation to meet demand growth will not exceed benefits of reduced emissions
	Cost per tCO_{2eq} decreased for all Fund-funded mitigation projects/ programmes	Project Completion Report	0	(N/A)	$156.2 / t CO_2 eq	
	Volume of finance leveraged by Fund funding	Project Completion Report	0	(N/A)	$38.2 million	It includes the anticipated private sector investment caused by TREP.
A3.0 Increased resilience of infrastructure and the built environment to climate change.	3.1 Number and value of physical assets made more resilient to climate variability and	Project Completion Report	0	(N/A)	$53.2 million	The full scope of the project is implemented as design

[29] Information on the Fund's expected results and indicators can be found in its Performance Measurement Frameworks available at the following link (Please note that some indicators are under refinement): http://www.gcfund.org/fileadmin/00_customer/documents/Operations/5.3_Initial_PMF.pdf

H.1.2. Outcomes, Outputs, Activities and Inputs at Project/Programme level

Expected Result	Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions
				Mid-term (Midterm targets are **not applicable** as the targets could be achieved only after the project completion)	Final	
Project/programme outcomes	**Outcomes that contribute to Fund-level impacts**					
M5.0 Strengthened institutional and regulatory systems	M5.1 Enhanced capacity assess renewable energy technologies and set off-take tariffs for power purchase Agreements (PPAs) for private sector funded investments	TPL's PPAs entered into IPPs	1 PPA	(N/A)	3 PPAs	PPAs shall be timely signed with renewable IPPs
	M5.2 Gender related training	Safeguard Monitoring Report	(N/A)	(N/A)	30% women participation	1. Require liaison with community chief/leaders and women's NGOs to source qualified women 2. This will be a mandated requirement by MEIDECC, TPL and contractor management
M6.0 Increased number of small, medium and large low-emission power suppliers	M6.1 Proportion of low emission power supply in a jurisdiction or market	TPL's Annual Report / Semi-Annual Progress Report	10%	(N/A)	< 50%	Both public and private investments shall be timely made.
	M6.2 Number of households, and individuals (males and females) with improved access to low emission energy sources	TPL's Annual Report / Semi-Annual Progress Report	No centralized electricity supply	(N/A)	15,000	
	M6.3 MWs of low emission energy and storage capacity	TPL's Annual Report / Semi-Annual	3.7 MW(RE) + negligibl	(N/A)	Additional 8.95 MW (RE), +	7.8 MW of RE is expected to be financed by IPPs

	installed, generated and/or rehabilitated	Progress Report	e (storage)		10.1 MW/22.2MWh of BESS	19.9MWh of BESS on Tongatapu and 2.3 MWh of BESS on outer-islands
Project/programme outputs	**Outputs that contribute to outcomes**					
1. Energy storage facilities installed	MWs of storage capacity installed	TPL's Annual Report / Semi-Annual Progress Report	negligible	(N/A)	10.1 MW/22.2 MWh	19.9MWh of BESS on Tongatapu and 2.3 MWh of BESS on outer-islands
2. Solar power generation installed	MWs of low emission energy capacity installed, generated and/or rehabilitated	TPL's Annual Report / Semi-Annual Progress Report	3.7 MW	(N/A)	Additional 1.15 MW	Additional 7.8 MW of RE is expected to be financed by IPPs Both public and private investments shall be timely made
3. Improved energy access	Number of households, and individuals (males and females) with improved access to low emission energy sources	TPL's Annual Report / Semi-Annual Progress Report	No centralized clean electricity supply	(N/A)	15,000	
4. Capacity building and project management program implemented	Number of staff of TPL and MEIDECC trained on renewable energy technologies and PPA	TPL's Annual Report / Semi-Annual Progress Report	Negligible	< 5	< 10	
	Number of staff in TPL and MEIDECC as well as technicians trained on outer-islands on O&M of renewable energy assets	TPL's Annual Report / Semi-Annual Progress Report	Negligible	< 7	< 15	
	Number of procurement contracts supported to be awarded	TPL's Annual Report / Semi-Annual Progress Report	0	5	< 5	
	Number of O&M manuals developed	TPL's Annual Report / Semi-Annual Progress Report	0	0	< 5	

Activities	Description	Inputs	Description
Output 1. Tongatapu- Installation of BESS			
Activity 1.1 Feasibility Study	Project Feasibility Assessments	(N/A)	
Activity 1.2 Procurement of the Turnkey Contract	Preparation of bidding documents and the bid evaluation report	PMU/TPL/Consultant	
Activity 1.3 Turnkey contract award	Contract signing	TPL and Contractor	
Activity 1.4 Design, Supply and Install	Designing, Supplying and Installation of the BESS system	Contractor	Installing multiple units of BESS to complement the renewable energy systems
Activity 1.5 Commissioning and Test-Run	Testing and commissioning certification issued by TPL	TPL/Consultant	
Activity 1.6 O&M training by Turn-Key contractor	O&M training workshops	Contractor	
Output 2. 'Eua and Vava'u: Istallation of grid-connected PV energy technologies			
Activity 2.1 Feasibility Study	Project Feasibility Assessments	(N/A)	
Activity 2.2 Procurement of the Turnkey Contract	Preparation of bidding documents and the bid evaluation report	PMU/TPL/Consultant	
Activity 2.3 Turnkey contract award	Contract signing	TPL and Contractor	
Activity 2.4 Design, Supply and Install	Designing, Supplying and Installation of the two Solar PV plants	Contractor	Installing the on-grid solar PV plants coupled with small BESS on 'Eua and Vava'u
Activity 2.5 Commissioning and Test-Run	Testing and commissioning certification issued by TPL	TPL/Consultant	
Activity 2.6 O&M training by Turn-Key contractor	O&M training workshops	Contractor	
Output 3. Outer-islands: Installation of five hybrid (Solar PV/Hybrid/Battery) systems and mini-grids			
Activity 3.1 Feasibility Study	Project Feasibility Assessments	(N/A)	
Activity 3.2 Procurement of the Turnkey Contract	Preparation of bidding documents and the bid evaluation report	PMU/MEIDECC/Consultant	
Activity 3.3 Turnkey contract award	Contract signing	MEIDECC and Contractors	
Activity 3.4 Design, Supply and Install	Designing, Supplying and Installation of the two Solar PV plants	Contractors and/or TPL	Installing mini-grid renewable-based hybrid systems coupled with small-scale BESS in five outer islands which includes installation of the mini-grid
Activity 3.5 Commissioning and Test-Run	Testing and commissioning certification issued by TPL	TPL/Consultant	
Activity 3.6 O&M training by Turn-Key contractor	O&M training workshops	Contractors	
Output 4. Capacity Building and Project Management			
Activity 4.1 Selection of Consultant and Contract Award	Recruitment of Consultant	TPL and MEIDECC	
Activity 4.2 Capacity Building and PPA Support	Providing expert's support	Consultant	- Improved capacity to assess renewable energy technologies and set off-take tariffs for power purchase agreements for private sector funded investments

			- Developed capacity of executing entities to manage assets and undertake operations and maintenance and improve community engagement
Activities 4.3 & 4.4. Project Management and Construction Supervision	Project Management and Construction Supervision Supports	Consultant	- Executing entities supported to provide project management in line with international standards and best-practices - Experts' support on both design and procurement activities, construction supervision, and development of operations and maintenance manuals

H.2. Arrangements for Monitoring, Reporting and Evaluation

Besides the arrangements (e.g. semi-annual performance reports) laid out in AMA, please provide project/programme specific institutional setting and implementation arrangements for monitoring and reporting and evaluation. Please indicate how the interim/mid-term and final evaluations will be organized, including the timing.

The PMU will be responsible for monitoring/reporting. The PMU will submit a quarterly progress report and a semi-annual report, including safeguards monitoring report, to facilitate the monitoring of the physical progress of TREP. Most monitoring activities take place at the subproject level, as follows:

- A detailed Project Administration Manual will be prepared setting out the reporting, monitoring and evaluation activities, responsibilities and budget.
- ADB (jointed by co-financiers like GCF and or the Government of Australia) will undertake 2 project reviews per year to assess progress of project implementation activities, compliance with covenants and project agreements, and to monitor progress to achieving project outputs and agree on any required modifications.
- ADB will undertake a mid-term review within 3 years of the Project being effective or at any time that ADB and the concerned Government consider it necessary. The midterm review mission will (i) review institutional, administrative, organizational, technical, environmental, social, economic, and financial aspects of the project based on the assumptions and risks included in the design and monitoring framework and updated PPR; (ii) review covenants to assess whether they are still relevant or need to be changed, or waived due to changing circumstances; (iii) assess the need to restructure or reformulate the project and the effects of this on the immediate objectives (purpose) and long-term goals of the project; and (iv) update the project's design and monitoring framework if restructuring or reformulation is necessary or its immediate objectives will change. The midterm review mission will be conducted in accordance with ADB's Project Administration Instructions (PAI).
- Within 6 months of physical completion of TREP, the national executing entities will submit a project completion report (PCR) to ADB. Then, ADB will prepare its own PCR[30] to evaluate the performance of the project to enhance transparency and accountability, and to learn from operation experience in the design and implementation of the project. These lessons are expected to be used to improve the design and performance of ongoing and future

[30] The PCR will be prepared within 24 months (the preparation will start after 12 months if the project needs to see a full year operation of the project to gauge the achievements of the outcomes) after project completion regardless of financial closure of the loan/grant account. A project is complete when all its outputs are completed (i.e. when the project's facilities are completed and ready to operate. If revenue streams are envisaged, then these should be occurring). The PCR can only be finalized and circulated to the Board after the financial closure of the loan/grant account, including all co-financed products administered by ADB.

ADB-financed and administered projects. The PCR is validated by the Independent Evaluation Department (IED). The PCR:

- provides a concise description of the project and its rationale;
- assesses the adequacy of preparation, design, implementation arrangements, and due diligence, including how problems were identified and handled, whether they were foreseen as potential risks at appraisal, and the adequacy of the solutions adopted during implementation;
- evaluates relevance of project design at appraisal and at completion, effectiveness in achieving outcomes and attribution to the project by assessing achievements of output targets including GHG emissions reductions, efficiency in delivering outputs, and sustainability of achieving output and outcome targets;
- evaluates the performance of the recipient, executing entities, co-financiers (as applicable) and ADB;
- identifies remaining issues and lessons learned from the project;
- suggests follow-up actions if required; and
- makes recommendations—based on the evaluation and lessons learned—for future project design and implementation as well as improvements in related ADB procedures.

- Within 2 years after the PCR is approved ADB's IED will evaluate and validate the PCR. Both PCR and IED's evaluation report are rated as highly successful, successful, less than successful, or unsuccessful. To align with other Multilateral Development Banks like the World Bank Group weighting systems for 'sovereign' project ratings, equal weights are applied to the four evaluation criteria (relevance, effectiveness, efficiency, sustainability) that determine the overall success rate. Both PCR and IED's evaluation report will be prepared in accordance with ADB's (i) Guidelines for the Evaluation of Public Sector Operations and (ii) PAI.[31]

- ADB will follow its project implementation processes and guidelines including reporting obligations under the AMA, and any additional terms that may be agreed in the FAA.

Adaptation/resilience monitoring

TREP does have the following adaptation aspects:

- Climate proofing infrastructure. TREP funds will be used to obtain equipment and technology to international standard and designed to resist climate change. This situation will be monitored, and PMU reports will report on this. Lessons will be learnt regarding climate change and resilience;

- Contribution of TREP to the nation's resilience. The provision of a modern, reliable, affordable, accessible energy supply by TREP is expected to make a strong contribution to the resilience of Tonga – its people and its economy. This will include increased economic and social and cultural activity, in particular on outer islands. PMU staff responsible for social affairs and participation will monitor this situation and report on it as appropriate.

[31] (i) https://www.adb.org/documents/guidelines-preparing-performance-evaluation-reports-public-sector-operations, and (ii) https://www.adb.org/sites/default/files/institutional-document/33431/pai-6-07a.pdf

I. Supporting Documents for Funding Proposal

☒ 1. NDA No-objection Letter

☒ 2. Feasibility Study

2A: Main Report (Technical, Financial and Economic Analysis)

2B: Poverty, Social and Gender Assessment

2C: Initial Environmental Examination (environmental assessment and management plan)

- 2Ca: Components on Tongatapu
- 2Cb: Components on Ha'apai, 'Eua, Vava'u and Ni'uafo'ou

2D: Financial Assessment (integrated Financial Model including sensitivity analysis and TPL's financial information following project implementation)

2E: Economic Assessment

2F: Gender Action Plan

2G: Resettlement Plan

☒ 3. Confirmation letters and letters of commitment for co-financing:

- Government of Tonga
- Tonga Power Limited
- Government of Australia
- Asian Development Bank

☒ 4. Project/Programme Confirmation/Term Sheet (including cost/budget breakdown, disbursement schedule, etc.) – *see the Accreditation Master Agreement, Annex I*

☐ 5. Maps and Photos illustrating the locations of the project (Please see Figure 3 and Feasibility Study Reports)

☒ 6. Timetable of project/programme implementation

☒ 7. Procurement Plan

☒ 8. Operation and Management Plan

☒ 9. 2017 Article IV Consultation—Press Release and the Staff Report for Tonga released by the International Monetary Fund

☒ 10. List of Sites Targeted for Acquisition by Tonga Power Limited

☒ 11. Letter of Intent on Operation Covenants from Tonga Power Limited

☒ 12. Methodology for the GHG Emission Reduction Calculation (including Excel Sheet)

☒ 13. Capacity Building Plan

** Please note that a funding proposal will be considered complete only upon receipt of all the applicable supporting documents.*