

Tender for Design, Engineering, Supply, Construction, Installation and Commissioning of 8MW / 12MWh F-R Battery Energy Storage System and 2MW Solar PV for Port Moresby, Papua New Guinea



PNG POWER Ltd
(The Electric Utility of Papua New Guinea)
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TENDER

for

**The Design, Engineering, Supply, Construction,
Installation, Testing and Commissioning of a
8 MW/12 MWh Battery Energy Storage System and 2MW
Solar PV System**

at

**The Moitaka Sub-Station
Port Moresby
Papua New Guinea**

TENDER NO: 12/2023
TENDER DATE: Thursday 12th October, 2023
DUE DATE FOR SUBMISSION OF BIDS: 26th October, 2023

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Abbreviations

<i>Abbreviations</i>	<i>Description</i>
PNG	Papua New Guinea
PPL	PNG Power Limited
GA	General Arrangement drawings
BESS	Battery Energy Storage System
BOQ	Bill of Quantities
BMS	Battery Management System
EMS	Energy Management System
POM	Port Moresby
F-R	Frequency Regulation

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Disclaimer

1. This tender document has been prepared to address if not all, most aspects of the tendered matter. The bidder should take time to thoroughly go through the document and see to it that the document is complete in all respects. Any discrepancies shall be raised to the Tender Officer via email within **7 days from the date of issuance of this document or the Invitation of Bids**. If no such discrepancies are made, it shall be considered that the document is complete in all aspects and has been accepted by the bidder(s).
2. PNG Power Ltd reserves the right to modify, amend or supplement this document.
3. While this tender document has been prepared in good faith, neither PNG Power Ltd nor their employees or advisors make any representation or warranty, express or implied, or accept any responsibility or liability, whatsoever, in respect of any statements or omissions herein, or the accuracy, completeness or reliability of information, and shall incur no liability under any law, statute, rules or regulations as to the accuracy, reliability or completeness of this document, even if any loss or damage is caused by any act or omission on their part.
4. All rights reserved. No part of this document may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of PNG Power Ltd.
5. The specifications mentioned for all the equipment which include Solar modules, PCU, combiner boxes, DC cables, transformer, CT, PT, LT/ HT cables, interfacing panels, switch gears & other associated equipment etc., to complete the power generation and evacuation to the designated substation, in the present bidding documents are for the reference only. It is subject to revision as per the design/ planning/ good engineering practices etc., to be carried out by the selected bidder, to the satisfaction of the Employer or its authorized representatives. It is advised that the bidders must satisfy himself with the prevailing site conditions before design/ plan. The design must be optimized as per the site conditions and directed to achieve the maximum output from the installed capacity at all times. Moreover, the components not separately mentioned, but are required to complete the plant for operation is also included in the scope of bidder and shall be vetted by the Employer or its authorised representatives.



SECTION - I:

Notice of Tender

SECTION 1: NOTICE OF TENDER

1.1 Project Background & Objectives

- 1.1.1 PNG Power Limited was corporatized under Section 3 (1) of the Electricity Commission (Privatisation) Act 2002 as the successor company to Papua New Guinea Electricity Commission (ELCOM). PNG Power Ltd is also governed by another Act of Parliament, the Electricity (Amendment) Act which established a regulatory regime for the Electricity Industry, authorized and responsible for generation, transmission, distribution and retailing of electricity throughout PNG.
- 1.1.2 Plagued by stability issues on its Port Moresby electricity grid, PPL has developed a Grid Stability Plan to address these issues. With Battery Energy Storage Systems already proving to be a commercially viable energy storage technology, PNG Power Ltd has plans to integrate a Frequency-Response BESS. The addition of a F-R BESS into the grid, while addressing stability issues, will also provide power system flexibility. Amongst its many benefits, the F-R BESS will also allow for integration of renewable energy such as solar in the POM grid, initially with 2MWac.
- 1.1.3 PPL, therefore, invites bids from eligible bidders to participate in the tender for Design, Supply, Construction, Installation, Testing and Commissioning of a Frequency -Regulation 8 MW / 12 MWh Battery Energy Storage System plus a 2MWac Solar System.

1.2 Particulars of Tender

- 1.2.1 PNG Power Ltd invites bids from prospective bidders through tendering for the Design, Engineering, Supply, Construction, Installation and Commissioning of F-R 8MW / 12 MWh BESS and 2MWac Solar System, as per the details given in this tender document.
- 1.2.2 The Bidding Documents are available on the PPL's website www.pngpower.com.pg from Wednesday 2nd October, 2023. Interested bidders may view/download the document, seek clarification, and submit their Bids up to the date and time mentioned in Table 1.
- 1.2.3 Accordingly, the online bid must also be uploaded by the respective bidders at <https://portal.tenderlink.com/pngpower> only. No other mode of participation is permitted for this tender document.
- 1.2.4 Bidders should submit their bid proposal online complete in all aspects on or before the last date and time of Bid Submission as mentioned on the PPL Tender portal <https://portal.tenderlink.com/pngpower> and as indicated in the Bid Information Sheet.

Tender for Design, Engineering, Supply, Construction, Installation and Commissioning of 8MW / 12MWh F-R Battery Energy Storage System and 2MW Solar PV for Port Moresby, Papua New Guinea

1.2.5 PP L reserves the right to cancel/withdraw this invitation for bids without assigning any reason and shall bear no liability whatsoever consequent upon such a decision.

1.2.6 Table 1: Bid Information Sheet

No	Item	Description
1	Project Owner	PNG Power Limited
2	Project Owner Mailing Address	PO Box 1105, Boroko, NCD, PNG Wards Road, Cordia Street, Hohola
3	Name Of Work	Design, Engineering, Supply, Construction, Installation and Commissioning of 8MW / 12 MWh F-R BESS and 2MWac Solar System at Moitaka, POM grid
4	Tender Number & Date	12/2023 , Thursday 12 th October 2023
5	Source of Funds	PNG Power Ltd intends to finance the project through domestic funding and internal resources
6	Type of Tender	On-line bidding system
7	Bidder Eligible for Bidding	The bid is open to bidders within and outside of Papua New Guinea
8	Cost of Bidding Documents	Free of Cost
9	Date, Time & Venue of Pre-Bid Meeting	Thursday 19 th October 2023, 10am PNG Time, PPL National Office, Hohola, PNG
10	Online Bid Submission Deadline	Thursday 26 th October, 2023, 5pm PNG Time
11	Date & Time of Opening of Tender (Technical Bid)	Friday 27 th October, 2023, 10:00am PNG Time
12	Date & Time of Opening of Tender (Financial Bid)	Friday 10 th Nov, 2023, 10:00am PNG Time
13	Venue for Opening of Bids	PPL National Office, Hohola
14	Technical Queries Contact Details	Name: Mr. Ivan Pekaea Title: GM National Systems Operations Email: ipekaea@pngpower.com.pg Phone: +675 324 3385
15	Tender Related Queries	Ivan Pekaea, ipekaea@pngpower.com.pg
16	Submission Link	PNG Power Ltd Tenders Office https://portal.tenderlink.com/pngpower

1.3 **Schedule of Activities**

1.3.1 The Bids will be opened in the presence of bidder's representatives, who choose to attend the bid-opening, at the venue; date and time as mentioned in the above Table 1.

1.3.2 Table 2: Schedule of Activities

No.	Milestone	Date	Time (PNG)
1	Release of tender	Thursday 12 th October, 2023	10:00am
2	Last Date of Submission	Thursday 26 th October 2023	5:00 pm
3	Pre-Bid Meeting (Technical Presentation by PNG Power Ltd & Q&A	Thursday 19 th October, 2023	10:00am-12:00noon
4	Site Visit	Thursday 19 th October, 2023	1:00pm-3:00pm
5	Response to Queries	Monday 23 rd October, 2023	5:00pm
6	Last date for submission of technical bid and financial response	Thursday 26 th October, 2023	5:00pm
7	Opening of Technical Bid Responses	Friday 27 th October, 2023	10:00am
8	Declaration of Shortlisted firms on basis of technical bid responses will be published on PNG Power Ltd official website	Tuesday 31 st October, 2023	5:00pm
9	Technical Presentation by Shortlisted bidders (presentation should be shared at least two days before the presentation date)	Thursday 2 nd Nov, 2023	9am to 3pm
10	Financial bid opening of only technically qualified bidders	Friday 10 th Nov, 2023	10:00am
11	Finalization of Bidder (to be notified via website/ e-mail as necessary)	Thursday 30 th Nov, 2023	5:00 pm



SECTION - II:

Instruction To Bidders (ITB)

SECTION 2: INSTRUCTION TO BIDDERS

2.1 Contents of Tender Document

2.1.1 Content of Tender Document

Section – I: Tender Notice
Section – II: Instruction to Bidders
Section – III: General Conditions of Contract
Section – IV: Scope of Works
Section – V: Technical Specifications
Section – VI: Bidder Response Formats & Annexures

The Bidder is expected to examine all instructions, forms, terms, and specifications as mentioned in the tender document. Failure to furnish all information required by the tender documents or submission of a bid not substantially responsive to the Bid Document in every respect will be at the Bidder's risk and is likely to result in out-right rejection of the bid.

2.1.2 Local Conditions

It shall be imperative for each bidder to fully understand the local conditions and factors, which may have any effect on the execution of the works covered under these documents and specifications.

2.1.2.1 Bidders eligible for bidding:

Bidding is open to bidders from within the Employer's country and overseas. Consortium/ Joint Venture of two or more firms as partners are not allowed.

2.1.2.2 Cost of bidding:

The Bidder shall bear all costs associated with the preparation and submission of its bid including site visit, and the Employer will in no case be responsible or liable for these costs, regardless of the conduct or outcome of the bidding process. Further the purchaser has the rights to get sample of Advanced Lead Acid Battery Bank tested by any reputed independent test lab (approved by PPL) at the cost of bidder.

2.1.2.3 Language of the Bid:

The bid prepared by the Bidder and all correspondence and documents related to the bid exchanged between the Bidder shall be written in English language.

2.1.2.4 Pre-Bid meeting:

A pre-bid meeting shall be organized by PPL at the time and venue specified in Section 1.2.6 (Table 1). All the queries related to this tender must be shared with the Project Owner through the Tenders Related Queries Contact at least one day before the date of pre-bid through written mode of communication. All the queries shall be replied in the pre-bid; in case any changes are required in the tender document the same shall be affected in the form of corrigendum to this tender.

2.1.2.5 Guided Site Visit:

1. The Bidders are advised to visit sites (at their own expense), prior to the submission of the bid, and make surveys and assessments as deemed necessary for proposal submission. The site visit will be facilitated by PPL officials. A bidder shall be deemed to have full knowledge of the site whether he inspects it or not. Submission of a tender by a bidder implies that the bidder has read this notice and all other contract documents and has made itself aware of the scope and specifications of the work to be done and local conditions and other factors bearing on the execution of the work.
2. The Bidder and any of its personnel or agents will be granted permission by PPL to enter upon its premises and lands for the purpose of such inspection, but only upon the express condition that the Bidder, its personnel and agents will release and indemnify PPL and its personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of the inspection.

2.1.3 Clarification

A prospective Bidder requiring any clarification of the Tender Documents may contact PNG Power Ltd in writing or via email only at PNG Power Limited's mailing address indicated in the Bid Information Sheet

2.1.4 Amendment of Tender Documents

At any time prior to the submission of the tender PNG Power Ltd may for any reason, whether at its own initiative or in response to a clarification requested by the Bidder, modify the tender documents by amendments. Such document shall be made available on websites, time to time.

All are requested to remain updated with the website. No separate reply/intimation will be given elsewhere.

2.2 Eligibility Conditions

2.2.1 General Eligibility Conditions

- 2.2.1.1 The bidder should be a body incorporated under the Companies Act of their country, which covers any amendment thereto. A scanned copy of Certificate of Incorporation of the Bidder shall be furnished in the bid.
- 2.2.1.2 Bidders should not be under a declaration of ineligibility for corrupt and fraudulent practice. In this regard an undertaking (self-certificates) has to be provided that the bidder has not been blacklisted/ debarred by any central/state government or any other institution including electricity boards.

2.2.2 Technical Eligibility Conditions

For bidder to be eligible they shall meet at least one of the two conditions, either 2.2.2.1 of 2.2.2.2.

- 2.2.2.1 The bidder and its technical partners must have experience in EPC execution and participation of Utility Scale Solar, BESS and F-R Projects on Turnkey basis including Design, Supply (Supply of Inverters can be inclusive or exclusive in the bidder's scope in the past experience), Construction, Installation, Testing and Commissioning of cumulative Capacity not less than 10 MWh in the last ten (10) financial years as on last date of bid of bid submission. However, such Grid connected Solar PV, BESS and F-R Projects must have been in satisfactory operation for at least six (6) months prior to the last date of bid submission.
- 2.2.2.2 Alternatively, the bidder or its technical partners shall have delivered or participated in the delivery of at least one (1) Turnkey EPC projects described 2.2.2.1 for PNG Power in PNG. However, such Grid connected Solar PV, BESS and F-R Project must have been in satisfactory operation for at least six (6) months prior to the last date of bid submission.
- 2.2.2.3 The list of projects commissioned at least 12 months prior to the last date of Bid Submission, indicating whether the project is grid connected, along with a scanned copy of the Commissioning certificate and Work Order/Contract/Agreement from the Client (or Owner) shall be submitted in

support of Clause 2.2.2.1 above. This shall include at least a project delivered to PNG Power in PNG.

2.2.2.4 The Performance Certificate must have been issued for a minimum duration of six (6) months from the date of commissioning. The Performance Certificate/Joint Meter Reading (JMR) reports shall have been issued by any state owned agencies or power departments or authorized representative of Power off-taker.

2.2.2.5 Bidder must meet the Technical Specifications as stipulated in the Tender, and the bidder(s) must be able to provide the after-sales warranty and support services.

2.2.3 Financial Eligibility Conditions

2.2.3.1 This is a fully paid project by PPL. On this basis a stringent financial capability assessment is not necessary other than the comfort to PPL that at the time of bidding the bidder demonstrates technical and financial capability to deliver this project. On the submission date, the bidder shall demonstrate that it has a balance of at least K2.5m in their account. The balance shall be for a date covered in the period of this tender up to the submission date.

Note: PNG Power Ltd reserves the right to waive minor deviations if they do not materially affect the capability of the Bidder to perform the contract.

2.3 Preparation of Tender

2.3.1 Language of Bid and Measure

All the tender related documents exchanged between Bidder and TERI shall be written in English language provided that any printed literature furnished by the Bidder may be written in another language as long as accompanied by an English translation of its pertinent passages in which case, for purpose of interpretation units of measurement shall be MKS system.

2.3.2 Documents Comprising the Bid

The tender prepared by the Bidder shall comprise the following components:

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- a) A covering letter.
- b) General particulars of bidder.
- c) Declaration by the Bidder.
- d) Details of EMD to be furnished by the bidder.
- e) For submission of Performance Bank Guarantee.
- f) Power of Attorney to be provided by the bidder.
- g) Experience letter.
- h) Tender document signed on each page, as a confirmation by the Bidder to accept all technical specifications/ commercial conditions along with all necessary enclosures/ annexures.
- i) Duly filled bidder response document including Schedules.
- j) A copy of technical presentation.

2.3.3 Bid Price

The bidder shall indicate prices on the appropriate financial bid schedule (in USD).

2.3.4 Bid Currencies

Prices shall be quoted in US Dollars (USD) only.

2.3.5 Duties and Taxes

The project cost/ Bid Price shall be inclusive of all duties and taxes, insurance etc. The prices quoted by the firm shall be complete in all respect and no price variation/ adjustment shall be payable, once price bid is accepted by PNG Power Ltd.

2.3.6 Performance Guarantee

The successful Bidders, who execute the agreement with PNG Power Ltd for the work, shall have to furnish a security amount equivalent to 10% of contract price in the form of Performance Bank Guarantee (PBG – as per format no 4) valid for a period of 66 months from the date of execution of agreement. The bank guarantee may be issued by a nationalized bank and shall be in favor of 'PNG Power Ltd'. The aforesaid Bank Guarantee shall be furnished prior to the execution of agreement.

2.3.7 Period of Validity of Tender

Validity of the price offer should be 6 (six) months from the date of opening of the financial bid of the tenders. Without this validity the tenders will be rejected.

In exceptional circumstances; PNG Power Ltd will solicit the Bidder's consent to an extension of the period of validity. The request and the response thereof, shall be made in writing. The contract performance security provided under clause 3.5 above shall also be suitably extended.

2.3.8 Bid Security (Earnest Money)

- 2.3.8.1 The bidder shall furnish, as part of its bid, bid security of 1% of the purchase order in the form of demand draft issued by a nationalized bank. The details of the same are to be furnished by the bidder as per format no. 5.
- 2.3.8.2 Any bid not secured with the tender fee and earnest money will be rejected by TERI as non-responsive.
- 2.3.8.3 No Interest shall be payable on the amount of Earnest Money Deposit (EMD) to those Bidders who fail to get the contract and the EMD will be released after the finalization of tender 3.7.4 The tender security (earnest money) may be forfeited: If a bidder withdraws its tender during the period of tender validity specified by the Bidder in the tender. If the successful Bidder fails to sign the contract within stipulated period and submit the performance security within the specified period of 15 days from the date of finalization of order.
- 2.3.8.4 EMD of successful bidder shall only be released after signing of agreement and submission of 10% (Ten percent) of contract price as performance bank guarantee.

2.3.9 Format and Signing of Tender

- 2.3.9.1 The bid must contain the name and places of business of the persons making the tender and must be signed and sealed by the Bidder with the usual signature of the authorized signatory. The name and designations of all persons signing should be typed or printed below the signature.
- 2.3.9.2 Tender by Corporation/ Company/ Firm / NGO must be signed with the legal name of the Corporation/ Company/ Firm / NGO by the 'President', Managing director or by the 'Secretary' or other designation or a person duly authorized.
- 2.3.9.3 The original copy of the tender shall be typed or written in indelible ink and shall be signed by the bidder or a person duly authorized to bid and bidder to the contract. The letter of authorization shall be submitted along with power-of-attorney. All the pages of the bid shall be initialed by the person or persons signing the tender.

2.3.9.4 The bid shall contain no interlineations, erasures or overwriting except as necessary to correct errors made by the Bidder in which case such corrections shall be initialed by the person or persons signing the tender.

2.3.10 Alternative Bids

Bidders shall submit bids, which comply with the bidding documents. Alternative bids will not be considered. The attention of Bidders is drawn to the provisions of Clause 2.3.13.3 and 2.3.13.4 regarding the rejection of Bids, which are not substantially responsive to the requirements of the bidding documents.

2.3.11 Evaluation of Bids

Information relating to the examination, clarification, evaluation and comparison of bids and recommendations for the award of a contract shall not be disclosed to bidders or any other persons not officially concerned with such process. Any effort by a bidder to influence the Purchaser's processing of Bids or award decisions may result in the rejection of the bidder's bid.

2.3.12 Clarification of Bids

To assist in the examination, evaluation and comparison of Bids, the Purchaser may, at its discretion, ask the bidder for clarification of its Bid. All responses to requests for clarification shall be in writing and no change in the price or substance of the bid shall be sought, offered or permitted.

2.3.13 Preliminary Examination of Bids/Responsiveness

2.3.13.1 Purchaser will examine the bids to determine whether they are complete, whether any computational errors have been made, whether required sureties have been furnished, whether the documents have been properly signed, and whether the Bids are generally in order.

2.3.13.2 Arithmetical errors will be rectified on the following basis. If there is a discrepancy between the unit price and the total price per item that is obtained by multiplying the unit price and quantity, the unit price shall prevail and the total price per item will be corrected. If there is a discrepancy between the Total Amount and the sum of the total price per item, the sum of the total price per item shall prevail and the Total Amount will be corrected.

2.3.13.3 Prior to the detailed evaluation, Purchaser will determine the substantial responsiveness of each Bid to the Bidding Documents including production capability and acceptable quality of the goods offered. A substantially responsive Bid is one, which conforms to all the terms and conditions of the Bidding Documents without material deviation.

- 2.3.13.4 Bid determined as not substantially responsive will be rejected by the Purchaser and/or the Purchaser and may not subsequently be made responsive by the Bidder by correction of the non-conformity.

2.4 Submission of Tender

- 2.4.1 The bid shall be submitted as per the guidelines given in the tender document.
- 2.4.2 The tender must be completed in all technical and commercial respect and should contain requisite certificates, drawings, informative literature, etc., as required in the specification.
- 2.4.3 Technical and financial bid as per format are to be submitted as two separate pdf documents marked Part-I & Part-II.
- 2.4.4 First pdf document (Part-I) should contain earnest money, technical specification, brochure literature, other required documents etc. It should be super scribed with tender number. All parts of tender documents except financial bid duly signed should be submitted as one combined pdf document. Requisite earnest money, tender fees in the form of Demand Draft should be included.
- 2.4.5 The second pdf document (Part-II) should contain financial bid only. It should be super scribed with Tender No. and 'Financial bid'. Anything in regard of financial condition, payment terms, rebate, etc. mentioned in financial bid may make the tender invalid. Therefore, it is in the interest of the bidder not to write anything extra in part-II except price.
- 2.4.6 EXPENSES OF AGREEMENT: A formal agreement for a period of 5 (Five) years from the date of commissioning and handing over of the system shall be entered into between PNG Power Ltd and the Contractor/ Bidder for the proper fulfillment of the contract. The expenses of completing and stamping of the agreement shall be paid by the successful bidder.
- 2.4.7 DEADLINE FOR SUBMISSION OF BIDS:
- 2.4.7.1 Bids must be submitted by the bidder in the date; time and address specified in the tender notice/documents.
- 2.4.7.2 The Purchaser may, at its discretion, extend the deadline for the submission of Bids by amending the Bidding Documents. All rights and obligations of the

Purchaser and Bidders previously subject to the deadline will thereafter be subject to the deadline as extended.

2.4.8 MODIFICATIONS AND WITHDRAWAL OF BIDS:

The Bidder is not allowed to modify or withdraw its Bid after the Bid 's submission.

2.4.9 DOCUMENTS COMPRISING THE BID:

The bidders are required to submit the bids in two parts as stipulated in Clause 2.4.4 and 2.4.5.

2.5 Tender Opening & Evaluation

The procedure of opening of the tender shall be as follows:

2.5.1 First Part (Part-I) submitted having tender specification and super scribed as 'Technical Bid' shall be opened at the time and date mentioned in the tender notice by PNG Power Limited's representatives in the presence of Bidders, who choose to be present.

2.5.2 Second Part (Part-II) containing Financial Bid shall be opened (after obtaining clarifications and establishing technical suitability of the offer) as per schedule. Second part of only those Bidders shall be opened whose first part (Part-I) shall be found technically suitable.

2.5.3 To assist in the examination, evaluation, and comparison of bids PNG Power Ltd may at its discretion ask the Bidder for a clarification of its bid. The request for clarification and the response shall be in writing via email correspondence.

2.5.4 PNG POWER Ltd reserves the right to interpret the Bid submitted by the Bidder in accordance with the provisions of this document and make its own judgment regarding the interpretation of the same. In this regard PNG POWER Ltd shall have no liability towards any Bidder and no Bidder shall have any recourse to PNG POWER Ltd with respect to the selection process. PNG POWER Ltd shall evaluate the Bids using the evaluation process specified in this document or as amended, at its sole discretion. PNG POWER Limited's decision in this regard shall be final and binding on the Bidders.

2.6 Procedure for Finalization of Bid

The Procedure for Finalization of Bid would be as follows:

2.6.1 Finalization of Bid:

- a) First the Technical bids shall be opened and evaluated.
- b) Then the price bid of technically qualified bidders shall be opened next

- c) The bidder with the highest score from the combined evaluations of the technical and financial proposals shall be the party to be awarded the contract. PPL reserves the right to make the final award based on compliance to this tender and any other conditions and terms presented by the bidder aimed at meeting and exceeding PPL's delivery target dates and performance requirements and dealing with delivery risks.

2.6.2 After work order is placed for work, it must be executed within the time schedule stipulated in work order. In case of delay (for any reason other than due to Force Majeure conditions or any extension thereof granted to him by PNG POWER Ltd a penalty equal to 1.0% of the price of the unperformed services for each week (For the purposes of calculation of delay, part of week shall be treated as week) of delay until actual performance up to a maximum deduction of 10% of the delayed services.

Release of payment to Contractor/ Bidder will be done as per the payment schedule mentioned clause 28 of Part-3.

2.6.3 PNG POWER Ltd reserves the right to accept any bid and to reject any or all bids.

2.6.4 Successful Bidder for contract shall be informed in writing.

2.6.5 From the time of Bid submission to the time of contract award, if any Bidder wishes to contact the Purchaser on any matter related to the Bid, it should be done in writing.

2.6.6 Any effort by a Bidder to influence the Purchaser and/or in the Purchaser 's decisions in respect of Bid evaluation, Bid comparison or Contract Award, will result in the rejection of the Bidder 's Bid.

2.6.7 Before execution of the work, a contract agreement for execution of the work shall be signed by the Bidder with PNG POWER Ltd within 30 days of communication from PNG POWER Ltd. In case agreement is not executed within the stipulated time due to delays by the Bidder, earnest money will be forfeited.



SECTION - III:

GENERAL CONDITIONS OF CONTRACT (GCC)

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PREAMBLE

This Section (Section – III) of the Bidding Documents provides the performance of the Contractor, payments under the contract or matters affecting the risks, rights and obligations of the parties under the contract.

Bidders may note that the respective rights of the Employer/ Owner and Bidders/ Contractors shall be governed by this Tender Documents and Contracts (to be) signed between the Employer/ Owner and the Contractor for the respective package(s). The provisions of this Tender Documents shall always prevail over any other documents in case of contradiction.

Further in all matters arising out of the provisions of this Section of the Tender Documents, the laws of Papua New Guinea shall be the governing laws and courts of the State of the Project Owner shall have exclusive jurisdiction.

SECTION 3: GENERAL CONDITIONS OF CONTRACT

3.1 The successful Bidder shall have to sign the contract with PNG Power Ltd.

Definitions:

- 3.2 PNG Power Ltd shall mean the Chief Executive Officer of PNG Power Ltd or his representative and shall also include its successors in interest and assignees. The 'Contractor' shall mean (successful bidder), i.e., the person whose tender has been accepted by PNG Power Ltd and shall include his legal representatives and successors in interest.
- 3.3 The work shall be completed within stipulated time from the date of placement of work order. However, PNG POWER Ltd may in case of urgency ask the bidder to complete the work earlier, with the mutual consent of the Contractor/ Bidder. In case the Contractor/Bidder fails to execute the said work within stipulated time, PNG POWER Ltd will be at liberty to get the work executed from the open market without calling any tender/e-tender and without any notice to the Contractor/Bidder, at the risk and cost of the Contractor/Bidder. If the cost of executing the work as aforesaid shall exceed the balance due to the Contractor/Bidder, and the Contractor/Bidder fails to make good the additional cost, PNG POWER Ltd may recover it from the Contractor/Bidders' pending claims against any work in PNG POWER Ltd or in any lawful manner.
- 3.4 On the request of the Contractor/Bidder and also in the interest of the organization PNG POWER Ltd is authorized to extend the validity of the agreement, subject to that the request of the Contractor/Bidder is received before the expiry of the agreement period, or any extended period granted to the Contractor/ Bidder. Maximum period of extension shall be 2 months on the same terms and conditions as contained in this agreement.
- 3.5 The agreement shall be deemed to be extended till the date of completion of last work order subject to the completion period.
- 3.6 It will be the sole responsibility of the Contractor, to execute orders placed as per time schedule, and to ensure quality parameters, specifications and other requirements provided in the tender document are as per agreement.
- 3.7 In the interest of the work and the program, agreement executed between the Contractor/Bidder and PNG POWER Ltd may be extended to a mutually agreed period, if the need so arises. It shall be sole responsibility of the Contractor/ Bidder to get verified the quality and quantity of the supplied material at the site of delivery.

3.8 **Liquidated Damages**

- 3.8.1 If the Contractor/ Bidder fails to perform the services within the time periods specified in the contract, PNG Power Ltd shall without prejudice to its other remedies under the contract deduct from the contract price as liquidated damage, a sum equivalent to 1.0% of the price of the unperformed services for each week (For the purposes of calculation of delay, part of week shall be treated as week) of delay until actual performance up to a maximum deduction of 10% of the delayed services. Once the maximum is reached, PNG Power Ltd may consider termination of the contract. In the case of violation of contract, PNG Power Ltd may confiscate pending payments/ dues of the Contractor/ Bidder assigning specific reasons and shall also have the power to debar/ blacklist the Contractor/ Bidder in similar circumstances. PNG Power Ltd may also invoke performance/security bank guarantee.
- 3.8.2 The Contractor/ Bidder shall have to comply with all the rules, regulations, laws and by-laws for the time being in force and the instructions if any, of the organization, in whose premises the work has to be done. PNG Power Ltd shall have no liability in this regard.

3.9 **Force Majeure**

- 3.9.1 Notwithstanding the provisions of clauses contained in this deed; the contractor/ bidder shall not be liable for forfeiture of its performance security, liquidated damages, termination for default, if he is unable to fulfill his obligation under this deed due to event of force majeure circumstances.
- 3.9.2 For purpose of this clause, 'Force majeure' means an event beyond the control of the contractor/bidder and not involving the contractor/bidder's fault or negligence and not foreseeable. Such events may include, but are not restricted to, acts of Government either in its sovereign or contractual capacity, wars or revolutions, fires, floods, epidemics, quarantine restrictions, and freight embargoes.
- 3.9.3 However, if a force majeure situation arises, the contractor/bidder shall immediately notify PNG Power Ltd in writing. The decision of the competent authority of PNG Power Ltd in above conditions shall be final.
- 3.10 The Contractor/Bidder shall not, without the consent in writing of PNG Power Ltd, transfer, assign or sublet the work under the contract or any substantial part thereof to any other party.
- 3.11 PNG Power Ltd shall have at all reasonable time access to the works being carried out by the Contractor/Bidder under the contract. All the work shall be carried out by the contractor/bidder to the satisfaction of PNG Power Ltd.

3.12 If any question, dispute or difference what so ever shall arises between PNG Power Ltd and the Contractor/Bidder, in the connection with the agreement except as to matters, the decisions for which have been specifically provided, either party may forthwith give to the other notice in writing of existence of such question, dispute or difference and the same shall be referred to the sole arbitration of the Chief Executive Officer of PNG Power Ltd or a person nominated by him. This reference shall be governed by the Papua New Guinea Public Services Arbitration Act 1969, and the rules made there under. The award in such arbitration shall be final and binding on both the parties. Work under the agreement shall be continuing during the arbitration proceedings unless PNG Power Ltd or the arbitrator directs otherwise.

3.13 PNG Power Ltd may intimate the Contractor/Bidder by notice in writing at any time to either stop the work all together or reduce or cut it down. If the work is stopped all together, the Contractor/Bidder will only be paid for work done and expenses distinctly incurred by him as on preparation or the execution of the work up to the date on which such notice is received by him. Such expenses shall be assessed by PNG Power Ltd, whose decision shall be final and binding on the contractor/bidder. If the work is cut down, the Contractor/Bidder will not be paid any compensation what so ever for the loss or profit which he might have made if he had been allowed to complete all the work included in the contract.

3.14 **Inspection and Tests**

3.14.1 PNG Power Ltd or its representative shall have the right to inspect and/or to test the goods to confirm their conformity to the contract. The special conditions of contract and/or the technical specifications shall specify what inspections and test PNG Power Ltd required.

3.14.2 PNG Power Ltd, its duly authorized representative shall have at all reasonable times access to the Contractor/ Bidders premises or works and shall have the power at all reasonable time to inspect and examine the materials and workmanship of the works during its manufacture.

3.14.3 The Contractor/ Bidder shall give PNG Power Ltd a written notice of 15-days before delivery of any material being ready for testing. It shall be mandatory that such notice should reach PNG Power Ltd within 30 days of placement of work order. Such tests shall be on the contractor/ bidder's accounts/ expenses except for the expenses of the inspector. PNG Power Ltd reserves the full rights, to waive off inspection of material.

3.14.4 The Contractor/Bidder is required to get the entire lot of the ordered material inspected at one time, before the supply of the materials.

3.14.5 All arrangements for the inspection of materials will be done by Contractor /Bidder.

3.14.6 The inspection by PNG Power Ltd and issue of dispatch instruction there of shall in no way limit the liabilities and responsibilities of the contractor/bidder in respect of the agreed quality assurance program forming a part of the contract.

3.15 **Warranty**

3.15.1 The Contractor/Bidder shall warrant as per standards for quality that anything to be furnished shall be new, free from all defects and faults in material, workmanship and manufacture, shall be of the highest grade and consistent with established and generally accepted standards for material of the type ordered, shall be in full conformity with the specifications, drawing or samples, if any and shall if operable, operate properly.

3.15.2 Nothing in Clause 3.14 above shall in any way release the contractor/bidder from any guarantee or other obligations under this contract.

3.16 **Performance of Equipment**

3.16.1 In addition to the warranty as already provided, the Contractor/ Bidder shall guarantee satisfactory performance of the equipment and shall be responsible for the period or up to the date specified in Clause 3.16.3 hereof after the equipment has been accepted by PNG Power Ltd to the extent for any defects that may develop such defects shall be removed at his own cost when called upon to do so by PNG Power Ltd.

3.16.2 The bidder to guarantee the materials / items supplied against any defect of failure, which arise due to faulty materials, workmanship or design for the entire defects liability period. The Defect liability period shall be 12 months from the date of commissioning. If during the defects liability period any materials / items are found to be defective, these shall be replaced or rectified by the bidder at his own cost within 7 working days from the date of receipt of intimation.

3.16.3 The Warranty period shall be 5 (five) years for complete system including battery from the date of commissioning and handing over of the system or number of lifecycles mentioned in the bid whichever is later. After completion of 5 years of installation due to ageing, available capacity shall not go below 95% of available capacity specified at the time of bidding.

- 3.16.4 The Contractor/Bidder shall rectify defects developed in the system within warranty period promptly. In case the defects are not rectified within 14 working days the receipt of the complaint by the Contractor/ Bidder, PNG Power Ltd shall have full liberty to restore the system in working condition. The expenditure so incurred by PNG Power Ltd shall be deducted from the contractor/bidder pending claims, security/performance guarantee deposit or in other law full manner.
- 3.16.5 The preparation of maintenance schedule is sole responsibility of the contractor/bidder. Additionally, a checklist shall be prepared to check/validate the critical operating parameters during maintenance. The checklist will be prepared by the bidder with all mandatory details.
- 3.17 Notice statement and other communication sent by PNG Power Ltd through registered post or telegram or fax or email to the contractor/bidder at its specified addresses shall be deemed to have been delivered to the contractor/bidder.
- 3.18 Any work which is not covered under this contract but is essentially required for the completion of job (to the satisfaction of PNG Power Ltd) shall be carried out by the Contractor as extra item or which payment shall be made separately at the rates decided by PNG Power Ltd.
- 3.19 The work shall be carried out by the Contractor/ Bidder as per design and drawings approved by PNG Power Ltd, wherever, necessary, the contractor/ bidder shall submit relevant designs and drawings for approval of purchaser, well in advance. Work carried out without PNG Power Ltd approval shall not be accepted and the purchaser shall have right to get it removed and to recover the cost so incurred from the Contractor/Bidder.
- 3.20 The Contractor/Bidder shall provide one copy of system pass-book containing instruction manual/routine maintenance manual and maintenance record of the systems with each unit supplied or installed, this shall be in English. The draft of pass-book shall be approved by PNG Power Ltd.
- 3.21 The Contractor/Bidder shall not display the photographs of the work and not take advantage through publicity of the work without written permission of PNG Power Ltd. The contractor shall distribute and fix a calendar at site, showing instructions, Dos, Don'ts with each unit. The format of calendar should be approved by PNG Power Ltd.

3.22 Patent Right and Royalties

The Contractor/Bidder shall indemnify PNG Power Ltd against all third party claims of infringement of patent, royalty's trademark or industrial design rights arising from use to the goods or any part thereof.

3.23 Packaging & Forwarding

3.23.1 Supplier shall pack or shall cause to be packed all commodities in boxes and containers and otherwise in such a manner as shall be reasonably suitable for shipment by road, sear or air without undue risk of damage in transit.

3.23.2 Exact weight and the extreme outside dimensions (length, width and height) of each container or box should be specified in technical. One copy of the packing list shall be enclosed in each package delivered. There shall also be enclosed in one package a master packing list identifying each individual package, which is part of the shipment.

3.23.3 The contractor/Bidder shall inform PNG Power Ltd of the date of each shipment from his works, and the expected date of arrival at the site at least seven (7) days in advance.

3.1 Delayed transportation and Wharfage

All costs and other expenses incurred due to delayed clearance of the material or any other reason shall be to the account of the contractor/bidder.

3.2 Insurance

The goods supplied under the contract shall be fully insured for 5 years against loss or damage incidental to manufacture or acquisition, transportation, storage during transportation and shall be included in the bid price. Complete BESS will be insured and insurance copy stating indemnification to be furnished by the bidder before release of second payment.

3.3 Transportation

The Contractor/Bidder is required under the contract to deliver the goods to the site. E-way bill to be facilitated and arranged by the bidder.

3.4 Termination for Insolvency

PNG Power Ltd may at any time terminate the contract by giving written notice to the Contractor/Bidder without compensation to the Contractor/Bidder, if it becomes bankrupt or otherwise insolvent, provided that such termination will not prejudice or affect any right of action or remedy, which has accrued or will accrue thereafter to PNG Power Ltd.

3.5 Termination for Inconvenience

PNG Power Ltd, may by written notice sent to the contractor/bidder, terminate the contract, in whole or in part at any time for its convenience. The notice of termination shall specify that termination is for the purchaser's convenience in the interest of PNG Power Ltd.

3.6 Applicable Law

The contractor/bidder shall be interpreted in accordance with the laws of the Independent State of Papua New Guinea.

3.7 Notice

3.30.1 Any notice given by one party to the other pursuant to the contract shall be sent in writing or by Email and confirmed in writing to the address specified for that purpose in the special condition of contract.

3.30.2 A notice shall be effective when delivered or on the notice's effective date, whichever is later.

3.8 Corrupt or Fraudulent Practices

3.31.1 The Purchaser requires that the Bidders observe the highest standard of ethics during the procurement and execution of the Project. In pursuance of this policy, the Purchaser defines, for the purposes of this provision, the terms set forth below as follows:

- a) "Corrupt practice" means behavior on the part of officials in the public or private sectors by which they improperly and unlawfully enrich themselves and/or, those close to them, or induce others to do so, by misusing the position in which they are placed, and it includes the offering, giving, receiving, or soliciting of anything of value to influence the action of any such official in the procurement process or in contract execution; and
- b) "Fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Purchaser, and includes collusive practice among Bidders (prior to or after Bid submission) designed to establish Bid prices at artificial non-competitive levels and to deprive the Purchaser of the benefits of free and open competition.

- 3.31.2 Will reject a proposal forward if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question.
- 3.31.3 Will declare a firm ineligible, either indefinitely or for a stated period of time, to be awarded a contract if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing, a contract.

3.9 **Others**

- 3.32.1 Technical details, such as SoC, PCS/ PCU efficiency, round trip efficiency and throughput etc., shall be supplied along-with each consignment and copy should be sent to PNG Power Ltd for records.
- 3.32.2 Internal test reports and data sheets of all components like cell/modules, PCS, sensors, transducers etc. shall be supplied along-with each consignment a copy should be sent to PNG Power Ltd for records.
- 3.32.3 The Contractor/Bidder in consultation with PNG Power Ltd will conduct training program for users, focusing on main features, operation and maintenance of the systems.
- 3.32.4 The Contractor/ Bidder shall continue to provide spare parts after the expiry of warranty period at the users cost till the product life. If the Contractor/Bidder fails to continue to supply spare parts and services to users, PNG Power Ltd shall take appropriate action against the contractor/ bidder.
- 3.32.5 After successful supply/commissioning of the system and training, the system will be handed over to the person designated by PNG Power Ltd.
- 3.32.6 It shall be the sole responsibility of the Contractor/Bidder to get verified the quality and quantity of the supplied material at the site of delivery.

3.10 **Payments**

The payments shall be made as per the following terms and conditions:

Payments will be made in line with the bidder's proposal delivery schedule. Generally, the proposed payments will constitute the following;

- a) Advance component that matches the delivery plan, work plans and project schedules
- b) Payments in percentage of total project in line with key project delivery milestones

- c) A retention fee payable only after 6 months of successful functioning of the FR- BESS and Solar PV Project.

PPL and the winning bidder can agree on the percentage breakup based on the finalized delivery schedule.

- d) Recoveries:

Whenever under this contract any money is recoverable from and payable by the bidder, the purchaser shall be entitled to recover such sum by appropriating in part or in whole by detecting any sum due to which any time thereafter may become due from the supplier in this or any other contract. Should the sum be not sufficient to cover the full amount recoverable the bidder shall pay to the purchaser on demand the remaining balance.

3.11 Documents

Following documents need to be submitted to PNG Power Ltd representatives for processing of payments:

A. 1st Payment (60-70%):

- a) Invoice of complete BOQ and a signed contract.

B. 2nd Payment (15-20%):

Second payment occurs after arrival of all the materials on site.

- a) Complete list of installation location verified by PNG Power Ltd representative

C. 3rd Payment (10-15%):

Third payment is made after successful testing and handover of the project to PPL

- b) The warranty certificates for complete system (as per Purchase Order)
- i. Complete system warranty certificate from the supplier
 - ii. Manufacturer warranty card / letter for all components and data sheet for various technologies battery cells/modules, inverter and PCS
 - iii. All reports should be stamped and signed by the authorized representative of the contractor / bidder
 - iv. Invoice of installation and commissioning as per purchase order.
 - v. Insurance copy of the complete system.

- vi. Proof for the establishment of service center for the sites (photo, registration docs).
- c) Commissioning and handover certificate (as prescribed), counter- signed by PNG Power Ltd.
- d) Minimum two (2) photographs (dated) for each premise in soft copy of the BESS Unit. Photos should be clear and of minimum postcard size. Photo should cover all the components supplied at site.

D. 4th Payment (5%)

Paid after 6 months from the successful handover date.

One year functionality report duly signed by bidder, representatives from PNG Power Ltd.

Comprehensive Annual Maintenance Contract half-yearly payment:

- a) Detailed complaint log of all the complaints received during the period (half yearly).
- b) Rectification log of all complaints attended and remedial measures taken (half yearly).
- c) Verification report signed by user and PNG Power Ltd representative.
- d) If the documents are not submitted within the specified stipulated time period, (at half yearly frequency) the contract will deem to be completed and the contractor will not have any claim for the payment.
- e) Complete records for complaint and rectification log should be maintained and available during any visit.

3.12 In case of any ambiguity in interpretation of any of the provisions of the tender, the decision of PNG Power Ltd shall be final.

3.13 Compliance:

All compliances (State/ Central/ Local /GST/ WCT/ ESI/ PF/ Labor law, etc., is to be met by the Contractor / Bidder) and the same is to be produced by the vendor at the time of payment.

3.14 Indemnification:

Notwithstanding contrary to anything contained in this RFQ, Supplier shall at his costs and risks make good any loss or damage to the property of the Purchaser and/or the other Supplier engaged by the Purchaser and/or the employees of the Purchaser and/or employees of the other Supplier engaged by the Purchaser whatsoever arising out of the negligence of the Supplier while performing the obligations under this contract.

3.15 Materials-Quality & Workmanship

3.38.1 Immediately on award of contract, the bidder shall submit a detailed project report within 10 working days having planning and testing strategy with provisions for quality check

performance at various stages of the project. The report shall also furnish details of method of checking and inspection and acceptance standards / values.

- 3.38.2 The bidder has to provide quality assurance certificates to PNG Power Ltd for required components of BESS and shall comply with appropriate codes & standards. Failure to abide by the same may result in rejection of contract by PNG Power Ltd. The Purchaser reserves the right to request for any additional information and also reserves the right to reject the proposal of any Bidder, if in the opinion of the Purchaser, the data in support of tender requirement is incomplete.
- 3.38.3 Bidder shall comply with the contract in all respects to the satisfaction of PNG Power Ltd.
- 3.38.4 For a period of 5 years, after system installation, the bidder shall be responsible for any defects that may occur due to faulty materials, design or workmanship. If it becomes necessary for the bidder to replace or repair any defective portion of the system, the bidder shall make such replacement or renewal within 48 hours of intimation and without any extra cost to PNG Power Ltd.
- 3.38.5 In-house system testing and visual inspection shall be done without any extra cost. The visual inspection shall be carried out in presence of PNG Power Ltd. Cost of Futile/abortive visit(s) shall be debited from the invoices.
- 3.38.6 PNG Power Ltd reserves the right to send any material being supplied to any recognized laboratory for testing, wherever necessary and the cost of testing shall be borne by the Bidder. In case the material is found not in order with the technical requirement / specification, the charges along with any other penalty which may be levied is to be borne by the bidder. To avoid any complaint, the supplier is advised to send his representative to the stores to see that the material sent for testing is being sealed in the presence of bidder's representative.
- 3.38.7 The time and the date of installation of the system stipulated in the Purchase Order shall be deemed to be the essence of the Contract, and installation must be completed within 8 (eight) weeks of issuing PO. If the contractor fails to install or any consignment thereof within the period prescribed for such installation, PNG Power Ltd shall be entitled at their option: As agreed under the liquidated damages clause, PNG Power Ltd has the rights to recover a price sum equivalent to 2 % of the price of any article which the contractor failed to deliver, for each month. The same applies to a part of the month during which the delivery of such products may be in arrears subject to a maximum of 10% of the price.

- 3.38.8 Bidder has to sign quality agreement, before supply of the material. Detailed terms and conditions will be shared along with purchase order/ LOA which needs to be signed on stamp paper at that time when purchase order is placed.
- 3.38.9 In order to ensure efficient and flawless running of the system, there should be a dedicated skilled person to take care of system working at each site (Category A, B & C). Separate component of CAPEX should be included in the financial Bid part for this workmanship.
- 3.38.10 Bidder shall be responsible to clean and remove all residuals from the site after the installation of the system.
- 3.38.11 **Prices basis for supply of materials:**
Bidders require quoting their prices on landed cost basis and separate price for each item. For supply to installation site, the price shall be inclusive of packing, forwarding, and freights, GST to be mentioned separately. The above supply prices shall also include unloading at site stores. Transit and storage insurance will be arranged by bidder.
- 3.38.12 Bidder shall provide detailed completion/ commissioning report stating details of equipment installed at the locations mentioned in the tender.



SECTION - IV:

SCOPE OF WORKS

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1. Project Particulars
2. Brief Scope of Work
3. Design and Engineering
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5. Construction and Erection Works
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1. PROJECT PARTICULARS

Design and Engineering	
Power Rating Instantaneous (MW)	10
Dispatchable Energy Capacity (MWh)	12
Output Voltage of Batteries (DC V)	600 – 800
Round Trip Efficiency	> 80%
Battery Chemistry	Lead-Acid
Power Conversion System	Bi-directional
Minimum Inverter Capacity (MW)	10
Minimum Transformer Capacity (MVA)	10
Design Life	≥ 15 years
Site Location and Land Details	
Site Coordinates	
Site	Moitaka
District	National Capital District
City	Port Moresby
Type of Land	State Land
Owner of Project	PNG Power Ltd
Owner of Land	Department of Lands & Physical Planning
Electrical Interconnection Details	
Substation	Moitaka Substation
Distance to Connection Substation (approx.)	100 m
Access	
Nearest Urban Area	Port Moresby
Nearest Sea Port	Motukea Wharf, Port Moresby
Nearest Airport	Jacksons International Airport
Performance Parameters	
Performance Ratio (PR)	82%
Capacity Utilization Factor (CUF)	
Availability	98%

Other Details	
Construction Water	To be arranged by PNG Power Ltd
Construction Power	To be arranged by PNG Power Ltd

2. **BRIEF SCOPE OF WORK**

- 2.1 Scope of Supply & Work includes all design & engineering, procurement & supply of equipment and materials, testing at manufacturers works, multi-level inspections, packing and forwarding, supply, receipt, unloading and storage at site, associated civil works, services, permits, licenses, installation and incidentals, insurance at all stages, erection, testing and commissioning of a 8 MW / 12 MWh F-R Battery Energy Storage System plus 2MW Solar PV, and performance demonstration with associated equipment and materials at Moitaka Substation, NCD, Port Moresby.
- 2.2 All works shall be executed as per Technical Specifications given in Section-V with reference to site specific design requirements.

3. **DESIGN AND ENGINEERING**

- 3.1 The Contractor shall prepare the detailed design basis report (DBR) along with relevant standards (with respective clause description), PERT Chart and MDL. The Contractor shall submit a copy to Employer (PNG Power Ltd) for review and approval prior to detail engineering.
- 3.2 All documents and drawings shall be submitted to the Employer soft copies for review and approval. Every drawing shall be submitted in '*.dwg' format. In case of design calculations done in spread sheet, editable (working) soft copy of the spread sheet shall also be submitted along with 'pdf' copies during every submission. The Employer shall return, as suitable, soft copies to the Contractor with category of approval marked thereon. The drawings/documents shall be approved in any one of the following categories based on nature of the comments/type of drawing or document:
- Category-I: Approved
 - Category-II: Approved subject to incorporation of comments. Re-submit for approval after incorporation of comments.
 - Category-III: Not Approved. Re-submit for approval after incorporation of comments
 - Category-IV: Kept for record/reference
 - Category-V (R): Re-submit for record/reference after incorporation of comments

- 3.3 Approval of document neither relieves the Vendor/Contractor of his contractual obligations and responsibilities for correctness of design, drawings, dimensions, quality, specifications of materials, weights, quantities, assembly fits, systems/ performance requirement and conformity of supplies with Technical Specifications, PNG statutory laws as may be applicable, nor does it limit the Employer/ Purchaser's rights under the contract.
- 3.4 Submission of basic design data, design documents, drawings and engineering information including GTP and test reports to Employer or its authorized representative for review and approval in hard or soft copy from time to time as per project schedule. The documents include, but not limited to, the following:
- i. Detailed technical specifications (GTP) of all equipment
 - ii. General arrangement and assembly drawings of all major equipment
 - iii. Schematic diagram for entire electrical system (DC, AC and auxiliary systems)
 - iv. GTP & GA drawings for all types of structures/ components, 11 kV or 66 kV switchgears (as applicable) & other interfacing panels
 - v. Test reports (for type, routine and acceptance tests)
 - vi. Relay setting charts
 - vii. Design calculation and sheets (licensed software as well as design templates)
 - viii. GA drawings of the entire project include equipment rooms/inverter control rooms, fire protection system, perimeter fencing, transformer yard fencing etc.
 - ix. Quality assurance plans for manufacturing (MQP), Standard Operating Procedure (SOP) and field activities (FQP).
- 3.5 Design of associated civil, structural, electrical & mechanical auxiliary systems includes preparation of single line diagrams and installation drawings, manuals, electrical layouts, erection key diagrams, electrical and physical clearance diagrams, design calculations for Earth-mat, Bus Bar & Spacers indoor and outdoor lighting/illumination etc., GTP and GA drawings for the major equipment including transmission line, design basis & calculation sheets, and other relevant drawings and documents required for engineering of all facilities within the periphery to be provided under this contract.
- 3.6 All drawings shall be fully corrected to match with the actual "As-Built" site conditions as submitted to Employer after commissioning of the project for record purposes. All as-built drawings must include the Good for Construction deviation list.

4. PROCUREMENT & SUPPLY

The equipment and materials for the Grid Connected Battery Energy Storage System (BESS) plus 2MW Solar PV with associated system (typical) shall include but not limited to the transit insurance, receipt, unloading, storage, erection, testing and commissioning of all supplied material for the following:

- 4.1 BESS of required power and energy capacity including unit batteries, Battery Management System (BMS), Power Conditioning System (PCS), Step-up transformers, LT & HT switchgear panels, Auxiliary supply system, DC & AC power cables, control and communication cables, along with RTU and related accessories for communication via existing SCADA system, HVAC system, fire-fighting system and other related accessories.
- 4.2 Auxiliary transformer(s) along with cables and accessories for BESS internal consumption.
- 4.3 Relay and protection system along with battery system.
- 4.4 LT Power and Control Cables including end terminations and other required accessories for both AC & DC power.
- 4.5 Internal 415V interconnection & indoor feeder panels to cater auxiliary needs of plant.
- 4.6 Indoor panels / outdoor structures having incoming and outgoing feeders with VCBs, CTs, PTs, Bus bars, cable terminals kits and Bus coupler having Main and transfer Bus. Each bay shall consist of VCB, CT, Isolators with earth switch, Las and PT's etc.
- 4.7 Installation, Testing and Commissioning of ABT meters with AMR facility and all necessary metering rated CTs and PTs as per applicable metering regulations as amended time to time and state metering code.
- 4.8 Providing necessary communication and Data Acquisition System to transfer real time data to SCADA as per specifications of the SCADA section in PNG Power Ltd and as per PNG Grid Code.
- 4.9 Lightning arrestor for BESS
- 4.10 HDPE pipes, cable conduits, cable trays and accessories/trenches
- 4.11 Earthing of entire plant as per relevant standards
- 4.12 Control room equipment
- 4.13 Testing instruments for maintenance and monitoring equipment
- 4.14 Fire protection system in buildings and fire extinguishers
- 4.15 Construction of suitable structure for termination of transmission line for taking off from plant end and receipt of lines at Substation end.

- 4.16 Design & construction of LILO Transmission line/cable at required voltage level from plant take off point to the designated substation and construction of bay at designated substation as per PNG Power Ltd requirements/procedures.
- 4.17 Any re-arrangement/ replacement of substation equipment/ materials, including bay construction, if required, at the evacuating substation necessary for evacuation of power from the plant.
- 4.18 All safety equipment including PPE, mats, etc. for safe working environment
- 4.19 Materials and accessories, which are required for satisfactory and trouble-free operation and maintenance of the above equipment like module cleaning system, supply of spares for all equipment, supply of tools etc.
- 4.20 Any other equipment / material, not mentioned but required to complete the Battery Energy Storage System in all respect.
- 4.21 The Solar PV System and all associated equipment/material to achieve the functionalities of charging the BESS and when not charging to supply to the POM grid.

5. CONSTRUCTION AND ERECTION WORKS

The items of civil design and construction work shall include all works required for the Battery Energy Storage System plus 2 MW Solar PV project and should be performed specifically with respect to the following but not limited to:

- 5.1 Conducting geotechnical investigation and topographical survey of the given area.
- 5.2 Earthwork for site grading, cutting, filling, levelling & compaction of land.
- 5.3 Construction and erection of boundary wall/fence and main/security gate(s).
- 5.4 Construction of foundation for mounting of battery bank modules
- 5.5 Civil foundation work of inverter, transformer, switchgears, equipment etc.
- 5.6 Construction of battery bank housing with necessary illumination system and finishing as required.
- 5.7 Suitable Communication System for telemetry, SCADA with remote monitoring capabilities.
- 5.8 Construction of Storm water drainage to its nearest outfall point & sewage network including rain water harvesting mechanism.

- 5.9 Erection of perimeter lighting along with all accessories and cabling.
- 5.10 Laying of underground / over ground cables (all types, as applicable) with proper arrangements along with appropriate sized ferrules, lugs, glands and terminal blocks.
- 5.11 Laying of cables within battery bank housing shall be over GI cable trays with proper support and accessories.
- 5.12 Construction of connecting transmission line including Design, route survey, foundation, erection, stringing, commissioning as per PNG Power Ltd procedures from take-off point at plant end to available 11/66 kV Step-up transformer.
- 5.13 Suitable earthing for plant along with earth pits as per standards.
- 5.14 All approvals, for equipment, items and works, which are not otherwise specifically mentioned in this document but are required for successful completion of the work in all aspects, including construction, commissioning and guaranteed performance are deemed to be included in the scope of the contractor.

6. STATUTORY APPROVALS

- 6.1 Obtaining statutory approvals/clearances/compliances on behalf of the Employer from various Government Departments, not limited to, the following:
 - i. Physical Planning board clearance, if required
 - ii. All other approval as and when, as necessary for setting up the Battery Energy Storage System including CEIG/CEA, power evacuation, etc. as per suggested guidelines. Grid connectivity approval will be the Scope of the Owner.
 - iii. All other statutory approvals and permissions and their respective compliances, not mentioned specifically but are required to carry out hassle free construction of the plant.
 - iv. Adequate and seamless insurance coverage during EPC to mitigate all risks related to construction of the plant to indemnify the Employer.
- 6.2 The Contractor shall comply with the provision of all relevant acts of the Independent State of Papua New Guinea including Employer's Liability Act, Contract Labor Act, Electricity Act, PNG Grid Code or any modification thereof or any law regarding whereto and rules made there under or amended from time to time.



SECTION - V:

TECHNICAL SPECIFICATIONS

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3. Procurement Scope
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15. Post-Sale Assistance
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20. Safety
21. Environmental Control
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23. Project management

1. Background

The objective of this project is to address the issue of grid instability currently faced on the Port Moresby Grid during grid operations and abnormal conditions.

Recent blackouts on the system have resulted after the system failed to return to a stable operating point after a transient or fault condition. Data grabs from recent outages caused by loss of major loads and transmission lines have uncovered the grid's inability to regulate system frequency. This also holds true at times during loss of generation.

After completion of this tender, PNG Power Ltd intends to identify an adequate company/contractor to design, supply and install a Frequency Regulation BESS in the Port Moresby Grid which will assist in regulating system frequency.

PPL has three (3) main electricity grids – namely the Port Moresby Grid, the Ramu Grid and the Gazelle Grid, which are not interconnected and supplying electricity to PNG's main towns. PPL also owns and operates other smaller centers in PNG that are mainly thermal generating plants and medium voltage distribution lines only.

The Battery Energy Storage System (BESS) is to be installed on the Port Moresby Grid. The Port Moresby Grid is PNG's biggest electricity grid in terms of generation capacity and load demand. It supplies electricity to PNG's National Capital District as well as the neighboring Central Province. The grid has a 66kV transmission system and an overhead 22kV and 11kV radial medium voltage distribution system. Generation mix comprises mainly of Gas turbines, Diesel and Hydro Power Stations. The maximum load demand of the system is 133 MW. See Figure 1.1 for a typical day load profile.

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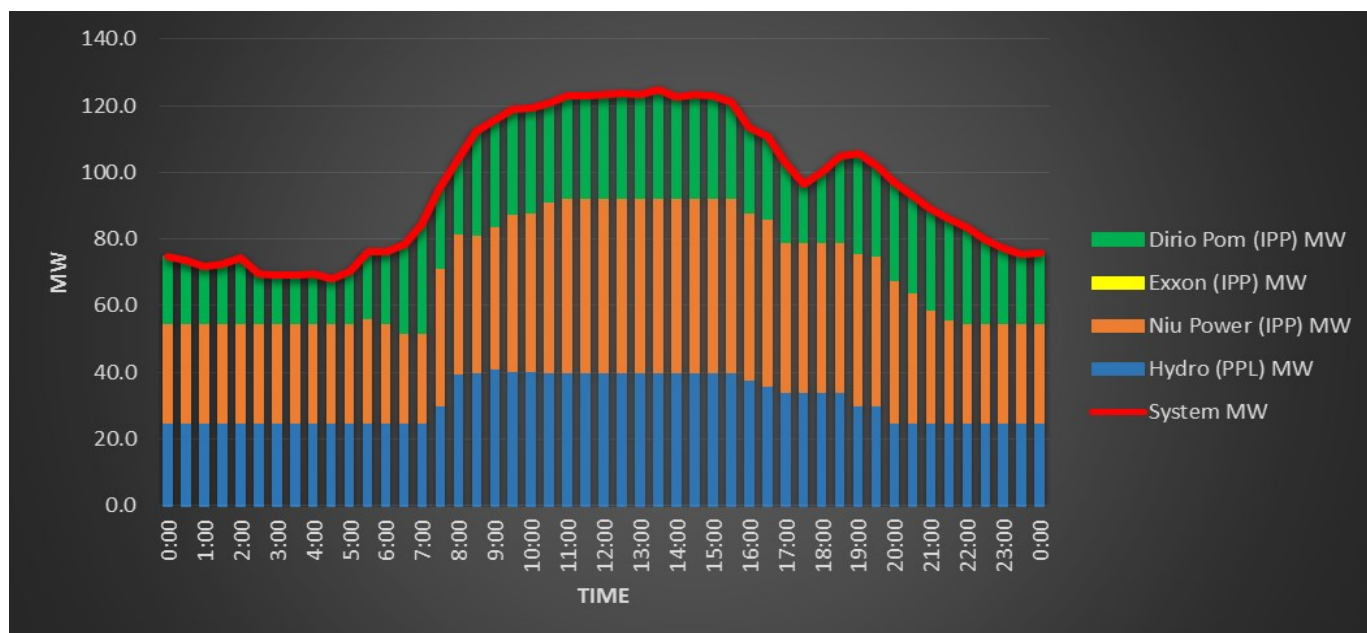


Figure 1.1 Typical Day Load Profile for Port Moresby System

Below is a broad overview of the current Port Moresby Grid:

▪ **Generation**

Generating Plants	No. of Plants	Available Capacity (MW)	Percentage Capacity (%)
Hydro	4	40.5	28.6
Thermal	3	101.0	71.4
Total		141.5	
PPL Generation	5	63.5	44.9
IPP	2	78	55.1
Total		141.5	

▪ **Transmission**

Voltage Level	No. of Lines	Total Line Length (km)
66 kV	19	149.51
33 kV	2	16.6

▪ **Substation**

	Capacity (MVA)	No. of Distribution Feeders	Distribution Voltage Level
Boroko	60	8	11
		1	22
Konedobu	50	7	11
Kanudi	19	2	11
Waigani	50	4	11
Bomana	15	3	11

2. Nomenclature

The following nomenclature shall be used throughout the Schedule of Requirement (SOR) section:

- Bidder: Company participating in the Bid process
- Vendor: Successful Bidder
- BESS: Battery Energy Storage System
- PPL: PNG Power Ltd, procurer of the BESS
- PNG: Papua New Guinea

3. Procurement Scope

The overall objective of the BESS procurement is to:

- i. Improve system quality through fast response by managing system frequency absorbing or discharging energy on a minute-to-minute basis to help maintain system frequency at 50 Hz.

The Solar PV System is to charge the BESS utilizing free fuel from the sun and when not charging the 2MW Solar PV will be used to trim the peak level thereby reducing the POM peak demand to more stable levels.

4. Project Site

Location

The project area is at Moitaka Substation, located in the National Capital District of PNG, and is situated [North East] of PNG's capital city of Port Moresby. The distance from Port Moresby to Moitaka is about 5 km. The site is a PPL generation site.

The Moitaka Substation is located at latitude of 9°26'1" S and longitude 147°8'28"E. Moitaka as an altitude of 5m above sea level. From the main city and sea port, the roads are paved, with occasional holes and bumps. Bidders can assess the road situation during site visit.

Topography

The Moitaka Sub-Station and Power Station lies along an area that tees-off from the Hiritano Highway. The site has a Substation, a diesel power station and office space. An orthophoto and a layout of the power station is provided as an attachment. The site is surrounded by settlers and vegetable gardens.

Seismicity/Hurricanes

PNG Power has no data on seismicity for Port Moresby. Occasional strong winds do occur.

5. Scope of Supply

The scope of supply for the BESS shall include the following principal elements. The Vendor shall be responsible for identifying and providing any and all other additional equipment, components, and services necessary to install and run a fully functional BESS.

- a) Design, fabricate, procure, ship to project site, assemble, test, start-up, commission, warrant and make ready for service a fully functional turnkey BESS and balance of system equipment that meets or exceeds all requirements.
- b) Conduct all equipment installation (field preparatory work, ground movements and other hand-work tasks shall be done by the PPL technical team) and integration with the equipment already installed in the power station
- c) All required equipment / materials labor and tools required to install, test, and commission the BESS
- d) Design, install and make ready for the electrical connection from the BESS to the AC point of connection as determined by the owner. Vendor is responsible for the low voltage AC connections, cable, and protection, back to BESS. The point of interface is the entrance of the step-up transformers at the power station.
- e) Design, install and test a Human Machine Interface (HMI) onsite.
- f) Provide on-site training classes for PPL operators, engineers, technicians and maintenance personnel
- g) Supply any special equipment and tools required for the operation and maintenance of the project
- h) Supply an initial complement of spare parts for one (1) year of operation
- i) Provide post sales and installation technical support of the system as part of a service contractual agreement
- j) Provide component replacement, disposal and take back at the end of their life
- k) Provide at minimum a five (5) year warranty for the battery, a three (3) year warranty for the power converter and a one (1) year warranty for the energy controller, and a separate cost breakdown for additional years
- l) Submit for PPL review and comment all SLDs and operational and control information on the BESS.
- m) Provide and maintain a Schedule for all design, fabrication, procurement, installation and testing activities for the project

The detailed engineering design works for the BESS system and integration with the existing system shall take place within one (1) month period from the award of the contract. It is anticipated that this service will commence on the 4th quarter of 2023.

The detailed engineering design shall include but not be limited to the following activities:

- Inception report
- Site visit and assessment
- Schedule of activities with time-line and risk assessment
- Preliminary engineering design report
- Bill of Quantities
- Equipment technical specifications
- Detailed engineering design final report.

The Vendor shall include in the design, battery lifetime considerations. This shall include optimal depth of discharge set points to minimize the leveled cost of electricity.

Duration: Installation, Commissioning and Training

The installation, commissioning and PPL personnel training shall start after the equipment shipment and approximately on the 1st quarter 2024. The duration of these activity shall last no more than five (5) months from the start. The hybrid power plant shall be fully operational from the 1st of June 2024.

Assistance to PPL during installation and commissioning shall include:

- Site progress meetings during installation and commissioning
- Attendance to all technical queries raised during site works face to face / email / telecom
- Handover to PPL at the end of the commissioning phase
- Technical training to PPL technical team during installation and during commissioning
- Performance testing of all individual systems and of the system integration
- Site visit / inspection at end of testing and commissioning of the system.

A project implementation plan shall be submitted with the Bidder's proposal.

6. Document Deliverables

The Bidder shall furnish complete documentation that will be used for determination of contract compliance, as well as, operation and maintenance of the BESS. The documentation shall be in English, well detailed and instructive. At a minimum, the Contractor's documentation shall consist of the following:

- a) Conceptual design package for PPL review
- b) System integration study for the micro-grid application according to operation concepts

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- c) BESS performance specifications and application-specific specification/operation
- d) Complete SLDs and BOQ for PPL review
- e) SLD diagram of the BESS system and SLD for the Solar PV System
- f) Complete commissioning plan including test and start-up procedures for PPL review
- g) BESS Control and protection settings. Technology to control grid stability by BESS with some form of illustration and evidence of the operations of the control technology.
- h) Maintenance Schedule
- i) Project Schedule
- j) Software Documentation
- k) Technology to protect battery fire hazard and providing evidences on the credibility of the mitigation technology.

All documentation shall be provided in:

- 1. Electronic submissions (two copies)
- 2. PDF format, all documents are to be provided in PDF format
- 3. Native file format when applicable, in addition to PDF format documents shall be provided in native file format.
- 4. Drawings shall be provided in AutoCAD format. Documents that were created in Word or Excel, etc. shall also be provided in those formats in addition to PDF.

Within thirty (30) days following receipt and approval of the Project Schedule, Vendor shall submit a drawing list identifying data, databases, data sheets, design criteria, Operations & Maintenance (O&M) manuals, procedures, reports, schedules, specifications, tables, and others as might be identified during the contract award phase.

The Vendor shall prepare and submit electronically in a timely manner all documents as required by the tender to PPL for review with sufficient information content to completely describe the details and requirements of the required services. PPL, upon receipt of proposals, shall review the documents. The documents shall be scanned in .pdf format and packaged in .zip files.

All Computer Aided Design and Drafting System (CADDs) shall be delivered in native file format as well as in .pdf format.

Design drawings will include but not necessarily be limited to the following types (if applicable):

- a) Civil-Structural
- b) Site Plan
- c) Site General Arrangement
- d) Building Structural Concrete Base Plans,

- e) Elevations and Details Grading, Paving Plan
- f) Miscellaneous Details & Sections Erosion Control Plan (if applicable)

Electrical

- a) System One Line Diagram and Three Line Diagram
- b) Protective Relay List, Breaker Trip Table, & Functional Drawings
- c) Breaker DC Elementary Diagrams
- d) Breaker External Connection Diagrams
- e) Relay Panel Internal Wiring Diagram
- f) Relay Panel External Connection Diagram
- g) Relay Panel Terminal Block Diagram
- h) Bus Differential Protection AC/DC Elementary Diagrams
- i) Line AC Elementary Diagram
- j) Line Potential Transformer Connection Diagram
- k) 120/240 VAC Schematic & Wiring Diagram
- l) 48/110 VDC Schematic & Wiring Diagram Phase Rotation Diagram
- m) 600 Volt Power One Lines
- n) DC One Line and Schematics 600 volt A/C Schematics Medium Voltage Schematics Inverter Schematics
- o) Isolation/Step Up Transformer Schematics and Wiring Diagrams
- p) Electrical Conduit, Tray, & Grounding Plans
- q) Wire Schedule (including fiber optics)
- r) Control Schematic Diagram
- s) Electrical Equipment Arrangement Plan
- t) Electrical Equipment Elevation
- u) Sections Switchgear Arrangements
- v) Control Panel Arrangements
- w) Relay Panel Arrangements

Controls

- a) Control System Architecture Diagram
- b) Control Logic Diagrams
- c) SCADA/EMS RTU Connection Diagram
- d) Supervisory Control Connection Diagrams BESS
- e) Multiple Site Fiber Optic Communication Plan

Mechanical

- a) Equipment Locations Plan HVAC Systems
- b) Fire Protection Systems
- c) Battery Thermal Management Systems
- d) Instrument Installation Details
- e) Instrument Data Sheets

7. Design Condition Requirements

The BESS shall be able to operate in the following conditions:

- a) Design Temperature Range: 10-50°C
- b) Relative Ambient Humidity 5-95%
- c) Pressure
- d) Outdoor Installation
- e) Peak Wind Gust:
- f) Seismic Zone:

It is the responsibility of the BESS Vendor to design all components to operate at safe rated sustainable operating temperatures over the required ambient temperature range. The BESS shall be fully contained in weatherproof, environmentally conditioned enclosures with minimum NEMA 3R (or equivalent) protection. System enclosure of the BESS shall be able to withstand the design conditions including the maximum wind speed.

8. Electrical Design Parameters Requirements

The BESS system shall operate with the following electrical specifications:

- a) Nominal system frequency: 50 Hz
- b) Frequency design tolerance: 47.0Hz – 52.0Hz
- c) System voltage shall be defined as per PCU/inverter voltage
- d) System rated currents shall be as per PCU/inverter currents
- e) System output voltage, current and frequency shall be compatible with existing power plant step up transformers

All other existing electrical component design parameters are found in Attachment A.

9. F-R BESS Requirements

The self-contained BESS shall include the battery cells and racking, DC interconnection cabling, an AC service transformer and distribution panels, HVAC systems, energy metering, data historian server, an HMI for energy management control and monitoring / diagnostics and all other materials and equipment needed to provide a fully functional battery system capable of being integrated to the hybrid power plant.

In the proposal, the Bidder shall address the following points that are applicable to the Bidder's technology:

- a) The proposed solution shall be scalable and modular in design. Energy capacity shall be able to be added or removed easily without affecting the BESS availability to the grid.
- b) Replacement of individual cells or cell modules shall not interrupt BESS availability to the power plant.
- c) Energy storage capacity shall be increased without replacing the main system power converter and Balance of System.
- d) Number of cycles (at 80% depth of discharge) shall be minimum 2500. The Bidder shall provide performance curve indicating number of expected life cycles vs. depth of discharge.
- e) Energy Storage Self-discharge shall be maximum 5%/month. The Bidder shall provide performance curve showing the self-discharge (over a six (6) month period).
- f) The BESS shall have dedicated auxiliary electric power systems to serve BESS ancillary loads (HVAC, lighting, etc.) and be able to be auto-transferred to a reliable backup source
- g) Data Acquisition / Monitoring / Alarms shall be included in the system
- h) Partial state of charge management
- i) AC/AC round trip efficiency shall be minimum 80%
- j) The BESS shall have a Battery Management System (BMS) capable of protecting and monitoring individual battery modules.
- k) The BESS shall be able to cope with the increase in power generation up to the levels as indicated in the potential projection of the load profile found in Figure 1.1.

Additionally, the vendor shall provide the information below in their proposal:

- 1. Battery technology which shall be lead-acid
- 2. Controlling parameters that determine life expectancy for the proposed system
- 3. The battery maintains constant output at demand levels less than rated output
- 4. The battery maintains rated output at a reduced state of charge than 100%
- 5. State of charge of the battery as a function of time during the charge cycle
- 6. Battery response time
- 7. Battery ramp up time

8. Energy storage capacity loss over time during standard use. Provide typical degradation curve information for the battery system proposed showing capacity loss over 10 years
9. The Battery has a thermal derating system
10. Replacement time of individual cells or cell modules
11. Disruption time of replacement of individual cells or cell modules
12. Maximum Discharge rate
13. Maximum Charge rate
14. Cooling System power consumption
15. Corrosion resistance of enclosure

Data Acquisition, monitoring and Software (HMI)

The Data Acquisition/monitoring/alarm system of the BESS or procedures shall have as minimum the following capabilities:

1. Monitoring requirements including but not limited to: battery state of charge, power charge/discharge status, AC-Voltage, Current, Power Factor, kW, kVA, kVAR. DC-DC voltage and current, battery thermal status, AC-DC conversion efficiency. Points of monitoring TBD during design.
2. Data Acquisition System shall have as minimum 16Mb of local memory and capability to be remotely accessed and data downloaded. Data points shall be recorded at a minimum of 1 minute, with the capability for instantaneous collection of data when data is outside of set parameters.
3. Alert the operator via user interface of battery system failure, control failure of each of the component connected to the system (if applicable);
4. The BESS is in imminent danger of failing to meet specified performance levels or potential safety hazards exist;
5. The BESS can no longer meet the specified performance criteria or safety hazards exist;
6. The BESS Vendor shall have the capability to remotely monitor the BESS via a cloud based remote service system and independently and automatically be alerted to BESS alarm conditions without relying on the local user to communicate such an alarm condition exists.
7. The BESS Vendor shall have the capability to respond to alarm conditions and provide required service to correct such alarm conditions within 12 hours from the inception of the alarm condition. The Vendor shall include, in the Operation and Maintenance Manual, the recommended corrective action and maintenance procedures for each alarm level or observed condition provided
8. The monitoring system shall be capable of informing the user of schedule maintenance requirements of the system

9. Meet current Cyber Security Requirements. Virtual access to the BESS by the BESS vendor will be provided by PPL via a virtual private network (VPN) connection
10. The ramp rate of charging and discharging of the BESS shall be programmable or set to a defined value by manually entering a value into the BESS HMI
11. The BESS control system shall be designed to provide for automatic, unattended operation of the BESS. However, the control system design also shall provide for local manual operation and remote operation. All modes of operation and its operational set-point functionality shall be remotely adjustable from the operator offices to allow change in settings and to turn on/off all controls or modes when appropriate.

The BESS monitoring system shall also be able to measure and show the following information on the HMI:

- a) Energy storage state of charge and discharge and thermal status
- b) Real-time energy and current flows and voltage level

Harmonics

The BESS must meet the harmonic specifications of IEEE 519. The maximum total harmonic distortion (THD) shall be less than 1.5%. And each wave harmonic distortion (HD) shall be less than 1%. This shall be proven by a test report from an authorized lab.

Protection Requirements and Balance of System Components (BOS)

The BESS system shall contain protective relaying features, circuit breakers or fuses which 'self-protect' the BESS in the case of internal electrical faults (short-circuit, under-voltage fault ride through, unbalanced current, fault current).

The BESS system shall also have temperature sensors and an integrated cooling system to keep the operating temperature of the system at appropriate levels (if applicable).

1. Model and sub-contractor of BOS components shall be chosen by the BESS Vendor.
2. Provide the functionality described elsewhere in the tender.
3. DC disconnect switches: UL listed, blade-type, heavy duty fused safety switches on the output of the Battery array in NEMA enclosure rating as required by installation location or may be integrated to the Inverters (or equivalent).
4. AC disconnect switches: UL listed, blade-type, heavy duty fused safety switches on the output of Inverter(s) in NEMA enclosure as required by installation location or may be integrated to the Inverter (or equivalent)
5. All listed feature shall be included in the detailed engineering design phase and iterated with PPL before final design.

Control System Requirements

The purpose of the control system shall be to guarantee simplified operations, grid compliant power production and maximizing asset return on investments by implementing advanced control algorithms.

The Bidder's proposal shall fully describe and demonstrate, by way of algorithms and other means, how the proposed BESS control system(s) will operate.

BESS control system shall integrate the following operational requirements:

1. The control system shall be distributed (central RTU unit and individual RTU units for each equipment, including inverters (if applicable)). This design shall allow the central RTU unit to continue functioning in the case of the malfunction of a remote RTU unit. The RTU plus SCADA system shall be capable of integrating all plant assets into a single management system, capable to make the connection from renewables (including solar panels and wind turbines), all the way to the network management system.
2. The operator shall have full control of the BESS control system via a user friendly graphic interface showing each individual component and the parameters associated with the operation and alarms
3. The BESS shall be completely dispatchable
4. The BESS control system shall allow energy forecasting
5. Any operating function shall be capable of being remotely and dynamically selected and prioritized
6. Function parameters (i.e., droop setting) of any operating function shall be capable of being remotely modified
7. The control system shall have the capability to be modified with additional features, additional components connection and additional variables for future upgrades
8. Communication between BESS and the data concentrator shall be RS-485/Serial or equivalent. Depending on final design (e.g., amount of monitored devices, equipment layout, distance, etc.), other communication methods may be recommended for approval that will provide the most efficient, reliable, and secure communication network. All signal/communication cables shall be shielded and protected from environment to ensure signal integrity. The BESS shall also have a device to allow high-speed fiber optic communications (or equivalent) to the master BESS controller.
9. The control system shall have the necessary hardware and software (i.e. firewalls & malware detection) such that it is compliant with the latest NERC CIP reliability standards for control system security requirements.
10. The Control system shall be able to control, monitor and interface to outgoing feeder and their protection relays

11. The Control system shall be able to control, monitor and interface to Smart Meters for household energy consumption for demand side management

The engineering tasks of the SCADA system shall include, but not be limited to, the following:

1. Additional and identifiable points or controls, if not provided initially through BESS control system interface base, must be programmed into interface for serial link communications (e.g., but not limited to, fire system activation & integrity, BESS building entry, breaker status).
2. A provided SCADA points list shall be prepared by the vendor and submitted to PPL for review and approval during the detailed engineering design phase.
3. Provide monitoring access and control access to all proposed BESS modes of operation, state of charge, available duration at various output levels, kW/kVar set points, kW/kVar flow, local/remote control, misc. BESS alarms/status.
4. Work items shall include all labor, materials, test equipment, & engineering required to complete SCADA communication integration.
5. The Vendor shall prepare plan and section drawings for the SCADA/data concentrator integration showing the location of all equipment.
6. The Vendor shall provide complete testing procedures for the BESS equipment and control system and provide commissioning of the data concentrator/SCADA integration. The prepared testing procedures shall be submitted to PPL for review and approval before any testing work is done

Internet/PPL Network connection

Fiber-optic internet connection is present at the project site. The Vendor shall provide information on the required type of connection needed in the detailed engineering design. Moreover, the Vendor shall be responsible for procuring and installing all Ethernet cables (or equivalent) and making required modifications to the network needed to enable all functionalities of the BESS.

Labelling

Install signage posted at site, including at least the following but also any signage required by the NEC or other applicable codes:

Laminated Diagrams including:

- a) AC and DC disconnect locations for the system indicated on a site plan.
- b) Electrical one-line diagram of system
- c) All signage required shall be mounted in appropriate and visible locations

All equipment shall be appropriately identified with permanent, self-adhesive labels.

Each DC disconnect shall be labeled with label material described above for operating DC current (Imp), system operating DC voltage (Vmp), maximum string DC voltage (Voc), and maximum system DC current (Isc). The BESS interconnection point shall be labeled as such indicating the system AC voltage, current, and the BESS rating in kW-ac and kWh.

10. 2MW Solar PV System Requirements

General Description

Total output of the Solar PV is 2MWac to be located at PPL Moitaka in the POM Grid. The facility will be connected to the POM grid at Moitaka 66kV system.

Output and basic functional requirements

The Solar module shall produce an instantaneous power of 2MWac. The main role is to charge the BESS. When not charging, the Solar PV power will be available during day time when the POM grid demand is about 100MW as a peak-shaver and not available at night when the grid demand is about 80MW.

Technical Requirements and Specifications

Notice on Grid-Connected Solar Photovoltaic System in Papua New Guinea released Dec 2019 by PPL required systems to comply with AS/NZS standards. The solar system therefore shall be consistent to this Notice. Where the AS/NZS Standard is silent or PPL has stated a particular requirement, the bidder shall use international best practice for the design and installation of the 2MW Solar System.

The PV Solar and BESS Project Installation must comply with the following;

1. AS/NZS 5033 Installation and safety requirements for photovoltaic (PV) arrays
 - AS/NZS 4777 Grid connection of energy systems via inverters
 - Part 1: Installation requirements
 - Part 2: Inverter requirements
 - AS/NZS 5139 Electrical Installations - Safety of battery systems for use with power conversion systems.

For this project the bidder shall also comply with the following relevant standards relating to the installation of the grid connect 2MW Solar PV installation to the POM grid:

- AS/NZS 3000 Wiring rules;
- AS/NZS 3008 Electrical installation - selection of cables;
- AS/NZS 1170 Structural design actions; and
- AS/NZS 1768 Lightning Protection.

Solar Modules

Solar modules comply with the relevant IEC standards (Note inverters shall also comply with AS/NZS 4777.2).

As stated within the AS/NZS 5033 standard, all PV modules shall be qualified to:

- IEC 61215-1 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1 Test Requirements
- IEC 61215-2 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 2 Test Procedure
- IEC 61730-1 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
- IEC 61730-2 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

In addition, the modules shall be qualified by the following relevant standard depending on the cell technology:

- IEC 61215-1.1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.1 Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61215-1.2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.2 Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules.
- IEC 61215-1.3, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.3 Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules.
- IEC 61215-1.4, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.4 Special requirements for testing of thin-film Cu(In,Ga)(S,Se)₂ based photovoltaic (PV) modules

All modules shall be classified as Safety Class II as specified in IEC 61730.

Class II basically means that the live parts in the module are double insulated with respect to being touched.

Inverters

As stated within the AS/NZS 4777 standard, inverters for use in inverter energy systems with photovoltaic (PV) arrays and/or batteries in Australia and this project shall conform to:

- *IEC 62109-1 Safety of power converters for use in photovoltaic power systems, Part 1: General requirement and;*
- *IEC 62109-2, Safety of power converters for use in photovoltaic power systems, Part 1: Particular requirements for inverter and*
- *the requirements within AS/NZS 4777.2.*

The inverters shall be equipped with droop control to reduce the power to the grid when the frequency increased in conjunction with FR control.

Battery

Pre-assembled battery systems and pre-assembled BESS can either;

- meet the Australian Best Practice guideline or

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- the battery systems used in the BESS comply with either the relevant Australia/New Zealand Standards, IEC standards or UL standards.

For this project No Lithium batteries will be used. Based on the recent experiences of fire involving Lithium batteries, they are not to be used for this project. Only Lead acid batteries are allowed and shall conform to the following standards:

- AS/NZS 4029.1 Stationary Batteries-Lead acid, Part 1: Vented type
- AS/NZS 4029.2 Stationary Batteries-Lead acid, Part 1: Valve regulated type
- IEC 60896 Stationary lead-acid batteries (series)

For this grid connect PV and BESS Project installations shall comply with AS/NZS 5033, AS/NZS 4777 and AS/NZS 5139. These also require the equipment comply with the equipment standards with exception that the UL standards are not generally listed in AS/NZS standards.

Output voltage of the battery (DC) shall be 600-800V.

Brief Description of Standards (in line with current work done by GSES of Australia¹)

For the standards to be used in this project, a brief statement on how they are applicable to the installation of PV systems and BESS is provided. It is the bidder's responsibility to ensure the details of these standards are obtained from the respective websites and organisations.

AS/NZS 5033 Installation and safety requirements for photovoltaic (PV) arrays

The current version of AS/NZS 5033 was published in 2021.

The **scope** of the standard states:

This document sets out general installation and safety requirements for electrical installations of PV arrays, including d.c. array wiring, electrical protection devices, switching and earthing provisions.

The scope includes all parts of the PV array up to but not including energy storage devices, power conversion equipment or loads. This document also includes d.c. safety issues related to any associated power conversion equipment.

This document does not apply to PV arrays in the following electrical installation types:

(a) Less than 100 W and less than 35 V d.c. open circuit voltage at STC.

¹ Solar and Battery Energy Storage is new to PNG. Guidelines are currently being developed by GSES. Bulk of the descriptions of the standards are adopted from GSES work on the assumption that PNG will be progressing to adopt the recommendations from GSES.

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(b) Transportable structures and vehicles that are in accordance with AS/NZS 3001.

(c) Boats in accordance with AS/NZS 3004.

This document does not apply to PV arrays on large-scale ground mounted PV power plants with restricted access to personnel and connected to dedicated high voltage systems. However, in the absence of an Australian Standard, this document should be used as guidance, subject to appropriate engineering principles being applied.

The safety requirements of this document are critically dependent on the inverters associated with PV arrays conforming to the requirements of IEC 62109-1 and IEC 62109-2 and all power conversion equipment conforming to IEC 62109 series Standards.

This document shall be read in conjunction with AS/NZS 3000.

When the installation of PV arrays is connected to the grid, this document shall be read in conjunction with the AS/NZS 4777 series. When the installation of PV arrays forms part of a stand-alone power system, this document shall be read in conjunction with the AS/NZS 4509 series (not applicable for this project). When the installation of PV arrays includes battery energy storage systems, this document shall be read in conjunction with AS/NZS 5139.

PV arrays that fall within the scope shall be installed in accordance with AS/NZS 3000 except as varied herein.

In Australia all grid connected PV systems shall be installed in accordance with this standard with the exception being: *large-scale ground mounted PV power plants with restricted access to personnel and connected to dedicated high voltage systems.* However, as specified in the scope: *in the absence of an Australian Standard, this document should be used as guidance, subject to appropriate engineering principles being applied.*

As stated within the standard, all PV modules shall be qualified to:

- IEC 61215-1 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1 Test Requirements
- IEC 61215-2 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 2 Test Procedure
- IEC 61730-1 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
- IEC 61730-2 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

In addition, the modules shall be qualified by the following relevant standard depending on the cell technology:

- IEC 61215-1.1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.1

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Special requirements for testing of crystalline silicon photovoltaic (PV) modules

- IEC 61215-1.2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.2 Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules.
- IEC 61215-1.3, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.3 Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules.
- IEC 61215-1.4, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.4 Special requirements for testing of thin-film Cu(In,Ga)(S,Se)₂ based photovoltaic (PV) modules

All modules shall be classified as Safety Class II as specified in IEC 61730.

Class II basically means that the live parts in the module are double insulated with respect to being touched.

AS/NZS 4777 Grid connection of energy system via inverters

This standard has two parts:

- Part 1: Installation requirements
- Part 2: Inverter requirements

Part 1 - AS/NZS4777.1 Installation Requirements

The current version of AS/NZS 4777.1 was publicised in 2016, however, it is currently being revised and new version shall be released either late 2023 or in 2024.

The **scope** of the standard states:

This Standard specifies the electrical and general safety installation requirements for inverter energy systems (IES) up to or equal to 200 kVA for the injection of electric power to an electrical installation connected to the grid at low voltage.

NOTES:

- Larger systems connected to a low voltage grid with local load may follow the same general guidelines.*
- This Standard may be used for low voltage installation of systems which may be connected to the grid at high voltage.*
- This Standard does not contain detailed installation requirements for the energy source(s) and its associated wiring.*

In Australia, all grid connected inverter systems under 200kVA shall be installed in accordance with this standard however the requirements in this standard could be applied to larger systems. Within Australia, Distributed Network Service Providers (DNSPs) often require extra protection relays on larger systems.

All inverters installed in Australia shall comply with the requirements of AS/NZS4777.2.

Therefore, in practice a solar installer/electrician will install systems that complies with AS/NZS 4777.1 and ensure they purchase and install an inverter that complies with AS/NZS 4777.2. However, AS/NZS4777.2 does specify settings for the different grid regions in Australia and it also requires the inverter to curtail solar power under specific conditions which the installer should be familiar to be able to explain it to the system owners.

It is part of the design responsibility of the bidder to design the inverter within the described principles in line with the POM grid system requirements.

Part 2 -AS/NZS4777.2 Installation Requirements.

The current version of AS/NZS4777.2 was published in 2020.

The of **scope** the standard states:

This Standard specifies device specifications, functionality, testing and compliance requirements for electrical safety and performance for inverters designed to facilitate connectivity between energy sources and/or energy storage systems and the grid, connected at low voltage. This includes electric vehicles that can operate as an energy source and energy storage system that can supply an electrical installation connected to the grid.

This Standard also applies to stand-alone inverters within an electrical installation that may be connected to the grid at low voltage via an a.c. input port.

As stated within the AS/NZS 4777 standard, inverters for use in inverter energy systems with photovoltaic (PV) arrays and/or batteries in Australia shall conform to:

- *IEC 62109-1 Safety of power converters for use in photovoltaic power systems, Part 1: General requirement and;*
- *IEC 62109-2, Safety of power converters for use in photovoltaic power systems, Part 1: Particular requirements for inverter and*
- *the requirements within AS/NZS 4777.2.*

AS/NZS 5139 Electrical Installations -Safety of battery systems for use with power conversion systems

The current version of AS/NZS 5139 was published in 2019.

The of **scope** the standard states:

This Standard sets out general installation and safety requirements for battery energy storage systems (BESSs), where the battery system is installed in a location, such as a dedicated enclosure or room, and is connected with

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power conversion equipment (PCE) to supply electric power to other parts of an electrical installation.

This Standard sets out the requirements from the battery system up to but not including the PCE. This Standard also applies to pre-assembled integrated battery energy storage systems, which also include PCE(s).

This Standard outlines the potential hazards that are associated with battery energy storage systems and their associated battery systems and specifies installation methods that minimize risks posed by these hazards.

This Standard is applicable for the following battery systems:

- (a) Nominal voltage between 12 V d.c. and 1500 V d.c.*
- (b) Connected to either single or multiple PCEs.*
- (c) Using secondary or rechargeable cells.*
- (d) With a rated capacity equal to or greater than 1 kWh and no more than 200 kWh, at —*
 - (i) C10 rating, for lead acid batteries; or*
 - (ii) 0.1C, for lithium technologies; or*
 - (iii) manufacturer's specified energy capacity, for other technologies.*

Where an installation includes multiple battery energy storage systems, this Standard applies to each individual battery energy storage system if —

- (A) the total energy storage capacity is equal to or greater than 1 kWh; and*
- (B) each individual BESS is no more than 200 kWh.*

This Standard does not apply to battery systems in the following electrical installation types:

- (1) Premises with critical power continuity requirements (e.g. acute care hospitals, substation support and black start).*
- (2) Telecommunication applications.*
- (3) Electric vehicles.*
- (4) Portable equipment.*
- (5) Uninterruptible power systems (UPS) that are in accordance with, AS 62040 Parts 1.1 and 1.2.*

(6) *Transportable structures and vehicles that are in accordance with AS/NZS 3001.*

NOTE 1: While this Standard applies to systems of up to 200 kWh, the general requirements of this Standard may be applied to larger installations.

NOTE 2: While this Standard applies for common BESS technologies, for other storage technologies the risk approach may be used to assess the hazards and determine mitigations that apply to the different storage technologies, e.g. super capacitors.

All battery energy systems in Australia shall be installed in accordance with this standard.

Lead acid batteries shall conform to the following standards:

- AS/NZS 4029.1 Stationary Batteries-Lead acid, Part 1: Vented type
- AS/NZS 4029.2 Stationary Batteries-Lead acid, Part 1: Valve regulated type
- IEC 60896 Stationary lead-acid batteries (series)

Lithium batteries shall conform with the following IEC standard:

- IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes-Safety requirements for secondary lithium cells and batteries, for use in industrial applications.

Preassembled BESS and BS shall conform with the following guideline:

- Best Practice Guide: battery storage equipment- Electrical Safety Requirements, V1.0

AS/NZS 3000 - Wiring rules

The current version of AS/NZS 3000 was published in 2018.

This standard sets out all the requirements for the design, construction and verification of electrical installations so any electrical installation installed in Australia must comply with the wiring rules.

The three standards listed in sections 2.1, 2.2 and 2.3 all state that the installation of grid connected inverter systems, PV arrays and battery systems shall all be in accordance with AS/NZS 3000.

Clause 7.3.2 Selection and installation of systems states that:

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- Photovoltaic array systems shall be in accordance with AS/NZS 5033; and
- Inverter systems in accordance with AS/NZS 4777

For battery systems it does reference AS 3011 Electrical installations —Secondary batteries installed in buildings but AS/NZS 5139 was published after AS/NZS 3000. AS 3011 also references AS 2676 Guide to the installation, maintenance, testing and replacement of secondary batteries in or on buildings.

So though AS3011 still exists, the Australian solar/BESS industry do apply AS/NZS5139 to all BESS installations.

AS/NZS 3008 Electrical installations - selection of cables

This version was published in 2017 and there are two parts, one part for Australia and one for New Zealand. The relevant Australian Standard is:

AS/NZS 3008 Electrical installation-selection of cables Part 1 Cables for alternating voltages up to and including 0.6/1kV typical Australian conditions.

Four criteria are given for the selection of cables; these are:

- a. current carrying capacity;
- b. voltage drop;
- c. short circuit temperature rise; and
- d. economic optimization.

There is a note in the scope saying that this standard can be applied to d.c. cabling.

AS/NZS 1170 Structural design actions

This version was published in 2021.

The installation of solar arrays in Australia shall be in accordance with:

- AS/NZS 1170 .2 Structural design actions; Part 2: Wind actions

The installation of battery stands in Australia shall be in accordance with:

- AS/NZS 1170 .1 Structural design actions; Part 1: Permanent, imposed and other actions
- AS/NZS 1170 .2 Structural design actions; Part 2: Wind actions
- AS/NZS 1170 .4 Structural design actions; Part 4: Earthquake actions in Australia

AS 1768 Lightning protection

The current version was published in 2021. Grid connected PV systems shall follow the requirement of this standard if the site is assessed as a lightning risk where lightning protection is required.

Summary of Major Equipment Standards and Guidelines

AS/NZS 4777, AS/NZS 5033 and AS/NZS 5139 list the relevant standards that the PV modules, inverters and battery systems shall conform to. The equipment standards are listed in sections 2.1 to 2.3 however, they have been summarized in this section.

PV Modules

PV modules shall be qualified to:

- IEC 61215-1 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1 Test Requirements
- IEC 61215-2 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 2 Test Procedure
- IEC 61730-1 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
- IEC 61730-2 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

In addition, the modules shall be qualified by the following relevant standard depending on the cell technology:

- IEC 61215-1.1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.1 Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61215-1.2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.2 Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules.
- IEC 61215-1.3, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.3 Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules.
- IEC 61215-1.4, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.4 Special requirements for testing of thin-film Cu(In,Ga)(S,Se)₂ based photovoltaic (PV) modules

Inverters

Inverters shall conform to:

- IEC 62109-1 Safety of power converters for use in photovoltaic power systems, Part 1: General requirement and;
- IEC 62109-2, Safety of power converters for use in photovoltaic power systems, Part 1: Particular requirements for inverter and
- AS/NZS 4777.2 Grid connection of energy systems via inverters, Part 2: inverter requirements

Batteries

Lead acid batteries shall conform to the following standards:

- AS/NZS 4029.1 Stationary batteries - Lead acid, Part 1: Vented type
- AS/NZS 4029.2 Stationary Batteries - Lead acid, Part 1: Valve regulated type

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- IEC 60896 Stationary lead-acid batteries (series)

Preassembled BESS shall conform to the following guideline:

- Best Practice Guide: battery storage equipment- Electrical Safety Requirements, V1.0

International Standards

Summary of the IEEE standards that are relevant to the installation of grid connected PV systems and BESS are listed above. The standards include installation (design) standards, equipment standards and also testing, commissioning and documentation standards.

IEC Installation(design) standards were identified for PV modules and batteries but not for inverters and this is probably because countries tend to have their own standards to specify the interconnection requirements to their respective grids.

The Institute of Electrical and Electronics Engineers (IEEE) have developed two international standards relevant to the interconnection of inverters to the grid.

North America historically have used Underwriters Laboratory (UL) standards for equipment however in recent years they have started to adopt the IEC standards for modules and also inverters. They do have a standard for batteries and often USA battery manufacturers comply with those standards.

IEC 62548 Photovoltaic (PV) arrays - Design requirements

The current version exists from 2016 however a new version is due to be released.

This was developed after AS/NZS 5033 had been developed however the lead author of the original AS/NZS 5033 is also the chair of the IEC Working Group that developed IEC 62548 and was the lead author for that standard.

For this reason, the two standards are very similar with some Australian requirements not necessarily in the IEC version. However, a diligent section by section comparison has not been undertaken.

IEC 62485 Safety requirements for secondary batteries and battery installations.

Different battery types installations shall conform to one of the six parts of IEC 62485: Safety Requirements for Secondary Batteries and Battery Installation. The relevant parts of this standard that refer to batteries that would be used for BESS installations include:

- IEC 62485.1 (2015) Safety requirements for secondary batteries and battery installations Part 1 general safety information

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- IEC 62485.2 (2010) Safety requirements for secondary batteries and battery installations Part 2 Stationary batteries
- IEC 62485.5 (2020) Safety requirements for secondary batteries and battery installations Part 5 Safe operation of stationary lithium-ion batteries

AS/NZS 5139 is not for the installation of any specific type of battery. The requirements for safe installation of the battery systems is based on the hazard that the battery presents e.g. explosive gases (lead acid batteries), fire (lithium ion, lead acid) chemical (Lead acid, Flow batteries). For this reason, for this project bidders shall use the Australian/New Zealand standard.

IEC 61215 Terrestrial photovoltaic (PV) modules - Design qualification and type approval

PV modules should conform to:

- IEC 61215-1 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1 Test Requirements
- IEC 61215-2 Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 2 Test Procedure

In addition, the modules should be qualified by the following relevant standard depending on the cell technology:

- IEC 61215-1.1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.1 Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61215-1.2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.2 Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules.
- IEC 61215-1.3, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.3 Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules.
- IEC 61215-1.4, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.4 Special requirements for testing of thin-film Cu(In,Ga)(S,Se)₂ based photovoltaic (PV) modules

These are the standards adopted in Australia, USA, Europe and many other countries for solar modules being installed in systems and for this reason should be adopted by PNG. These shall be used for this project.

IEC 61730 Photovoltaic (PV) module safety qualification

In addition to conforming to IEC 61215 the modules should also conform to:

- IEC 61730-1 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
- IEC 61730-2 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

These are the standards adopted in Australia, USA, Europe and many other countries for solar modules being installed in systems and for this reason should be adopted by PNG. These shall be used for this project.

IEC 60896 Stationary lead-acid batteries

Different battery types installations shall conform to one of the parts of IEC 60896: Stationary Lead Acid batteries.

The relevant parts of this standard that refer to batteries that would be used for BESS installations include:

- IEC 60896-11 (2002) Stationary lead-acid batteries Part 11: Vented types - General requirements and methods of test
- IEC 60896-21 (2004) Stationary lead-acid batteries Part 21: Valve regulated types - Methods of test
- IEC 60896-22 (2004) Stationary lead-acid batteries Part 22: Valve regulated types- Requirements

For this project only lead acid batteries that comply with either the Australian standards or the IEC standards or the UL standards are used.

IEC 62109 Safety of power converters for use in photovoltaic systems

Inverters installed in grid connect PV systems and BESS supplying power onto the grid should conform to:

- IEC 62109-1 (2010) Safety of power converters for use in photovoltaic power systems, Part 1: General requirement and;
- IEC 62109-2 (2011) Safety of power converters for use in photovoltaic power systems, Part 2: Particular requirements for inverter

These are the standards adopted in Australia, USA, Europe and many other countries for inverters being installed in systems and for this reason should be adopted by PNG. Bidders shall comply with these standards.

IEC 62930 Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC

In the past, often standard a.c. cables were being used in PV arrays installations which led to safety issues, hence this standard was developed. All PV array wiring shall conform to the requirements of IEC 62930 Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC.

Bidders shall adopt this standard or any equivalent standard for this project.

IEC 62446 Photovoltaic (PV) systems- requirements for testing documentation, and maintenance.

There are 3 standards in this series:

- IEC 62446-1 (2018) Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 1: Grid connected systems – Documentation, commissioning test and inspection.
- IEC 62446-2 (2020) Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 2: Grid connected systems - Maintenance of PV systems.
- IEC 62446-3 (2017) Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 3: Photovoltaic modules and plants - Outdoor infrared thermography.

Papua New Guinea Existing Technical Documents

Papua New Guinea Grid Code

The PNG Grid code was released in November 2014.

The scope states:

The grid code specifies the following:

- i. Technical and performance standards to be completed by the Transmission Network owner and its System Operator, Power Producers, Regulated Retailers, large Local customers and any other Users of the Transmission network;*
- ii. Rules, procedures and requirements for the connection of Users; and, for the planning of the development of Transmission Network, and for system operation; and*
- iii. Rules and procedures in the enforcement and settling disputes resulting from violations of the code.*

In Australia, the power system comprises transmission network and distribution network. The transmission network transfer power from a generation point generally at high voltage (66kV to 500kV) to a point where it is then reduced to 33kV and 11kV for the distribution network to the end users.

It appears that in PNG the whole grid is called a transmission network however this will be clarified during the meeting with PNG Power Limited (PPL).

There is nothing in the code with respect to installation of PV systems. There does not appear to be any reference to AS/NZS 3000 for electrical wiring.

Electrical Trade Circular No 35; Solar Standby Facility

Electrical Trade Circular No. 35: Solar Standby Facility is part of Engineering Standard: HQH - GCW 014 and was published in 2017.

The Electrical Trade Circular No. 35 provides standard requirements with regards to Solar Standby Facility (SSBF) circuit system, operation and the related system components.

This document is referring to a stand-alone power system that contains solar modules, solar controller, battery and inverter that is used to provide power when the grid has failed. It requires a changeover switch so that the premise where the system is installed is either connected to grid power or the solar standby system. The solar system will never feed power onto the grid.

Notice on grid-connected Solar Photovoltaic System in Papua New Guinea

This notice from PPL was released in December 2019 and has the following stated objective:

1.1.1. *The objective of this Notice is to facilitate the connection of Rooftop Solar PV Systems to the PNG Power's distribution networks, while also ensuring:*

- a. That all customers are treated in an equitable manner;*
- b. That technical performance of the PNG Power system in its steady state and transient operations is not compromised; and*
- c. That PNG Power still recovers its reasonably efficient costs of providing electricity services, as per its Licence and Electricity Regulatory Contract with the Independent Consumer and Competitions Commission (ICCC).*

1.1.2 *The remainder of this Notice details the following:*

- a. Types of solar PV connections allowed;*
- b. Eligibility for Phase 1 of the Program*
- c. Tariffs and other commercial terms;*
- d. Installation and testing requirements; and*
- e. Application and implementation procedures.*

The notice states that the grid connected PV system shall be installed by a certified solar electrician who is defined as:

A contractor that (1) carries a valid electrical contractor's or electrician's licence to carry out electrical installation and commissioning works and issued by PNG Power, and (2) is an accredited installer of the Clean Energy Council of Australia or holds an alternative accreditation that is deemed by PNG Power to be equivalent.

Clause 5.1.2 in the notice states:

Electrical wires and accessories used for electrical connections should conform to applicable AS/NZS standards and practices approved by PNG Power.

However, AS/NZS 5033 or AS/NZS 4777 are not specifically stated in the notice.

Clause 5.1.3 in the notice states:

Electrical installation should conform to AS/NZS 3000 Wiring Rules and all other standards and practices approved by PNG Power.

However, AS/NZS 3000 Clause 7.3.2 does state that PV array installations shall comply with AS/NZS 5033 and Inverter installation shall comply with AS/NZS4777.

Therefore, based on this notice, grid connected systems in PNG shall comply with the relevant Australian standards.

Department of Works Earthquake Design Advice Note

This advice note was released in Dec 2019 and was developed by Geoscience Australia. It is an Interim-to-Interim Amendment to PNGS 1001-1982: Part 4 Earthquake Design Actions.

This will be relevant to design and install guidelines with respect to the installation of BESS within buildings and installation of PV arrays on buildings.

What the bidder needs to submit?

1. SLDs for the Solar System
2. List, description and specification of main equipment and warranty on the main equipment
3. BOQ for the Solar System

11. Transport & Shipment

Bidders shall indicate specific transportation requirements for all BESS components and associated risks. The Vendor shall be responsible for the product integrity until product handover to PPL within the perimeter of the power station.

Prior to transportation, the battery shall be tested according to UN 38.3 UN Manual of Tests and Criteria for the Transportation of Dangerous Goods. The Bidder shall specify its ability to provide shipment to the project location.

12. Installation Requirements

Installation of the BESS system and the integration with existing power generation and power transformation components shall conform to standard industry practices and environmental, health and safety rules.

Installation services shall encompass all necessary management, engineering advisory, installation equipment, labor, and supervision and installation materials to realize the BESS. The Bidder shall provide a detailed installation plan that indicates milestone schedule, hours of operation, utility service needs, site access, laydown yards, construction trailers, environmental controls and emergency response. Bidder shall provide a detailed mobilization plan prior to award.

Bidder shall specify the list of equipment needed for works.

Vendor shall store all components, equipment, and material normally requiring protection on arrival at the Site under weatherproof coverings and shall protect the components, equipment, and material from damage during construction until completion.

Vendor shall erect a temporary fence to demarcate energized substation areas for the duration of the installation.

Vendor shall be responsible for compliance with state and local ordinances and shall be responsible for obtaining all necessary permits. Installation delays associated with non-compliance with regulations, shall not be considered as excusable delays and/or entitle the Vendor to a change in work timeline.

The Vendor shall submit to PPL as part of the Schedule of Work Plan, a document detailing:

- a) the electricity and raw water requirements for the installation works
- b) predicted moments of power outages due to equipment installation works

The Vendor shall also make provisions for a temporary construction power load center to provide electricity in moments of PPL grid unavailability due to construction works. The Vendor shall provide all commodities required for purposes of commissioning and start-up activities and the Performance Tests in accordance with manufacturers' and/or Subcontractors' published specifications for the components, equipment, and material. The Vendor shall be responsible for any initial filling of any chemicals, lubricants, and any other consumables necessary for the startup activities and Performance Tests.

Grounding

A suitable equipment grounding system shall be designed and installed for the BESS system. This system shall be tied to the project site grounding system. The grounding system shall provide personnel protection for step and touch potential in accordance with IEEE 80. The system also shall be adequate for the detection and clearing of ground faults within the BESS. The Vendor shall determine, design and install the required interconnections between the BESS and project site grounding systems. The Vendor shall provide the requirements of the project site grounding system allowing PPL to self-perform the modifications and upgrade needed.

Interconnection

The Vendor shall install an AC bus bar to perform all system integrations. Please refer to the conceptual single line diagram included as part of the RFP (Attachment C).

The Vendor shall perform the installation of all interconnection equipment and materials required between the bus bar and the BESS. The BESS Vendor is responsible for the installation of all cables between the bus bar and the BESS converter, the DC cable between the BESS inverter and the BESS trailer and a self-contained BESS.

PPL will self-perform the modifications required to the existing substation ground grid and the connections from the existing ground grid to the grounding points of the BESS.

Structural / Foundation Pads / Conduit

The Vendor shall furnish the design for the structural components of the BESS, concrete pads/foundations as required, and conduit required for the complete BESS. All BESS foundations and structures, if required, shall be designed by a qualified registered professional engineer. All final (Issued for Construction) drawings, specifications and calculations shall be wet-stamped by a Registered Civil/Structural Engineer licensed to work in PNG. The Vendor is responsible for Geotechnical surveying if required.

The Vendor shall perform the design and installation of the concrete pad/foundation and buried conduit installation.

Mounting System

During the BESS components installation, the Vendor shall:

- a) Secure all components to floor or walls.
- b) Include structural load design calculations signed and sealed by a qualified professional engineer licensed to work in PNG.

Spill Containment

The BESS design shall mitigate against electrolyte spills that are credible for the types of cells used (if applicable). The design shall include features that contain electrolyte spills (to be emptied by contracted chemical disposal company in the event of a spill) and prevent discharge to surrounding site soils.

Personnel Safety

In general, the ESS shall be designed with personnel safety as the top priority.

Fire Protection

The Vendor shall design and install a fire protection system that conforms to international and national codes and standards. The fire protection system design and associated alarms shall take into account that the BESS will be unattended at most times. In the event that codes do not exist

for the proposed BESS, current industry-accepted best practices shall be employed.

13. Testing Requirements

Factory Testing – Energy Storage

The Vendor shall test and submit test data for the cells designated for use on this project. At a minimum, the following tests shall be performed.

- a) Capacities, Amp-hour and Watt-hour
- b) Ramp rate
- c) Heat Generated
- d) Efficiencies
- e) As applicable, maximum noxious and toxic material release rates
- f) Application simulations as required by PPL

The Vendor shall capacity test 100% of the production cells to ensure compliance with design requirements. The Vendor may propose optional alternate testing programs that result in a benefit to PPL. However, the base proposal shall include capacity testing of 100% of the cells. All proposals for alternate testing shall include details of the proposed plan and the cost benefit to PPL.

Testing shall be performed according to applicable standards as provided in Section Standards and Certifications of the SOR/Technical Requirements.

PPL shall witness performance and modes of operation testing.

Commissioning - Acceptance and Performance Testing

The Vendor shall develop and perform a commissioning program that will include but not be limited to procedures for design verification, operational acceptance testing, Start-up procedures, functional acceptance testing and safety testing. The Vendor shall demonstrate the ability of the systems to operate safely and reliably in a coordinated manner throughout the range of normal and transient operating conditions, for which they were designed. This commissioning program will assure that the BESS will perform as designed and that the system meets the performance criteria specified elsewhere in the tender. All modes of operation as described in these specifications shall be tested. The Vendor shall determine that the BESS is fully operational and suitable for acceptance testing witnessed by PPL. The Vendor shall document all acceptance and performance tests performed. The Vendor shall submit documentation, analyses, and a summary in a test report for PPL records.

The commissioning program will be developed by the Vendor (approved by PPL and shall demonstrate to PPL that the BESS is operational and performs as specified. Vendor shall have a detailed test plan and schedule with which all mechanical, electrical, plumbing and structural systems are tested and verified to be acceptable). These tests shall include, as a minimum:

- a) Grounding and electrical resistance testing
- b) Systems initial operation and adjustment and tests associated with BESS functions
- c) Electrical insulation verification testing and continuity checks
- d) Circuit breaker testing and calibration
- e) Electrical control circuit continuity checks
- f) System phase and rotation verification
- g) Verification of sensors, metering and alarms
- h) Verification of all control functions, including automatic, local and remote control
- i) Verification of system integration with other equipment including solar panels and diesel generators (as a minimum testing all operation modes as described in this SOR/tender)

Mechanical

The Vendor shall visually inspect all system to ensure compliance with the P&IDs and the project design drawings. Mechanical commissioning and start-up activities shall include, but not be limited to the following:

- a) Initial operation of all equipment
- b) Cleaning and flushing all plant systems (if applicable)
- c) Identifying design problems for engineering resolution and providing supervision and labor to implement the engineering corrections
- d) Checking documentation for proper set points.
- e) Initial fills and charges for system start-up
- f) Daily maintenance of all components, equipment, and systems.

Electrical

All electrical power, instrument, and control cables shall be inspected and checked for proper installation, and shall be continuity-tested to verify proper termination and control action. Each circuit shall be tested prior to energizing. All 1000 V insulation rated cables and equipment shall be Insulation Resistance tested after installation and prior to termination. Electrical testing and checkout shall apply to all switchgear, cables and electrical equipment, protective relays and components, controls and instrumentation within the Scope of the Contract. The Vendor shall calibrate and test all electrical devices.

All protective device calibration and test data shall be recorded. The Vendor shall provide the initial calibration set-points. Records shall be maintained by the Vendor to reflect corrections or modifications implemented during or after system start-up, and shall be reissued with the as-built documents.

All test instruments shall be calibrated to standards certified by the National Institute of Standards & Technology (NIST) or equal within three months prior to their use and on a regular schedule or as needed to maintain accuracy and certification. Records of instrument certification shall be maintained on the Site until transferred to PPL with as-built documents.

At a minimum, the following Electrical Test Procedures shall be prepared:

- a) Switchgear Tests
- b) Circuit Checkout
- c) Grounding Grid Checkout
- d) Protective Relay Tests
- e) Cable Tests
- f) Bus Duct Tests
- g) UPS System Tests
- h) DC System Tests

14. Operator Training Requirements

Training of PPL personnel shall be given by the Vendor prior to the completion of the works in English language, in accordance with a timetable to be agreed upon with PPL and shall include onsite and classroom training covering the O&M of the BESS. Such training shall be conducted by trainers who are experienced in the O&M of the BESS's components, equipment, and systems. The Vendor shall coordinate the overall program, which will be developed to familiarize the O&M personnel with each of the various operating systems, the major mechanical equipment, and the control systems.

The training shall allow PPL's technical personnel, three (3) people, to safely and reliably start up, operate, and shut down all components, equipment, and systems.

The Bidder shall submit a training plan with a schedule of the different training activities as part of the proposal. This shall include (but not be limited to) training on:

- a) Components present in the BESS and all the potential hazards associated with each component

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- b) Spare parts replacement and maintenance
- c) All alarm conditions, troubleshooting and how to solve these alarm conditions including Vendor's assistance in these instances.
- d) All operating modes of the BESS as described in the SOR
- e) Start-up and shut-down of the BESS
- f) Data acquisition system, including how to retrieve data
- g) HMI and its functionalities including all parameters which can be monitored
- h) Basic training on algorithms of the control system

NB: Training points c) to g) shall be presented with actual simulations, allowing each trainee to gain practical experience.

Given the novelty of the equipment installed for the PPL team, the training program shall not prescind any item required for the safe and reliable operation of the BESS system. The Vendor shall assume PPL to possess basic experience in the maintenance and operation of power generation systems, and limited experience in control systems and software operation.

The Vendor shall provide a person to coordinate and lead the program. This person shall have a technical background (electrical engineering degree or equivalent) and shall be fluent in English. This person shall also have previously completed at least 4 trainings on BESS.

Further On-The-Job-Training will be provided as PPL's O&M staff supports the Commissioning program by operating equipment and systems during initial start-up and operation.

The Vendor shall furnish PPL with complete instruction, O&M manuals for all components, equipment, and systems furnished by the Vendor. The information shall be separated into logical groups or sections with identifying tabs. Each instruction/O&M manual shall have an index listing all leaflets in the same order as they appear in the manual. Individual submittal of various manufacturers' instruction books and other documents will not be acceptable. Preliminary copies of the final instruction/O&M manual for all components, equipment, and systems furnished by the Vendor shall be submitted as part of the proposal.

The Vendor shall submit to PPL two (2) bound sets and one (1) electronic version on USB of the Final O&M Manuals package.

Training and O&M Manuals shall be provided in English Language.

15. Post-Sale Assistance

The system should provide a low maintenance structure that can be safely inspected without any specialist equipment. The Vendor shall provide a simple and easy to use operations & maintenance guideline.

The Vendor shall include maintenance of the BESS for a period of at least one (1) year to be included in the contract price. The maintenance shall include all aspects of daily operation of the BESS and all periodic maintenance procedures (e.g. daily, monthly, quarterly, semi-annually, annually) covering electrical systems, mechanical systems, grounding/lightning protection systems, fire suppression systems.

At the end of the maintenance service, the Vendor shall establish a formal turnover process in which all pertinent system testing documentation and drawings are submitted in a turnover package to PPL to transfer care, custody, and control of scoped systems to PPL.

The Vendor shall establish system turnover boundaries for all BESS systems. Piping and instrumentation diagrams (P&IDs) shall be marked up to show boundaries of the mechanical systems. Single line electrical drawings shall be marked up to indicate the electrical system boundaries.

The turnover package shall include, but not limited to, the following documents:

1. Completed System Commissioning Procedures
2. System Turnover Forms
3. System Turnover Punch list
4. Supplier (Vendor) Inspection and Test Reports
5. Electrical Checkout Verification Drawings
6. Circuit Breaker Testing and Calibration Records
7. Relay Testing and Calibration Records
8. Electrical Data Sheets
9. Insulation Resistance Reports

Spare Parts and Equipment

The Bidder shall evaluate its design with regard to failure rates, effects and BESS reliability. The Bidder shall provide a recommended spare parts list, including availability and replacement schedule as part of the proposal.

In addition to the warranty, the Vendor shall provide for the disposal and replacement of battery cells throughout the lifetime of the BESS. At the end of the serviceable life of the battery, if a new technology is available with higher performance capabilities, the Vendor shall propose the new technology as a replacement.

16. Decommissioning Requirements

The Vendor shall be responsible for the decommissioning of the Project and the restoration of Sites at the end of the BESS service life. Decommissioning responsibilities shall include developing and implementing a program for the recycling or proper disposal of installed infrastructure and mitigation or remediation of any and all environmental impacts arising from or associated with the Project. The Bidder shall describe its decommissioning plan, including programs for recycling of installed infrastructure, if any and how the respondent will remediate or mitigate the environmental impacts in compliance with all applicable Environmental Laws in effect at the time of decommissioning so that the Site is returned to the condition it was in immediately prior to implementation of the Project. This information shall be provided as part of the Technical proposal of the bidder.

17. Warranty & Performance Guarantee

Vendor warrants PPL that the equipment and materials furnished hereunder and the completed BESS project are fit for the purpose of producing and storing electricity in accordance with the requirements and are free from defects in workmanship and materials. Vendor makes all such warranties for a period of minimum seven (3) years for the battery, five (2) years for the power converter and three (1) years for the energy controller, after the date of acceptance of the project by PPL. In addition, Vendor shall clearly indicate life expectancy given current and projected load profiles provided in this tender (Figure 1.1).

The Vendor shall also guarantee an energy capacity of at least 80% of the initial nominal capacity after a period of five (5) years. If the BESS drops below this threshold, the Vendor shall augment or replace the battery.

Bidder shall submit the warranty certificate and performance guarantee applicable to all components of the system.

All components from subcontractors shall be guaranteed by the Vendor.

18. Standards & Certifications

The project design shall meet all applicable industry standards and codes including but not limited to NEC, NESC, ASCE, IEEE, standard utility practice. In the event specific codes are not available for the BESS, current industry accepted best practices shall be employed.

The Bidder shall be certified to ISO 9001 and ISO 14001.

Below is the list of mandatory standards which the proposed product shall possess and which the Bidder shall submit as part of the proposal.

Battery:

For this project the battery shall be lead acid batteries.

Pre-assembled battery systems and pre-assembled BESS can either;

- meet the Australian Best Practice guideline or
- the battery systems used in the BESS comply with either the relevant Australia/New Zealand Standards, IEC standards or UL standards.

For this project No Lithium batteries will be used. Based on the recent experiences of fire involving Lithium batteries, they are not to be used for this project. Only Lead acid batteries are allowed and shall conform to the following standards:

- AS/NZS 4029.1 Stationary Batteries-Lead acid, Part 1: Vented type
- AS/NZS 4029.2 Stationary Batteries-Lead acid, Part 1: Valve regulated type
- IEC 60896 Stationary lead-acid batteries (series)

For this grid connect PV and BESS Project installations shall comply with AS/NZS 5033, AS/NZS 4777 and AS/NZS 5139. These also require the equipment comply with the equipment standards with exception that the UL standards are not generally listed in AS/NZS standards.

Output voltage of the battery (DC) shall be 600-800V.

BESS interconnection/System:

1. IEEE 519 Harmonic Voltage Limits Voltage Distortion Limits Bus Voltage at PCC Individual Voltage Distortion (%) Total Voltage (for PCS) or equivalent
2. IEC 62477-1:2012 or equivalent - Electronic equipment for use in power installations (protections class)

3. IEC 61000-6-4 (Electromagnetic compatibility (EMC) -Part 6-4: Generic standards - Emission standard for industrial environments) or equivalent
4. IEC 61000-6-2 Electromagnetic compatibility (EMC) -Part 6-2: Generic standards - Immunity for industrial environments or equivalent

The following standards are desirable but not mandatory:

1. UL 1741 Standard for interconnecting distributed resources with electric power systems (Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources) (for PCS) or equivalent
2. IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems or equivalent
3. IEC 62103 - Electronic equipment for use in power installations or equivalent
4. Recommendations for the connection of generating plant to the distribution systems of licensed distribution network operators G59/3 or equivalent
5. EN 61000-4-3 Electromagnetic compatibility. Testing and measurement techniques -Radiated, radio-frequency, electromagnetic field immunity test or equivalent
6. BS EN 60255 - measuring relays and protection equipment or equivalent
7. UL 508C/CSA 22.2 No. 14 Electrical Safety and Workmanship or equivalent

It is desirable for the Control System and communication system to meet the following standards:

1. IEC 61850 is a standard for the design of electrical substation automation or equivalent
2. IEC 61131 standard for programmable components or equivalent
3. IEC 62439 Ethernet redundancy or equivalent
4. IEC 62351 Power systems management and associated information exchange - Data and communications security
5. IEC 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems

The Bidder shall provide evidence of possessing these certifications and standards or equivalent in the proposal.

19. Procurement Responsibility

Bidder shall operate within the highest standards of ethical business conduct and personal integrity. Business relationships with other entities shall be conducted in a manner that reflects a positive image of PPL.

Bidder shall provide all component, equipment, material, and labor procurement services, including, but not limited to:

- a) Purchasing
- b) Subcontracting
- c) Expediting and control
- d) Supplier (vendor) inspections
- e) Supplier (vendor) field services
- f) Transportation studies and logistics
- g) Material control

Vendor shall be responsible for Customs clearance of the equipment shipped to PNG. PPL will provide the franchise to the vendor in order to clear the goods at custom. It is the vendor's responsibility to organise inland transportation to PPL Moitaka, Port Moresby.

Purchasing and material control

It shall be Vendor's responsibility to prepare all required components, equipment, and material specifications, to purchase all required items (if not manufactured by the Vendor), to inspect procured items to ensure conformance with the Contract documents, and to expedite delivery of all procured items to maintain the Project Schedule and meet the Schedule milestone dates.

Vendor's purchasing and material control efforts shall support the Project Schedule.

A procurement status report shall be provided monthly with the Project Progress Report identifying Vendor and award status for each subcontract if applicable.

The vendor shall be responsible for receipt, warehousing, management, and protection of all components, fabricated items, equipment, and material received for the Project.

20. Safety

Vendor shall establish a safety program and adhere to those safety requirements at all times. Vendor shall submit to PPL a manual on its safety program, including a description of how it will be utilized on Site. The vendor's safety program shall be agreed to by PPL and vendor prior to commencement of any vendor activities at Site. Vendor's safety program shall be coordinated with PPL's safety. Bidder's safety program shall be based on the following and such other items as appropriate.

Vendor's Site safety program shall include, but not be limited to, procedures and requirements for personnel safety; vehicle and motorized equipment operation; emergency response, including fire, first aid, and ambulance; and lockout/tag-out procedures.

Personal safety equipment shall be specifically detailed in the safety manual.

The Vendor shall enforce all of its safety guidelines at all times. In the event that the vendor fails to promptly correct any violation of safety or health regulations, PPL may suspend all or any part of the Work. The vendor shall not be entitled to any extension of time or reimbursement for costs caused by any such suspension order.

Failure of PPL to order discontinuance of any or all of Vendor's operations shall not relieve the Vendor of its responsibility for the safety of personnel and property. The Vendor shall perform all Work in strict accordance with its PPL approved Environmental, Health, and Safety (EHS) Plan. The Vendor shall ensure that all its Subcontractors and their respective agents and employees, comply with the Vendor's EHS programs, to be approved by PPL prior to commencement of construction activities at the Site, and Subcontractors' safety programs, as the same may be supplemented from time to time. If the standards or requirements provided in the foregoing are inconsistent, The Vendor shall perform, or cause to be performed, the foregoing obligations in accordance with the requirements of the most stringent program, rule, standard, criteria, or guideline.

PPL has the right, but no obligation, to supervise or cause Vendor's compliance with this Section and will have no liability for failing to cause the Vendor to comply with this Section.

First Aid Station

The Vendor shall maintain an appropriately equipped first aid station for the treatment of minor injuries. A first aid station shall be onsite in an easily accessible and highly visible area. Vendor shall at all times retain sufficient personnel trained in first aid procedures.

The Vendor, with the help of PPL shall make arrangements with one or more local medical facilities for the treatment of more serious injuries. The Vendor's Safety program shall specifically define the procedures and responsibilities for summoning emergency medical support to the Site when needed.

Fire Protection

The Vendor shall be responsible for fire protection prior to Turnover. The “first response” to a fire shall be provided by the Vendor to allow personnel evacuation and contain the fire until the local government fire department can respond. In fulfilling this responsibility, the Vendor shall provide temporary fire protection facilities and equipment, and ensure nominated Vendor's Site personnel are trained in their use.

The Vendor shall coordinate its fire response preparations with the local authorities and notify UNOPS.

21. Environmental Control

PPL may require the Vendor to conduct an environmental site assessment and/or environmental sampling at the Project Site.

The Vendor shall implement necessary procedures and provide controls and labor as required to meet all environmental laws, regulations, restrictions and regulatory guidelines that may apply to the Project, including the construction, start-up, and commissioning of the BESS. This includes, but is not limited to, such items as Site erosion and dust control, hazard communication manuals, spill control plans and procedures, management and disposal procedures for hazardous materials, and temporary Site storage procedures.

The Vendor shall develop and maintain a Spill Prevention, Control, and Counter measures (SPCC) plan, if required. The Vendor shall be responsible for reporting any spills or releases, and for remediating any spills or releases at Bidder's expense and to PPL's satisfaction.

The Vendor shall also be responsible for the collection, storage, management, transportation, and disposal of all wastes, hazardous and non-hazardous, generated by and in the course of the Project, including wastes generated during the construction, start-up, and commissioning of the BESS.

The Vendor shall be responsible for temporary and permanent erosion control facilities, which shall be in accordance with country requirements.

Hazardous Materials

Hazardous materials include chemicals, substances, materials, or wastes, subject to state or local laws, ordinances or regulations, as: a hazardous material, hazardous substance, hazardous waste, pollutant, or contaminant; or as toxic, ignitable, reactive, or corrosive; or as otherwise potentially harmful to human health or the environment.

No hazardous materials shall be allowed on PPL's property, except as strictly necessary, and only in such quantities and for such periods as may be necessary, to efficiently perform the work required of the Vendor. The Vendor shall provide PPL with Material Safety Data Sheets (MSDSs) covering all hazardous materials furnished, used, applied, stored, present, generated, or disposed of, in connection with, or otherwise associated with, the Project. MSDSs shall be provided at least two (2) weeks prior to the materials' arrival in PNG. PPL may, in its sole discretion, prohibit the hazardous material from being brought on to the PPL's property, or may require the removal of hazardous material from PPL's property.

The Vendor shall be responsible for: identifying all hazardous materials (including hazardous wastes) furnished, used, applied, stored, present, generated or disposed of under this Contract; the proper use, management, storage, labelling, disposal, and other handling of all such materials; the proper training of employees in the safe use of such materials; and compliance with all state, and local laws, regulations, and ordinances.

Asbestos

The Vendor shall not supply, furnish, use, apply, store, keep on site, or dispose of materials and/or products containing asbestos. This prohibition includes such items as insulation, high temperature wiring insulation, packing, gaskets, roofing material, and floor coverings; even though the item is encapsulated or asbestos fibers are impregnated with a binder material.

In the event an acceptable substitute cannot be located, any materials and/or products containing asbestos shall be approved in writing by PPL. An MSDS form shall be provided with all approved materials and products.

Mercury

The Vendor shall not supply, furnish, use, apply, store, keep on site, or dispose of materials and/or products containing mercury. This prohibition includes such items as switches, relays, level controls, mercoids, manometers, firewater sprinkler deluge systems, fluorescent lights, and mercury-filled instruments, even though the mercury is encased or encapsulated.

Lead

The Vendor shall not supply, furnish, use, apply, store, keep on site, or dispose of lead-based products. This prohibition includes such items as paints and coatings, solders and alloys, and water.

Polychlorinated Biphenyls (PCBs)

The Vendor shall not supply, furnish, use, apply, store, keep on site, or dispose of materials and/or products containing PCBs. This prohibition includes such items as transformers, magnets, capacitors, and fluorescent lighting ballasts, even though the PCBs are encased or encapsulated.

22. Project Schedule

The Bidder shall submit in Form G: Section 2 a detailed Project schedule including but not limited to the following activities:

- a) Detailed Engineering Design
- b) Equipment procurement
- c) Factory Testing
- d) Shipment
- e) Installation
- f) Training
- g) Commissioning

This shall clearly indicate the amount of time required for each activity and for the overall project to be completed.

23. Project management

The work detailed in this SOR/Tender, shall be conducted and managed under the direction of the Vendor's Project Manager. The Project Manager shall act as the Vendor's official representative, providing a single point of contact with PPL for day-to-day correspondence exchange, decision making. The Project Manager shall also be responsible for providing PPL with project status reports and projections.

The Vendor's project manager who shall be responsible for the following activities:

- a) Preparing and maintaining the Project schedule
- b) Procuring permits, and other governmental approvals.
- c) Performing comprehensive topographical, geological, geotechnical, archaeological, cultural, environmental and hydrological investigations (if needed).
- d) Engineering, designing, procuring and/or manufacturing of all permanent and temporary components, equipment, and materials.
- e) Scheduling all construction activities and deliveries of equipment and materials to the Site
- f) Establishing onsite facilities required for installation and emergency safety procedures.
- g) Removal from storage and installation of all components, equipment, and material.
- h) Training of PPL O&M personnel.
- i) Testing, start-up, and commissioning.
- j) Acting as Vendor's representative on Site.
- k) Managing project controls, accounting, receipt inspection, warehousing, and inventory

controls.

- l) Preparing and submitting invoices for payment by PPL.

The BESS vendor's Project Manager shall be asked to attend bi-weekly meetings with PPL representatives during certain portions of the design process. The purpose of these meeting is to receive a status report on the progress of the design package and to discuss any open items or requests for information each party may have submitted to the others.

As a minimum, Vendor shall submit to PPL the following documents, which summarize the status of the project, at the indicated frequency (if applicable):

- a) Project Progress Report – Bi-Weekly
- b) Updated Project Schedule – Bi-Weekly
- c) Document Register (engineering) – Monthly
- d) Invoices for Milestones, Sales and Use Taxes, and Time and Material (T&M) Scope Change Orders – Monthly
- e) Expediting Reports – Monthly
- f) Construction Schedule – Weekly
- g) Action Items/Issues List – Weekly
- h) Quality Assurance and Quality Control Reports – Bi-Weekly
- i) Work Remaining List – Weekly after 90% completion of each phase (engineering, construction, and start- up)
- j) Damage Reports – Daily
- k) EHS or Public Relations Incident Reports - Immediate verbal notification followed by prompt written report(s)
- l) Recordable/Lost-Time Accident Reports and Incident Reports – Immediate verbal notification followed by prompt written report(s)

Project Progress Report

The Project Progress Report shall be submitted bi-weekly and shall contain the following information, (if applicable):

- a) Executive summary of overall progress including key milestones achieved as well as significant issues and mitigation/recovery plans.
- b) Up-to-date list of activities finished during the report period and activities to be performed during the next month (one-month look-ahead).
- c) Project Schedule report providing status, forecast, and critical path analysis. If the Project Schedule status indicates a slippage in the critical path, a narrative report shall explain the cause of the delay and describe corrective action, which will be taken to meet the key Project dates and the Guaranteed Completion Dates. The Project Schedule shall be revised accordingly and submitted for PPL's approval.

- d) Curves for planned vs. actual progress by function (engineering, procurement, construction, and start-up).
- e) Engineering report providing status of the engineering/design documents, issues and concerns.
- f) Procurement report providing status of the procurement, fabrication, and delivery of major components, equipment, and material (if purchased via a subcontractor). The report shall discuss any issues and concerns. The report shall state the schedule for shop inspection of components, equipment, and material and a summary report of inspections completed during the report month.
- g) QA/QC Report
- h) Progress photographs (before and after system installation)
- i) Cost Summary Report as described in this Section, including the current project Cost Performance Index (CPI) and CPI trend.
- j) Appendix(s) containing the updated versions of the following items:
- k) Detailed Project Schedule, which shall also be provided electronically in form acceptable to PPL
- l) Document Register (as described above) showing the current status
- m) Expediting Report
- n) Work Force Report
- o) Action Item List(s)
- p) Work Remaining Lists showing the current status
- q) Site Report providing status of construction and/or start-up, issues, and concerns.
- r) Once the installation works have commenced, it shall contain:
- s) EHS Report, including details of recordable events, lost-time accidents, or
- t) Public Relations Incidences
- u) Log of recordable and lost-time accidents to date

Project Schedule

The Updated Project Schedule shall present the status of permit procurement; performance of geological, geotechnical, environmental, and hydrological investigations; engineering, design, procurement and/or manufacture of all permanent and temporary components, equipment, and materials; shipment, delivery, unloading and storage; removal from storage and construction; training of PPL's O&M personnel; testing, start-up, and commissioning completed during the previous month and planned for the next month; and critical path. This schedule shall also be presented at monthly Project meetings with PPL. The submittal frequency will change as the Project proceeds towards completion.

Document Register

The Document Register shall list the documents required for the Work, including specifications, studies, critical calculations, drawings, and test reports, and shall track the percent complete, show predicted completion/issue dates, revisions, and other pertinent information. The Document Register shall be attached to the monthly Project Progress Report and issued to PPL prior to design review meetings.

Invoices

Invoices shall be submitted in accordance with the terms of the Contract and identify the milestones completed.

Expediting Reports

Expediting Reports shall track the status of Bidder's, Vendors', Fabricators', and Subcontractors' engineering, design, procurement, fabrication, and delivery of major components, equipment, and material. The Expediting Report shall be attached to the monthly Project Progress Report and include the following information, as a minimum:

- a) Name and location of the Vendor, Fabricator, or Subcontractor
- b) Start and finish dates, which shall be qualified as either predicted or actual
- c) Percentage progress
- d) Inspections and/or tests dates
- e) Delivery of components, equipment, and material

Action Items/Issues List

An Action Items/Issues List shall be developed for each major area, including engineering, design, permitting, procurement, fabrication, construction, start-up, and testing. Vendor's Project Manager shall issue this list to PPL for use as a coordination tool between Vendor and PPL. Completed actions and resolved issues shall be archived for record; remaining items shall be prioritized for high, medium and low priority and assigned to a responsible individual; origination date, planned and actual completion dates, and status shall be tracked. The Action Items/Issues List shall be attached to the monthly Project Progress Report.

Progress meetings

Progress meetings of PPL and Vendor shall be held at least once per month. Monthly progress meetings will be held via Skype until mobilization of Bidder's work force at the project construction site. After mobilization, the progress meetings might be held at the site. Vendor shall be represented by Vendor's Project Manager as appropriate. Vendor's Key Personnel and/or subcontractor shall be in attendance if so requested by PPL or Bidder. All matters bearing on the progress and performance of the Work since the preceding progress meeting shall be reviewed,

including any unresolved matters, difficulties, or delays. The meeting agenda shall include, but not be limited to, the following:

- a) Safety review
- b) Review of the schedule and Work in Progress
- c) Problems in the Work and resolution
- d) Identification of potential problems and risks
- e) Review of submittal schedule
- f) Review of equipment and material delivery schedules
- g) Planned progress during current and succeeding work period
- h) Coordination requirements for immediate work
- i) QA/QC review
- j) Administrative and general matters

Vendor's Project Manager shall prepare and distribute written minutes of each meeting of the Parties to PPL within five (5) business days following the meeting. The meeting minutes shall include sufficient information to allow a thorough understanding of the information presented, document all action items, and identify the responsible individual assigned to each action item. PPL shall provide comments within five (5) business days of receiving the minutes, and the final minutes shall be reissued by Vendor within the following five (5) business days. PPL and Bidder each reserve the right to record meetings in audio/visual electronic media format and one copy of any electronic media recording of meetings shall be provided to the other Party.

Vendor shall prepare minutes and final minutes of meetings with its Subcontractors in the same manner described above and include PPL in the distribution of the final minutes.



SECTION - VI:

FORMATS & ANNEXURES

See the document titled *Proposal Format*.