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The World Bank

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Report No: PAD2436

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED IDA CREDIT
IN THE AMOUNT OF SDR 3.9 MILLION
(US$5.55 MILLION EQUIVALENT)
AND A
PROPOSED IDA GRANT IN THE AMOUNT OF SDR 3.4 MILLION
(US$4.75 MILLION EQUIVALENT)

AND

ON A PROPOSED SCALING-UP RENEWABLE ENERGY IN LOW INCOME COUNTRIES PROGRAM GRANT
IN THE AMOUNT OF US$7.1 MILLION

AND

ON A PROPOSED GLOBAL ENVIRONMENT FACILITY GRANT
IN THE AMOUNT OF US$946,750

AND

ON A PROPOSED SMALL ISLAND DEVELOPING STATES INITIATIVE (SIDS DOCK) GRANT
IN THE AMOUNT OF US$1.6 MILLION

TO THE

SOLOMON ISLANDS

FOR AN
ELECTRICITY ACCESS AND RENEWABLE ENERGY EXPANSION PROJECT

June 11, 2018

Energy & Extractives Global Practice
East Asia And Pacific Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective April 30, 2018)

Currency Unit	Solomon Islands Dollar (SBD)
SBD 7.79 =	US$1
US$ 1.43806 =	SDR 1

FISCAL YEAR
January 1 – December 31

Regional Vice President:	Victoria Kwakwa
Country Director:	Michel Kerf
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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ADFD	Abu Dhabi Fund for Development
BP	Bank Procedure
CAGR	Compound Annual Growth Rate
CapEx	Capital Expenditures
CIF	Climate Investment Fund
CO_2	Carbon Dioxide
CPF	Country Partnership Framework
CPS	Country Partnership Strategy
DA	Designated Account
DV	Domestic Violence
EAEP	Electricity Access Expansion Project
EDCF	Economic Development Cooperation Fund of the Government of Korea
EPC	Engineering, Procurement and Construction
ERR	Economic Rate of Return
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
FHH	Female Headed Household
FIRR	Financial Internal Rate of Return
FM	Financial Management
FTE	Fixed Term Estate
GBV	Gender Based Violence
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GPOBA	Global Partnership on Output Based Aid
GRS	Grievance Redress Service
GW	Gigawatt
GWh	Gigawatt Hour
HES	Honiara Electricity System
HIES	Household Incomes and Expenditure Survey
IDA	International Development Association
IFC	International Finance Corporation
IFRs	Interim Financial Reports
INDC	Intended Nationally Determined Contributions
IPF	Investment Project Financing
IPP	Indigenous Peoples Plan
IRENA	International Renewable Energy Agency
IVA	Independent Verification Agent
kW	Kilowatt
kWh	Kilowatt hour
LCOE	Levelized Cost of Electricity

MHH	Male Headed Household
MMERE	Ministry of Mines, Energy and Rural Electrification
MoFT	Ministry of Finance and Treasury
MoLHS	Ministry of Lands and Housing Survey
MW	Megawatt
NPV	Net Present Value
OBA	Output Based Aid
O&M	Operations and Maintenance
OP	Operational Policy
OVR	Output Verification Report
PBA	Performance-Based Allocation
PDO	Project Development Objective
PIM	Project Implementation Manual
PPA	Pacific Power Association
PPSD	Procurement Strategy for Development
PV	Photovoltaic
RAMSI	Regional Assistance Mission to the Solomon Islands
RE	Renewable Energy
RPF	Resettlement Policy Framework
SBD	Solomon Islands Dollar
SCD	Systematic Country Diagnostic
SCF	Strategic Climate Fund
SIDS	Small Islands Development States
SIDS-DOCK	Small Islands Development States Initiative Multi-Donor Trust Fund
SIEA	Solomon Islands Electricity Authority
SIG	Solomon Islands Government
SISEP	Solomon Islands Sustainable Energy Project
SREP	Scaling-up Renewable Energy Program
tCO2eq	Tons of carbon dioxide equivalent
TOL	Temporary Occupation License
TRHDP	Tina River Hydropower Development Project
US$	United States Dollars
WACC	Weighted Average Cost of Capital
WBG	World Bank Group

BASIC INFORMATION

Country(ies)	Project Name	
Solomon Islands	Electricity Access and Renewable Energy Expansion Project	
Project ID	**Financing Instrument**	**Environmental Assessment Category**
P162902	Investment Project Financing	B - Partial Assessment

Financing & Implementation Modalities

[ ] Multiphase Programmatic Approach (MPA)	[ ] Contingent Emergency Response Component (CERC)
[ ] Series of Projects (SOP)	[ ] Fragile State(s)
[ ] Disbursement-linked Indicators (DLIs)	[ ] Small State(s)
[ ] Financial Intermediaries (FI)	[ ] Fragile within a non-fragile Country
[ ] Project-Based Guarantee	[ ] Conflict
[ ] Deferred Drawdown	[ ] Responding to Natural or Man-made Disaster
[ ] Alternate Procurement Arrangements (APA)	

Expected Approval Date	Expected Closing Date
2-Jul-2018	31-May-2023

Bank/IFC Collaboration

No

Proposed Development Objective(s)

The project development objective is to increase access to grid-supplied electricity and increase renewable energy generation in Solomon Islands.

Components

Component Name	Cost (US$, millions)
Renewable energy hybrid mini-grids	10.00
Electricity connections in low income areas	1.50
Grid-connected solar power	5.00
Enabling environment and project management	3.45

Organizations

Borrower:	Solomon Islands
Implementing Agency:	Solomon Islands Electricity Authority (Solomon Power)

PROJECT FINANCING DATA (US$, Millions)

SUMMARY

Total Project Cost	19.95
Total Financing	19.95
of which IBRD/IDA	10.30
Financing Gap	0.00

DETAILS

World Bank Group Financing

International Development Association (IDA)	10.30
IDA Credit	5.55
IDA Grant	4.75

Non-World Bank Group Financing

Trust Funds	9.65
Strategic Climate Fund Grant	7.10
Support for Small Island Developing States (SIDS) DOCK Suppo	1.60
Global Environment Facility (GEF)	0.95

IDA Resources (in US$, Millions)

	Credit Amount	Grant Amount	Total Amount
National PBA	5.55	4.75	10.30
Total	**5.55**	**4.75**	**10.30**

Expected Disbursements (in US$, Millions)*

WB Fiscal Year	2018	2019	2020	2021	2022	2023	2024
Annual	0.00	0.54	0.90	1.60	2.84	3.78	0.64
Cumulative	0.00	0.54	1.44	3.04	5.88	9.66	10.30

** Expected disbursements cover IDA financing only.*

INSTITUTIONAL DATA

Practice Area (Lead)

Energy & Extractives

Contributing Practice Areas

Climate Change and Disaster Screening

This operation has been screened for short and long-term climate change and disaster risks

Gender Tag

Does the project plan to undertake any of the following?	
a. Analysis to identify Project-relevant gaps between males and females, especially in light of country gaps identified through SCD and CPF	Yes
b. Specific action(s) to address the gender gaps identified in (a) and/or to improve women or men's empowerment	Yes
c. Include Indicators in results framework to monitor outcomes from actions identified in (b)	Yes

SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category	Rating
1. Political and Governance	Low
2. Macroeconomic	Low
3. Sector Strategies and Policies	Moderate
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	High
6. Fiduciary	Substantial
7. Environment and Social	Moderate
8. Stakeholders	Moderate
9. Other	
10. Overall	Substantial

COMPLIANCE

Policy

Does the project depart from the CPF in content or in other significant respects?

[ ] Yes [✓] No

Does the project require any waivers of Bank policies?

[ ] Yes [✓] No

Safeguard Policies Triggered by the Project	Yes	No
Environmental Assessment OP/BP 4.01	✓	
Performance Standards for Private Sector Activities OP/BP 4.03		✓
Natural Habitats OP/BP 4.04	✓	
Forests OP/BP 4.36		✓
Pest Management OP 4.09		✓
Physical Cultural Resources OP/BP 4.11	✓	

Indigenous Peoples OP/BP 4.10	✓	
Involuntary Resettlement OP/BP 4.12	✓	
Safety of Dams OP/BP 4.37		✓
Projects on International Waterways OP/BP 7.50		✓
Projects in Disputed Areas OP/BP 7.60		✓

Legal Covenants

Sections and Description

The Recipient shall cause the Project Implementing Entity to, and the Project Implementing Entity shall, maintain, throughout the Project implementation period, staff and personnel in adequate numbers for the implementation of Project activities. Without limitation to the generality of the foregoing, the Recipient shall cause the Project Implementing Entity to, and the Project Implementing Entity shall:
(a) maintain throughout the Project implementation period, a financial management specialist; and
(b) (i) by no later than three (3) months after the Effective Date, recruit or appoint the following staff and/or personnel: (A) a Project manager; and (B) a program manager; (C) a procurement specialist; (D) a safeguards specialist; and (E) a solar engineer; and (ii) thereafter maintain such positions throughout the Project implementation period.

(Section I.A of Schedule 2 to the Financing Agreement; Section I.A of Schedule 2 to the Grant Agreement; Section I.A of the Schedule to the Project Agreement; and Section I.A of the Schedule to the Trust Fund Project Agreement)

Sections and Description

By no later than three (3) months after the Effective Date, the Recipient shall cause the Project Implementing Entity to, and the Project implementing Entity shall, prepare and adopt a Project Implementation Manual.

(Section I.C of Schedule 2 to the Financing Agreement; Section I.A of Schedule 2 to the Grant Agreement; Section I.C of the Schedule to the Project Agreement; and Section I.A of Schedule to the Trust Fund Project Agreement)

Sections and Description

The Recipient shall not submit an application for withdrawal of Financing proceeds allocated from time to time to Category (2) unless and until the Association has received, from the Independent Verification Agent, an Output Verification Report in form and substance satisfactory to the Association, verifying that the eligibility and functionality of Electrical Connections claimed in the Subsidy Payment are in accordance with the Project Implementation Manual and this Agreement.

(Section I.D.2 of Schedule 2 to the Financing Agreement)

Conditions

Type	Description
Effectiveness	(i) the Financing Agreement has been executed and delivered and all conditions precedent to its effectiveness have been fulfilled; (ii) the Grant Agreement has been executed and delivered and all conditions precedent to its effectiveness have been fulfilled; (iii) the Project Agreement has been executed and delivered and is legally binding upon the Project Implementing Entity; (iv) the Trust Fund Project Agreement has been executed and delivered and is legally binding upon the Project Implementing Entity; (v) the Subsidiary Agreement has been executed and delivered and is legally binding upon the parties thereto; (vi) the Trust Fund Subsidiary Agreement has been executed and delivered and is legally binding upon the parties thereto; and (vii) if the World Bank so requests, the condition of the Project Implementing Entity, as represented or warranted to the World Bank at the date of the Trust Fund Project Agreement, has undergone no material adverse change after such date. (Section 4.01 of the Financing Agreement and Section 5.01 of the Grant Agreement)

Solomon Islands

Electricity Access and Renewable Energy Expansion Project

Table of Contents

I. STRATEGIC CONTEXT

A. Country Context

1. **An archipelago of 997 islands, Solomon Islands has a total land area of 29,900 km^2 spread over 1.34 million km^2 of ocean.** The population of approximately 616,000 is dispersed across 90 inhabited islands. The country has one of the lowest population densities (20 persons per km^2) and urbanization rates (17 percent) in the world.[1]

2. **Solomon Islands has one of the lowest levels of gross domestic product (GDP) per capita among the Pacific Island states, at US$2,013 per capita.** The country is still recovering from many years of intermittent political turmoil and civil strife. Locally referred to as the "tensions," the conflict during 1998-2003 disrupted the functioning of state and social institutions, which resulted in a 40 percent decline of GDP[2]. Ever since, peace has generally been maintained. Solomon Islands remains a fragile country.[3] To mitigate the impact of the high cost diesel fuel, the Solomon Islands Government (SIG) took the initiative in considering options for development of domestic sources of energy, particularly hydro and other renewables.

3. **The wide distribution of the population and the low densities make the capital costs of connecting consumers very high relative to the revenue generation.** As a result, there are few roads on most of the islands, limited commercial shipping between islands, and air transportation is unaffordable for most citizens. Access to essential services such as water, sanitation, or electricity is low: less than 20 percent of the population has access to any electrical power supply. When electricity is available, it is costlier than elsewhere in the world and is often less reliable. Rates of access to an improved water source (primarily piped water), improved sanitation, and grid electricity are significantly higher in urban areas, but the quality of services for those who have them is variable.

4. **Gender inequality is generally high in Solomon Islands, as illustrated in the country's ranking as 156 on the gender inequality index.[4]** Of the gender inequalities in the country, two are particularly relevant for this project. First, as addressed by the Systematic Country Diagnostic (SCD), paid employment is rising in importance, but opportunities for women are particularly scarce and there is a gender gap in access to paid work. Secondly, the rate of gender based violence (GBV) is high: 64 percent of women aged 15-49 who had ever been in a relationship reported having experienced some form of violence (emotional, physical and/or sexual).

B. Sectoral and Institutional Context

5. The Ministry of Mines, Energy and Rural Electrification (MMERE) is the supervising ministry, and its Energy Division bears responsibility for legal and regulatory development, institutional strengthening, and supervision of the vertically integrated, state-owned utility, the Solomon Islands Electricity Authority (SIEA),

[1] Population data based on Solomon Islands 2012/13 HIES – National Analytical Report [Volume 1], October 2015.
[2] To support the stabilization of Solomon Islands, neighboring countries led by Australia deployed the Regional Assistance Mission to the Solomon Islands (RAMSI) to restore law and order and other basic state functions
[3] Solomon Islands is on the Harmonized List of Fragile Situations FY18 with a harmonized Country Policy and Institutional Assessment average score of 3.1.
[4] United Nations Development Program Human Development Report 2016.

trading as Solomon Power (SP) since December 2015[5]. Operating under the Electricity Act, SP is the main supplier of electricity in the country, and responsible for electric power generation, transmission, and distribution to all urban and provincial centers, including Honiara, nine provincial centers (so-called "outstations"), and Noro Township in the Western Province.

6. **Solomon Islands is almost entirely dependent on imported, refined petroleum fuels for national energy needs for electricity generation, transport, and lighting.** SP supplies electricity to urban centers through diesel generators. SP's Honiara power system is almost entirely diesel-based. The total installed capacity of Honiara Electricity System (HES) is 33.6 MW, out of which 32.6 MW are diesel generators and one MW is a solar farm. Peak demand of the HES has increased from 9.3 MW in 2003 to 15.5 MW in 2016, representing a compound annual growth rate (CAGR) of four percent.

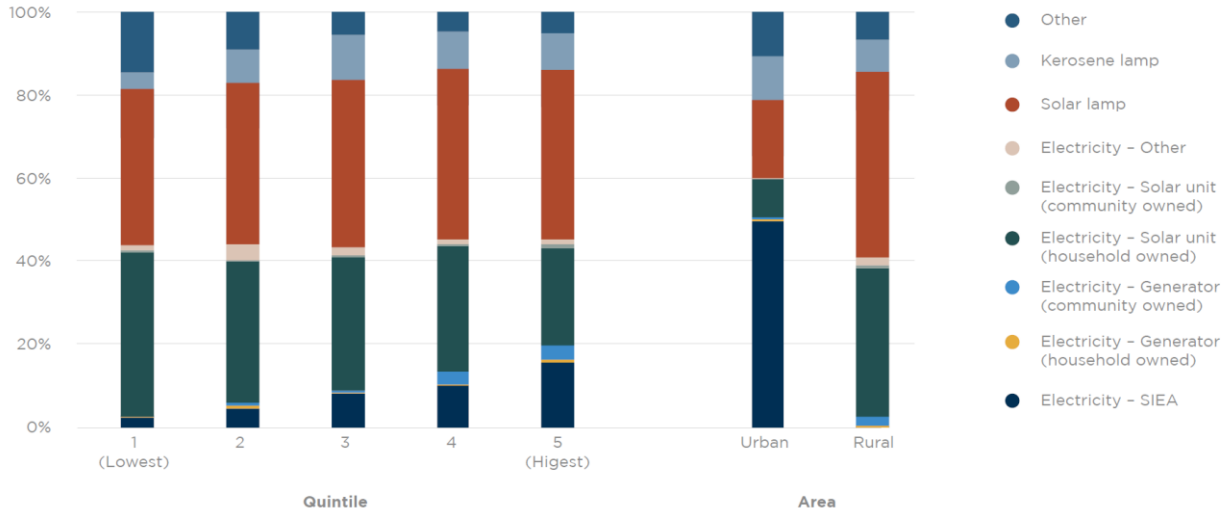
7. **To expand access and to improve reliability, affordability, and sustainability of electricity services, SP plans to implement a least-cost expansion plan and expand its network coverage.** The least-cost expansion plan requires installation of over 54 MW new capacity in a combination of hydropower, solar and storage, and diesel capacity to meet the demand growth at the least economic cost.[6] The proposed Electricity Access and Renewable Energy Expansion Project will contribute to affordability and sustainability of electricity services by increasing the annual electricity output from renewable energy, which will reduce reliance on diesel generation and lower the blended cost of generation.

8. **Solomon Islands has one of the lowest rates of electrification in the region.** Dispersed population across an island archipelago and the poor performance of SP in the past constrained its capacity to expand the grid even in the capital city (Honiara), but SP is currently planning a significant program of grid extensions and development of outstations. According to the 2012/13 Household Incomes and Expenditure Survey (HIES), while 45 percent of the households are said to have access to electricity, a majority of the households only have small solar panels, typically of 20 watts. While 64 percent of the population of Honiara is connected, only six percent of the remainder of the country is connected to grid electricity.

[5] SP has successfully rebounded from a financial crisis in 2001. The International Development Association (IDA)-funded Solomon Islands Sustainable Energy Project (SISEP), approved in June 2008 with additional financing to scale up the original project approved in November 2014, was instrumental in turning around management and the financial and operational performance of SP. This was accomplished through financing of an experienced and competent management team, together with technical assistance to support management decisions in financial and technical areas.

[6] This least-cost expansion plan analysis was prepared in the framework of the preparation for the Tina River Hydropower Project.

Figure 1 : Source of energy for lighting by quintile and by urban and rural areas



Source World Bank staff analysis of 2012/13 HIES.

9. **SP has a goal of doubling its existing customer base by 2021.** SP has recently started to invest in strengthening and expanding its electricity network to help it meet its ambitious goal to double the number of customers from 15,500 to 30,000 by 2021 – including connections in both Honiara and outstations – a goal that MMERE also supports. While solar home systems and solar lanterns will remain the most appropriate source of basic electricity services for part of the rural population, the focus of the proposed project is to support SP in reaching the next tier of customers through grid extension.

10. **The initial connection cost is high and support is being provided through the Electricity Access Expansion Project (EAEP), funded by the Global Partnership on Output Based Aid (GPOBA).** Both MMERE and SP recognize that the extremely high cost of connection is a serious impediment for new customers to connect to the grid, especially for low-income households. The Bank approved the US$2.5million EAEP, supported by GPOBA, in July 2016 to provide targeted subsidies[7] to low-income households for the initial connection fee and in-house wiring cost. Initial feedback from SIG and beneficiaries is very positive and there is interest in expanding the program to more beneficiaries.[8] The proposed project would continue to subsidize the connection cost in selected geographical areas.

11. **Renewable energy can play a key role in increasing access in a sustainable manner, contribute to lower the cost of supply and enable a reduction in the level of tariff.** A major obstacle in expanding the use

[7] This includes funds a client executed grant of US$2.23million along with Bank executed funds for supervision in the amount of US$0.27million. A subsidy of US$794 is paid under the program for connections in Honiara, and US$994 for connections in outstations.

[8] A willingness to pay analysis was also conducted during preparation of EAEP to determine household's willingness to pay once they received an electricity connection. The economic analysis considered only the consumers' surplus of switching from the supply provided by charging and using car batteries to grid electricity supply. The surplus is based on the cost savings from charging batteries and replacing them every two years, to using grid electricity (30 kWh per month in Honiara, charging batteries cost approximately SBD 45 per charge, and the battery can last around a week, for a limited use of two energy efficient lamps, and phone charging). Thus, it is assumed that the willingness to pay of consumers is at least the amount they currently pay of US$24 a month. Also, switching to grid electricity avoids the need of replacing the battery, usually after two years, with a cost of US$100 per battery. Using the revised electricity tariff for the lowest residential tier below 50 kWh a month of US$0.70/kWh, the monthly bill would be US$21, lower than the current cost of charging batteries, but providing much more electricity than before.

of electricity and promoting economic development is the high average retail electricity tariff of approximately US$65 cents/kWh, which is the highest in the Pacific and among the highest in the world. Renewable energy can play a key role in increasing electricity access in a sustainable manner. A number of initiatives are under way that will provide additional generation needed to supply new consumers. Support from development partners is further described below.

12. **Potential for solar photovoltaic (PV) generation is being explored in complement to the Tina River Hydropower Development Project (TRHDP) under development.**[9] Development of both hydropower, and other renewable energy such as solar PV could help reduce the cost of generation in Solomon Islands. The Bank and other partners are already supporting the development of hydropower through the TRHPD. It is estimated that irradiation is in the range of 5.5 to 6.5 kWh/m^2/day, and the daily load profile with maximum demand at mid-day makes PV a favorable option to serve the load. In addition, the cost of PV continues to reduce and has an extremely low operating cost, making it an increasingly attractive technology.

13. **Several development partners provide support to Solomon Islands in the energy sector.** The Energy Program of the Secretariat of the Pacific Community's Economic Development Division provides financing to MMERE for various activities, as does the Japan International Cooperation Agency, Governments of the United Arab Emirates and New Zealand, and the Asian Development Bank (ADB). The World Bank, the International Finance Corporation (IFC), ADB, Australia, Green Climate Fund (GCF), Economic Development Cooperation Fund (EDCF) of the Government of Korea and the International Renewable Energy Agency/Abu Dhabi Fund for Development (IRENA/ADFD) are supporting SIG to develop the 15 MW TRHDP. In addition, the Solomon Islands Sustainable Energy Project (SISEP) aims to improve the operational efficiency, system reliability, and financial sustainability of SP. Increases in transmission capacity, improvement of power supply efficiency, and tariff reforms (supported under SISEP) are expected to lay the groundwork for increasing access to grid-based electricity.

14. **In the energy sector, gender inequality is pronounced and this stems from women being primarily employed in traditional administrative or finance roles**. Most of positions within the energy sector are technical roles, and traditionally women have not considered these types of roles as viable career paths, nor have they been encouraged to pursue these roles by their employers. The Pacific Power Association (PPA) benchmarking 2017 (2015 data) reports that 21.3 percent of the total workforce employed in Pacific power utilities are women, with four percent of female representation at technical levels. SP has 21 percent female employee base and six percent female employees at technical level. This puts the organization at the top of Pacific regional statistics. However, the stark gender gap is recognized and SP is committed to improving gender equality within the power sector.

15. **As a result, the proposed project will support the transformation of women's employment in the energy sector's in three specific ways.** *First,* the project will design and implement a program employing rural women in maintaining solar panels and sites. *Second,* to increase the share of women employed, it will also assess the main barriers for women to take technical and managerial roles, and design measures to address these.[10] *Third,* findings from the private sector in Solomon Islands confirms that women are experiencing sexual harassment in work places and that absenteeism is linked to the experience of GBV. To enhance the working environment for women in the energy sector, the project will, in close collaboration with IFC, support SP in following up on the Waka Mere Commitment to Action it has signed with regard to implementing GBV

[9] Supported by several donors, including the World Bank (see Report No: PAD2258).

[10] Depending on the main barriers to women's employment within the sector, the program will involve targeted skills training to women within the sector or on the supply side (this could be in collaboration with the new skills program CAUSE supported by the Bank in the country); introduction of HR procedures to favoring female candidates (as in Australian Origin Energy) or; women's leadership training as the Bank is supporting in the Vietnam National Energy Company.

policies as well as to developing supportive and respectful workplaces. This will include setting up a framework at SP to build a productive and respectful workplace culture and implement a workplace response to domestic violence.

C. Higher Level Objectives to which the Project Contributes

16. **Solomon Islands' 2016-35 National Development Strategy places emphasis on increasing electricity access and the promotion of renewable energy.** It is widely acknowledged that access to electricity contributes to economic and social development, and has particular benefits for improved education and health for women and children. Increasing access through renewable energy will help reduce Greenhouse Gases (GHG) emissions and enhance system sustainability. This project is consistent with SIG's plans to increase electricity access and increase the percentage of renewable energy in the total energy mix.

17. **The project is aligned with the World Bank Group's Country Partnership Strategy (CPS) FY2013-2017 (Report #76349), the forthcoming Country Partnership Framework (CPF) FY2018-2023 under preparation, the Solomon Islands SCD (Report #115425), and the Bank's twin goals.** The World Bank Group's CPS (FY2013-2017) is structured around two engagement areas: underpinning improvements in public service provision and strengthening economic resilience. The project supports the Bank's engagement in both areas by extending access to electricity and improving economic resilience by easing constraints, and promoting climate friendly growth. In particular, the project will support CPS outcome # 5 of lower cost and reliable electricity from cleaner energy sources.[11] The SCD recognizes the need to significantly expand access, in particular grid level access (including to enable productive purposes) and also the dependence of access expansion on the price of electricity. The project addresses these issues by expanding (mini) grid services to several outstations and introducing additional solar generation, which will contribute to displace expensive diesel generation and reduce the electricity cost. The forthcoming CPF (FY2018-2023) under preparation is structured around three focus areas: (i) strengthening the foundations of well-being, (ii) promoting inclusive and sustainable growth, and (iii) managing uneven development. The project supports the Bank's engagement in the first area, with improving renewable power generation and access to electricity. The proposed project is consistent with the Small States Roadmap and Pacific Possible study and it supports the twin goals of reducing poverty and increasing shared prosperity for the poorest 40 percent of the population by extending and connecting additional people to electricity networks, while improving sustainability and affordability through the replacement of diesel generation with more affordable sources of power. Finally, the project is consistent with the objectives of clean renewable energy development of the World Bank's Energy Directions Paper.[12]

18. **The project will contribute to the reduction of GHG emissions and to the achievement of SIG's Intended Nationally Determined Contribution (INDC) commitment.** The project will contribute to global efforts to mitigate climate change by promoting the use of clean energy technologies, including the use of solar energy solutions in rural areas to displace kerosene for lighting and diesel for electricity generation. SIG's INDC is to reduce GHG by 18,800 tons of carbon dioxide equivalent (tCO2eq) per year by 2025 and by 31,125 tCO2eq per year by 2030. Based on the economic analysis, the project is cost effective in achieving GHG emission reductions, by 96,889 tCO2eq over the 25 years of the project life.

[11] The forthcoming Country Partnership Framework (CPF) FY2018-2023 is planned to be presented to the Board in August 2018.
[12] Report No. 79597.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

The project development objective is to increase access to grid-supplied electricity and increase renewable energy generation in Solomon Islands.

B. Project Beneficiaries

19. The primary beneficiaries of the project's Component 1 (Renewable Energy Hybrid Mini-grids) and Component 2 (Electricity Connections in Low-income Areas) are the households, micro-enterprises and users of community infrastructure in the planned outstation mini-grid areas as well as those in the peri-urban areas within existing grid coverage and the planned extension of the Honiara grid. A total of 1,500 connections, including 1,350 households (of which approximately 10 percent are female-headed), 150 businesses and community infrastructure (schools and health facilities) in low income areas, equating to approximately 9,345 people, will benefit directly from the project.[13]

20. The availability of reliable electricity supply will benefit all customers served by the project-supported mini-grids as there will be increased commercial activities, productivity, and savings on energy expenditures. By providing households with access to electricity, women can undertake more productive activities, such as handicrafts in the evening, children can complete school homework and studies after school, food can be kept in fridges or ice boxes, and the household can feel safe and secure in their residence at night. Public institutions, including health facilities and schools, may also be connected to electricity, enabling the provision of improved health and education services to the communities for extended hours, as required. Finally, small businesses benefit from affordable and reliable electricity and both men and women can take advantage of available electricity to open and run small businesses[14].

21. The primary beneficiaries of the project's Component 3 (Grid-connected Solar Power) are the electricity consumers of the Honiara grid as the project will contribute to stabilizing and reducing prices over the longer term; SP in terms of implementation of a medium-term renewable energy plan and reduction of generation cost through fuel diversification; and MMERE and SIG in terms of achieving longer-term sustainability for the sector.

22. More generally, the project will strengthen the capacity of SP, SIG, and MMERE to implement key energy sector projects and build technical and fiduciary skills to support rural electrification. The project will also contribute to building a sustainable private sector industry for the supply, operation, and maintenance of renewable energy systems in Solomon Islands, including in rural areas. As such, it will provide opportunities for employment and increase in female paid workers.

[13] The total number of people is derived from the number of new household connections and the average household size in Solomon Islands (5.7 people per household). Solomon Islands 2012/13 HIES.

[14] The gender assessment conducted through the project showed that in communities recently covered by the SIEAEP, several women immediately took advantage of getting connected to electricity by opening a small canteen. The assessment conducted interviews in these communities, all women interviewed had various ideas for small businesses, some of them requiring electricity (like running canteens, selling cold drinks and ice blocks, etc.). It is outside the scope of the project to influence the success of the business as factors other than electricity are involved. However, the project will gender disaggregate the share of male and female enterprises among the beneficiaries to identify constraints and opportunities.

C. PDO-Level Results Indicators

23. Progress will be measured against the following PDO level results indicators:

- People provided with new or improved electricity service (number); and
- Annual electricity output from renewable energy as a result of the renewable energy constructed under the project (GWh).

24. Section VII describes the additional intermediate indicators (including SREP-aligned indicators) to be used for this project.

III. PROJECT DESCRIPTION

A. Project Components

25. The proposed project is comprised of the four components summarized below. More details are provided in Annex 1.

26. **Component 1 — Renewable Energy Hybrid Mini-grids (US$10 million).** Component 1 would finance supply, installation, and initial maintenance of new hybrid mini-grids throughout Solomon Islands. SP has identified a long list of 35 potential locations suitable for such mini-grids, taking into account population density (number of households), public facilities such as hospitals and schools, 'anchor' loads such as tourism facilities, food processing or other commercial operations, and potential sources of renewable energy (mainly solar PV). These 'candidate' mini-grids are located in Central Province, Choiseul, Guadalcanal, Isabel, Makira, Rennel, Temotu, and Western Province. SP has established a process of prioritizing those mini-grids based mainly on the average cost per connection, ability to pay, accessibility, and safeguards considerations, namely land availability.[15] Preliminary pre-selected sites have been identified (Ulava, Santa Ana, Lambi, Visale and Tingoa), but need to be confirmed as land needs to be secured. The need for geographical diversity across provinces may also be considered, taking into account not only the mini-grids proposed to be financed under this project but also those to be financed through ADB and New Zealand financing.

27. **Component 2 — Electricity Connections in Low-income Areas (US$1.5 million).** Component 2 would finance electricity connections to households, micro enterprises (such as small canteens), and community infrastructure (e.g., schools and hospitals) in low-income areas, through an output based aid (OBA) mechanism, building on the EAEP. This component would provide one-off OBA subsidies to eligible beneficiaries to cover a portion of the upfront cost of electricity service connections in the Honiara grid (existing service area and planned expansion areas) and in the outstations, including those to be developed through Component 1, and possibly others. Eligibility criteria will be based on the geographic location, and then self-selection: interested consumers will apply for a service connection per existing processes.[16]

[15] At an initial stage information on estimated costs or ability to pay is limited. After detailed surveys have been conducted in priority sites, a business case the specific investment, including detailed design and comprehensive technical and economic analyses, will be prepared and submitted to SP board for approval.

[16] Under the current program, consumers will be qualified if: (i) beneficiaries fall under the prepaid residential category; (ii) beneficiaries do not have a previous connection under their name; (iii) service connection is capped to 10 Ampère for a period of 12 months; and (iv) service connections are individual, and cannot be shared with other households.

28. **Component 3: Grid-connected Solar Power (US$5 million).** Component 3 would finance the supply, installation, and initial maintenance for one or more grid-connected solar facilities in Solomon Islands. This facility(ies) would be developed on the basis of a design, supply, and installation contract, and with an option for maintenance for an initial period[17]. Ownership and future operation will remain with SP. The displacement of fossil fueled generation is expected to improve energy affordability, and contribute to further improvements in the financial performance of SP.

29. **Component 4 — Enabling Environment and Project Management (US$3.45 million).** Component 4 consists of two subcomponents. Subcomponent 4.1 would finance specific areas of project management and implementation, including gender related activities, as well as technical assistance and training activities for SP. Subcomponent 4.2 would finance equipment, technical assistance and training activities to be carried out by SP for the benefit of MMERE.

B. Project Cost and Financing

30. **Solomon Islands will benefit from the Scaling-Up Renewable Energy in Low-Income Countries Program (SREP).[18]** In June 2014, the SREP sub-committee endorsed an investment plan (SREP IP) submitted by MMERE, for the development of renewable energy totaling an estimated amount of US$40.3 million, including US$14 million of SREP funding and co-financing from the private sector, multilateral development banks (World Bank and Asian Development Bank). The proposed project contributes to the SREP IP's Renewable Energy Access Project. More details regarding the SREP IP and investment criteria are provided in Annex 5.

31. **Solomon Islands will also receive support from the Small Islands Development States Initiative (SIDS-DOCK) Multi-donor Trust Fund[19] and the Global Environment Facility (GEF).** SIDS-DOCK provides grants to recipients with focus on two outcomes: (a) creating an enabling regulatory and institutional environment to remove barriers on the implementation of renewable energy and energy efficiency policy reforms, based on international best practices; and (b) implementation of renewable and energy efficiency projects that demonstrate the potential for scale-up through climate finance and other sources of funding. GEF has funded 40 projects in Solomon Islands in the areas of biodiversity, land degradation, and climate change, valued at over US$260 million in grant funding and US$900 million in additional co-financing. Both sources of funds will be used to finance the proposed project.

32. The total proposed financing by component is summarized in Table 1.

[17] While for now SP intends to perform maintenance directly, there is an option of including maintenance in the design, supply and installation contracts.
[18] SREP is part of the Strategic Climate Fund, with the objective to pilot and demonstrate the economic, social, and environmental viability of low carbon development pathways in the energy sector by creating new economic opportunities and increasing energy access through the use of renewable energy
[19] SIDS-DOCK is a partnership of the Energy Sector Management Assistance Program, the United Nations Development Program, Alliance of Small Island States, the Government of Denmark, and the Government of Japan, established in 2011.

Table 1: Project Financing by Component and Source of Funding (US$ million equivalent/US$ million)

Project Components	Project cost	IDA Financing Credit*	IDA Financing Grant*	Trust Funds SREP	Trust Funds SIDS-DOCK	Trust Funds GEF
Component 1. Renewable Energy Hybrid Mini-grids**	10.00	2.05	0.35	6.00	1.60	-
Component 2. Electricity Connections in Low-income Areas ***	1.50	-	1.50	-	-	-
Component 3. Grid-connected Solar Power	5.00	3.50	0.55	-	-	0.95
Component 4. Enabling Environment and Project Management	3.45	-	2.35	1.10	-	-
Subcomponent 4.1 - Project management costs and technical assistance to SP	*2.95*	-	*2.35*	*0.60*	-	-
Subcomponent 4.2 - Technical assistance for the benefit of MMERE	*0.50*	-	-	*0.50*	-	-
Total Costs/Financing required	**19.95**	**5.55**	**4.75**	**7.10**	**1.60**	**0.95**

Notes:
* IDA financing for Component 2 and 4 is provided by the IDA Grant only. The split between IDA Credit and IDA Grant for Components 1 and 3 shown in the table is only indicative. The use of IDA credit and IDA grant will be fungible. There is a single disbursement category covering expenses in the Components 1, 3 and 4.1 to mitigate the complexity associated with having 5 different types of financing.
** The diesel generators under component 1 will be financed out of IDA funds.
*** While not included in the Table, customer contributions for connections are estimated at US$0.1 million, and SP contribution at US$0.3 million.

33. **GEF and SREP additionality.** The project supports the most important priorities of the SIG in the energy sector: increased access, greater affordability of electricity services, and enhanced energy security. Both the GEF and SREP funds are critical to demonstrate the viability of grid-connected solar and hybrid solar-diesel mini-grids systems (respectively) and enhance the capacity of the SIG to deliver on the renewable energy agenda and to strengthen the institutional framework for greater involvement of the private sector (more on maximizing finance for development below). Given the nascent stage of renewable energy development in Solomon Islands, GEF and SREP financing are key to demonstrate viable approaches, and reduce regulatory, financial, and capacity barriers while creating the conditions for future replication and scale up. Access to grid electricity is Solomon Islands is low (12 percent). The remoteness, lack of economies of scale, and poor infrastructure mean that the cost of providing electricity, including through conventional fuels, is high. Solomon Islands has an untapped potential for renewable energy, especially solar. The project would help demonstrate the viability of renewable energy based mini-grids as the best alternative for electrification. This project therefore contributes to global environmental benefits through GHG emissions reduction and the achievement of the INDC target, and potentially enables more investment in solar PV and further GHG reduction beyond the project target. The proposed project is also highly complementary to other current and pipeline projects in the country, such as the TRHDP (financed by the Bank and other partners) and the ADB-supported project to hybridize existing diesel mini-grids, or plans by New Zealand to finance complementary mini-grid investments.

34. **Use of grant funding.** The use of the GEF, SREP, and IDA grant funding is critical to lower the high upfront costs of solar-based renewable energy generation in a dispersed, island nation, thereby making end-use customer tariffs more affordable. The current end user tariff is US$0.65 per kWh, which was reduced from US$0.93 per kWh in 2014. Although lower, this tariff is still among the highest in the Pacific and around the world. Using grant financing would allow for a faster, more dramatic reduction in end-user tariffs, making

electricity more affordable to the general population, thereby further driving the increase in electricity penetration across the country. SREP support for Component 4 would allow for upstream work to be developed to attract additional private sector investment going forward.

C. Lessons Learned and Reflected in the Project Design

35. The project has been designed based on lessons and experiences learned from similar projects of the World Bank and other development partners, including the Solomon Islands EAEP, the first and second phases of the Vanuatu Rural Electrification Project, and the Kiribati Grid Connected Solar PV Project. It also builds on lessons learned from hybrid mini-grids for rural electrification around the world. Key lessons reflected in the design are:

a. **Technical assistance is needed to support implementation of project activities.** The project design reflects the thin implementation capacity at SP and the need to strengthen project management and procurement arrangements. The project also provides financing for extensive technical assistance to allow for additional support to design and supervision of the project components as needed, as well as for an appropriately staffed project management and implementation team.

b. **There is lack of maintenance resources and capacity in Solomon Islands.** As a result, many of the systems installed under other projects in the Pacific fail to be maintained. Building on SP's recent experience of establishing and running a number of mini-grids in outer islands, SP will retain the responsibility to operate and maintain the mini-grids and grid-connected solar facilities to be financed through the project, with an option of being assisted by the private sector during an initial period of three to five years. The project will also seek to involve the local community, in particular women, in basic maintenance and upkeep of the facilities. Mini-grids will be procured through competitive tenders and vendors will also be required to provide acceptable guarantee and defects liability period (in the order of five years), and possibly also maintenance.

c. **Where possible, leveraging private sector investment and expertise is the most sustainable delivery model from a financial and operational point of view** (especially when the private sector is selected on a competitive basis). The project will support MMERE to build an enabling environment conducive to future private sector investments. Currently, since the mini-grids and grid-connected solar facilities under the proposed project may not have sufficient scale to attract direct private sector investment SP will make the investments as needed. Nevertheless, the project will explore the opportunities for private sector involvement, for example, in maintenance of these facilities. Bundling several activities into a single procurement has the potential to further attract private sector for supply and installation and achieve lower prices through economies of scale. Component 4 will provide technical assistance to adapt the regulatory framework and enable additional private sector investment in the future.

d. **Land titling for electrification projects is complex in Solomon Islands.** Land is generally communally owned by clans or tribes. About 88 percent of land is customary and 12 percent registered.[20] Up to now, people who want to apply for an electricity connection have needed to present a valid land title. The title is difficult to obtain, as a large proportion of the population is living in areas for which there are no titles, or only temporary titles. As a solution to this issue under the EAEP, recently the Land Boards, through the Commissioner of Lands, issued a blanket

[20] Solomon Islands SREP IP.

authorization allowing all people living on government land to be connected even in the absence of a valid land title. Other solutions being developed under the EAEP will be applied to this project.

e. **Verification of low-income household connections will be done on a random sample basis.** Inspections will be performed to verify that the installations are done in eligible households, technical requirements have been met, and systems are fully operational. Verification will be undertaken by a Bank-financed verification agent, similarly to what happens under the EAEP.

f. **Electrification can have a positive impact on women and children.** Evidence from the 2009 Population and Housing Census Report on Economic Activity and Labor Force shows that 75% of employed women are mostly involved in unpaid activities related to family work, such as producing goods for family consumption (subsistence), and time-consuming activities, such as cooking, washing and gathering wood. Connecting power to time saving appliances can help alleviate the physical and time use burden of these activities, particularly for women. The combination of savings and reliable power presents further opportunities for entrepreneurship, for instance, phone charging or refrigerated drinks sales. Lighting also helps extend business hours and/or perform family work such as washing or cooking after dark. Also in Vanuatu access to lighting in other projects (e.g., in rural Vanuatu under Lighting Vanuatu) has contributed to energy autonomy for women, the elderly, and children. Women are now playing a greater role in the management of a household's energy and lighting than they generally have in the past. During the review of Lighting Vanuatu, most women talked about the additional work they now undertake in a positive, social sense – small groups of relatives or friends coming together to work on weaving, sewing, or handicrafts in the evenings; more generally, most villagers found that there was now more opportunity to socialize.

g. **Finally, the project design takes into account lessons learned on the sustainability of rural electrification projects**.[21] Rural electrification projects must be consistent with the overall national electrification plan. Projects must also utilize least cost design and not be technology driven. Early efforts must be made to maximize community awareness, involvement, and support. Importantly, the design must reflect the capabilities of the retailers/vendors and service providers and ensure adequate financing. In addition, training should be provided to participating government staff, retailers/vendors, service providers, and consumers. Finally, customers must have access to quality products and qualified maintenance and repair services, as well as spare parts over the long term.

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

36. The Ministry of Finance and Treasury (MoFT) will be the recipient for the various financing, and will enter into an IDA Financing Agreement and a Grant Agreement, covering grants from SREP, SIDS-DOCK and GEF, with the World Bank. Overall responsibility for oversight and implementation of the project will be with SP. SP will be the implementing agency for the project, and will sign Project Agreements with the World Bank, as well as Subsidiary Agreements with the MoFT, passing on the financing. SP has been implementing Bank-financed projects for several years, including the on-going SISEP and EAEP.

[21] Operational Guidance for World Bank Group Staff: Designing Sustainable Off-Grid Rural Electrification Projects: Principles and Practices, 2008.

37. SP will recruit or appoint a team of people to strengthen SP's capacity to implement the project. These consultants or SP staff will be integrated in SP's own structure and will, together with SP's other units, implement and deliver the project. The core team will be constituted by a project manager, an OBA program manager, a procurement specialist, a solar engineer, an environment and social safeguards specialist, and a financial management specialist, all with experience and qualifications acceptable to the Bank. The project manager is also expected to manage other projects of SP. This team will be further complemented by a manager for contracts, a manager for construction, as needed. Part of this team already exists within SP's own staff[22], part is expected to be recruited under SISEP or SIEAEP, and be transferred to this project, and part will be recruited during project implementation. Except for the financial management specialist who is already in place, the rest of the core team will be appointed or recruited by SP within three months of effectiveness. The project manager will be responsible for the coordination and day to day implementation of all project activities, along with other involved SP staff. The procurement specialist will work with the project manager and the manager for contracts to support all procurement activities for the project and ensure adherence to appropriate procurement procedures. Depending on the workload of current SP staff, SP may also need to hire a project accountant. These experts will also be responsible for training SP's staff as necessary.

38. Implementation of Component 2 will follow the implementation arrangements defined under the EAEP. The OBA program manager will coordinate implementation of this component with the project manager. If needed, the OBA program manager could also be financed by the project[23]. The OBA Independent Verification Agent, to be hired by the Bank, will work with the OBA program manager to verify connections under Component 2.

39. SP's finance department will be responsible for financial management of the project, in coordination with the project manager. The project manager will liaise and coordinate with the MMERE and other agencies as the case may be for coordination regarding the sector studies requiring their involvement (notably the sector studies planned under Component 4.2).

40. Adequate technical assistance for project implementation will be critical. Based on experience with other projects implemented by SP, the team proposed in this section should be adequate to design and supervise project activities. The project will also provide support for the recruitment of consultants and/or an owner's engineer to assist with review of project design, and preparation of bidding documents as well as supervision of the contractors, as needed.

41. A Project Implementation Manual (PIM) will be adopted within three months of project effectiveness. Project implementation arrangements are described in more detail in Annex 2.

[23] Recruitment for this position will be done under the SISEP and SIEAEP projects, but if needed the position could be transferred for financing under the proposed project.
[23] Recruitment for this position will be done under the SISEP and SIEAEP projects, but if needed the position could be transferred for financing under the proposed project.

B. Results Monitoring and Evaluation

42. The results framework, described in Section VII, identifies results indicators for the project as a whole, as well as for each of its components. In addition to keeping track of the progress towards the outcomes and outputs of the PDO and project components, respectively, the results framework includes indicators to track progress on citizen engagement, gender, and GHG emissions reduction, among others.

43. SP, will be responsible for collecting and verifying data and for submitting progress reports to the SIG and the Bank on a semi-annual basis for both the PDO indicators and the intermediate indicators. Not later than four months after the closing date, SP will prepare a completion report to be shared with SIG so that SIG can incorporate it into the completion report for submission to the Bank.

C. Sustainability

44. SIG and SP have demonstrated strong commitment and ownership of the project. The project concept was developed by SIG through a participatory process as part of the SREP IP preparation in 2014. SIG further requested IDA financing for the project in mid-2017, reaffirming its commitment to the project activities.

45. **Technical sustainability.** The project has been prepared based on underlying analyses, including the SREP IP and the least cost system planning studies, to ensure the design is sound and provides the least cost solution to provide access to electricity and expand renewable sources of energy into the energy mix. The project components have been tested in Solomon Islands and/or other countries with similar characteristics. SP has experience with the proposed technology and arrangements, in particular:

- Component 1: SP recently commissioned two mini-grids in Seghe and Taro, and plans to extend the same model to other locations.
- Component 2: This component is designed following the same design as the EAEP, to provide additional electricity connections to households, micro-enterprises, and community infrastructure in low-income areas.
- Component 3: SP is already managing grid-connected solar facilities financed by the United Arab Emirates, New Zealand, and its own funds.

46. **Financial sustainability.** The financial performance of the project is critical to ensure long-term sustainability of the project. The tariffs for the systems provided, even if developed under grant or concessional finance, need to cover operation and maintenance expenditures and the depreciation of the assets for long-term sustainability.

D. Role of Partners

47. **Support from development partners.** Both the World Bank and a number of other development partners are active in the sector. The World Bank is supporting the sector through: (a) the previously mentioned SISEP, working on improving operational efficiency, system reliability, and financial sustainability of SP; (b) the EAEP, which aims to increase access to electricity by providing targeted subsidies for additional electricity connections in low income areas; and (c) support for the 15 MW TRHDP, in association with the IFC, ADB, Australia, and GCF, EDCF and IRENA/ADFD. With the assistance of the ADB, SP will also hybridize some of the existing diesel-based outstations with SREP funding. In addition, SP is also preparing to develop the 500 kW Fiu River Hydropower Project to connect to the Auki grid on the island of Malaita with financing

from ADB. The Energy Programme of the Secretariat of the Pacific Community's Economic Development Division provides technical assistance to MMERE, including on development of the Solomon Islands National Energy Policy in 2014. The Japan International Cooperation Agency grant-funded a 50 kW parking lot rooftop solar facility for SIEA, and the Governments of New Zealand and United Arab Emirates co-financed the one MW solar farm mentioned earlier. The Government of New Zealand is also preparing a project covering expansion of mini-grids to outstations and connections to low-income households.

48. **Considerations regarding World Bank Group's maximizing finance for development approach.** Given the weak financial viability of the proposed mini-grids and the relatively small size of both the mini-grids and the grid-connected solar facilities, there would be limited investment interest from the private sector at this stage. In addition, there is little capacity at the Ministry to manage private investments in the energy sector. Component 4 will provide technical assistance to the Ministry and sector stakeholders to review the need for any revisions to the licensing and regulatory framework to lay the foundation for possible private sector investments in the energy sector. To build up capacity of local contractors, the project will facilitate local contractors' participation in household connections, and the contracts for the design, supply, and installation of the mini-grids and grid-connected solar facilities will have an option for operations and maintenance by the private sector.

V. KEY RISKS

A. Overall Risk Rating and Explanation of Key Risks

49. The overall risk rating is Substantial. The key risks to the PDO are related to institutional capacity for implementation at SP, including sustainability and fiduciary risks. In addition, while safeguards risks are considered moderate, the availability of land is considered to be a risk.

50. **Institutional capacity for implementation, including sustainability and fiduciary risk.** While technical capacity at SP is good and SP has experience in implementing Bank-funded projects, capacity is overstretched given the many projects currently being implemented by SP. Consultants will be recruited under the project to support SP in project implementation, and technical assistance to safeguard management will be made available as needed. An option for contracting the maintenance support during an initial period is provided under the project to mitigate weak capacity of SP and engage local participation in the project.

51. **Safeguards aspects and land availability.** While safeguard risks are considered moderate, community ownership of land in Solomon Islands can be problematic because at times it is not clear who owns the land. Disputes amongst families are common, especially if there is compensation associated with any development, which causes delays in achieving community agreement for the construction of infrastructure. The risk in securing suitable land to develop the project is mitigated through site selection and consideration of land owned by SP. For Component 1, SP will first identify their initial shortlisting of sites, clarify its current ownership, and then seek to lease the land on a long term 'willing buyer-willing seller' basis, through consultations and negotiations. The Environmental and Social Management Framework (ESMF) describes the process in detail and includes SP having either internal staff or external consultants for safeguards. Alternative locations can be pursued if the process to secure land is significantly impeding a subproject. SP has experience building mini-grids across the country and both the task team and SP are well aware of the difficulties when land is acquired by other means (e.g., eminent domain). For Component 3, the potential sites are currently owned by SP, except for one site which is privately held and which SP would seek to acquire

if that site is selected for the development of the grid connected solar plant. The ESMF details land ownership, as well as due diligence being undertaken and to be undertaken during the process of securing land.

52. **Climate and Disaster Risks.** A climate and disaster risk screening was conducted for this project given the country and project context and concluded that the overall climate and disaster risk is moderate[24]. Overall, the following climate change and natural risks were identified as hazards: extreme temperature, extreme precipitation and flooding, droughts, sea level rise, storm surge, strong winds, earthquakes, volcanic eruption, and landslide. Historic trends and future projections of average annual temperatures and average annual rainfall indicate that the country is exposed to moderate hazard of extreme heat and moderate exposure to extreme rainfall days caused respectively by an increase in average annual temperatures over the next 50 years and annual precipitations over the next 10 years. Water scarcity is considered very low or non-existent in the Solomon Islands and is expected to occur less than once every 1,000 years, entailing a low risk of droughts in the country. Conversely, the hazards of sea level rise and strong winds are considered to pose a high risk in the Solomon Islands. Future projections indicate a sea level rise could reach almost half a meter in the next 80 years and average tropical cyclone wind speed will increase in the next 10 years. Regardless of the expected increase in strong winds and sea rise level, forecast of storm surges are highly uncertain. In addition to the climate change risks, the Solomon Islands is in a high seismic and volcanic hazard area, which entails a high exposure to earthquakes, volcanic eruptions and landslides. Impacts are expected to be as follows: (i) the impact of higher temperatures, increased precipitation or storm surges, stronger winds, longer dry periods, and sea level rise is considered to be medium in the solar PV and storage capacity installed and low on the diesel generators implemented as back-up; (ii) the impact of earthquakes, volcanic eruption, and landslide may be high for the renewable energy technology installed, as these hazards may result in potential damage to solar panels, structures and overall plants' layout, but moderate for the diesel generators due to their robustness. In order to mitigate the above risks, these will be taken into account for the technical design of the project and the selection of the technology. Appropriate capacity building and technical assistance will also be provided to the electrical utility and through design studies that could reduce the risks and the impact of climate change and other natural hazards by contributing to increase the institutional knowledge and know-how of renewable energy technology. Finally, the broader development context of the project could significantly reduce the impact pollution in the Solomon Islands as the solar PV technology installed is expected to reduce fossil fuel consumption of end-users.

VI. APPRAISAL SUMMARY

A. Economic and Financial Analysis

53. The economic and financial analysis was conducted for Components 1 and 3, in line with the World Bank Guidelines for Economic Analysis of Power Sector Investment Projects 2017 and Social Value of Carbon in Project Appraisal 2014[25]. Further information and details are available in Annex 4.

54. **Component 1 - Renewable Energy Hybrid Mini-Grids.** The baseline economic rate of return (ERR) of the proposed hybrid solar/diesel mini-grids is 6.7 percent (NPV US$ 3.43 million), which is above the three percent hurdle rate for Solomon Islands. These returns are inclusive of local and global environmental

[24] The World Bank Group's Climate and Disaster Risk Screening Tool was used (Global website: climatescreeningtools.worldbank.org; World Bank users: wbclimatescreeningtools.worldbank.org).

[25] Component 1 and 3 are the main components supporting infrastructure investments, and where costs and benefits can be better quantified.

benefits, which add 1.5 percentage points (NPV US$1.50 million) to the ERR. This economic analysis uses fully diesel-powered mini-grids as the counter factual to the solar-diesel hybrid mini-grids, which are designed to supply 24/7. Since the specific locations of the hybrid mini-grids have not yet been identified, the analysis uses estimated cost and demand data. The expenditures incurred on the capital infrastructure are the largest cost of the project, i.e., over 57 percent of the overall cost. The analysis estimates that 89 percent of the economic benefits come from avoiding diesel fuel expenditures. A sensitivity analysis was conducted on this component at a discount rate of six percent, which leads to an almost breakeven project, with NPV of US$0.27 million including local and global environmental benefits. By valuing the additional electricity delivered by the project in financial terms, the financial analysis concluded a financial internal rate of return (FIRR) of47.2 percent, reflecting US$7.95 million financing as grant for this component.

55. **Component 3 – Grid-connected Solar Power.** The baseline ERR of the proposed grid-connected solar power plants against the counterfactual scenario is 13.1 percent (NPV US$7.75 million), which is above the three percent hurdle rate for Solomon Islands. These returns are inclusive of local and global environmental benefits, which add 2.2 percentage points (NPV US$1.77 million) to the ERR. Two solar plants with total installed capacity of 1.9 MW were planned. This economic analysis uses the existing diesel powered thermal plants in Guadalcanal province as the counter factual to the grid-connected solar power farms. The expenditures incurred on the capital infrastructure are the largest cost of the project, i.e., over 78 percent of the overall cost. The analysis estimates that almost 89 percent of the economic benefits come from avoiding diesel fuel expenditures. A sensitivity analysis was conducted on this component at a discount rate of six percent, which leads to an NPV of US$3.98 million including local and global environmental benefits. By valuing the additional electricity delivered by project in financial terms, the financial analysis derived a FIRR of 34.1 percent, reflecting US$1.5 million financing as grant.

56. **Reduction in GHG emissions.** The project helps reduce GHG emissions by 96,889 tCO2eq over the project life. For Component 1 it is estimated that the benefits from avoided global environmental damage cost are US$ 1.49 million and the hybrid mini-grids can avoid over 44,548 tons GHG emissions (undiscounted). The abatement cost is -43.39 US$/ton. For Component 3 it is estimated that the benefits from avoided global environmental damage cost are US$ 1.80 million and the solar farms can avoid over 52,341 tons of GHG emissions (undiscounted). The abatement cost is -114.58US$/ton[26].

B. Technical

57. The equipment and technologies for implementation and operation of mini-grids and grid-connected solar generation are commercially available and have been widely deployed in developed and developing countries., These activities together and the connection of additional customers will be implemented according to internationally accepted technical standards and practices. These activities are an extension of those that SP is already carrying out. While various modalities will be considered to determine the most appropriate implementation arrangements, SP will mostly be following the existing models for implementation of these activities.

58. Component 1 (Renewable Energy Hybrid Mini-grids). For the mini-grids SP has recently successfully commissioned two mini-grids in Seghe and Taro, and plans to extend the same model to other locations from a list of 35 locations through the proposed project). Construction of the mini-grids would be carried out through design, supply and installation contracts, and SP may further decide how to handle operations and

[26] While the contribution to reduction of GHG emissions under Component 2 has not been quantified, it is expected that this component will also have climate co-benefits, since connecting more people to the grid will likely displace dirtier fuel sources (kerosene, wood burning etc.) currently in use by the targeted population.

maintenance during an initial period through the private sector. The specific locations will be decided during project implementation based on several factors, such assize, viability, and availability of land.

59. Component 2 (Electricity Connections in Low-income Areas). SP will be using the same mechanism already developed under the EAEP. A recent review of the project has found that the current level of subsidy under the EAEP is still adequate, but this will be reviewed from time to time to ascertain whether this is still the case, in particular as there are indications that the program will be achieving some economies of scale/cost reductions.

60. Component 3 (Grid-connected Solar Power). SP has recently commissioned a grid-connected solar project (1 MW) co-funded by the United Arab Emirates and the Government of New Zealand at Fighter 1, Henderson. The grid-connected solar plant(s) to be developed through the project would follow a similar model and specifications. SP would develop the solar plant(s) based on a supply and installation contract with an option for maintenance for an initial period, but the facilities would be owned and operated by SP. SP has already started to review the existing specifications to adapt them as needed.

C. Financial Management

61. The financial management assessment was carried out in accordance with the "Principles Based Financial Management Practice Manual" issued by the Board on March 1 2010, which states that with respect to projects financed by the Bank, the grantee is required to maintain appropriate implementation arrangements, including accounting, financial reporting, and auditing systems adequate to ensure that they can provide the Bank with accurate and timely information regarding the project resources and expenditures. Overall, the existing financial management arrangements of SP satisfy the financial management requirements of the Investment Project Financing Bank Policy. The assessed financial management risk of the project is considered moderate provided a project accountant can be financed through this project, if required by SP.

D. Procurement

62. The procurement under this project will follow procurement procedures specified in the World Bank Procurement Regulations for IPF Borrowers (July 2016, revised November 2017) and the provisions stipulated in the Financing/Grant Agreements and Project Agreements to be entered into by the Bank and SIG and SP, respectively. The project implementation agency is SP, which will procure all the contracts under the project. A Project Procurement Strategy for Development (PPSD) was prepared as the basis for procurement arrangements and planning. A Procurement Plan covering the whole project implementation period is available and was finalized on April 5, 2018. Key procurement risks are: (a) lack of procurement and contract management capacity, which may result in delay of procurement and inadequate management of signed contracts; (b) insufficient capacity in preparing technical sections of procurement documents in line with international good practice which may result in difficulties in contract management; and (c) limited number of local suppliers/contractors, etc. Risk mitigation measures will be implemented as follows: (a) recruitment and/or appointment of a project manager, a manager for contracts, and a procurement specialist; (b) adoption of the Systematic Tracking of Exchanges in Procurement to closely monitor progress and identify delays in procurement; and (3) approaching international market for majority of procurement. Further details are provided in Annex 2.

E. Social (including Safeguards)

63. The project is expected to have positive social outcomes, while potential impacts relate to land acquisition and impact on physical assets. The provision of electricity supply through new connections (Components 1 and 2) and more reliable supply (Components 1 and 3) will strengthen socio-economic integration in subproject locations through access to education, improved health outcomes, and income generating opportunities. The majority of land required by the project is for solar PV arrays under Components 1 and 3, the latter of which will use one or more sites owned by SP. For Component 1, where acquisition of customary land may be required, SP will use a "willing buyer-willing seller," negotiated lease/license or other agreed and documented arrangement and avoid any economic or physical displacement. Customary land may also be used where power poles under Components 1 and 2 are required and cannot be located in the road corridor. However, the footprint is minimal (<1m2) and consultation and consent of the landowner will be gained prior to construction, via the same methods as Component 1 for solar sites. Land related issues are expected to be minimal as subproject identification has included ensuring a high level of community demand and ownership of the project. Clear documentation by SP of any land acquisition will further avoid land-related issues. Environmental and Social Management Plans (ESMPs) prepared for subprojects under Components 1 and 3 will include due diligence reports on the land ownership and any recent acquisitions. Other social issues include minor construction impacts (dust, noise, and vibration), health and safety, and use of local water supplies.

64. OP 4.10, Indigenous Peoples, and OP 4.12, Involuntary Resettlement, are triggered. An ESMF, which includes a Resettlement Policy Framework (RPF), has been prepared to describe the potential social impacts, required assessments for subprojects, consultation and grievance redress procedures, and roles and responsibilities throughout project implementation. Subproject design and preparation will be done on the basis that no involuntary acquisition will be used. SP has extensive experience with avoiding land acquisition on similar projects. However, in the unlikely scenario that a site is critically needed for a subproject and all other options have been exhausted, eminent domain may be applied. To this end, the RPF describes all possible acquisition processes for customary land in compliance with OP/BP 4.12. Consultation and grievance redress for this project will be managed by SP's Customer Service Department and will include awareness campaigns, targeted consultations and a consultation program for each component.

65. Indigenous peoples (IP) will be the principal beneficiaries for subprojects, and hence elements of an Indigenous Peoples Plan (IPP) have been incorporated into project design in line with OP 4.10, primarily for Component 1 and some under Component 2. The ESMF describes the requirements for subprojects that will affect IP, including free, prior, and informed consultation; social assessment, including potential adverse impacts; and preparation of an IPP per the Indigenous Peoples Planning Framework in the ESMF. The ESMF has been disclosed in-country and in InfoShop on December 21, 2017.

66. Under Component 2 there is the potential for low income households to be denied connection due to their lease status. Currently SP is unable to connect households without a current Temporary License to Occupy (TOL) or Fixed Term Estate (FTE), which can occur in low-income households when they fail to pay the required fee, or in areas with informal settlements. This may lead to unintentionally favoring those areas or households – within low income areas - that are wealthier. As of February 2018, SP now plans to connect households on TOL land, regardless of title, as the Commissioner of Lands has provided authorization in writing. Similar resolution is currently being sought by SP for informal settlements on FTE land. The finalized process will be included in the ESMP(s) for the component. Beyond the new wiring at

each household, the component will involve minimal construction, limited to installation of auxiliary power poles for low-voltage wires.

F. Environment (including Safeguards)

67. The project is category B under OP 4.01, Environmental Assessment, and is expected to have minimal environmental impacts, with most potential impacts related to the construction of the solar PV arrays under Components 1 and 3. The potential sites for the arrays and their ancillary equipment are between one and five hectares and located in the vicinity of Honiara, Auki, and coastal villages in Guadalcanal and Makira provinces. The sites are all anthropogenically altered and contain a mixture of cleared land, native grasses, brush, and secondary growth. Some sites will require clearing of vegetation. Potential impacts during construction include sedimentation of watercourses, poor waste management, and impacted air quality from dust and emissions. Some removal or trimming of trees may be required for construction of distribution lines. During the operation of the mini-grids, there are potential impacts from the improper disposal of spent storage batteries.

68. While no critical natural habitats have been identified for potential sites assessed in the ESMF, OP/BP 4.04, Natural Habitats, is triggered in the case that other sites are used where habitats may exist. Villages across the country are in close proximity to areas of primary growth vegetation, and it is possible that other sites will be considered for the project (specifically Component 1) where presence of critical natural habitats are identified. SP have a longlist of mini-grid locations and will plausibly consider locations beyond the four currently shortlisted. Similarly, physical cultural resources are unlikely to be encountered, but OP/BP 4.11, Physical Cultural Resources, has been triggered as a precaution. In the event that an artifact or similar is found, for example during excavations as part of Components 1 or 3, a chance find protocol will ensure appropriate steps are taken.

69. An ESMF has been prepared that describes the environmental impacts and environmental assessments for subprojects. Subprojects under Component 3 will require an Environmental and Social Impact Assessment (ESIA) be undertaken to determine and plan for the range of potential impacts, while ESMPs will be required for Component 1 subprojects. A sample ESIA has been prepared for the East Honiara site, as part of the ESMF, as well as an ESMP template. SP is responsible for subproject ESIAs and ESMPs.

70. **Citizen engagement.** The project will engage the community in consultation throughout implementation, notably on environmental and social impacts of project activities, and this is tracked through an indicator in the results framework[27]. The project will ensure that women are adequately informed, invited and participate in community consultations and their concerns and interests are addressed.

G. Other Safeguard Policies (if applicable)

71. No other safeguard policies are triggered for the project.

[27] The indicator is “Project supported organization(s) publish reports on inputs and effect of consultation on project/policies”

H. World Bank Grievance Redress

72. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit *http://www.worldbank.org/en/projects-operations/products-and-services/grievance-redress-service*. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

VII. RESULTS FRAMEWORK AND MONITORING

Results Framework
COUNTRY: Solomon Islands
Electricity Access and Renewable Energy Expansion Project

Project Development Objectives

The project development objective is to increase access to grid-supplied electricity and increase renewable energy generation in Solomon Islands.

Project Development Objective Indicators

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
Name: People provided with new or improved electricity service	✓	Number	0.00	9345.00	6 monthly	Project reports	SIEA/SP
People provided with access to electricity under the project by household connections (grid or off-grid).	✓	Number	0.00	7695.00	6 monthly	Project reports	SIEA/SP
People provided with access to electricity through Community electricity connections under the project.	✓	Number	0.00	1500.00	6 monthly	Project reports	SIEA/SP

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
People provided with access to electricity under the project through microenterprises		Number	0.00	150.00	6 monthly	Project reports	SIEA/SP
Description:							
Name: Annual electricity output from renewable energy capacity constructed under the project		Gigawatt-hour (GWh)	0.00	5.66	6 monthly	Project reports	SIEA/SP
Description: The annual output from solar facilities constructed under component 1 and 3, estimated at 2.5 GWh and 3.2 GWh respectively.							

Intermediate Results Indicators

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
Name: Generation capacity of energy constructed or rehabilitated	✓	Megawatt	0.00	3.40	6 monthly	Project reports	SIEA/SP
Renewable energy generation capacity (other than hydropower) constructed under the	✓	Megawatt	0.00	3.40	6 monthly	Project reports	SIEA/SP

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
project							
Description:							
Name: Number of mini-grids constructed under the project		Number	0.00	5.00	6 monthly	Project reports	SIEA/SP
Description: This indicator measures the number of mini grids commissioned by SP.							
Name: Number of households connected to electricity through the project		Number	0.00	1350.00	6 monthly	Project reports	SIEA/SP
Number of female headed households connected to electricity through the project		Number	0.00	135.00	6 monthly	Project reports	SIEA/SP
Description: Households provided with access to electricity through the project include those connected via Component 1 (Renewable energy hybrid mini grids) and Component 2 (Electricity connections in low income areas), but the indicator will be measured using the number of households connected through Component 2 (as this is a proxy). Disaggregated data on female-headed households is tracked to evaluate impact and target barriers to electrification. The National Statistics Office found that 10% of the households are female headed (person in charge of the household), although this is sometimes interpreted as the most senior person present.							
Name: Number of micro-enterprises connected to		Number	0.00	75.00	6 monthly	Project reports	SIEA/SP

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
electricity through the project							
Number of female headed micro-enterprises connected to electricity through the project		Number	0.00	8.00	6 monthly	Project reports	SIEA /SP
Description: This indicator measures the number of micro-enterprises (canteens) connected to electricity through the project. Disaggregated data on female-headed micro enterprises are tracked to evaluate impact and target barriers to electrification. No data is currently available as to the number of female-headed businesses, a figure of 10% of total businesses is used as an estimate.							
Name: Access strategy study completed		Yes/No	N	Y	6 monthly	Project reports	SIEA/SP
Description: This indicator measures progress towards completing the technical assistance and studies to be developed under component 4.2.							
Name: Tariff review completed		Yes/No	N	Y	6 monthly	Project reports	SP/SIEA
Description: This indicator measures whether the tariff review has been completed. It is expected that over time the introduction of renewable energy and the increase of access to electricity in Solomon Islands will enable a reduction of the electricity tariff. The review will confirm whether the conditions are such as to enable a reduction in tariff.							
Name: Project-supported organization(s) publish reports on inputs and effect		Yes/No	N	Y	At midterm and closing	Project reports	SIEA/SP

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
of consultation on project/ policies							
Description: This indicator measures the level of community engagement in project implementation. It will be measured at midterm and closing.							
Name: Net greenhouse gas emissions	✓	Tones/year	0.00	13800.00	6 monthly	Project reports	SIEA/SP
Description:							
Name: Percentage of women employed in basic maintenance of solar facilities constructed through the project		Percentage	0.00	80.00	6 monthly	Project reports	SIEA/SP
Description:							
Name: Percentage of women in technical or managerial roles within SP		Percentage	6.00	10.00	6 monthly	Project reports	SIEA / SP
Description: The baseline value was provided by Solomon Power. According to the benchmarking report from the Pacific Power Association (PPA) in 2017 (2015 data), 21.3 percent of the total workforce employed in Pacific power utilities are women, with four percent of female representation in technical levels.							

Indicator Name	Core	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
Name: Percentage of staff that believe domestic violence is never acceptable		Percentage	31.00	41.00	Yearly	Project reports	SIEA / SP
Description: The baseline of 31% is taken from the Solomon Islands Demographic and Social Statistics. The project will offer training to SP in cooperation with the IFC. After each training, a survey will be undertaken to measure, among others, the perception of staff on whether domestic violence is acceptable or not. Based on the survey, the percentage of staff that believes domestic violence is never acceptable will be recorded.							

Target Values

Project Development Objective Indicators

Indicator Name	Baseline	YR1	YR2	YR3	YR4	YR5	End Target
People provided with new or improved electricity service under the project	0.00	0.00	1869.00	5607.00	7476.00	9345.00	9345.00
People provided with access to electricity under the project by household connections (grid or off-grid)	0.00	0.00	1539.00	4617.00	6156.00	7695.00	7695.00
People provided with access to electricity through Community electricity connections under the project	0.00	0.00	300.00	900.00	1200.00	1500.00	1500.00
People provided with access to electricity under the project through microenterprises	0.00	0.00	30.00	90.00	120.00	150.00	150.00
Annual electricity output from renewable energy capacity constructed under the project	0.00	0.00	1.66	1.66	5.16	5.66	5.66

Intermediate Results Indicators

Indicator Name	Baseline	YR1	YR2	YR3	YR4	YR5	End Target
Generation capacity of energy constructed or rehabilitated	0.00	0.00	1.00	1.00	3.10	3.40	3.40

Indicator Name	Baseline	YR1	YR2	YR3	YR4	YR5	End Target
Renewable energy generation capacity (other than hydropower) constructed under the project	0.00	0.00	1.00	1.00	3.10	3.40	3.40
Number of mini-grids constructed under the project	0.00	0.00	2.00	3.00	4.00	5.00	5.00
Number of households connected to electricity through the project	0.00	0.00	250.00	810.00	1080.00	1350.00	1350.00
Number of female headed households connected to electricity through the project	0.00	0.00	27.00	81.00	108.00	135.00	135.00
Number of micro-enterprises connected to electricity through the project	0.00	0.00	15.00	45.00	60.00	75.00	75.00
Number of female headed micro-enterprises connected to electricity through the project	0.00	0.00	2.00	5.00	6.00	8.00	8.00
Access strategy study completed	N	N	N	N	Y	Y	Y
Tariff review completed	N	N	N	Y	Y	Y	Y
Project-supported organization(s) publish reports on inputs and effect of consultation on project/policies	N			Y		Y	Y
Net greenhouse gas emissions	0.00	400.00	3300.00	6800.00	10300.00	13800.00	13800.00

Indicator Name	Baseline	YR1	YR2	YR3	YR4	YR5	End Target
Percentage of women employed in basic maintenance of solar facilities constructed through the project	0.00	0.00	80.00	80.00	80.00	80.00	80.00
Percentage of women in technical or managerial roles within SP	6.00	6.00	7.00	8.00	9.00	10.00	10.00
Percentage of staff that believe domestic violence is never acceptable	31.00	31.00	35.00	38.00	40.00	41.00	41.00

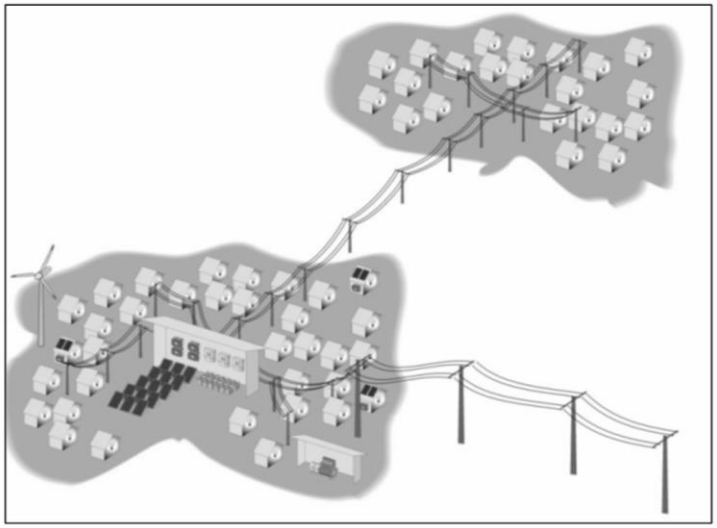
ANNEX 1: DETAILED PROJECT DESCRIPTION

COUNTRY: Solomon Islands
Electricity Access and Renewable Energy Expansion Project

1. The proposed project has an estimated cost of US$19.95 million and is comprised of the four components summarized below.

2. **Component 1 — Renewable Energy Hybrid Mini-grids (US$10 million).** Component 1 will finance supply, installation, and initial maintenance of new renewable hybrid mini-grids throughout Solomon Islands. A schematic representation of a mini grid installation in a community is provided in **Figure 1** below.

Figure 1: Mini grid installation - example



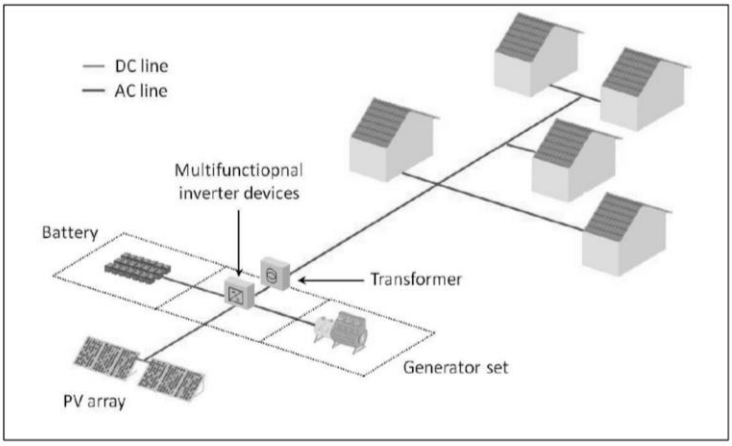
3. SP has identified a long list of 35 potential locations suitable for such mini-grids, taking into account population density (number of households), public facilities such as hospitals and schools, 'anchor' loads such as tourism facilities, food processing or other commercial operations, and potential sources of renewable energy (mainly solar PV). These 'candidate' mini-grids are located in Central Province, Choiseul, Guadalcanal, Isabel, Makira, Rennel, Temotu, and Western Province. SP has established a process of prioritizing those mini-grids based mainly on the average cost per connection, ability to pay, accessibility, and safeguards considerations, namely land availability[28]. Preliminary pre-selected sites have been identified (Ulava, Santa Ana, Lambi, Visale and Tingoa), but need to be confirmed, as land needs to be

[28] At an initial stage information on estimated costs or ability to pay is limited. SP uses proxies such as the number of household within a 2-10km radius and information or socio-economic activity. These are later refined at subsequent stages after detailed surveys have been conducted in priority sites. A business case is prepared including detailed design and comprehensive technical and economic analyses to be submitted to SP board for approval of the specific investment.

secured[29]. The need for geographical diversity across provinces may also be considered, taking into account not only the mini-grids proposed to be financed under this project but also those to be financed through ADB and New Zealand financing.

4. A schematic example of the elements of a mini grid is provided in **Figure 2** below. The installations will be modular, scalable based on the community size and with demand growth, and will allow for other generation sources, such as small hydro, to be connected in future[30]. Although there are a range of mini grid solutions, the initial technical design is based on SP's recent experience establishing renewable energy hybrid mini grids in Seghe and Taro, where solar photovoltaics (PV) panels with battery storage and diesel back up were installed[31]. The solar system produces electricity during the day time while charging the batteries which supplies electricity at night time. The diesel generator is used as back up only, for example in cloudy days, early mornings, and/or during the evening peak demand if the battery storage is not sufficient. The generator backup services a dual purpose to provide regular battery equalization chargers, and to quickly charge the batteries when discharged to reduce long-term damage to the battery.

Figure 2: Elements of a Mini grid - example



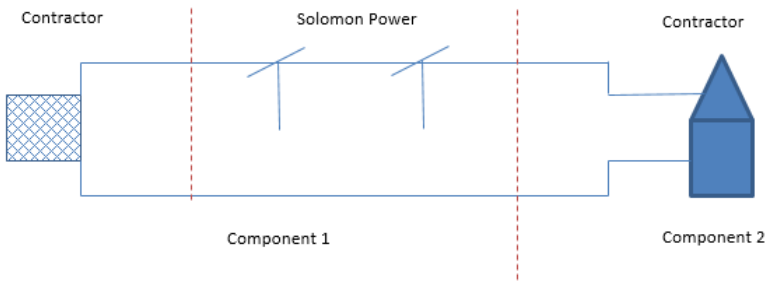
5. Based on the long list of potential sites, the average number of households for each site is slightly over 150. Benchmarking the average hybrid mini-grid characteristics for Seghe and Taro, a standard mini-grid established would potentially require solar panels of 150 kW, battery storage of 300kWh and a diesel generator as a back-up of 140kW to connect 100% of the houses. A similar configuration is proposed for each mini grid to be established under this component, appropriately scaled to fit the specific communities to be served (i.e. adapted to the population size and electricity demand of the selected sites)

[29] Securing land may take up to one year depending on the category of the land (customary, perpetual state, provincial or government land)
[30] Should technologies other than solar PV be selected for generation, appropriate safeguard instruments may need to be prepared.
[31] For example, Taro, containing 157 households, required solar panels for 150 kW, diesel generation for 120 kW and 300 kWh in storage; Seghe with 113 households required solar panels for 100 kW, diesel generation for 120 kW and 200 kWh in storage to service 100% of households.

and optimized to reduce emissions. The generator will be sized to be able to meet the full load when insufficient storage is available. SP investigated the efficiency and adequacy of this configuration which came up as very satisfactory as it i) provide end-users with 24 hours supply, and ii) optimize the cost of the system and minimize the use of fuel[32].

6. SP will prepare the bidding documents for the mini-grids, with support from a solar engineer or an owner's engineer, as needed, who would also support SP during tender evaluation, and supervision during construction. SP has recently implemented other mini-grids, and it would therefore use similar technical specifications, adapted and optimized for the specific sites, and also taking into account some of the lessons learned[33]. The elements to be tendered out under component 1 are the installation and construction of the mini-grid, including the generation facility and up to the distribution point, as represented in **Figure 3** below, with the household connections to be undertaken by contractors under component 2.

Figure 3: Elements of the mini-grid to be tendered out in component 1



7. The construction of the mini grids will be competitively tendered through a design, supply and installation contract (which will include maintenance and/or training and a guarantee period). SP is familiar with operating and maintaining hybridized systems and it is proposed that it would own, operate, and maintain these mini-grids in the long run. In the short term, however, and as an option, a maintenance

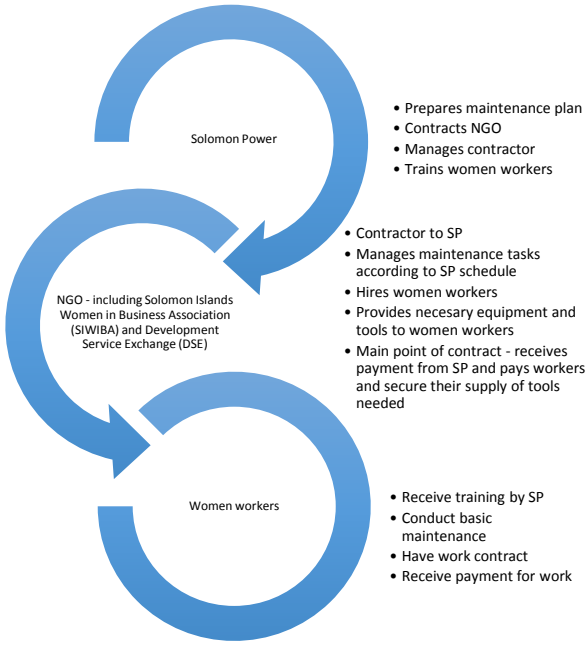
[32] The mini-grids will be located in the outstations of the Solomon Islands. The price of diesel fuel reaches 1 USD/L in these areas due to its remoteness. This is almost 40% more expensive than the price of fuel in Honiara, the capital city, where diesel costs 0.71 USD/L. The hybrid-mini-grids suggested in the proposed project include batteries to reduce the use of the diesel gensets to less than 20% of operational time of the mini-grid and thus accrue substantial savings in fuel along the project lifetime. In the absence of diesel backup generation, the solar PV + battery system would need to have a larger generation capacity to produce and store excess electricity that can be released when the solar resource is not available (e.g. adverse weather conditions, nighttime, etc.), so that quality of service (i.e. no load shedding) is maintained. This increases the cost of the system in comparison to a hybrid system very significantly (considering both upfront and ongoing costs): to maintain the same characteristics of security of supply, the cost for the mini-grid would be at least 80% higher, with a total battery capacity at least 2.5 times larger and a total PV capacity at least 40% higher to store and produce enough energy on a daily basis without diesel. The inclusion of a diesel generator will allow better management of the battery bank.

[33] For example, the need to adapt the demand forecast to the local circumstances.

contract for an initial period of 3-5 years could also be tendered out as part of the same package to ensure appropriate maintenance and learning by SP of the particular technology[34].

8. While the contractors or SP will conduct technical maintenance, women groups from the rural local communities will be employed to conduct basic maintenance and upkeep of the solar panels and mini-grid sites (for example removal of weeds and cleaning of panels). A consultant will be hired under component 4 to design and assist in setting up the appropriate implementation and contractual arrangements for this program, which will in principle include the elements described in **Figure 4**.

Figure 4: Elements of the rural women employment program



9. An NGO would assist SP to manage the maintenance tasks, hire the women and provide the necessary materials. SP envisages a cost of around US$2,000 per year for each mini grid, including an allocation for the NGO to manage the contract, coordinate activities with SP and workers as well as to provide the necessary equipment and tools to workers. SP would provide training to workers.

10. Alternative management models for the mini-grids have also been considered. In particular, initial due diligence was undertaken by a Bank team in July 2015 on the potential Rural Electricity Service Companies that had been identified to support mini-grids under the SREP project: it showed that these were operating as small-scale operations energy retailers only, with limited ability to pre-finance the capital expenditure required for the mini-grids. The option of developing these mini-grids through private sector investment was also considered. However, given the poor financial viability of the mini-grids, and

[34] Mini-grid contracts will be procured through competitive tender and vendors will also be required to provide acceptable guarantee and defects liability period (in the order of five years). While for now SP intends to perform maintenance directly, there is an option of including maintenance in the contracts.

the absence of a sector regulator and appropriate capacity at the Ministry at this stage[35], it was considered that private sector investment would not be adequate in the short term. Having said this, Component 4 will provide technical assistance to conduct upstream work, consider options and lay the foundation for possible alternative models in the future, including enabling additional private sector investment going forward.

11. Experience in the region points to a cost of approximately US$2 million per mini grids of similar sizes.[36] As already mentioned, this figure will need to be scaled up or down depending on the actual size of the mini-grids that are ultimately selected for financing. Assuming similar sizes, the project would aim at financing five to six mini-grids. These estimated costs are high.[37] This may be explained by the high costs of doing business in remote islands in the Pacific, but SP may be able to obtain better prices through competitive selection procedures. If actuals costs come lower or if more financing becomes available, the project could cover more mini-grids.

12. The mini grids to be financed under the project will contribute to increase SP's customer numbers by adding 1500 new customers including commercial, community services and low-income households. A cost of service and tariff study has been conducted in 2015 taking into account the generation mix at the time and forecasting a progressive introduction of alternative renewable sources into the generation mix (i.e. hydro and solar) along with a customer growth rate of 12%/year. The study concludes that the tariff would be reduced going forward. Having said this, the study does not consider the possible increased costs of delivery through mini-grid (vs grid). Component 4 includes the financing of an update to the cost of service and tariff study to take into account SP's plans to expand significantly into outstations in the future. With regards to affordability, and as mentioned earlier, while no specific affordability survey has been conducted for this project, the economic and financial analysis conducted for the Electricity Access Expansion Project identified the willingness to pay at US$28/month for rural areas of Solomon Islands. This was done by comparing what communities were spending on alternative sources of power (namely battery charging). At the current tariff levels (which would be applied on a uniform basis), this means that for the average consumption of 30kWh per month, customers would be saving on average 30% on their energy expenditure[38] .

[35] Capacity would be needed to define and manage concessions, ensure quality of the service provided, calculate appropriate tariffs and/or the size of a possible viability gap, etc.

[36] This figure is based on the cost of the recently established mini-grid in Taro and Seghe and the cost estimated for the establishment of mini grids under the Vanuatu Rural Electrification project (VREP II).

[37] An assessment conducted recently in Niger found the cost for solar mini-grids (including generation, storage, distribution and connections) to be around US$6,000 per kWp installed, which would be less significantly less than the estimated costs for this project and for a similar project in Vanuatu.

[38] A willingness to pay analysis was also conducted during preparation of EAEP to determine household's willingness to pay once they received an electricity connection. The economic analysis considered only the consumers' surplus of switching from the supply provided by charging and using car batteries to grid electricity supply. The surplus is based on the cost savings from charging batteries and replacing them every two years, to using grid electricity (30 kWh per month in Honiara, charging batteries cost approximately SBD 45 per charge, and the battery can last around a week, for a limited use of two energy efficient lamps, and phone charging). Thus, it is assumed that the willingness to pay of consumers is at least the amount they currently pay of US$24 a month. Also, switching to grid electricity avoids the need of replacing the battery, usually after two years, with a cost of US$100 per battery. Using the revised electricity tariff for the lowest residential tier below 50 kWh a month

13. **Component 2 — Electricity Connections in Low-income Areas (US$1.5 million).** Component 2 would finance electricity connections to households, micro enterprises (such as small canteens) and community infrastructure (e.g., schools and hospitals), in low income areas, through an output based aid (OBA) mechanism, building on the EAEP[39]. This component would provide one-off OBA subsidies to eligible beneficiaries to cover a portion of the upfront cost of electricity service connections in the Honiara grid (existing service area and planned expansion areas) and in the outstations, including those to be developed through Component 1, and possibly others. Eligibility criteria will be based on the geographic location, and self-selection: interested consumers will apply for a service connection per existing processes.[40] The criteria to be applied and the level of subsidy to be offered will be described in the Project Manual and may be revised from time to time as may be appropriate.

14. The OBA subsidy will cover materials and installation of the service line and auxiliary pole, when needed; a pre-paid meter; and in-house wiring, including protection, earthing, and two LED light bulbs[41]. **Figure 5** illustrates the service line connection, in-house wiring and auxiliary pole (if needed). SP would competitively procure and pre-finance the materials for the service line and install the service line using its own staff/electrical contractors and also import in-house wiring materials in bulk. It would then contract licensed electrical contractors for large batches of works (e.g., up to 500 connections for Honiara). The combination of improved affordability of energy and profitability would contribute to improvements in the economics and financial returns from connecting new customers near existing grids, who are currently considered uneconomic to connect by the utility without an OBA subsidy. As part of the verification process, an Independent Verification Agent (IVA), to be hired by the Bank, will conduct a short survey with households to assess how the household perceives the electricity connections and the difference that it is making or is expected to make to their lives. The IVA will also collect data on how many beneficiaries are female headed households.

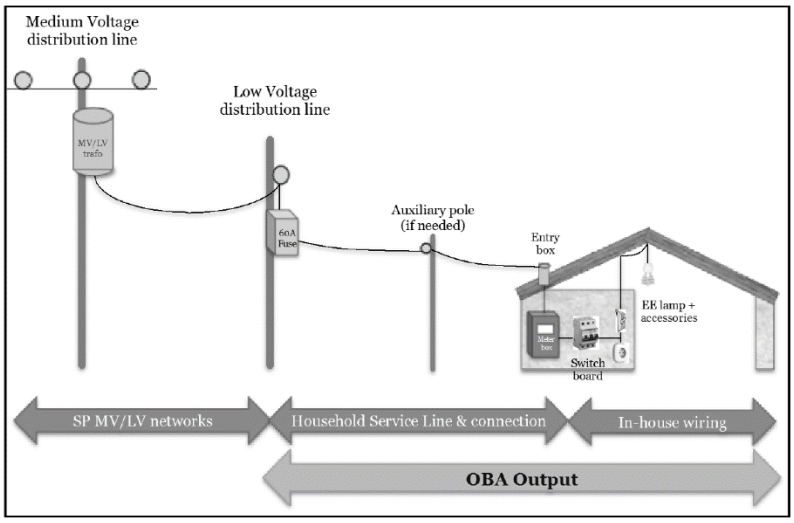
of US$0.70/kWh, the monthly bill would be US$21, lower than the current cost of charging batteries, but providing much more electricity than before.

[39] The definition of micro enterprises and community infrastructure will be included in the PIM.

[40] Under the current program and in order to qualify, consumers will fall into the following criteria: (i) beneficiaries fall under the prepaid residential category; (ii) beneficiaries do not have a previous connection under their name; (iii) service connection is capped to 10 Ampère for a period of 12 months; and (iv) service connections are individual, and cannot be shared with other households.

[41] The current level subsidy per connection in the Honiara grid area is US$794 (SBD6,354), and the subsidy per connection in the outstations is USD994 (SBD7,954), and it accounts for 72 percent of the total cost of a household connection and wiring in Honiara, and 79 percent at outstation areas. These values will be defined in the Project Manual but may evolve over time based on evolution of costs, in which case the Project Manual may be amended to reflect the new agreed amounts from time to time as may be necessary after agreement with the Bank

Figure 5: Schematic Diagram of electricity network, service line and in-house wiring



15. The funds provided through this component will enable a scale-up of the existing OBA program operating under EAEP. The scale-up is meant to finance connection of households to the mini-grids to be built under Component 1, but also others across SP's grid network as a complement to the network extensions being performed by SP in its investment plan[42].

16. A gender assessment was conducted to determine whether there were gender gaps associated with the project and with this component. The study, which included a survey conducted in rural areas covered by the OBA program, concluded that there was no gender gap associated with the connections fees currently charged under the OBA program and female headed households (FHH) found the customer contribution to be paid through the project to be at an acceptable level[43]. As such, no differentiated fee for FHH is proposed under the program. Having said this, because poverty levels of FHH are generally higher than those of male headed households (MHH), the project will track the percentage of FHH connected through the program. Disaggregated data on female-headed households will be important to evaluate impact and target barriers to electrification. If, during the course of the project it is found that the ration of FHH connected is much lower than 10% (the ratio of FHH in SI), corrective measures may be needed[44].

17. Consistently with what is done for EAEP, SP will conduct awareness campaigns in rural communities to inform them about the opportunity to get connected through the program, discuss the application process and its requirements, and also discuss other issues like electricity safety. By definition, these rural

[42] It is estimated that around US$0.65million would be needed to connect the households in the mini-grid locations.
[43] Electricity tariffs were found to be expensive, but not the connection fee.
[44] See "Why Measuring Energy Access for Women Makes Smart Business, The Case of Lao PDR (A Lessons Learned Note from the EAP Gender and Energy Facility)", accessible at http://documents.worldbank.org/curated/en/547301506533359927/pdf/120104-BRI-PUBLIC-P151262-M-E-Laos-Energy-and-Gender-Note.pdf

communities have never used electricity, and may not be aware of the dangers but also the opportunities of getting connected. The gender assessment suggested that these awareness campaigns could be used for sharing information on the types of appliances that can be used, or as opportunities to share information aimed at addressing GBV[45]. If needed, the technical assistance to be provided under Component 4 could be used to develop further such material.

18. It is expected that Component 2 will have climate co-benefits, since connecting more people to the grid will likely displace dirtier fuel sources (kerosene, wood burning etc.) currently in use by the targeted population.

19. **Component 3: Grid-connected Solar Power (US$ 5 million).** Component 3 would finance the supply, installation and initial maintenance for one or more grid-connected solar facilities in Solomon Islands. Over the last few years market-based prices of solar PV electricity in developing countries are showing a clear rapidly decreasing trend, and single-digit PV electricity prices (per kWh) can now be achieved in many developing countries. Given the high cost of power in Solomon Islands, adding solar generation to displace diesel can go a long way in lowering the average cost of power in the country. There are some limits to the amount of variable sources of power that can be integrated in the country's generation mix, in particular intermittent generation without storage. Having said this, as of now the amount of variable generation is limited to one MW of solar at Henderson. When combined with storage and with projects like Tina hydro, there is significant room to grow solar generation in the country.

20. The addition of grid connected solar power would contribute to increase the overall share of renewable energy in Solomon Islands energy mix. A number of renewable energy projects are being planned in Honiara, and in outstations, for example: additional grid-connected solar power, hydropower projects such as the proposed Tina River Hydro Scheme (Honiara) and the Fiu River Hydro scheme (Auki, Malaita), or new hybrid (solar-diesel) mini grids and/or conversion of existing outstations from all diesel to solar-diesel. The large displacement of fossil fueled generation is expected to improve energy affordability, and contribute to further improvements in financial performance of SP.

21. SP would like to move quite fast on a number of grid-connected solar projects/sites. One of the main constraints for these kinds of projects in the country is the availability of land. SP has identified a number of possible sites, as follows:

(i) SP headquarters rooftop (0.4MW – US$1.0million): This site is readily available. SP is conducting technical inspections of the buildings physical structure and robustness to support a solar infrastructure. SP hired a civil engineer with the results to come out in the first quarter of 2018.

(ii) Henderson (2MW - US$5.5 million): SP has installed one MW solar at this site (financed by New Zealand and MASDAR/United Arab Emirates). In the same plot of land, there is still space to install

[45] Women are mostly involved in time consuming activities related to family work such as cooking, washing and gathering wood. Connecting power from mini-grids to time saving appliances can help alleviate the physical and time burden of these activities, particularly for women. SP can support these by educating consumers about different type of appliances that can be purchased.

an additional two MW. The estimated cost for the solar facility including storage would be US$10 million. The land is available and ready to use.

(iii) East Honiara substation (0.5 MW, US$1.3 million): There is space in the existing East Honiara substation owned by SP that could be used to install 0.5 MW of grid-connected solar. The estimated cost for the solar facility including storage would be US$2.5m. The land is available and ready to use, and SP would like to promote this site as a 'green energy' hub.

(iv) Tanagai (1.5 MW, US$6.5 million): SP is in the process of acquiring land that it would like to use for a 1.5 MW grid-connected solar plant. The estimated cost for the solar facility including storage would be US$7.5 million. There is currently one person living on part of the land (along one of the site boundaries).

(v) Auki (1 MW, US$2.6 million): SP may also be interested to install a one MW solar facility in the Auki outstation. The estimated cost for the solar facility including storage would be US$5 million. There is limited availability of land.

22. The aggregation of all projects above come to a total of 5.4 MW of generation and US$16.9 million of investment. Based on the envelope available for this project, SP has requested financing for 1.5MW at the Henderson site and for the SP rooftop, to be confirmed.

23. The solar plant to be developed on the basis of a design, supply and installation contract, possibly bundled with the procurement of the mini-grids to attract better conditions, and with an option for maintenance for an initial period which could be tendered out as part of the same package. Ownership and future operation will remain with SP. The utility is financially stable but has limited experience in working with independent power producers. The small size of the proposed facilities would also probably not be sufficient to attract serious independent power producer players and/or good prices under an auction. The project would therefore envisage to finance a smaller facility for demonstration effect of the benefits of a well-structured competitive process. Support would also be provided under Component 4 to assist the Government and SP perform upstream analysis to enable additional generation projects to come on board, if possible through private sector investment.

24. Similarly, to component 1, SP will action towards including women in the basic upkeep and maintenance of the solar facility to be established through component 3, following the same approach. It is estimated that the cost for the program would be US$13,500 per year for each 1MW plant.

25. **Component 4 —Enabling Environment and Project Management (US$ 3.45 million).** Component 4 would finance project management, technical assistance and training for SP, and also provide support for technical assistance and training to be carried out by SP for the benefit of MMERE, as follows:

(a) Subcomponent 4.1 - Project management costs and technical assistance to SP (US$2.95million). This subcomponent will finance project management support, technical assistance and training to strengthen the capacity at SP to manage and implement the project as well as to increase access to electricity and the penetration of renewables into the grid. The component will support (i) financing for consultants to implement the project and strengthen SP's capacity, notably for hiring a project manager, who is also expected to manage other projects of SP (manager for projects), a manager for contracts, manager for construction, procurement and financial management staff, among others; (ii) a solar engineer and/or owners' engineers as may be needed for preparation of bidding documents, and support during tender, supervision of the construction and commissioning works; (iii) preparation of any additional feasibility studies as may be needed to support the development of additional mini-grids or grid-connected solar sites, (iv) preparation of the environmental impact assessments and environmental management plans, compliance and reporting; (v) a gender specialist to design the program for women employed in maintenance of solar panels and site, to conduct an assessment on obstacles for women to take on technical roles and identify measures, and to assist SP in developing a Gender Based Violence policy for the company and train staff for successful policy implementation[46] (vi) technical assistance and training may also be provided to SP in areas related to the project activities, for example in the fields of integration of renewables, network planning and training of electricians[47]; (v) incremental operating costs.

(b) Subcomponent 4.2 - Technical assistance for the benefit of MMERE (US$0.5million). This subcomponent will finance technical assistance, training and office equipment to create an enabling environment and framework for increasing electricity access and the penetration of renewables in Solomon Islands[48]. Support to be provided by the SP to assist the MMERE will include: (i) the development of a comprehensive electricity access strategy for the country (development of technical standards, institutional and implementation arrangements, financing needs and mechanisms); (ii) financing of upstream technical assistance to facilitate additional private sector investment in the sector (identification of investments, PPP arrangements, suitable arrangements for concession agreements, licensing framework, etc.) (iii) update of cost of service and tariff studies; (iv) financing for an energy advisor to assist MMERE in these activities; (v) training, (vi) office equipment and incremental operating costs of the SP necessary to implement activities under this subcomponent.

[46] This will be conducted with the IFC initiative Waka Mere Commitment, which actions on respectful workplaces by implementing a workplace response to domestic violence.
[47] As mentioned above, one area that has been highlighted as a bottleneck in the process of extending access to the grid to households that are currently not being served, is the limited number of licensed electricians that can install the internal wiring in new households to be connected to the grid (only 60 active licensed electricians and all in Honiara).
[48] Although some areas had been indicated under the SREP investment plan – such as the need to standardize and streamline the approach for land acquisition for distribution extensions and small mini grids – according to MMERE this support is no longer needed.

ANNEX 2: IMPLEMENTATION ARRANGEMENTS

COUNTRY: Solomon Islands
Electricity Access and Renewable Energy Expansion Project

Project Institutional and Implementation Arrangements

1. MoFT will be the recipient for the various financing, and will enter into an IDA Financing Agreement and a Grant Agreement, covering SREP, SIDS-DOCK and GEF grants, with the World Bank. Overall responsibility for oversight and implementation of the project will lie with SP. SP will be the implementing agency for the project, and will sign Project Agreements with the World Bank, as well as Subsidiary Agreements with the MoFT, passing on the financing. SP has been implementing Bank-financed projects for several years, including the on-going SISEP and EAEP.

2. SP will recruit or appoint a team of people to strengthen SP's capacity to implement the project. These consultants and/or SP staff will be integrated in SP's own structure and will, together with SP's other units, implement and deliver the project. The core team will be constituted by a project manager, an OBA program manager, a procurement specialist, a solar engineer, an environment and social safeguard specialist, and a financial management specialist, all with experience and qualifications acceptable to the Bank. The project manager is also expected to manage other projects of SP. This team will be further complemented by a manager for contracts, a manager for construction, as needed. Part of this team already exists within SP's own staff[49], part is expected to be recruited under SISEP or SIEAEP, and be transferred to this project, and part will be recruited during project implementation.

3. Except for the financial management specialist, who is already in place, the rest of the core team will be appointed or recruited by SP within three months of effectiveness. The project manager will be responsible for the coordination and day to day implementation of all project activities, along with other involved SP staff. The procurement specialist will work with the project manager and the manager for contracts to support all procurement activities for the project and ensure adherence to appropriate procurement procedures. SP's finance department will be responsible for financial management of the project, in coordination with the project manager. Depending on the workload of current SP staff, SP may also need to hire a project accountant[50]. These experts will also be responsible for training SP's staff as necessary.

4. Implementation of Component 2 (Connections to Low-income Households, microenterprises and community services) will follow the implementation arrangements defined under the EAEP. The OBA program manager will coordinate implementation of this component with the project manager. If needed, the OBA

[49] For example, the financial management specialist. Ultimately, it is SP's intention to have these positions as part of its own operating structure, and so it is possible that, during the life of the project, some of these positions will transition into SP's payroll.
[50] Project accounts for SISEP and EAEP are currently maintained using SP staff, but the additional work load required for this project may make it necessary for the project to finance an additional accountant, to be confirmed during the course of the project.

program manager could also be financed by the project[51]. The OBA Independent Verification Agent, to be hired by the Bank, will work with the OBA program manager to verify connections under Component 2.

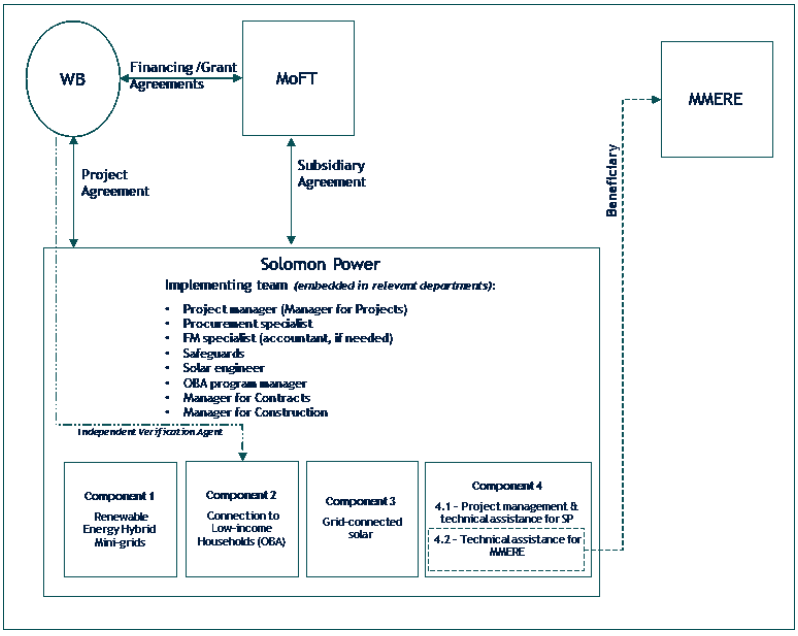
5. The project manager will liaise and coordinate with a focal point to be appointed at MMERE and other agencies as the case may be for coordination regarding the sector studies requiring their involvement, notably the sector studies in Component 4.2. Procurement and financial management for these contracts will still be conducted by SP, but MMERE will be the beneficiary. As such, the MMERE will be called to contribute to the development of Terms of Reference (or technical specifications if applicable), participate in evaluation committees, and will also be collaborating with the SP on the supervision of the consultants' work.

6. Although SP has experience with World Bank project implementation, itis still in the process of improving the implementation in line with international best practice and World Bank procurement regulations. Adequate technical assistance for project implementation will be critical. Based on experience with other projects implemented by SP, the team proposed in this section should be adequate to design and supervise project activities. The project will also provide support for the recruitment of a solar engineer and/or an owner's engineer to assist with review of project design and preparation of bidding documents as well as supervision of the contractors as needed.

7. A draft Project Implementation Manual (PIM) is already available and it is expected to be finalized and adopted within three months of effectiveness.

8. The project implementation arrangements, are shown schematically in **Figure 6**.

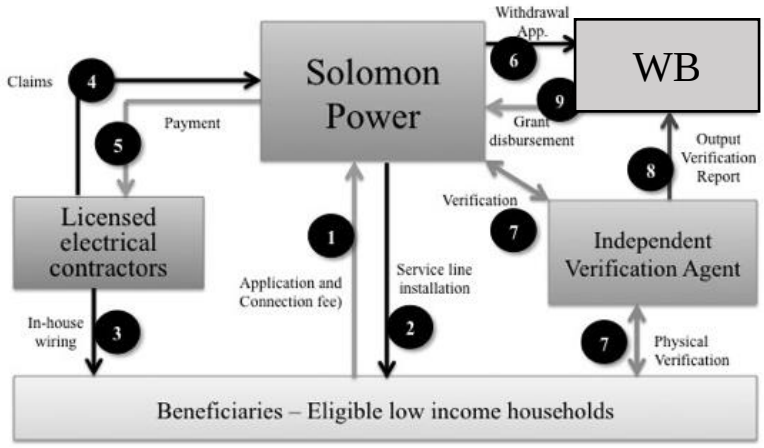
Figure 6: Project Implementation arrangements



[51] Recruitment for this position will be done under the SISEP and SIEAEP projects, but if needed the position could be transferred for financing to the new project.

9. **Implementation arrangements for Component 2.** The OBA Program Manager will coordinate implementation of this component with the project manager. If needed this expert could also be financed by the project. SP will manage the process of connecting households, micro-enterprises and community services to the grid and installing internal wiring. SP will be responsible for receiving customer requests for electricity connections and assessing the eligibility of each customer request. SP will carry out the electricity connections from the distribution line to the house/building, provide the materials for the standard basic in-house wiring, and assign a competitively selected electrical contractor to perform the internal wiring. Prior to energizing the connection and installing the meter, SP will assess the safety standard of the wiring service. SP will procure the materials and pay for wiring services, before consolidating a number of connections and submitting a 'subsidy claim' to the World Bank's task team and the IVA for verification. The IVA will verify the outputs claimed and will prepare an Output Verification Report (OVR) with recommendations for payments. The task team will review the OVR and recommend payments for the approved outputs. The implementation arrangements are presented below in **Figure 7**:

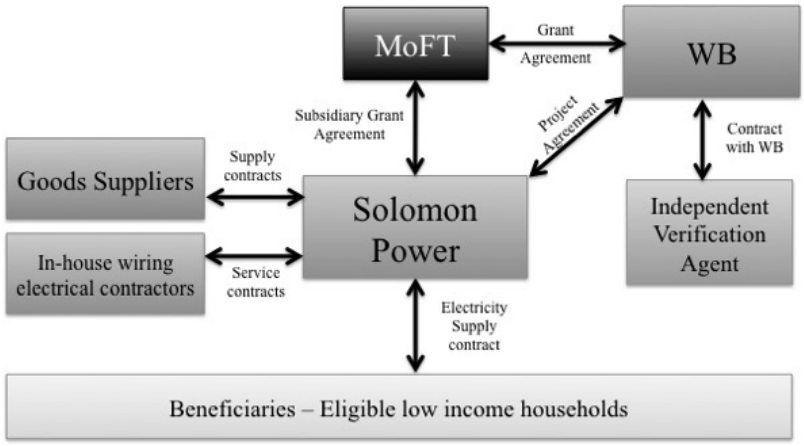
Figure 7: Implementation Arrangements for Component 2



10. **Targeted consultation and awareness campaign.** The customer service and public relations department of SP will be responsible to reach beneficiaries and inform them of the objectives and structure of the program, as well as encourage them to apply for the subsidy. SP will also provide communication material and information of the safe use of electricity, in the form of vouchers, posters, focus groups, among others. The awareness campaign will consist in public consultations and face-to-face interviews with beneficiaries to illustrate how the OBA subsidy scheme works. It is responsibility of SP to properly explain to eligible households and provide advice on the benefits, costs, and tradeoffs of grid electricity, as well as how the program works, who can benefit, what are the procedures, etc. The objectives of the identification process and the awareness campaign are: i) to inform the village of eligible participants; ii) to ensure that all eligible households who decide to participate are well advised of the costs, obligations, and financial requirements of participating; and iii) to raise awareness of the whole community on the OBA program. Posters and schematic drawings written in local language will be provided highlighting the dangers of inappropriate use of electrical appliances, and recommending best practices. The OBA Program Manager will support SP in the preparation and design of the awareness campaign.

11. Contractual agreements. **Figure 8** below summarizes the proposed contractual agreements for Component 2.

Figure 8: Proposed contractual agreements for Component 2



Financial Management

12. The financial management (FM) assessment was carried out in accordance with the "Principles Based Financial Management Practice Manual" issued by the Board on March 1 2010 which states with respect to projects financed by the Bank, the grantee is required to maintain appropriate implementation arrangements which include – including accounting, financial reporting, internal control procedures, and auditing systems, adequate to ensure they can provide the Bank with accurate and timely information regarding the project resources and expenditures. Overall, the financial management arrangements satisfy the financial management requirements of the Investment Project Financing Bank Policy. The assessed financial management risk of the project is considered moderate provided financing is available for a project accountant, if required by SP.

13. **Implementing Agency.** SP will be responsible for the implementation of the FM aspects for this project. SP has had a long experience providing the FM requirements for World Bank financed projects through the SISEP, which commenced in 2008. There has been substantial progress in the FM performance of SP both within the organization and in FM implementation of World Bank financed projects. This is demonstrated in the continued improvement of the FM performance rating from 2010 to now. Based on these reviews There is sufficient capacity within SP to satisfactorily deliver the FM requirements for this project. Notably, the current financial management specialist in charge of existing World bank projects would also be in charge of FM for SIEAREEP. However, given that this is the third World Bank financed project being delivered concurrently through SP consideration could be given to financing a project accountant to assist SP to deliver this project, if needed.

14. **Accounting and Staffing Arrangements.** Consistent with other World Bank financed projects implemented by SP, the project accounts will be incorporated into the SP accounts. The SP accounting package, SAGE, meets the WB requirements for maintaining an adequate accounting system. Currently there is dedicated SP staff member responsible for maintaining the accounts of World Bank financed projects and liaising with the Bank on Financial Management related issues. Currently the project accountant is financed from SP operations and this is likely to remain however the project will have provision for financing the project accountant if required by SP. These FM arrangements meet the expected FM staffing requirements for project.

15. **Budget Arrangements.** The project budget will be prepared and monitored by SP which has experience in managing budgets, both for the corporation and ongoing World Bank financed projects. As there are four sources of finance, and only IDA is funding all 4 components, the budget will need to be broken down both by component and source of finance adding some complexity to both the preparation and monitoring of the budget. Component 2 is proposed to be output based and monitoring of the budget for this component will be limited to ensuring the subsidies do not exceed the amount allocated for the component. An overall budget should be formulated, initially using the project appraisal document as the first reference point and should be consistent with information provided in the procurement plan. A more detailed annual budget will be developed from the overall budget and monitored on a quarterly basis. Financial Reports (more below) will include budget to actual comparisons.

16. **Internal Controls.** SP has strong internal controls, which are documented in its Financial Manual. These controls are adequate to provide assurance over project expenditure. In addition, SP has developed a Financial Management Manual for SISEP and has a SIEAEP/GPOBA manual. These manuals adequately cover FM processes and procedures for this project and can used as the basis for the FM section of the project manual. Project accounts will be maintained either by an employee of the SP or a project accountant financed through the project. Authorizations for expenditure provide adequate segregation of duties and staff from MoFT will have a mandatory signatory for Withdrawal Applications consistent with other World Bank financed projects implemented by SP. No additional internal controls are recommended for this project, there is generally compliance to the controls as outlined in the Financial Manual and the control risk is moderate.

17. **Flow of Funds.** In addition to using direct payments and possible pre-financing (reimbursement), project funds will flow from the Bank into a pooled designated account maintained by SP which includes funds from other World Bank financed projects. SP has an accounting system and capacity within the finance section to ensure adequate segregation of funds by project and source of funds within the one account using different fields. Monthly reconciliations of the designated account balance should be completed to show the breakdown of the balance by project and source of finance. While there is no prescribed way of sequencing the disbursement of funds, SP should give consideration to the most advantageous way of sequencing payments between the sources of finance[52].

[52] This may include disbursing the funds with earlier closing date first, and possibly exhausting some sources of funds first to simplify disbursement arrangements as implementation progresses. In this regard, one possible way to sequence funds may be (i) SIDS-DOCK for component 1 first; (ii) GEF for component 3 first; (iii) IDA Grant; (iv) SREP grant; (v) IDA credit.

18. **Financial Reporting Arrangements.** SP will prepare calendar semester Interim Financial Reports (IFR) due to be received by the Bank within 45 days after the end of the reporting period. The format for these reports will need to be acceptable to the Bank and must include project commitments; and income and expenditure for the reporting period, year to date and cumulative figures.

19. **External Audit Arrangements.** No separate project audit will be required as the project activities will be included in the SP accounts. Hence a copy of the SP entity audited financial statements will meet the auditing requirements subject to the agreed financial statement disclosures in the main part of the accounts or in the notes to the accounts. The Bank will reserve the right to request additional assurance through a Special Purpose Audit, financed through project funds if there are concerns over the accuracy of the project accounting.

20. General Note (to be included in the SP Accounts)**:**

"Solomon Power received World Bank IDA funds, and Trust Funds from SREP, SIDS-DOCK, and GEF to implement the Electricity Access and Renewable Energy Expansion Project to provide hybrid mini-grids, connections to low-income households, grid connected to solar power, and project management costs."
For each source of finance and a consolidated summary the following note should be included, although the format can be agreed between Solomon Power and the Bank prior to the first disclosure requirements.
"Note X. World Bank Financing
(a) "Solomon Power received (IDA/SREP/SIDS-DOCK/GEF) funds dated mm/dd/yy for implementation support

Current Year	**Preceding Year**	**Cumulative**
$	**$**	**$**
Amounts received during the year	X	X	X
Expenditures during the year	X	X	X

(b) The proceeds of the Electricity Access and Renewable Energy Expansion Project Financing has been expended in accordance with the intended purposes as specified in the Financing/Grant Agreements.

Supervision Plan

21. An FM implementation review field mission will be conducted at least once a year with additional missions early in implementation to ensure all World Bank FM requirements are met. In addition, the FM team will conduct a desk review of the semester IFRs and the project notes to the accounts in the SP audited annual financial statements

Disbursements

22. The project will use three disbursement methods: advance, reimbursement and direct payment. Component 2 will only be disbursed through Direct Payments and as Component 1 will include a small number of contracts only, it is anticipated the majority of funds from this component will also be disbursed through

Direct Payments. A pooled designated project account (DA) will be opened and can be used for all project sources of financing. The ceiling for the DA will be agreed and included in the project Disbursement and Financial Information Letters[53]. Disbursement for replenishments for the Designated Account will be based on a Statement of Expenditure. Disbursements for Component 2 will be made through a separate category and will require an Output Based Verification Report provided by an independent verification agent prior to each disbursement. To enable assurance that funds allocated to Subcomponent 4.2 will be used for activities benefiting the MMERE, a separate category has also been included.

23. All direct payments will be paid based on records evidencing eligible expenditures, e.g. copies of receipts, supplier invoices.

24. The SIDS-DOCK grant will have a closing date of June 30, 2020 whereas the rest of the financing will have a closing date of May 31, 2023.

25. The project will have three disbursement categories as outlined in the table below.

Category	IDA Credit (expressed in US$ equivalent)	IDA Grant (expressed in US$ equivalent)	GEF (US$)	SREP (US$)	SIDS - DOCK (US$)	Percentage of Expenditures to be Financed (inclusive of Taxes)
Goods, works, non-consulting services, consulting services, incremental operating costs and training and workshops for Component 1, 3, and 4.1	5,550,000	3,250,000	946,750	6,600,000	1,600,000	100%
Subsidy payments under Component 2		1,500,000				100%
Goods, consulting services, incremental operating costs and training and workshops for Component 4.2				500,000		100%
TOTAL AMOUNT	5,550,000	4,750,000	946,750	7,100,000	1,600,000	

[53] The project will use separate disbursement letters for IDA and Trust Fund resources.

Procurement

26. The procurement under this project will follow the procurement procedures specified in the World Bank Procurement Regulations for IPF Borrowers (July 2016 and revised in November 2017) and the provisions stipulated in the Financing/Grant Agreements and Project Agreements to be entered into by the Bank and SIG and SP respectively. The project implementation agency is SP, which will procure all the contracts under the project.

27. SP prepared a PPSD with the key conclusions of:

a) There are constrains in infrastructure, geographic isolation and remoteness, as well as capacity of existing governance institutions which challenges and affects project implementation. High cost of goods and commodities, which are mostly imported, and services contribute to high unit costs even in comparison with regional pacific islands. As national market is thin, it is expected that suppliers, goods and services will come from international and regional markets.
b) The SP implemented similar mini grids under design, supply and installation contracts, and therefore is familiar with this arrangement. It is proposed to apply the same arrangement for the new project.
c) SP has implemented World Bank financed projects in the past, however, the implementation capacity is relatively thin. SP will need to recruit consultants to assist in project implementation, including qualified procurement experts to support procurement related tasks.

28. Accordingly, the procurement arrangements are:

29. For Components 1 and 3, it is expected that the mini grids will be procurement through request for proposals (RFP) with two-stage and two-envelope and international competition. Pre-qualification will be applied; for Component 1, the materials for distribution networks will be procured through RFB with international competition and then the networks will be installed by SP's own resources; SP will take actions to mitigate the risks with this arrangement (e.g. coordination of supply and installation as well as matching progress with the grids, quality control and assurance, etc.).

30. For Component 2, procurement will follow the same arrangement under EAEP. All the materials will be procured through EAEP and the same amount of subsidy per connection is applicable to this project with verification by a consultant to be hired by the World Bank.

31. For Component 4, some individual consultants will be employed to support project implementation. It is expected most of these individuals will be transferred from SISEP or EAEP on the basis of direct selection. This component will also finance consulting services of policy review, strategy preparation, etc. for the benefit of MMERE. Due to the size of contracts, it is expected CQS will be used and the consultants will be selected by SP.

32. In the interest of capacity building of the SP, the project implementation is aligned in the structure of SP for project implementation, and some individual consultants including a procurement specialist will be financed to strengthen the capacity.

33. The main risks and mitigation measures have been discussed between the Bank and SP, and are summarized as follows:

Risk Identified	Mitigation Measures
Limited capacity at SP to undertake procurement and fiduciary functions	Consultants will be hired to strengthen the capacity. Additionally, SP will designate its own staff to work with the consultant so that the staff can have on-the-job training.
Limited capacity of local market.	International market will be approached. Some works may be subcontracted to local contractors.
Delay in procurement and implementation	STEP will be used to plan and monitor procurement process. Contractors will be required to provide realistic logistic plan in their bids which will be reviewed by SP so as to address logistic issues. Land acquisition should be finished before contract is awarded. Timely payment to contractors.
Inappropriate/unqualified subcontractors chosen by main contractors resulting in poor delivery of work	Clear definition of qualification requirements in procurement documents.
Limited capacity for contract management	Solar engineer and/or an owner's engineer will be hired to assist contract management

34. **Hands-on Expanded Implementation Support:** With the agreed risk mitigation measures, it is expected that no additional hands-on support will be needed from the World Bank. However, the World Bank task team will provide necessary procurement training and normal advice at the early stage of project implementation.

35. **Procurement Plan**. Based on the analysis of the PPSD, SP has prepared a procurement plan which will be also published on the World Bank's external website through STEP. The procurement plan will be updated annually in agreement with IDA, or as required, to reflect project implementation needs. The summary procurement plan is as follows.

Description (Value cannot exceed 250 Characters)	Reference No.	Procurement Category	Procurement Method	Estimated Amount (US$)	Review Type	Planned Start Date
Supply and installation for 5 mini-grids	SP-C1-1	CW	RFP	7,500,000.00	Prior	2018/10/01
Supply of distribution network material for the 5x solar power plants in SP-C1-1 to develop the 5x mini grids	SP-C1-2	GO	RFP	4,000,000.00	Prior	2020/03/01
Electrical Contractors to do in house wiring	SP-C2-1	NC	RFB	1,500,000	Prior	2019/10/01

Description (Value cannot exceed 250 Characters)	Reference No.	Procurement Category	Procurement Method	Estimated Amount (US$)	Review Type	Planned Start Date
Supply and installation for a solar plant (SP roof)	SP-C3-1	CW	RFP	1,040,000.00	Prior	2018/10/01
Supply and installation for a solar power plant (Henderson or other site)	SP-C3-2	CW	RFP	3,900,000.00	Prior	2018/06/01
Manager OBA	SP-C4-1	CS	CDS	200,000.00[54]	Prior	2019/01/15
Manager Projects	SP-C4-2	CS	CDS	1,000,000.00	Prior	2019/01/15
Manager Contracts	SP-C4-3	CS	CDS	300,000.00	Prior	2019/01/15
Env and Social Safeguard Specialist	SP-C4-4	CS	CDS	150,000.00	Post	2019/01/15
Manager Construction	SP-C4-5	CS	CDS	300,000.00	Prior	2019/01/15
Solar Engineer	SP-C4-6	CS	CDS	450,000.00	Prior	2019/01/15
Procurement Specialist	SP-C4-7	CS	CDS	120,000.00	Post	2019/01/15
Tariff review study	SP-C4-8	CS	CQS	150,000.00	Post	2020/01/30
Safeguard studies - preparation of ESMPs	SP-C4-9	CS	INDV	50,000.00	Post	2019/03/30
Gender Specialist	SP-C4-10	CS	INDV	70,000.00	Post	2018/09/30
Review and revisions of the electricity act (updating, integration of renewables, private sector framework, access strategy)	ME-C4-1	CS	CQS	120,000.00	Post	2018/10/01
Preparation of an access strategy	ME-C4-2	CS	CQS	150,000.00	Post	2018/06/01
Energy advisor for access and tariff review	ME-C4-3	CS	INDV	200,000.00	Post	2019/10/01
Office, IT equipment	MC-C4-4	GO	RFQ	3,000.00	Post	2019/06/01

36. **Procurement Supervision.** In addition to prior review of procurement transactions, at least one procurement mission will be fielded annually to support implementation. Procurement post reviews will be conducted annually.

[54] This consultant will be transferred from the on-going Sustainable Energy Project. The total value of contract is above the prior-review threshold.

Environmental and Social (including safeguards)

37. SP will have responsibility for implementing the ESMF and ensuring compliance with World Bank safeguards policies. The ESMF has been disclosed in-country and in InfoShop on December 21, 2017. The scale of the potential impacts and the corresponding ESMF requirements is such that SP can incorporate the ESMF implementation into their usual business operations. Specifically, the Technical Department and Customer Service Department will cover most safeguard related responsibilities. It is noted that although they are in the processing of appointing them, SP currently do not have in-house environmental and social specialists, and consultants will be relied on in some instances. For components 1 and 3, roles and responsibilities on each subproject will be described in a subproject-specific ESMP and/or, when triggered, in the IPP.

38. Other entities will support SP in implementing the ESMF. The Environmental and Conservation Division will review and approve subproject ESMPs while also taking responsibility for organizing review and approval of IPPs, followed by review and 'no objection' from the World Bank. The Environmental and Conservation Division will also be tasked with auditing implementation of the ESMPs and IPPs (including review of monthly monitoring reports from SP) and ensuring acceptable environmental management and mitigation during the project. The World Bank task team will support SP in safeguards implementation throughout the project, including guidance on instruments, safeguards reporting and managing any impacts during subproject preparation and construction.

Monitoring and Evaluation

39. Monitoring and evaluation for the project will be undertaken with support from the SP project team, who will be responsible for collecting, verifying, and collating information and submitting consolidated reports to the Bank. The Results Framework (Section VII) identifies result indicators for the project as a whole as well as for each of its components, including the annual target values for the results indicators and baseline data against which project implementation progress and results will be measured. Semi-annual progress reports on both PDO indicators and intermediate indicators in the results framework will be submitted to the Bank.

ANNEX 3: IMPLEMENTATION SUPPORT PLAN

COUNTRY: Solomon Islands
Electricity Access and Renewable Energy Expansion Project

Strategy and Approach for Implementation Support

1. The strategy for implementation support has been developed on the basis of the nature of the Project and responds to specific nature of the Project. World Bank team members will be based in the region, mostly in the Sydney office to ensure timely response to the client, perform close project implementation support, and anticipate implementation problems. The objective is to ensure that the World Bank's resources and staff are sufficient to supervise and support implementation.

Implementation Support Plan and Resource Requirements

2. **Country and sector dialogue.** The Bank team will continue maintaining a close dialogue with the Government, MMERE, SP, and other relevant sector institutions in order to strengthen focus on project implementation.

3. **Support to project implementation capacity.** The Bank team will coordinate with the SIEA/SP and MMERE teams to provide support as needed to ensure that all the key functions are fulfilled. As described in Annex 2 expertise at SP and MMERE will be further complemented as necessary to increase the team's efficiency.

4. **Support to investments execution.** Consultants will be hired to support SP to develop the detailed design and/or supervision of contracts related to the grid-connected solar and mini-grids. In addition, the Bank will undertake supervision missions to perform technical due diligence to ensure that contractual obligations are met. The Bank's project team and SP's project team will conduct regular site visits to project targeted areas throughout the duration of the project.

5. **Procurement requirements and inputs** The Bank's Procurement Specialist supporting the project is based in Sydney and will provide close support and advice to the implementation units of the projects. In addition to the prior review supervision to be carried out from the World Bank country office, two implementation support missions per year will be fielded. Additionally, annual ex-post review would be conducted on a sample basis for the contracts that are not subject to the Bank's prior review. One post review report, which would include physical inspection of sample contracts, would be prepared each year. The Bank's project team will help strengthen procurement management efficiency by: (a) reviewing relevant procurement documentation and providing timely feedback to the project implementation teams at SP; (b) providing clear guidance on the Bank's Procurement Regulation to the implementation units as needed; and (c) monitoring procurement progress against the updated Procurement Plans. Tailored training to procurement staff of the implementation units will be provided as part of implementation support to the project to facilitate the procurement process.

6. **Financial management requirements and inputs:** The Bank's FM Specialist supporting the project is based in Sydney. FM implementation support intensity and frequency will be in line with risk-based approach,

and will involve a collaborative approach with the entire task team. A first implementation support mission will be performed two months after project effectiveness. Afterwards, the missions will be scheduled by using the risk based approach model and will include the following diligences: (a) monitoring of the financial management arrangements during the supervision process at intervals determined by the risk rating assigned to the overall FM Assessment at entry and subsequently during implementation (based on Implementation Status and Results Reports); (b) integrated fiduciary review on key contracts; (c) review of IFRs; (d) review of audit reports and management letters from the external auditors and follow-up on material accountability issues by engaging with the task team leader, client, and/or auditors; the quality of the audit (internal and external) is to be monitored closely to ensure that it covers all relevant aspects and provide enough confidence on the appropriate use of funds by recipients; and (e) other assistance to build or maintain appropriate financial management capacity and efficient internal control system.

7. **Environmental and Social Safeguards.** Compliance with environmental and social safeguards related to the rehabilitation and upgrading of the transmission and distribution networks will be a primary responsibility of the project implementation team at SP. The team will implement safeguards for the priority investments. The Bank's project team will pursue close monitoring of environmental and social management under the project.

8. The Bank team will be composed of a mix of skills and experience for successful project implementation. The table below outlines the expected staff weeks and travel required to make sure the actions and schedule are appropriately resourced.

Table 1 – Estimated Implementation needs

Time	Focus	Skills Needed	Partner Role
First 12 months	Establishment of the project implementation unit for Component 1 at SP. Finalization of procurement documents.	Engineering; procurement; financial management; environmental; and social and legal.	Close cooperation with SP and MMRE
12-60 months	Review of progress in construction and capacity building; review of sector technical and financial performance; procurement; monitoring and evaluation; safeguards; financial management.	Engineering; sector regulatory and planning; Monitoring and Evaluation Specialist; environmental and social.	Close cooperation with SP and MMRE

Table 2 – Estimated Staff Weeks and Travel

Skills Mix Required

Skills Needed	Number of Staff Weeks per year	Number of Trips per year	Comments
General supervision and project management (Task Team Leader)	8	3	Sydney
Technical specialists	10	4	Washington DC, Sydney/other
Procurement specialist	2	2 (shared with other projects)	Sydney
Financial management specialist	2	2 (shared with other projects)	Sydney
Safeguards	3	2 (shared with other projects)	Sydney/Manila
Disbursement specialist	2	-	Manila
Independent Verification Agent	10	Field staff	Honiara

ANNEX 4: ECONOMIC AND FINANCIAL ANALYSIS

COUNTRY: Solomon Islands
Electricity Access and Renewable Energy Expansion Project

1. This annex presents the economic and financial analyses for the investments under the proposed project. The economic analysis reflects the project's development impact in terms of expected benefits and costs. The economic analysis shows that the proposed project is economically viable after the consideration of environmental externalities. The economic and financial analysis was conducted for Components 1 and 3, the main components supporting infrastructure investments, and where costs and benefits can be better quantified. This economic analysis is consistent with the World Bank Guidelines for Economic Analysis of Power Sector Investment Projects 2017 and Social Value of Carbon in Project Appraisal 2014.

Component 1 - Renewable Energy Hybrid Mini-Grids

2. The baseline economic rate of return (ERR) of the proposed hybrid solar/diesel mini-grids against the counterfactual scenario comprising fully diesel-powered mini-grids is 6.7percent (NPV US$3.43 million), which is above the 3% hurdle rate for Solomon Islands.

Rationale

3. It is estimated that 65%[55] of the population has no access to electricity in Solomon Islands. Lack of access to electrification particularly affects the population in the outstations, where there is no electricity network and energy demand is only partly met with mostly traditional sources of energy, such as candles or kerosene lamps, and few decentralized systems, such as diesel-powered mini-grids. Due to the remoteness of these outstations, unelectrified households currently spend a significant amount on these energy sources. Diesel fuel gets particularly unaffordable in the outstations, where the price reaches roughly US$1/L. Along the lines of the 2016-2035 National Development Strategy of the Solomon Islands, SP intensifies its efforts to increase electricity access in the outstations with affordable and sustainable solutions. As part of these solutions, solar mini-grids backed up with diesel generators and batteries, can provide with continued electricity supply to communities in the outstations, while reducing the cost of diesel fuel during their lifetime, the emissions and the local environmental impacts of otherwise diesel-fueled mini-grids. Through this component, the propose project aims at implementing 5 hybrid mini-grids, an overall installed capacity of 2.3 MW, which will be key to meet the electricity needs of Solomon Island's population in the outstations.

[55] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

Counterfactual to Hybrid Mini-Grids

4. This economic analysis uses fully diesel-powered mini-grids as the counter factual to the solar-diesel hybrid mini-grids. This choice is based on the following reasons:

- SP's access plans for the coming years concentrate in providing the population in the outstations with electricity solutions beyond the traditional sources, such as candles or kerosene lamps, If the solar-diesel hybrids were not implemented in this project, the Solomon Island Government would make use of diesel only mini-grid to meet its access targets.[56]
- Except for 1MW solar installed capacity and solar off-grid solutions, diesel is responsible for the totality of the energy generation in the Solomon Islands and thus, the predominant source of electricity,
- Several diesel-powered mini-grids are already implemented throughout the country, being this a well-known solution relatively easy to replicate from the technical point of view.

Cost Benefit Analysis of the Hybrid Mini-Grids

5. The economic viability of the program was assessed through a cost-benefit analysis performed over 25 years of project lifetime. The net benefits for the program were calculated by comparing total system costs and benefits for the "with project" and "without project" scenario. A sensitivity analysis was carried out by calculating the switching values for important input variables identified in the project risk matrix. The analysis includes a consideration of the relevant environmental and social externalities.

6. By the time this cost-benefit analysis was conducted, the exact location of the mini-grids had not been determined amongst the 35 sites, which SP had pre-selected to host the mini-grid systems. Therefore, the economic analysis follows a *framework approach*. This is, the 5 mini-grids are modeled based on the standard demand and load profiles of Seghe and Taro[57], communities where hybrid mini-grids are already in place, as well as communities[58] where the application of hybrid mini-grids has been analyzed in detail, such as Hauhui, Sasamunga, Vonunu and Namugha. Therefore, each modeled mini-grid system is dimensioned to incorporate 0.3 MW solar capacity installed, 0.15 MW diesel power generation capacity and a battery of 4 hours storage capacity to supply 24/7 (service tier 4[59]).

Project costs

CAPEX costs

7. The analysis uses estimated costs provided by SP. It uses a cost of US$ 0.69/W diesel generation, US$1.43/W solar PV generation and US$386.91/Wh batteries. It was assumed that a replacement of the diesel generator and the battery would be required after 20 years. The costs estimated for the network,

[56] In a scenario, where a credible counterfactual to mini solar-diesel hybrid mini-grid is the continuation of status quo (i.e. reliance on kerosene and candles etc.), the economic benefits of the project would be calculated based on estimates of willingness to pay of consumers in the beneficiary communities. In Solomon Islands, however, the most credible counterfactual to the current project is a diesel only mini-grid given SIG's commitment to expanding electricity access.
[57] Taro, Seghe and Afio – Establishment of Hybrid Generation Systems in the Provinces.
[58] Hauhui, Sasamunga, Vonunu and Namugha: Establishment of Hybrid Generation Systems in the Provinces.
[59] The Sustainable Energy for All Multi-tier Framework measures access on the tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access). See: http://trackingenergy4all.worldbank.org.

excluding the service connection and house wiring costs, and the switchboards are respectively US$ 500 000 and US$75,000 per mini-grid. Land is another capital expenditure that was considered in this study. It was estimated that 1 ha of land will be needed per mini-grid and a cost of US$6.3/$m^2$ of land in the outstations. Land costs per mini-grid were estimated to be US$62,500. These costs add to a capex of US$million per mini-grid system comprising 0.3 MW solar capacity installed, 0.15 MW diesel power generation capacity and a battery of 4 hours storage capacity each.

OPEX costs

8. The operation and maintenance (O&M) costs are estimated based on the real costs of existing hybrid mini-grid systems in Seghe and Taro sites. The annual O&M cost associated to the generation equipment and batteries and to the distribution infrastructure are respectively US$ 10 000 and US$ 5 000. Over the lifetime of the project, these costs represent US$1.31 million and were accounted from year 2 of the project onwards; this is, once completed the implementation works of the distribution infrastructure for the first batch of mini-grids. Annual diesel cost expenditures account for US$0.33 million over the lifetime of the project. This cost was calculated based on an assumed diesel generation capacity factor of 1% as per the existing hybrid systems in Seghe and Taro and a diesel cost of US$1 per liter consumed in the outstations and in the first year of operation of the project, 2020. This cost adds freight, local commissions, sale taxes and overhead costs of delivering the fuel to the outstations to the international crude oil price. This price was assumed to increase from US$64/barrel in 2017 to US$72/Barrel in 2025, and up to US$86/Barrel by 2045. These projections through 2045 are based on the World Bank commodities price forecast released on April 26, 2017. Overall, OPEX costs represent US$ 1.64 million over the lifetime of the project.

Project benefits

Fuel costs of the counterfactual using fully diesel-powered mini-grids

9. The avoided fuel cost of the counterfactual constitutes the main economic benefit associated with solar power generation. These avoided costs are calculated based on the diesel supply requirement of producing electricity equivalent to that generated from the hybrid mini-grids installed under this component of the project. As mentioned above, the counterfactual is assumed to be mini-grid systems powered solely by diesel. A capacity utilization factor of 33% was used in this case based on existing systems currently operating in the country, such as the diesel-powered mini-grid in Gizo. The same diesel cost and crude oil forecasts as those described in the *OPEX costs* section were considered under the counterfactual scenario. Overall, the avoided diesel fuel expenditures are estimated in US$11.28 million over the lifetime of the project.

Avoided diesel CAPEX

10. In the counterfactual scenario, it was assumed that a replacement of the diesel generator would have to take place every 5 years. This assumption was made based on observation of existing diesel-powered systems with similar capacity utilization factors. These savings add to US$0.31 million over the lifetime of the project.

Avoided diesel O&M

11. In the absence of information on the volume of these expenses in the Solomon Islands, the diesel operating costs were estimated at 20% of the avoided diesel CAPEX per year. This estimation is based on the costs registered in systems of similar characteristics in the region[60] and represents US$1.11million over the lifetime of the project.

Avoided local environmental damage costs

12. The damage costs for particulate matters (PM10), nitrogen oxides (NOx) and sulfur oxides (SO2) from diesel generation plants are from the latest version of the World Bank's Guidelines for Economic Analysis of Power projects (which are based on the 2015 Update of the Six Cities Study). These costs are detailed in Table 1. Assuming an affected population of 0.1 million[61], the benefits from avoided local environmental impacts add up to US$0.01 million over the project's lifetime.

Table 1. Damage costs

	Damage costs [$/kWh]
NOX	0.00011
PM-10	0.00003
Sox	0.00005
Total	0.00019

Avoided global environmental damage cost

13. Avoided global externalities constitute another economic benefit of hybrid mini-grids, given that solar power replaces thermal generation. Emissions of diesel based generation displaced by mini-grids are estimated using an emission factor of 0.66 kg/GWh. The carbon emission reductions are valued based on the World Bank Guidance on the Social Value of Carbon (released on July 2014) and using the base case values of US$30 in 2015 through US$80 in real terms by 2050. Correlating the values forecast to 2017 prices, it is estimated that the benefits from avoided global environmental damage cost are US$1.49 million and the hybrid mini-grids can avoid over 44,548 tons of greenhouse gas (GHG) emissions (undiscounted) from being released to the atmosphere. The abatement cost is -43.39 US$/ton.

Non-quantified benefits

14. The proposed project is also expected to have various additional benefits which are either uncertain or difficult to quantify such as (i) employment generation and; (ii) economy of scale benefits, which can help facilitate further reductions in cost of PV and, potentially, the development of manufacturing industries. These benefits have not been included in this economic analysis.

[60] Development of Off-Grid Electricity Supply in Vanuatu: Pre-Feasibility Studies for Hybrid Mini-Grids (September 2016).
[61] Based on existing literature on previous renewable energy projects conducted in the Solomon Islands, such as Tina River Hydropower Development project (P161319).

Economic analysis

15. In addition to the costs and benefits noted in the previous section, the economic analysis rests on the following additional assumptions:

- Discount rate for calculation of NPV: 3 percent as per the World Bank Interim Guidelines' (issued in May 2016) recommendation of using a discount rate equivalent to twice the average rate of growth of the projected GDP per capita in real terms. Since the real GDP per capita of Solomon Islands is projected to grow at an average rate of 1.3 percent during the project period[62], a discount rate of three percent has been used in the economic analysis by rounding out the discount rate implied by the guidance.
- It was also assumed that a first batch of three mini-grid systems would be implemented during year 1 of the project and their distribution network during year 2. Subsequently, a second batch of two mini-grid systems would be implemented during year 2 of the project and their distribution network during year 3.
- The final sites selected by SP do not count on existing public power infrastructure.

16. The resulting energy balance is shown in Table 2.

Results

17. The economic analysis shows that this proposed component of the project is economically viable after the consideration of environmental externalities. The baseline economic rate of return (ERR) of the proposed hybrid solar/diesel mini-grids against the counterfactual scenario comprising fully diesel-powered mini-grids is 6.7 percent (NPV US$3.43 million). These returns are inclusive of local and global environmental benefits, which add 1.5 percentage points (NPV US$1.50 million) to the ERR (Table 3).

18. Table 4 shows the calculations of the economic returns for 3 percent discount rate. This table also shows that the levelized cost of electricity (LCOE) of the hybrid mini-grid solutions modeled in this component, US$0.23/ kWh, is lower than the LCOE of the counterfactual scenario (US$0.27/ kWh).

19. The expenditures incurred on the capital infrastructure are the largest cost of the project; over 57 percent of the overall cost. The analysis estimates that 89 percent of the economic benefits come from avoiding diesel fuel expenditures. All in all, the net present value (NPV) of the project, including environmental local and global benefits, indicates US$3.43 million. A sensitivity analysis was conducted on this component at a discount rate of 6 percent. A discount rate of 6 percent leads to an almost breakeven project with NPV of US$0.27 million including local and global environmental benefits (table 4).

[62] Real GDP per capital projection are from the Debt Sustainability Analysis for Solomon Islands carried out by World Bank and IMF

Table 2. Project energy balance

		2019	2020	2021	2022	2023	2024	2025	2026	2043	2044
New capacity solar	[MW]	0.900	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
New capacity diesel	[MW]	0.450	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
Total new capacity	[MW]	1.350	2.250	2.250	2.250	2.250	2.250	2.250	2.250	2.250	2.250
Solar CF	%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%
Solar generation	[GwH]	1.466	2.44	2.44	2.44	2.44	2.44	2.44	2.44	2.44	2.44
Diesel CF	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Diesel generation	[GwH]	0.04	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total generation	[GwH]	1.51	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52

Table 3. Summary of Economic Analysis

		NPV	2019	2020	2021	2022	2023	2024	2025	2026	2043	2044
Solar and diesel Generation												
Capital cost	[$USm]	6.17	3.05	2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M	[$USm]	0.87	0.00	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Diesel cost expenditure	[$USm]	0.33	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Incremental T&D Costs		2.68	0.00	1.73	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Incremental T&D O&M Costs	[$USm]	0.44	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Land cost	[$Usm]	0.30	0.19	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total costs	**[$USm]**	**10.79**	**3.24**	**3.94**	**1.24**	**0.09**	**0.09**	**0.09**	**0.09**	**0.09**	**0.10**	**0.10**
Benefits												
Avoided diesel capex	[$USm]	0.31	0.05	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.08
Avoided diesel fuel expenditure	[$USm]	11.28	0.00	0.36	0.62	0.62	0.63	0.63	0.63	0.63	0.68	0.68
Avoided diesel O&M	[$USm]	1.11	0.00	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
total benefits	**[$USm]**	**12.70**	**0.05**	**0.42**	**0.68**	**0.69**	**0.69**	**0.77**	**0.69**	**0.69**	**0.74**	**0.83**
total economic flows	**[$USm]**	**1.91**	**-3.19**	**-3.52**	**-0.56**	**0.59**	**0.59**	**0.68**	**0.60**	**0.60**	**0.65**	**0.73**
ERR	[%]	**5.2**										
Local environmental impacts												
Diesel	[$USm]	*0.01*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Economic flows including local environmental impacts	[$USm]	1.93	-3.19	-3.52	-0.56	0.59	0.60	0.68	0.60	0.60	0.65	0.74
ERR including local environmental impacts	[%]	**5.2**										
Avoided GHG emissions	[$USm]	*1.49*	0.03	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.11	0.11
Economic flows incl. global GHG benefits	**[$USm]**	**3.43**	**-3.16**	**-3.46**	**-0.50**	**0.66**	**0.66**	**0.75**	**0.67**	**0.67**	**0.76**	**0.85**
ERR including global GHG	[%]	**6.7**										
ERR target	[%]	3.0										

Table 4. Summary of the economic returns

	Discount rate		3.0%	6.0%
[1]	**Economic rate of return**			
[2]	ERR	[%]	5.2	4.8
[3]	ERR+local externalities	[%]	5.2	4.9
[4]	ERR+local+GHG	[%]	6.7	6.4
[5]	Levelized cost of hybrid mini-grid	[US$/kWh]	0.23	0.28
[6]	Levelized cost of diesel mini-grid	[US$/kWh]	0.27	0.26
[7]	**Composition of NPV**			
[8]	Land costs	[$Usm]	0.30	0.29
[9]	Diesel cost expenditure	[$Usm]	0.33	0.23
[10]	Capital costs	[$USm]	6.17	5.40
[11]	T&D costs	[$USm]	2.68	2.50
[12]	Generation O&M	[$USm]	0.87	0.61
[13]	T&D O&M	[$USm]	0.44	0.30
[14]	**total costs**	**[$USm]**	**10.79**	**9.33**
[15]	*Benefits [avoided capex and fuel]*			
[16]	Avoided diesel fuel	[$USm]	11.28	7.79
[17]	Avoided diesel capex	[$USm]	0.31	0.22
[18]	Avoided diesel O&M	[$USm]	1.11	0.56
[19]	**total benefits**	**[$USm]**	**12.70**	**8.57**
[20]	**NPV (before environmental benefits)**	**[$USm]**	**1.91**	**-0.76**
[21]	local env. benefits: avoided grid gen.	[$USm]	0.03	0.02
[22]	NPV (incl. local environmental benefits)	[$USm]	**1.93**	**-0.74**
[23]	value of avoided GHG emissions	[$USm]	1.49	1.01
[24]	**NPV (including environment)**	**[$USm]**	**3.43**	**0.27**
[25]	Lifetime GHG emissions, undiscounted	[tons CO2eq]	-44548.0	-44548.0
[26]	Marginal abatement cost	[$/ton]	-43.38	-16.64

Sensitivity analysis

20. Given the uncertainty around some of the variables affecting the economics of this component of the project, a sensitivity analysis was carried out on the most influential variables to analyze their impact on the project ERR. These variables are i) the solar PV capital cost, ii) the batteries pack cost, iii) the diesel fuel price, iv) the solar capacity factor of the hybrid mini-grid, and v) the diesel capacity factor of the hybrid mini-grid. The switching values analysis is summarized in Table 5.

21. The switching value for the solar PV capital cost is US$3.81 /W, implying that if the solar PV capital costs would increase by roughly two and a half times, the ERR would fall to the 3% baseline value of the

discount rate. Similarly, the switching value of the battery pack is over twice the baseline value. This is, this component of the project would be breakeven assuming a double cost of the battery pack. The diesel fuel price at which NPV would be zero is 66% lower than its baseline value. In other words, assuming that the price of diesel fuel would drop to US$0.34 per liter, the project's economic rate of return would equal the discount rate.

Table 5 – Switching Values

Input	Unit	Baseline Value	Switching Value
Solar PV capital cost	US$/Watt	1.43	3.81
Battery pack cost	US$/pack	487 500	1 201 856.7
Diesel fuel price (2018)	US$/L	1	0.34

Financial analysis

22. The financial analysis for this component of the project was carried out by valuing the additional electricity delivered by the project in financial terms. To do so, the following taxes were considered based on existing and planned mini-grids conducted by SP as cited across this study:

- taxes on capital cost account for 30 percent of the capital investment and 7.5 percent of distribution equipment,
- taxes over labor for O&M of the generation assets or the distribution infrastructure is 40 percent of the total O&M cost,
- it was assumed that taxes over land add 7.5 percent of its total value,
- a 20 percent lump sum was added to cover contingency measures, in case these needs to be applied.

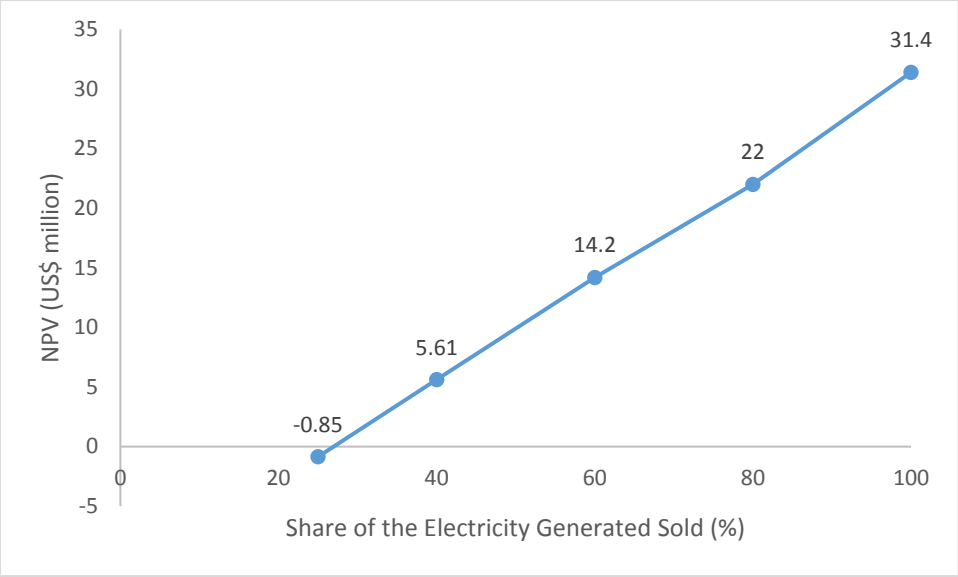
23. The Weighted Average Cost of Capital (WACC) was calculated based on 85.4% IDA credit over the overall IDA financing and grant funds for the remaining amount. Including a 4% on-lend margin on the IDA credit, the WACC is 0.97% excluding taxes. Based on the discussions with the utility, a tariff of US$0.65/ kWh until 2020 with a subsequent 20 percent drop over this price was considered in this financial analysis. Assuming that all electricity produced in the project is sold, the financial internal rate of return (FIRR) is 47.2 percent (Table 6).

24. A sensitivity analysis was performed on the amount of electricity sold, given the uncertainty in the communities' response to the provision of electricity services for first time. The sensitivity analysis considered additional scenarios in which the electricity sold is respectively 80 percent, 60 percent and 40 percent and 25 percent of the electricity generated in this component of the project. Figure 1 represents the NPVs obtained under the different scenarios. According to the results obtained, this component of the project will return financial benefits if at least 25% of the electricity generated, roughly, is sold.

Table 6 – Financial Internal Rate of Return of Component 1 (2017 Constant Prices) in nominal terms.

		NPV	2019	2020	2021	2022	2023	2024	2025	2026	2043	2044	2045
Benefits													
Electricity generated	[GWh]		0.00	1.51	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
Electricity tariff	[USD/KWh]		0.65	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Government grants	[$USm]		4.77	3.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total revenues	[US $ m]	*50.91*	4.77	4.02	1.44	1.48	1.52	1.56	1.59	1.63	2.49	2.55	2.61
Costs													
Tax over capital costs	[$USm]	*11.31*	4.17	2.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax over incremental T&D costs	[$USm]	*3.28*	0.00	2.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax over O&M costs	[$USm]	*2.30*	0.00	0.05	0.08	0.08	0.08	0.08	0.09	0.09	0.13	0.14	0.14
Tax over T&D O&M	[$USm]	1.15	0.00	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.07	0.07
Tax over land	[$USm]	0.35	0.21	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Contingency		*1.06*	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net financial flows	[$USm]	***31.45***	**-0.68**	**-1.04**	**-0.04**	**1.36**	**1.40**	**1.43**	**1.47**	**1.50**	**2.29**	**2.34**	**2.40**
FIRR	[%]	47.2											

Figure 1. NPVs of component 1 at different volumes of electricity sold.



Component 2 – Electricity Connections in Low-income Areas

25. The economic viability of electricity connection in low income areas was established recently as part the Solomon Islands Electricity Access Expansion Project. For this reason and given the small size of this component, a formal cost benefit analysis has not been carried out. Assuming a conservative scenario, in which the US$1.5 million investment associated with this component does not return economic benefits, the overall project would still be economically viable with a NPV of US$6.37 million for the overall project's net cashflow.

Component 3 – Grid-connected Solar Power

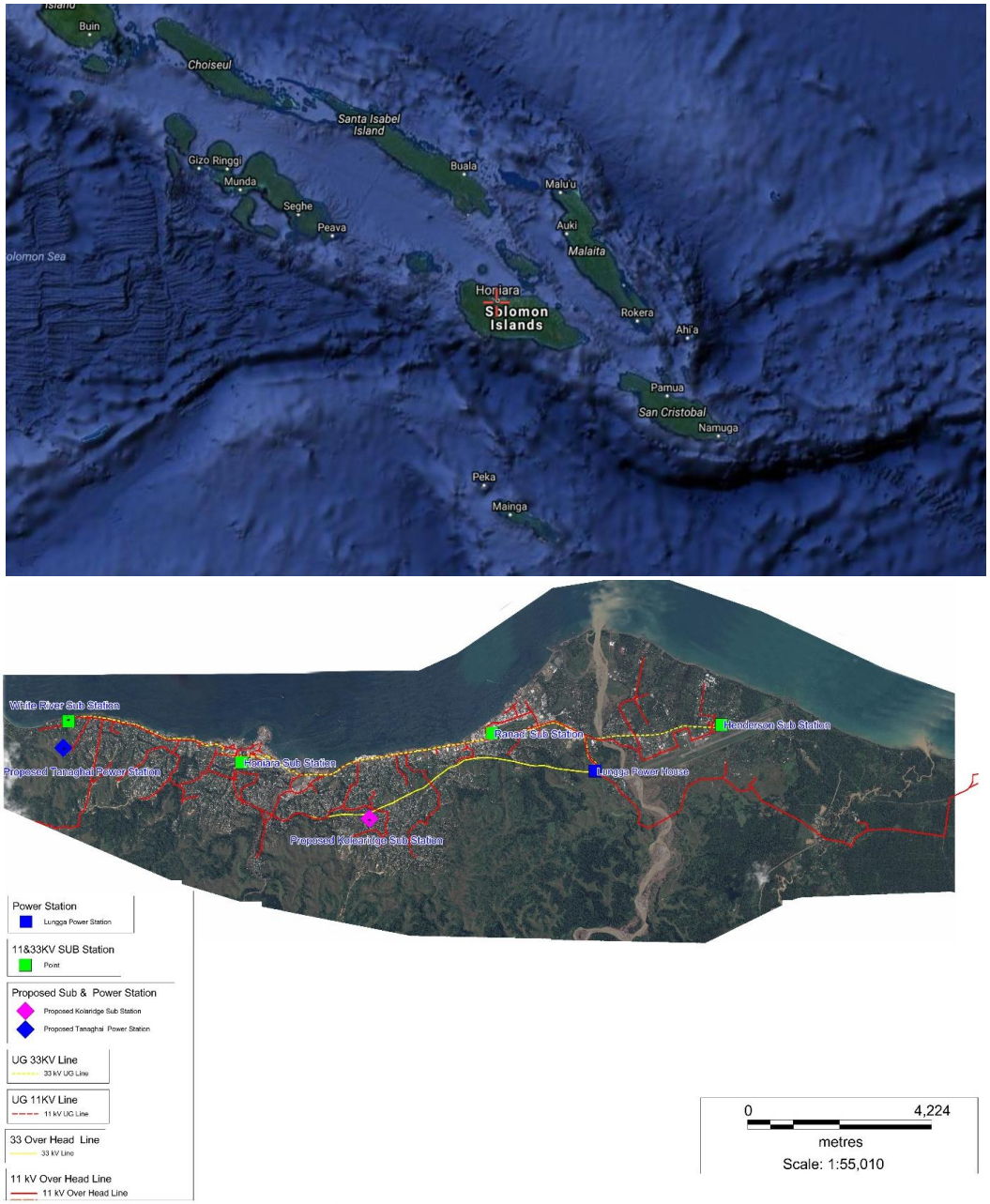
26. The baseline ERR of the proposed grid-connected solar power plants against the counterfactual scenario comprising the existing diesel-powered thermal plants to meet demand is 13.1 percent (NPV US$7.75 million), which is above the 3% hurdle rate for Solomon Islands.

Rationale

27. Solomon Islands is almost entirely dependent on imported, refined petroleum fuels to meet the energy needs for electricity generation, transport and lighting. The total installed capacity in Honiara, Solomon Islands' capital city, is 33.6 MW out of which only one MW is a solar farm commissioned in 2016. Honiara is located in Guadalcanal province, the only one in the country that counts on transmission infrastructure. Figure 2 represents Solomon Islands power system, owned and operated by SP. The dependency on diesel imports of the power system in Guadalcanal province has raised concerns on the energy security of the Solomon Islands' power system. This component of the project will contribute to increase energy security in Solomon Islands by increasing the participation of solar power in its energy mix.

By displacing substantial amounts of expensive diesel, this component will also help to improve energy affordability in the country. Currently, Solomon Islands imports diesel mainly from Australia and Singapore at a price of US$0.74 /L when it reaches Honiara port. The intensive used of expensive diesel reflects in the electricity tariff, currently US$ 0.65/kWh. Through the two solar farms proposed in this component, a total installed capacity of 1.9 MW, the project aims at achieving a lower-cost power-supply alternative than the existing thermal power generation. This alternative is also expected to improve the sustainability of Solomon Islands' power system by mitigating GHG emissions globally and reducing locally environmental impacts.

Figure 2. Solomon Islands' power system



Counterfactual to Grid Connected Solar Power Farms

28. This economic analysis uses the existing diesel powered thermal plants in Guadalcanal province as the counter factual to the grid-connected solar power farms. This choice is based on the following reasons:

- Except for 1MW solar installed capacity and solar off-grid solutions, diesel is responsible for the totality of the energy generation in the Solomon Islands and thus, the predominant source of electricity,
- SP agenda to multiply connections in Guadalcanal concentrate on intensifying the distribution network by reducing the cost of power production and grid connection through cheaper sources of power. The existing transmission infrastructure can technically allocate an increased demand in the near-term future thus, installing additional diesel-based generation capacity and extending the transmission backbone is out of the utility's scope to meet the energy demand.

Cost Benefit Analysis of the Grid Connected Solar Power Farms

29. The economic viability of this component of the project was assessed through a cost-benefit analysis performed over 25 years of project lifetime. The net benefits for the solar power farms were calculated by comparing total system costs and benefits for the "*with project*" and "*without project*" scenario. A sensitivity analysis was carried out by calculating the switching values for important input variables identified in the project risk matrix. The analysis includes a consideration of the relevant environmental and social externalities.

30. By the time this cost-benefit analysis was conducted, SP had identified five sites that could be exploited for solar power generation and indicated preference of two of them to install a total capacity of 1.9 MW of solar power. All five identified sites present an excellent solar resource and pre-feasibility studies had indicated the technical viability of implementing solar power plants. The two preferred sites had the additional favorable conditions of land readiness and the transmission infrastructure availability in both sites. One of the sites is in the area of the existing 1MW Henderson solar plant in Honiara. The area currently hosting the solar plant is sufficient to allocate a second farm of 2.1 MW installed capacity. To successfully evacuate the power generated, exploiting this site would require connecting the existing solar facility and the proposed one through a transmission cable. The analysis of costs has considered this investment. The second site is SP headquarters rooftop. The dimensions of the building would allow installing 0.4 MW PV solar capacity without an extra investment of transmission. SP had indicated that, according to the technical analysis conducted, batteries would not be required in any of the sites and grid stability would not be a concern.

Project costs

CAPEX costs

31. The analysis uses estimated costs provided by SP. It uses a solar PV cost of US$2.60/W, which adds up to US$ 4.68 million over the lifetime of the project for a total of 1.9 MW solar PV installed capacity. The transmission costs related to the site at Henderson are estimated in the amount of US$300,000 for an extension a high voltage cable of roughly 300 meters to connect the new solar farm in Henderson with the

existing Henderson solar plant. Distribution costs are not considered in this component as the low voltage distribution line extensions are covered under the component 2 of the proposed project. The transmission and distribution costs associated to the site in the SP building rooftop are negligible. The cost of land is a significant capital expenditure and it has been considered in this study. It has been estimated that 1 ha of land is needed per MW of solar PV installed. The cost of land in Honiara is estimated in US$12.5/m2, which represents twice the cost of land in the outstations. However, given that 0.4 MW will be installed in SP rooftop, land has only been accounted as cost for the remaining 1.5 MW. This cost represents US$190,000.

OPEX costs

32. The O&M costs are estimated based on the real costs of the existing Henderson solar plant and current costs of maintaining and operating the transmission infrastructure in Honiara. Together, the annual O&M costs associated to the generation equipment and the line extension for power evacuation between the new and the existing Henderson plants are estimated in US$51,000. Over the lifetime of the project, these costs represent US$0.86 million and were accounted from year 3 of the project onwards; this is, once completed the implementation works of the capital assets.

Project benefits

Fuel costs of the counterfactual using diesel thermal power generation

33. The avoided fuel costs of the counterfactual constitute again the main economic benefit associated with solar power generation. These avoided costs are calculated based on the diesel supply requirement of producing electricity equivalent to that generated from the overall 1.9 MW of solar PV power plants. As mentioned above, the counterfactual is assumed to be diesel thermal power generation.

34. Overall, the avoided diesel fuel expenditures are estimated in US$ 10.60 million over the lifetime of the project. This cost was calculated based on an assumed diesel generation capacity factor of 46% as per the existing diesel thermal plants currently operating in the country and a diesel cost of US$ 0.74 per liter consumed in Honiara and in the first year of operation of the project, 2020. This cost adds freight, local commissions, sale taxes and overhead costs of delivering the fuel to the outstations to the international crude oil price. This price was assumed to increase from US$64/barrel in 2017 to US$72/Barrel in 2025, and up to US$86/Barrel by 2045. These projections through 2045 are based on the World Bank commodities price forecast released on April 26, 2017.

Avoided diesel CAPEX

35. While the counterfactual scenario does not contemplate adding any extra capacity, it was assumed that a replacement of the diesel thermal generators would have to take place in 20 years. This assumption was made based on observation of performance of the existing thermal capacity. Assuming a diesel capex cost of US$1.67/W[63], these savings add to US$0.65 million over the lifetime of the project.

[63] Estimated cost of diesel thermal generation capacity in grid-connected plants as observed in recent analysis conducted for Solomon Islands. See Tina River Hydropower Development project (P161319).

Avoided diesel O&M

36. The diesel thermal plants operating costs are reported to be roughly US$14,100/ GWh. Therefore, the annual avoided O&M costs add to US$0.04 million and US$ 0.74 million over the lifetime of the project.

Avoided local environmental damage costs

37. The damage costs for particulate matters (PM10), nitrogen oxides (NOx) and sulfur oxides (SO2) from diesel generation plants are from the latest version of the World Bank's Guidelines for Economic Analysis of Power projects (which are based on the 2015 Update of the Six Cities Study). These costs are detailed in Table 1. Assuming an affected population of 0.1 million[64], the benefits from avoided local environmental impacts add up to US$ 0.02 million over the project's lifetime.

Avoided global environmental damage cost

38. The emissions of diesel based generation displaced by solar power generation are estimated using an emission factor of 0.66 kg/GWh. The carbon emission reductions are valued based on the World Bank Guidance on the Social Value of Carbon (released on July 2014) and using the base case values of US$30 in 2015 through US$80 in real terms by 2050. Correlating the values forecast to 2017 prices, it is estimated that the benefits from avoided global environmental damage cost are US$1.80 million and the solar farms can avoid over 52 341 tons of GHG emissions (undiscounted) from being released to the atmosphere. The abatement cost is -114.58US$/ton.

Non-quantified benefits

39. It is expected that this component of the project will bring the following additional benefits: (i) energy security, (ii) macroeconomic benefits through the development of local know-how on solar technology, (iii) employment generation and; (iv) economy of scale benefits, which can help facilitate further reductions in cost of PV and, potentially, the development of manufacturing industries. These benefits are difficult to quantify or uncertain and thus, they have not been included in this economic analysis.

Economic analysis

40. In addition to the costs and benefits noted in the previous section, the economic analysis rests on the following additional assumptions:

- Discount rate for calculation of NPV: 3 percent as per the World Bank Interim Guidelines' (issued in May 2016) recommendation of using a discount rate equivalent to twice the average rate of growth of the projected GDP per capita in real terms. Since the real GDP per capita of Solomon Islands is projected to grow at an average rate of 1.3 percent during the project period, a discount rate of three percent has been used in the economic analysis by rounding out the discount rate implied by the guidance

[64] Based on existing literature on previous renewable energy projects conducted in the Solomon Islands, such as Tina River Hydropower Development project (P161319).

- The implementation works in the 0.4 MW site would take place on year 1 and the remaining 1.5 MW would be implemented on year 2.
- Based on the existing plant in Henderson, a capacity factor of 17.5 percent was assumed for the solar farms.

41. The resulting energy balance is shown in Table 7.

Table 7. Project energy balance

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2043	2044
New capacity	[MW]	0.40	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Solar CF	[%]	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Solar generation	[GwH]	0.61	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91

Results

42. The economic analysis shows that this proposed component of the project is economically viable after the consideration of environmental externalities. The ERR of the proposed solar farms against the counterfactual scenario comprising the existing diesel thermal plants is 13.1 percent (NPV US$7.75 million). These returns are inclusive of local and global environmental benefits, which add 2.2 percentage points (NPV US$1.77 million) to the ERR (Table 8).

43. Table 9 shows the calculations of the economic returns for 3 percent discount rate. This table also shows that the levelized cost of electricity (LCOE) of the solar farms modeled in this component, US$0.11/ kWh, is lower than the LCOE of the counterfactual scenario (US$0.23/ kWh).

44. The expenditures incurred on the capital infrastructure are the largest cost of the project; over 78 percent of the overall cost. The analysis estimates that almost 89 percent of the economic benefits come from avoiding diesel fuel expenditures. The NPV of the project, including environmental local and global benefits, indicates US$7.75million. A sensitivity analysis was conducted on this component at a discount rate of 6 percent. A discount rate of 6% leads to an NPV of US$3.98 million including local and global environmental benefits (Table 9).

Table 8. Summary of Economic Analysis

		NPV	2018	2019	2020	2021	2022	2023	2024	2025	2026	2043	2044
Solar Generation													
Capital cost	[$USm]	*4.68*	0.79	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M	[$USm]	*0.84*	0.00	0.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Incremental T&D Costs	[$USm]	*0.28*	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Incremental T&D O&M Costs	[$USm]	*0.02*	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
total costs	**[$USm]**	***6.00***	**0.98**	**4.45**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**
Avoided diesel capex	[$USm]	*0.65*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avoided diesel fuel expenditures	[$USm]	10.60	0.11	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.57	0.63	0.64
Avoided diesel O&M	[$USm]	0.74	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Land cost	[$USm]	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total benefits	**[$USm]**	*11.98*	**0.12**	**0.60**	**0.60**	**0.60**	**0.60**	**0.61**	**0.61**	**0.61**	**0.61**	**0.67**	**0.68**
Total economic flows	**[$USm]**	5.98	**-0.86**	**-3.85**	**0.55**	**0.55**	**0.55**	**0.56**	**0.56**	**0.56**	**0.56**	**0.62**	**0.63**
ERR	[%]	**10.9**											
Local environmental impacts	[$USm]	*0.02*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Economic flows including local environmental impacts	[$USm]	6.00	-0.86	-3.85	0.55	0.55	0.55	0.56	0.56	0.56	0.56	0.62	0.63
ERR including local environmental impacts	[%]	**10.9**											
Avoided GHG emissions	[$USm]	*1.76*	0.01	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.14	0.14
Economic flows incl. global GHG benefits	**[$USm]**	**7.75**	**-0.84**	**-3.78**	**0.62**	**0.63**	**0.63**	**0.63**	**0.64**	**0.64**	**0.65**	**0.76**	**0.77**
ERR including global GHG	[%]	**13.1**											
ERR target	[%]	3.0											

Table 9. Summary of the economic returns

	Discount rate		3.0%	6%
[1]	**Economic rate of return**			
[2]	ERR	[%]	10.9	10.9
[3]	ERR+local externalities	[%]	10.9	10.9
[4]	*ERR+local+GHG*	[%]	13.1	13.1
[5]	Levelized cost of solar PV	[US$/kWh]	0.11	0.10
[6]	Levelized cost of diesel generation	[US$/kWh]	0.23	0.22
[7]	**Composition of NPV**			
[8]	Land cost	[$USm]	0.18	0.18
[9]	Capital costs	[$USm]	4.68	4.44
[10]	T&D costs	[$USm]	0.28	0.27
[11]	Generation O&M	[$USm]	0.84	0.58
[12]	T&D O&M	[$USm]	0.02	0.01
[13]	**total costs**	**[$USm]**	**6.00**	**5.47**
[14]	*Benefits [avoided capex and fuel]*			
[15]	Avoided diesel fuel	[$USm]	10.60	7.38
[16]	Avoided diesel capex	[$USm]	0.65	0.36
[17]	Avoided diesel O&M	[$USm]	0.74	0.52
[18]	**total benefits**	**[$USm]**	**11.98**	**8.26**
[19]	**NPV (before environmental benefits)**	**[$USm]**	**5.98**	**2.79**
[20]	local env. benefits: avoided grid gen.	[$USm]	0.02	0.01
[21]	NPV (incl. local environmental benefits)	[$USm]	**6.00**	**2.80**
[22]	value of avoided GHG emissions	[$USm]	1.76	1.18
[23]	**NPV (including environment)**	**[$USm]**	**7.75**	**3.98**
[24]	Lifetime GHG emissions, undiscounted	[tons CO2eq]	-52341.2	52341.2
[25]	Marginal abatement cost	[$/ton]	-114.58	-53.45

Sensitivity analysis

45. Given the uncertainty around some of the variables affecting the economics of this component of the project, a sensitivity analysis was carried out on the most influential variables to analyze their impact on the project ERR. These variables are i) the solar PV capital cost, ii) the diesel fuel price, iii) the capacity factor of the solar farms, and iv) the diesel thermal plant capacity factor. The switching values analysis is summarized in Table 10.

46. The switching value for the solar PV capital cost is US$6.90 /W, implying that the ERR would fall to the 3% baseline value of the discount rate if the solar PV capital cost increases by roughly two and a half times. The diesel fuel price would have to drop to 0.12US$/L in 2018 to make this component of the project breakeven. This means that the price of diesel fuel would have to decrease to US$0.12 per liter, for the

project's economic rate of return to be equal to the discount rate. Similarly, the switching value of the solar farm capacity factor decreases to 7.6 percent, this is 9.9 percentage points lower than its original value of 17.5 percent.

Table 10 – Switching Values

Input	Unit	Baseline Value	Switching Value
Solar PV capital cost	US$/Watt	2.60	6.90
Diesel fuel price (2018)	US$/L	0.74	0.12
Solar farm capacity factor	%	17.5	7.6

Financial analysis

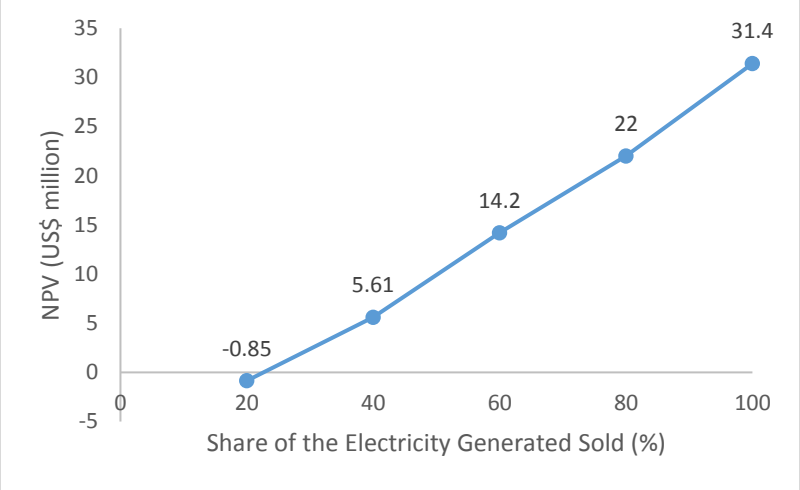
47. The financial analysis for this component of the project was carried out by valuing the additional electricity delivered by project in financial terms. To do so, the following taxes were considered based on existing and planned mini-grids conducted by SP as cited across this study:

- taxes on capital cost account for 30 percent of the capital investment and 7.5 percent of the transmission and distribution costs,
- taxes over labor for O&M of the generation assets or the distribution infrastructure is 40 percent of the total O&M cost,
- it was assumed that taxes over land add 7.5 percent of its total value,
- a 20 percent lump sum was added to cover contingency measures, in case these needs to be applied.

48. The WACC was calculated based on 86.4% IDA credit over the overall IDA financing and grant funds for the remaining amount. Including a 4% on-lend margin on the IDA credit, the WACC is 3.33% excluding taxes. Based on the discussions with the utility, a tariff of US$0.65/ kWh until 2020 with a subsequent 20 percent drop over this price was considered in this financial analysis. The FIRR reaches 34.1 percent under the assumption that all electricity generated is sold (Table 11).

49. A sensitivity analysis was conducted to test the response of the NPV with lower amounts of electricity sold, as there is an element of uncertainty around the number of new connections that will materialize once this component of the project is implemented. The sensitivity analysis considered additional scenarios in which the electricity sold is respectively 80 percent, 60 percent, 40 percent and 20 percent of the electricity generated in this component of the project. Figure 3 represents the NPVs obtained under the different scenarios. According to the results obtained, this component of the project will be breakeven if roughly 20% of the electricity generated is sold.

Figure 3. NPVs of component 3 at different volumes of electricity sold.



Considerations on the level of tariff and resilience to tariff reductions

50. A major obstacle in expanding the use of electricity and promoting economic development is the high average retail electricity tariff of approximately US$65 cents/kWh, which is the highest in the Pacific and among the highest in the world. It is expected that the substitution of diesel generation, through this and other projects that SP is undertaking, will enable tariff reductions in the future[65]. This analysis considers a 20 percent drop of the current tariff by 2020, but further reductions may be possible. The financial model shows that the investment on hybrid mini-grids would be less resilient to tariff reductions than the investments on grid-connected solar plants. The mini-grids component becomes breakeven when considering the current tariff until 2020 and a drop down to US$0.14/kWh afterwards. At this tariff, the grid-connected investment would still be financially viable, with a NPV of US$3.35 million. Thus, the financial analysis identifies the lower tariff threshold at US$0.14/kWh, which is set by the hybrid mini-grids financial viability. This calculation of the lower tariff threshold is intended to demonstrate resilience of the financial viability results to tariff reductions, and a simplified indication of the tariff level needed to recover the project's investment and O&M levels. It does not reflect the potential or feasibility of general tariff reductions in the wider energy system of the country, which would also depend on other factors.

[65] A specific willingness/ability to pay analysis was not performed as part of this work. However, analysis performed in the Electricity Access Expansion Project (P151618) indicates a willingness to pay of US$ 28/month for rural areas of Solomon Islands and an average consumption of 30kWh per month, which implies an upper tariff limit of US$0.93/kWh, although this value is very high when compared to people's average incomes.

Table 11 – Financial Internal Rate of Return of Component 3 in nominal terms.

		NPV	2018	2019	2020	2021	2022	2023	2024	2025	2026	2043	2044	2045
Benefits														
Electricity generated	[GWh]		0.61	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Electricity tariff	[USD/KWh]		0.65	0.65	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Government grants	[$USm]		0.32	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Revenues	[US$ m]	*38.51*	0.72	3.17	1.63	1.67	1.71	1.76	1.80	1.85	1.89	2.88	2.95	3.02
Costs														
Tax over capital costs	[$USm]	*6.33*	1.05	5.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax over incremental T&D costs	[$USm]	*0.32*	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax over O&M costs	[$USm]	*1.61*	0.00	0.00	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.13	0.14	0.14
Tax over T&D O&M	[$USm]	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax over land	[$USm]	0.20	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contingency		*0.98*	1.01	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.75	0.00	0.00	0.00
Net financial flows	[$USm]	***29.05***	**-1.55**	**-2.83**	**1.55**	**1.59**	**1.63**	**1.67**	**1.72**	**1.76**	**1.80**	**2.74**	**2.81**	**2.88**
FIRR	[%]	34.1												

ANNEX 5: SCALING-UP RENEWABLE ENERGY PROGRAM IN LOW INCOME COUNTRIES

COUNTRY: Solomon Islands
Electricity Access and Renewable Energy Expansion Project

Results Framework

Indicator	SREP funded project	Transformational Scale up[66]
Annual electricity output from RE as a result of SREP interventions (GWh)	5.66 GWh	102.9GWh[67]
Number of women and men, businesses and community services benefiting from improved access to electricity and fuels as a result of SREP interventions	9,345 people including 4,579 women[68] 150 businesses and community services	289,431 people including 141,821 women 8,946 businesses and community services
Financing leveraged through SREP funding [$ million]	US$15.5 million split as follows: SIDS DOCK: US$1.60m GEF: US$0.95 m IDA: US$10.30m GPOBA[69]: US$2.23m Gov. contr. US$0.33m Private sector US$0.09m	US$ 170 million
SREP leverage ratio [1:X]	1:2.2	1: 24
Tons of GHG emissions reduced or avoided -Tons per year [tCO_{2eq}/yr] -Tons over lifetime of the project [tCO_{2eq}]	3,876 tCO2eq/yr 96,889 tCO2eq over 25 years lifetime	355,825 tCO2eq

[66] *Based on Solomon Islands Government's Intended National Determined Contribution (INDC) target by 2030, http://prdrse4all.spc.int/system/files/solomon_islands_indc.pdf.*
[67] Based on 47MW as per the Solomon Islands INDC document cited above and average capacity factor of 25%.
[68] The number of beneficiaries has been estimated on the basis of 1,350 households, 75 microenterprises and 75 community services. The average household size in Solomon Islands is 5.7 people per household (source: Solomon Islands 2012/13 Household Income and Expenditure Survey). It is estimated that 49% of the population is female (source: World Development Indicators). An estimate of 2 beneficiaries has been used per microenterprise and 20 beneficiaries per community service.
[69] Mobilized through a separate project, the Electricity Access Expansion Project (P151618). See paragraph 6 for more details.

Co-benefits[70] :

- Enhanced energy security from the development of endogenous sources of renewable energy electricity
- Reduced dependency on imported fossil fuels
- Reduced carbon emissions through replacement of diesel generation with renewable generation.
- Better health services due to lighting in clinics and improved ability to store vaccines.
- Reduce safety hazards from use of traditional sources of energy (e.g. household fires from toppled kerosene lamps)
- Fostered economic development through job creation and income generation from productive uses of electricity
- Improved gender equality and women's socioeconomic status
- Promotion of a low-carbon development pathway.

Introduction

Country and sectoral context.

1. Solomon Islands is an archipelago consisting of six major islands and over 900 smaller islands and has a total land area of 29,900 km^2 spread over 1.34 million km^2 of ocean. The population of approximately 616,000 is dispersed across 90 inhabited islands and has among the lowest population densities and urbanization rates in the world, with approximately 20 people per km and 17 percent urbanization rate, respectively.[71] It also has one of the lowest GDP per capita among the Pacific Islands states. (approximately US$ 2,013). The country's recent history has been marked by intermittent political turmoil and civil unrest and natural disasters[72]. Since recovering from the 1998-2003 civil conflict, the country's commodity based economy remains fragile and vulnerable to external shocks.

2. Solomon Islands is highly dependent on imported, refined petroleum products to meet its energy needs for electricity generation, transport and lighting, which leaves the country vulnerable to global oil price fluctuations. Furthermore, it has one of the highest electricity retail tariffs in the Pacific region and in the world, with an average of US$65 cents per kWh in January 2017 (compared to approximately US$ 93 cents per kWh in 2014). In spite of the high electricity tariff, the overall electricity access rate is less than 20 percent, with an electrification rate below 5 percent in rural areas, home over 80 percent of the population.

3. According to the 2012/13 HIES, while 45 percent of the households are said to have access to electricity, majority of the households only have small solar panels, typically of 20 watts. The percentage of households supplied by the national utility SP is merely 12 percent nation-wide, most of which are located in Honiara, Solomon Islands capital city and largest load center. Data collected by *Doing Business* reveal that it takes approximately 53 days and costs 1,253.7 percent of income per

[70] Further co-benefits listed in paragraphs 21 to 24 of this section.

[71] Population data based on Solomon Islands 2012/13 Household income and Expenditure Survey – National Analytical Report [Volume 1], October 2015

[72] Earthquakes of April 2007 and February 2013 of magnitudes 8.1 and 8, respectively.

capita for a local business located in Honiara, to obtain permanent electricity connection and supply to warehouse[73].

4. The country's ability to provide reliable and affordable infrastructure services is constrained by its geographical spread, high energy cost and dependency on fossil fuels, which provide a low incentive to expand the distribution areas in underserved areas and thus, negatively impact the country's economic and social development. As part of its strategy to improve energy security, increase electricity supply and affordability, SP has embarked on the implementation of its least cost expansion plan, which requires the installation of over 54 MW new generation capacity. In addition, the country has developed comprehensive plan which outlines projects and interventions that would be needed to accelerate the development of renewable energy projects in the country; the SREP Investment Plan (the IP).

SREP Investment Plan

5. In May 2014, the government of Solomon Islands, through MMERE submitted an investment plan to the SREP sub-committee for endorsement for a funding allocation of US$ 15 million[74] of SREP funding to support a greater penetration of renewable energy and increased access to electricity in the country. The SREP IP was elaborated in consultation with all relevant government agencies and with the support of the World Bank and the Asian Development Bank. The total funding envelope presented under the SREP IP amounted to US$40.3 million with co-financing from SIG, the private sector and the two MDBs. The financing plan envisaged at the time of preparing the SREP IP is presented below.

Table 1: SREP IP indicative financing plan (2014)

		Private Sector	SREP	ADB[1.]	World Bank[1.]	Government/ SIEA	Total
Preparation of Investment Proposal			0.3				0.3
Regional Component[2.]			1.0				1.0
Renewable Energy Access Project (World Bank supported)							
1.	Renewable Energy Mini-grids	3.0	5.4	-	2.5	2.0	12.9
2.	Grid Extensions	-	-	-	3.5	3.0	6.5
3.	Project Preparation	-	0.5	-	-	-	0.5
4.	Technical assistance	-	1.0	-	1.0	-	2.0
	Subtotal	**3.0**	**6.9**	**0.0**	**7.0**	**5.0**	**21.9**
Solar Power Development Project (Asian Development Bank supported)							
5.	Grid-connected solar power	-	3.8	4.5	-	1.5	9.8
6.	Household solar	1.0	1.0	1.0	-	1.0	4.0
7.	Project Preparation	-	1.0	-	-	-	1.0
8.	Technical assistance	-	1.0	1.0	-	-	2.0
	Subtotal	**1.0**	**6.8**	**6.5**	**0.0**	**2.5**	**16.8**
	Total	**4.0**	**15.0**	**6.5**	**7.0**	**7.5**	**40.3**

Source: ADB/WB/Solomon Islands Government estimates
1. Financing by ADB and WB may be provided as either loan or grant (or both) depending on Solomon Islands governments decision for utilizing country allocation of respective agencies.
2. Activities to be presented under a separate proposal

[73] Source: World Bank, Doing Business 2017 Equal Opportunities for All - Economy Profile 2017: Solomon Islands

Box 1: Solomon Islands Electricity Access and Expansion Project

The Bank has approved the US$2.23million Solomon Islands Energy Access Expansion Project, supported by the Global Partnership for Output Based Aid (GPOBA), in July 2016 (and a supplementary grant of US$0.27 for project supervision). The project development objective is to increase access to electricity services in low-income areas of Solomon Islands, by providing targeted subsidies to low-income households, micro-enterprises and community services to help new customers pay the initial connection fee and basic internal wiring. It will cover connections to the grid both in peri-urban areas within existing grid coverage and at planned outstation mini-grid areas.

Initial connection fees and internal wiring have been found to be major impediments to increasing the electrification rate in the country. Under the project the Solomon Power will use their own staff and subcontractors for service line installation and connections, and will hire licensed electrical contractors competitively to complete the internal wiring. It is expected that through hiring services in bulk (for extension of service lines and in-house wiring), economies of scale and cost reductions may be achieved. The subsidy per connection in the Honiara grid area is US$794 (SBD6,354), and the subsidy per connection in the outstations is USD994 (SBD7,954). The OBA subsidy accounts for 72 percent of the total cost of a connection and wiring in Honiara, and 79 percent at outstation areas. Users from Honiara will contribute US$100, whereas users from outstations will contribute US$50. The OBA subsidy is disbursed on the basis or results: i.e., upon verification of correctly installed and functioning electricity connections.

The first pilot connections were completed in January 2017 in peri-urban Honiara and initial feedback from SIG and beneficiaries is very positive and there would be interest in expanding the program to more beneficiaries. By May 2018, a total of 354 households have been connected, with 132 additional connections currently being verified. The project experienced a slow start due to issues that have now been resolved so the number of connections is now expected to accelerate significantly. By the end of the 5-year program it is expected that a total of 2,240 low income households, 124 community services and 124 micro-enterprises equating to approximately 15,498 people, will benefit directly from the project. The project closing date has been extended to March 31, 2020, allowing more time for all the connections targets under the project to be achieved.

6. Subsequently to the endorsement of the SREP IP and given the limitation in IDA availability, the World Bank decided to implement the Renewable Energy Access Project presented in the IP, under two standalone operations:
   - The Solomon Islands Electricity Access Expansion Project (EAEP), US$2.23million supports electricity connections to low income households under an output based mechanism. The EAP is financed by the Global Partnership for Output Based Aid – see Box 1 for more details; and
   - The Electricity Access and Renewable Energy Expansion project (or the Project); which forms the basis of this proposal.

7. The Project financing amounts to US$19.95m with funding provided by IDA (US$10.3 million), Small Island Developing States Initiative – SIDS-DOCK - (US$1.6 million), the Global Environment Facility (US$ 0.95 million) and SREP (US$7.1 million).

Project description

8. The project development objective is to increase access to grid-supplied electricity and increase renewable energy generation in Solomon Islands.

9. The Project is split into four components, as follows:

- **Component 1 — Renewable energy hybrid mini-grids (US$10million).** Component 1 would finance new hybrid mini-grids throughout Solomon Islands. SP has identified a long list of 35 potential locations suitable for mini grids taking into account population density (number of households), public facilities such as hospitals and schools, 'anchor' loads such as tourism facilities, food processing or other commercial operations, and potential sources of renewable energy sources (mainly solar PV). These 'candidate' mini-grids are located in Central Province, Choiseul, Guadalcanal, Isabel, Makira, Rennel, Temotu and Western Province. SP has established a process of prioritizing those mini-grids based mostly on the average cost per connection, accessibility and safeguards considerations, namely land availability.[75] Additional feasibility studies will be conducted by SP in the priority sites to determine their suitability.

- **Component 2 — Connections to low income households (US$1.5million).** This component would finance household connections to low income households, through an output based aid (OBA) mechanism, building on the EAEP. This component would provide one-off OBA subsidies to eligible low-income households to cover a portion of the upfront cost of electricity service connections in the Honiara grid (existing service area and planned expansion areas), and in the outstations including those being developed through Component 1, and possibly others. Eligibility criteria will be based on the geographic location, self-selection. Consumers will apply for a service connection as per current processes.[76]

- **Component 3: Grid-connected solar power (US$ 5 million).** Component 3 would finance the supply and installation for one or more grid-connected solar facilities in Solomon Islands and the corresponding technical assistance. This facility(ies) would be developed on the basis of an EPC contract, and with an option for a maintenance contract for an initial period of 3-5 years. Ownership and future operation will remain with SP. The displacement of fossil fueled generation is expected to improve energy affordability, relative to the present, and contribute to further improvements in the financial performance of SP.

- **Component 4 — Enabling Environment and Project management (US$ 3.45million**). This component will focus on project management costs and technical assistance to SP as well as technical assistance for MMERE to enabling environment and framework for increasing electricity access and the penetration of renewables in Solomon Islands.[77] Financing will be provided to SP for project staff, additional feasibility studies as may be needed, the recruitment of an owners' engineers and for safeguard studies. With regards to MMERE, while the areas for support are being discussed and finalized, examples of possible areas are as follows: (i) development of a comprehensive electricity access strategy for the country (development of technical standards, institutional and implementation arrangements, financing needs and mechanisms); (ii) financing of upstream

[75] When calculating the average cost per connection will mostly depend of the total costs and population to be covered, but a number of factors comes into play, such as the costs linked to accessibility and logistics, environmental considerations and gender – currently under discussion.
[76] Under the current program and in order to qualify, consumers will fall into the following criteria: (i) beneficiaries fall under the prepaid residential category; (ii) beneficiaries do not have a previous connection under their name; (iii) service connection is capped to 10 A for a period of 12 months; and (iv) service connections are individual, and cannot be shared with other households.
[77] Although some areas had been indicated under the SREP investment plan – such as the need to standardize and streamline the approach for land acquisition for distribution extensions and small mini grids – according to MMERE this support is no longer needed.

technical assistance facilitate additional private sector investment in the sector (identification of investments, PPP arrangements, suitable arrangements for concession agreements, licensing framework, etc.) (iii) update of cost of service and tariff studies; (iv) training of electricians.[78]

10. **SREP Additionality.** Project supports the most important priorities of the SIG in the energy sector: increased access, greater affordability of electricity services and enhanced energy security. The SREP funds are critical to demonstrate the viability of hybrid solar-diesel mini-grids systems and enhance the capacity of the government to deliver on the RE agenda and to strengthen the institutional framework for a greater involvement of the private sector. Given the nascent stage of RE development in Solomon Islands, SREP financing is key to demonstrate viable approaches, reduce regulatory, financial and capacity barriers while creating the conditions for future replication and scale up.

11. Access to electricity is Solomon Islands is low (20 percent). The remoteness, lack of economies of scale, and poor infrastructure mean that to cost of providing electricity, including through conventional fuels, is high. Solomon Islands has an untapped potential for renewables, especially solar. The project would help demonstrate the viability of renewable energy base mini-grids as the best alternative for electrification. The use of SREP grant funding would be critical to lower the high upfront costs of solar-based renewable energy generation in a dispersed, island nation, thereby making end-use customer tariffs more affordable. SREP support for component 4 would allow for upstream work to be developed to attract additional private sector investment going forward. SREP support would also help increase the availability of renewable energy in rural areas, therefore reducing the dependency of fossil fuel. Solomon Islands is currently almost 100% dependent of fossil fuels. The proposed project is also highly complementary to other current or pipeline projects in the country, such as the Asian Development Bank (ADB)-supported project to hybridize existing diesel mini-grids, or plans by New Zealand to finance complementary mini-grid investments.

Assessment of Proposed Project with SREP Investment Criteria

12. **Increased installed capacity from renewable energy sources.** The Project will facilitate additional 3.4MW of solar generation capacity, including approximately 1.5 MW through the hybrid mini-grids This will be equivalent to an aggregate of approximately 5.66 GWh generated from renewable energy annually.

13. **Increased access to energy through renewable energy sources.** The primary beneficiaries of Component 1 (hybrid mini-grids) and Component 2 (Connections to low income households) are the households in the planned outstation mini-grid areas as well as those in the peri-urban areas within existing grid coverage and the planned extension of the Honiara grid. The proposed project will improve access to electricity to approximately 9,345 people including 4,579 women. This represents a total of 1,500 connections, including 1,350 households (of which approximately 10 percent are female-headed), and 150 businesses and community infrastructure in low income areas.[79]

[78] As mentioned above, one area that has been highlighted as a bottleneck in the process of extending access to the grid to households that are currently not being served, is the limited number of licensed electricians that can install the internal wiring in new households to be connected to the grid (only 60 active licensed electricians and all in Honiara).

[79] The total number of people is derived from the number of new household connections by the average household size in Solomon Islands (5.7 people per household). Solomon Islands 2012/13 HIES.

14. **Low Emission Development.** The Project will contribute to a reduction of GHG emissions by 3,876 tCO2eq per year and 96,889 tCO2eq over the life of the investments, which is estimated to be 25 years. This has been estimated using the marginal generation displaced by the project and assuming an emission factor of 0.66 kg/kWh for diesel.[80]

15. **Affordability and competitiveness of renewable sources.** The project will facilitate access to additional people to electricity networks, while improving sustainability and affordability through the replacement of diesel generation with more affordable sources of power. At US$65 cents/kWh, SP has highest electricity rate in the Pacific and among the highest in the world. The project economic analysis identified that the project will avoid over $21.6 million in diesel related costs which will facilitate tariff reduction by reducing the level of diesel dependency, generating clean and sustainable energy and subsidizing connections to over 1500 low income families, schools and health centers. Although no affordability survey has been conducted, it is understood that the expensive tariff is one of the major factors for the extremely low annual consumption per capita. Having said this, unelectrified households currently spend a significant amount on expensive alternative sources of energy such as kerosene lamps, candles, and charging of batteries and mobile phones at diesel-based charging stations, while grid-supplied electricity, albeit expensive by international standards, is still more economical than the currently available alternatives. The willingness to pay has been estimated at US$28 per month for rural areas of Solomon Islands, by comparing what communities were spending on alternative sources of power. At the current tariff levels (which would be applied on a uniform basis countrywide), this means that for the average consumption of 30kWh per month, customers would be saving on average 30 percent on their energy expenditure. A cost of service and tariff study has been conducted in 2015, taking into account the generation mix at the time and forecasting a progressive introduction of alternative renewable sources into the generation mix (i.e. hydro and solar) along with a customer growth rate of 12 percent per year. The study concludes that the tariff would be reduced going forward with the introduction of additional RE generation. However, the study does not consider the possible increased costs of delivery through mini-grid (vs grid). Discussions are ongoing to include, under Component 4 of the project, the financing of an update to the cost of service and tariff study to take into account SP's plans to expand significantly into outstations in the future.

16. **Productive uses of energy.** Increased energy access the hybrid mini-grids will stimulate income-generation activities the development of productive uses and job creation in rural areas. Small business owners and household beneficiaries will be able to extend the running hours of services such as charging stations, barber shops, tailor shops, grocery stalls, saw mills and grocery shops. mini-grids have the advantage of being able to provide high levels of power to support productive loads in remote areas (e.g., commercial, light industrial, agricultural processing, etc.), while stimulating employment and providing added value for local economic development. Experience has shown that rural electrification can lead to economic and social development, but targeted assistance may be required to encourage beneficiaries offset the upfront cost of connecting to electricity. This will partially be provided through the Project's component 2 (connection of low income households).

17. **Economic, social and environmental development impact.** The Project will contribute to stabilizing and reducing prices over the longer term through fuel diversification. It will assist SP to integrate renewable energy into the grid and MMERE and the Government to improve longer term

[80] Tina River Hydropower Development Project (P161319)

sustainability for the sector through a lower dependence of volatile fuel prices. In addition, it will foster the expansion of electricity infrastructure for economic and social development using low carbon sources through (i) improved electricity services in rural areas, (ii) accrued educational and health benefits due to reduced air pollution from reduced use of kerosene, (iii) reduced GHG emissions from using renewable energy sources, and (iv) increased opportunities for income generation through promoting productive uses of electricity.

18. **Economic and financial viability.** The economic analysis shows that Component 1 and Component 3 are economically viable. Regarding component 1, the baseline economic rate of return (ERR) of the proposed hybrid solar/diesel mini-grids against the counterfactual scenario is 6.7percent (NPV US$ 3.43million), which is above the 3% hurdle rate for Solomon Islands. These returns are inclusive of local and global environmental benefits, which add 1.5 percentage points (NPV US$1.50 million) to the ERR. This economic analysis uses fully diesel-powered mini-grids as the counter factual to the solar-diesel hybrid mini-grids, which are designed to supply 24/7 (service tier 4[81]). The financial analysis for this component of the project was carried out by valuing the additional electricity delivered by the project in financial terms. The financial internal rate of return (FIRR) is 47.2 percent, reflecting US$7.95 million grant financing in this component. The baseline ERR of component 3 is 13.1 percent (NPV US$ 7.75 million), again above the 3% hurdle rate. These returns are inclusive of local and global environmental benefits, which add 2.2 percentage points (NPV US$ 1.77 million) to the ERR. This economic analysis uses the existing diesel powered thermal plants in Guadalcanal province as the counter factual to the grid-connected solar power farms. The financial analysis of this component indicates and FIRR of 34.1percent, reflecting US$1.5 million grant financing.

19. **Leveraging of additional resources.** The Project directly leverages financing resources from IDA, SIDS-DOCK and GEF totaling US$12.85 million. This is complemented by a parallel US$2.23 million financing from GPOBA to connect low income households to electricity (see Box 1) which will inform the implementation of the project component 2. Total co-financing is equivalent to US$15.5 million, including contributions of US$0.33 million from SP, and US$ 0.09million from customers/private sector to cover the service connections required to connect new customers under Component 2. Thus, US$1 of SREP funding leverage approximately US$2.18 of additional financing.

20. **Gender.** Gender gaps in the Solomon Islands are pronounced in the areas of (i) economic opportunity, with 76% of women concentrated in subsistence activities compared to 50% of men in rural areas, and only 30% of women compared with 51% of men in paid work in urban areas; (ii) women bear a high share of the burden of family care responsibility which reduces their time availability for potential productive activities; (iii) high levels of violence against women; and (iv) overall low participation in decision making at all levels. In the energy sector, gender inequality is pronounced and this stems from the women being primarily employed in traditional administrative or finance roles. Most of positions within the energy sector are technical roles, and traditionally women have not considered these types of roles as viable career paths, nor have they been encouraged to pursue these roles by their employees. The PPA benchmarking 2017 (2015 data) reports that 21.3% of the total workforce employed in Pacific power utilities are women, with 4% of female representation in technical levels. SP recognizes the stark gender gap and is committed to improving gender equality within the power sector. As a consequence, the project will target employment of women in the energy sector in three

[81] The Sustainable Energy for All Multi-tier Framework measures access on the tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access). See: *http://trackingenergy4all.worldbank.org*.

specific ways. First, the project will design and implement a program employing rural women in maintaining solar panels and sites. Secondly, to increase the share of women employed, it will also assess the main barriers for women to access technical and managerial roles, and design measures to address these. Thirdly, findings from the private sector in Solomon Islands confirms that women are experiencing sexual harassment in the work place and that absenteeism is linked to the experience of gender based violence (GBV). Following, to enhance the working environment for women in the energy sector, the project will in close collaboration with IFC support SP follow up on the Waka Mere Commitment to Action it has signed on to, with regard to implement GBV policies as well as to develop supportive and respectful workplaces. This will include setting up a framework at SP to build a productive and respectful workplace culture and implement a workplace response to domestic violence. The project will monitor activities through sex-disaggregated data regarding beneficiaries with respect to households connected to the mini-grids, and subsidy beneficiaries and the project results framework will further include indicators to track progress towards addressing the relevant gender gaps which have been identified.

21. **Co-benefits of renewable energy scale up**. The Project is expected to have several co-benefits at both local and global scale.

    a) Environmental and health co-benefits. The Project will contribute to the reduction of greenhouse gas (GHG) emissions and for SIG to achieve its Intended Nationally Determined Contribution (INDC) commitment. SIG's INDC is to reduce GHG by 18,800 tons of carbon dioxide equivalent (tCO_{2eq}) per year by 2025 and by 31,125 tCO_{2eq} per year by 2030. The Project helps reduce GHG emission by 96,889 tCO_{2eq} over the life of the project (estimated to be 25 years). The health benefits of electricity stem from cleaner air, reduced risk of burns, fires, and accidents, better nutrition and food safety from refrigeration, and improved health knowledge from access to communications and mass media, as well as, ultimately, improved health services due to electrification of health clinics. There is some emerging (although still limited) evidence that women and children are those who benefit most from the switch from health-damaging kerosene lighting. A recent study reports that accidental ingestion of kerosene is the primary case of child poisoning in the developing world, and a frequent cause of infant burns (e.g. in Bangladesh, kerosene lamps are responsible for 23 percent of infant burns). In addition, women and children spend a larger proportion of their time indoors and thus experience a greater exposure to pollutants than males.

    b) Economic co-benefits. The economic benefit of the household connections derives from increased access to modern electricity services and a substitution away from lower quality or more expensive alternatives. The project will particularly target those customers that reside in areas with no grid coverage and are unlikely to have grid coverage in the near future. The main benefit type under Component 1 and 3 is the reduced spending on diesel fuel for electricity generation compared to the baseline fuel use in the existing village generators and co-generation gensets, given that the majority of Component 1 and 3 sites already have existing distribution infrastructure and several diesel generators. Enhanced energy security through reduced dependence on imported fossil fuels and traditional sources of energy will be achieved. In addition, the project will generate employment opportunities, mainly from construction, operation and maintenance of RE based mini-grids. Increased access to electricity will support income generating activities through fostering productive uses. The economic co-benefits of the project include:

- Downward pressure on affordability of electricity.
- Improved balance of payments due to reduced fossil-fuel imports and reduced outflow of foreign reserves.
- Employment opportunities during project construction stage and then after for O&M.
- Increased economic activity due to ability for households and small businesses to generate additional income through value-adding, particularly for agri-business.
- Increased empowerment of women who receive proportionally higher benefits from increased access to energy.

c) Social co-benefits. The social co-benefits result from improved access to electricity through renewable energy sources that is expected to help reduce the physical burden associated with organizing alternative energy sources. Access to electricity is expected to have positive benefits, particularly for women, by releasing valuable time spent on household chores to engage in income generation activities widening their employment opportunities (including in the renewable energy supply industry). Access to clean energy can go a long way in improving health and reducing premature mortality, especially among women and children, by reducing reliance on fuels such as kerosene for lighting and lowering indoor-air pollution. Clean, improved, and reliable lighting can also increase the opportunities for learning/education of children. Furthermore, access to electricity can help households engaged in agricultural and food production activities to use improved technologies such as water pumping for irrigation, grinders, millers, etc. impacting food security and income generation.

22. **Monitoring and Evaluation.** Overall monitoring and evaluation of the project activities would be performed by the SP. It that capacity it will have the responsibility to collect data and report on the performance indicators on a six-monthly basis for the PDO indicators and for the intermediate outcome indicators at the component level. The Project's result indicators and associated monitoring mechanisms are presented in Section VII (Results Framework and Monitoring) of the PAD.

Implementation Readiness

23. **Country/ sector strategies.** See Section I.C of the main PAD.

24. **Institutional arrangements.** The Ministry of Finance and Treasury (MoFT) will be the Recipient for the various financing and will enter into the Financing/Grant Agreements with the World Bank. Overall responsibility for oversight and implementation of the Project will lie with SP. SP will be the implementing agency for the project, and will sign Project Agreements with the World Bank, as well as Subsidiary Agreements with the Ministry of Finance and Treasury, passing on the financing. SP has been implementing Bank-financed projects for several years and has experience with World Bank project implementation, including with fiduciary and safeguard policies. SP is currently implementing two World Bank projects; (i) the SISEP, and (ii) the EAEP. The implementation arrangements proposed for the project build on previous experience managing other World Bank-financed operations with SP. A detailed description of the proposed mechanisms is presented in Annex 2 (Implementation arrangements).

25. **Sustainability.** See Section IV. C of the main PAD.

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