



TERMS OF REFERENCE

For

SAMARAI ISLAND SOLAR-DIESEL HYBRID POWER PROJECT

This document was prepared by:

System Loss Team

OFFICE OF THE COO
PNG Power Ltd
Cnr Wards Road & Cordia St
PO Box 1105, BOROKO
NCD, 111, Papua New Guinea

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1.0 INTRODUCTION

PNG Power Ltd (PPL) is a fully integrated power authority responsible for generation, transmission, distribution and retailing of electricity throughout Papua New Guinea and servicing individual electricity consumers. PNG Power Ltd also undertakes regulatory roles on behalf of the Independent Consumer and Competition Commission (ICCC). These responsibilities include approving licenses for electrical contractors, providing certification for models of electrical equipment and appliances to be sold in the country and providing safety advisory services and checks for major installations.

Moreover, PNG Power Ltd is a State Owned Entity (SOE). The Independent Public Business Corporation (IPBC) holds the shares for corporatized state entities as trustee of the General Business trust. The IPBC acts as the sole shareholder on behalf of the Government. The Minister for State Enterprises appoints a Board who reports to IPBC. PNG Power Ltd, through the Board provides regular financial and operational reports and a Five-year Business Plan to IPBC on an annual basis.

PNG Power Ltd is a vertically integrated business employing approximately 1750 people both permanent and casual employees and operating twenty one (21) power supply systems and six distribution and retailing centers.

PNG Power Ltd seeks reputable and competent energy firms to **Design, Supply & Install** a Solar-Diesel Hybrid Power System for its Samarai Island micro-grid system.

2.0 GENERAL OVERVIEW

Samarai Island is an historic island in the Milne Bay Province of Papua New Guinea. The island is currently serviced by a diesel based power system consisting of two (2) 80kW generator sets operated by PNG Power Ltd to maintain the standing system load at all times.

The proposed project here is to incorporate a completely new solar power with battery bank and a new diesel generator back-up as hybrid system to replace the existing generation plant.

This terms of reference (TOR) specifically seeks reputable energy firms to **Design, Supply & Install** the system to meet our specific requirements outlined in this TOR.

3.0 PHYSICAL MAPPING

3.1 GPS Coordinates

Samarai Island is located South East of Alotau town (coordinates: 10°36'49.56" S, 150°39'58.50" E).

3.2 Transport

Main transport to and from Alotau is by Dinghy. Tug Boats and Barges can be used to transport cargos. Dinghy fare from Alotau to Samarai Island is K30.00 per person one way.

3.3 Population

Samarai Island is historic island with most of the colonial residential buildings still tenanted. Currently a population of 450 people reside permanently on the island while people from the neighbouring islands of Sariba and Logea come to the island for marketing and shopping purposes.

3.4 Social & Economic Activities

The Island has;

- i. 1x Health Centre
- ii. 1x Primary School
- iii. 1x Elementary School
- iv. A local Level Government Office Complex

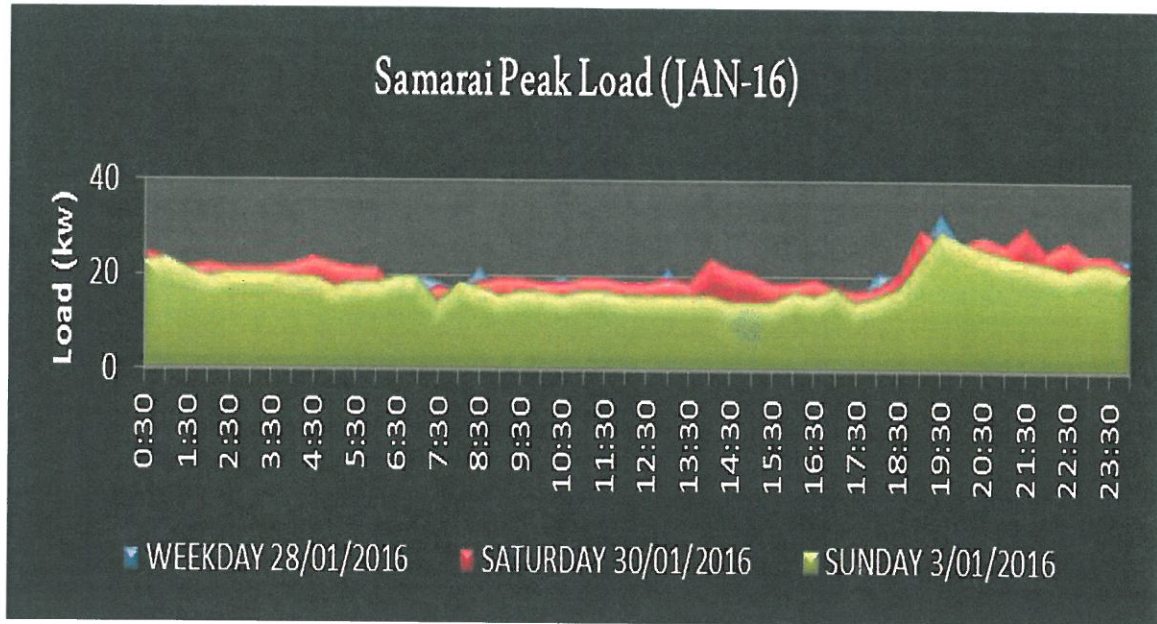
Economic activities on the Island include;

- i. 3x Trade Stores
- ii. A mini-retail Shop
- iii. 3 x Guest Houses. The guest house rates are at K180/night with 3 full meals.
- iv. A Pearl Farm

3.5 Load Demand

Currently a total of 90 customers are connected to the micro-grid through PNG Power Ltd credit meters.

The existing load demand of the island is shown in the graph below taken from 2016 statistics. The dates of maximum load captured during the month of January 2016 were selected for this graph.



Time	0:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00	5:30	6:00
Weekday	23	22	21	20	20	21	21	21	20	21	21	17
Saturday	25	24	22	23	22	22	22	23	24	23	22	22
Sunday	23	24	22	20	21	21	21	20	20	18	19	19
Time	6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00
Weekday	18	20	19	17	22	17	19	18	20	17	20	18
Saturday	17	16	18	17	19	20	20	19	19	20	20	19
Sunday	20	20	15	19	18	16	17	17	16	17	17	16
Time	12:30	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00
Weekday	17	22	17	17	18	18	18	19	17	16	16	21
Saturday	19	20	19	24	22	21	19	19	20	18	17	18
Sunday	16	16	16	16	15	15	15	17	16	18	15	16
Time	18:30	19:00	19:30	20:00	20:30	21:00	21:30	22:00	22:30	23:00	23:30	24:00
Weekday	20	25	34	27	29	27	26	26	25	25	24	24
Saturday	21	30	28	27	29	27	31	26	28	25	25	22
Sunday	18	24	30	28	26	25	24	23	22	23	23	21

4.0 TECHNICAL REQUIREMENTS

PNG Power Ltd wishes to invite reputable and equally qualified energy firms to submit bids for the **Design, Supply & Installation** of a complete Solar-Diesel Hybrid Power System for Samarai Island.

4.1 General Requirement

The proposed Solar-Diesel Generator Hybrid Power System under this Terms of Reference (TOR) must include but not limited to the following system of equipment;

- i. A PV Array System shall be designed to generate 800kWh of energy per day.
- ii. An Energy Storage System (ESS or Battery Bank) to store energy and supply the demand during evening hours and bad weather periods.
- iii. An inverter system of 100kW with 48V dc input and 415V ac output to charge battery bank and supply load demand
- iv. Control System to monitor demand and supply to ensure energy demand is met by the PV Array, Battery Bank or Diesel Genset in a safer manner giving maximum output and maintaining system integrity.
- v. A communication system to enable remote monitoring and data storage for reporting and maintenance purposes
- vi. The system shall be modular type to allow for further expansion when required.
- vii. Design shall also consider room to cater for incorporation of Wind Turbine system in the future.
- viii. System structures shall be designed to withstand wind speeds reaching 50km/h
- ix. Due to high atmospheric salt content the structures & components shall be corrosion resistant and be able to withstand such atmospheric conditions for more than 15 years.
- x. Supply & Installation of a reputable diesel generator with weather & sound proof canopy
- xi. All wiring and system designs must conform to Australia & New Zealand standards and other international standards.

4.2 Photovoltaic System

Environmental conditions where the PV Arrays will be installed include;

- i. High ambient temperature, high humidity and high atmospheric salt content in the air.
- ii. Wind Speed reaching 50km/h
- iii. Peak Sun Hours per day can be expected at 6.5 Hours.

PV System Design & Supply Requirements shall include but not limited to;

- i. The PV Array shall meet the total daily energy requirement of 800kWh
- ii. The PV Array sizing to be optimized to be comfortably accommodated in the limited power station area. An area of 0.365 Ha is made available for this project.

- iii. The solar panels shall have a life expectancy in excess of 25 years.
- iv. Clear technical specifications of panels to be supplied including model and durability
- v. Warranty periods of the Solar Panels shall be provided by the bidder.

4.3 Photovoltaic Support Structure (Rack)

- i. The material of Rack and mounting brackets of the solar arrays must be designed to withstand strong winds in excess of 50km/hour.
- ii. All support structure components including brackets and fasteners must be able to resist at least 20 years of outdoor exposure without any appreciable corrosion.
- iii. Tilt angle shall be adjustable between 10-30 degrees facing north.
- iv. A manual containing construction and assembly of the mounting structures and mounting of modules shall be provided.
- v. Footings designed to suit ground mounted concrete footing
- vi. Concrete footing strength and dimensions must be specified considering the weight of panels and wind load

4.4 Battery Bank

- i. Battery Bank's daily depth of discharge (DoD) shall be 40%
- ii. Battery Bank shall have Autonomous days of **2 days**
- iii. Batteries shall have life expectancies in excess of 10 years
- iv. For efficient management, batteries are required to be installed on racks in a shed under or beside solar arrays.
- v. Batteries may be exposed to salt spray during dispatch so they should be individually enclosed in plastic or other protective materials that can be easily removed on arrival at the project sites.
- vi. Warranty period and special conditions of batteries must be provided.

4.5 Battery Bank Shed

- i. Battery bank shed shall be designed to cater for the battery bank sized in clause 4.4
- ii. Design shall consider tropical marine environment subject to intermittent salt spray with wind speed reaching 50km/h. Shed structure and materials must therefore be able to withstand high corrosive environment and strong winds for more than 20 years
- iii. Properly ventilated and provided with exhaust fan and cooling system if necessary
- iv. Internal wiring and lightings for the shed shall be supplied and installed
- v. The battery shed shall also accommodate the inverters with controls and main dc and ac distribution boards
- vi. The rooftop shall be utilised for PV panel installations

4.6 Battery Charge Controllers

Battery charge controllers are required to regulate charging and discharging of the battery bank.

- i. The charge controllers and inverters can be separate or integrated units.
- ii. Charge controllers shall have an access of 20% spare capacity to take up any future load increase.
- iii. Integrated monitoring and management features are highly preferred.

4.7 Inverter System

The Inverter or clusters of inverters considered in this design must meet the following requirements;

- i. 100kW Inverter Capacity
- ii. 3 Phase bi-directional Inverter(s), or
- iii. Single phase bi-directional inverters connected in multi clusters to give 3-phase ac 415 volts output.
- iv. Input voltage of 48V dc and 415V ac output
- v. Built in panels and gauges to display all parameters including but not be limited to; voltage, current, power, power factor, frequency, battery state of charge, energy produced, energy used, temperature,. etc.
- vi. The inverter(s) shall have the ability to supply the load directly during the day as well as charging the battery bank.
- vii. In the event when the battery bank reaches a voltage level beyond the nominal depth of discharge, the inverter must be able to switch on the diesel genset to supply the load as well as charge the battery bank.
- viii. The inverter(s) must be able to supply/accommodate the existing reactive loads with a power factor of not less than 0.9.

4.8 Controls & PLC

The system must be designed to be controlled systematically by pre-programmed controllers and sensors either by PLC or Inverter-Controls integrated system. The control features must include but not be limited to;

- i. Signal the ATS to start the genset when the battery bank voltage falls beyond the nominal DoD
- ii. Signal the ATS to shut down genset when battery bank voltage reaches 100% of the charge capacity and or when PV Array begins to supply power to the inverter at full capacity.
- iii. The control system must be able to signal the genset to kick in during peak load hours so as not to exert too much stress on the battery bank

- iv. Smart management technologies being able to manage the charging and discharging of battery bank and switching the genset at most appropriate times to ensure integrity of all components is maintained.
- v. Must have digital panels and gauges to display every parameters of the system

4.9 Balance of System (BOS)

Balance of system equipment includes but not limited to the following;

4.9.1 Fuses & Switchgear

- i. Suitably sized fuses both dc and ac shall be supplied and installed to protect system components.
- ii. Contractor shall supply and install suitable sized and type switches and breakers for protection and isolation purposes
- iii. PV Array and junction boxes shall be protected with dc lightning arrestors

4.9.2 Main Distribution Board

- i. Contractor shall Design, Supply & Install a Main Distribution Board for the output of the Hybrid Power System
- ii. The key hardware in the control and Distribution Board shall be as follows;
 - o Main Switch: 3P Isolator with three positions "AUTO – OFF – GEN"
 - o Distribution Isolators
 - o Load Shedding Contactor
 - o Switchgear for local Power House Circuits
 - o KWh Meter
 - o Suitably Sized AC & DC buses

4.9.3 Cabling & Wiring Accessories

- i. The contractor shall be able to design & supply appropriate and suitable cable sizes and types for all PV array cabling, battery bank wiring, Inverter and controls wiring
- ii. Contractor shall also be able to supply associated cabling accessories and hardware including but not limited to; conduits, glands, cable tray, connectors, heat shrinks, ducts, labels and all that is required to complete the project
- iii. DC Voltage rating: 1000VDC
- iv. Insulated orange circular PVC or XLPE cables for ac cabling
 - v. Copper Conductor with voltage rating of 0.6/1kVAC for ac cables
- vi. Minimum temperature breakdown rating of V90
- vii. All cabling shall be marked and colour coded to allow for identification

- viii. All cable entry to and from enclosures shall be through the underside of the enclosures and glanded and sealed to ensure that IP rating of the enclosure is maintained
- ix. All cable installations shall be done in compliance with Australia and New Zealand Wiring Rules Standards.

4.9.4 Communication & Data Logging

- i. Communication for remote monitoring using mobile communication shall be included
- ii. Data logging with storage devices that can capture and store data for a month or more is highly preferred.

4.9.5 Combiner Box

- i. Combiner boxes must be fused (overcurrent protected) and lightning protected
- ii. Corrosion free with sufficient IP rated
- iii. Complete with mounting attachments and cable entry allowances

4.9.6 Signage & Labelling

- o Safety signage and labelling of system key components shall be provided and installed as per relevant AS/NZS Standards and where information will provide assistance to ongoing maintenance and operation of the system
- o All signs and labels shall be fit for purpose, made of durable materials and colour coded as per the requirements of the relevant standards. Size of the signs and associated text heights shall be visible for purpose.

4.10 Back-up Diesel Generator

- i. Contractor shall supply a 65kVA 3phase Diesel Generator as a back-up to cater for high demand and/or low irradiation conditions
- ii. Genset shall be strictly from the known brands; Cummins or CAT
- iii. A 250A or suitably sized Automatic Transfer Switch shall be supplied aswell
- iv. 50Hz, 415V output with controls built into it
- v. Contractor shall provide and clearly specify Product and Manufacturer's warranties
- vi. Contractor shall provide Genset manual and other shop drawings
- vii. Contractor shall provide as built drawings for the genset control wirings & installations

5.0 SYSTEM DESIGN & STANDARDS

System Design shall consider all of the 'TECHNICAL REQUIREMENTS' specified in clause 4.0 above but not necessarily limited to that. Bidders shall use their discretions to come up with competitive and technically sound system that shall deem to meet our requirements.

Moreover, the design of the System shall follow typical electrical standards adopted in PNG which shall be in accordance with Australia and New Zealand relevant standards enlisted below:

- a) AS/NZS3000 Wiring Rules
- b) AS/NZS4509 Stand-alone power systems
- c) AS 4086.2 Secondary batteries for stand-alone power supplies
- d) AS/NZS5033 PV Array
- e) AS 3010.1 Electrical Installations - Supply Generating set
- f) AS 1768 Lightning Protection
- g) AS 3595 Energy management programs
- h) AS 1359.51 Noise level limits

A complete system design shall be furnished and submitted to Client (PNG Power Ltd). Method of submission shall be;

- 3x Hard Copies Printed and binded with hard covers
- Soft copies in MS Word, MS Excel & PDF formats shall be downloaded onto USB Storage device or CD Disks and submitted together with.

AS BUILT DRAWINGS

Contractor shall formulate and submit 'As Built Drawings' for the hybrid power system installation upon completion and commissioning of the system. Drawings shall be in both Single Line Drawings and Schematics forms.

6.0 SUPPLY

- Bidder shall furnish and supply a complete BOQ for materials required to fully complete and commission the requirements of this project.
- Bidder shall also prepare and submit a realistic schedule of delivery of materials & equipment.
- Materials & Equipment shall be packed nicely in containers and or other suitable packages and delivered to Port Moresby Wharf according to BOQ provided in the bid.
- Customs and wharf handlings shall remain Client's (PNG Power Ltd) responsibility.

7.0 INSTALLATION

- Contractor shall prepare and submit a realistic installation schedule from mobilisation to commissioning and demobilisation
- Contractor shall provide a Method Statement specifying the Scope of Works for the Installation
- Project Site shall be prepared for installation by PNG Power Ltd
- Installation works should be within bidders specified schedule and cost budget
- Contractor shall supply maximum of two (2) equally qualified and experienced personals to provide supervisory and leading hand roles in the installation while support labour shall be provided by the Client (PNG Power Ltd).
- Cost of PNG Power Ltd personals involving in the installation should not be factored into the bidders cost.
- Local casual engagements shall remain PNG Power Ltd.'s responsibility
- Installation shall be in accordance with design and specified local & international standards

8.0 PROGRAM DURATION

Bidding firms are requested to submit a realistic program or schedule of delivery and budget for the Design, Supply & Installation of this Project.

9.0 FACTORY INSPECTION

A factory inspection by two (2) technical officers of PNG Power Ltd to inspect project materials at the Contractor's yard or warehouse prior to delivery. Travel & accommodation expenses shall be factored into the bidders schedule and cost.

10.0 PAST EXPERIENCES & REPUTATION

Bidders are required to provide records and evidences of successfully achieving similar projects in the past. Inclusive of reference & recommendation letters would be highly regarded.

11.0 SCHEDULE OF BIDS

To expedite the process, bidders are required to take note of the preliminary schedule of bids and respond with a realistic delivery schedule.

#	Activities	Duration	Dates
1	Invitation of bids on Public Tender	7Days	30/08/17 – 08/09/17
2	Bid Submission Duration & Closing Date	6 Weeks	11/09/17 – 20/10/17
3	Bid Evaluation & Contract Documentation	10 Weeks	23/10/17 – 22/12/17
4	Contract Award Notice		28/12/2017
5	Contract Signing		10/01/2018
6	Delivery of Project Design	4 Weeks	10/01/18 – 09/02/18
7	Delivery of Project Materials & Equipment	16 Weeks	10/01/18 - 04/05/18
8	Installation & Commissioning	16 Weeks	07/05/18 – 20/08/18

Table 11.0 Schedule of bids

12.0 BID VALIDITY PERIOD

Bids shall remain valid for a period of sixty (60) days. The validity period shall commence from the date on which a bid is completed or formalized to the satisfaction of the Client (PNG Power Ltd) within the invitation period as per Clause 11.0 Schedule of Bids.

13.0 FININCIAL PROPOSAL

13.1 Costing

The total costing under this term of reference shall include;

- i. The Design of the Solar-Diesel Hybrid Power System of Samarai Island
- ii. Supply of the complete system units and freight from supplier's port of origin to Port Moresby wharf with all documentations including manuals and design specifications.
- iii. Successful installation and commissioning of the system.

13.2 Schedule of Payment

PNG Power Ltd requires a lump-sum based proposal with indicative program and target estimates for defined inputs. The bidder is also requested to provide a daily schedule of rates together with the bid. Any request by the employer for additional inputs will be negotiated and agreed as a variation.

The lump sum payment would be paid out in the following manner but not necessarily in the listed order;

No.	Delivery Items	Percentage of Payment	Remarks
1	Contract Signing & Submission of System Design	40%	
2	Successful delivery of Battery units to Port Moresby and upon successful Inspection of Batteries	15%	
3	Successful delivery of Solar Panels & Inverters and rest of the Project Materials & Equipment to Port Moresby and upon successful inspection	20%	
4	Successful Installation & Commissioning of the Project	20%	
5	6 Months Retention from the commissioning date	5%	

Table 13.2 Payment Schedule

Cost shall include 10% GST.

13.3 Method of Payment

Invoices shall be issued upon completion of deliverables. PNG Power Ltd's Terms of Payment (TOP) is 30 days from the receipt of invoices. An open Purchase Order shall be raised to facilitate all payments under each deliverables.

13.4 Currencies & Exchange Rate

Bid costing submitted in foreign currencies other than PNG Kina (PGK) are accepted. However, payments will be made using the exchange rate of the closing date of proposal submission which is the **20th October, 2017**.

13.5 Financial Capacity

Bidders must have healthy financial records and bank statements that could be provided when requested.

14.0 EVALUATION & ACCEPTANCE OF TENDERS

14.1 General

PNG Power Ltd does not bind itself to accept the lowest or any bid, and reserves the right of accepting the whole of any Bid, or such part or parts of any Bid as it thinks fit.

14.2 Non-Conforming Tender

Any Bid which does not comply with the requirements of these General Conditions of TOR might not be considered. All bids received after the submission date will not be accepted.

14.3 Evaluation Criteria

The following particulars and criteria but not necessarily limited to them shall be considered during Tender evaluations;

- Company Registration & Legal Documents
- Workers Compensation & Company Insurance Cover/Policy
- Ability of the Tenderer
- Experiences of the Tenderer
- Tenderer's previous experience with PNG Power Ltd but not really necessary
- Financial Status & Credit rating
- Technical capacity & evidence of tools & equipment
- License to carry out Electrical installations
- Cost Price in comparison to PNG power Ltd's cost estimate

15.0 COMMUNICATION BETWEEN PNG POWER LTD & BIDDER

Any queries and responses between PNG Power Ltd and the Bidder during the bid period and or bid evaluation period instigated by either party shall be in writing.

16.0 CONTRACT AWARD

The Contract shall be deemed to have been entered into with successful Bidder when the Formal Instrument of Agreement has been duly executed by the successful Bidder and PNG Power Ltd and the financing agreement (if any) proposed by the Bidder and accepted by PNG Power Ltd has been signed by both parties.

17.0 CLOSING DATE & TIME

Bids shall be submitted in the form of;

1. 3 x Hard Copies clearly printed and binded
2. Soft Copies through email or via storage devises including flash drives and CD

All bids shall be addressed to:

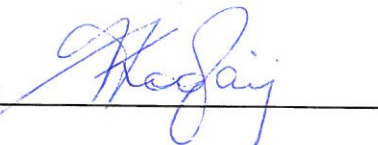
Mr. Bruce Hoga
Manager System Loss
PNG Power Ltd
Cnr Wards Road & Cordia St
PO Box 1105, BOROKO
NCD, 111, Papua New Guinea

Soft Copies of Bids can be submitted via email on email addresses; BHoga@pngpower.com.pg , VLimbia@pngpower.com.pg and ATomba@pngpower.com.pg and Hard Copies hand delivered to the reception at PNG Power Ltd head office at Hohola in Port Moresby.

All bids must be submitted no later than **4:00 pm** (UTC + 10:00 Guam Port Moresby Time) **20th October, 2017**.

Please note that the financial proposal is all inclusive and shall take into account various expenses likely to be incurred by the contractor during the contract period. All envisaged costs including travels must be included in the financial proposal.

Approved by: _____



Mr. Bruce Hoga
Manager System Loss