Schedule B

Standard Specification

Power Conversion System (PCS)

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2022-04-21	0	Approved for Use	J. Zuliani	M. Mitchell	D. Anders
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**
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Table of Contents

1. General

1.1.1.1 This document shall be read as part of a complete Specifications package consisting of documents numbered below:

- *Energy Storage System* Request for Proposal (RFP)
- *Battery Energy Storage System* Specification
- *Power Conversion System* Specification
- Power Transformer Specification
- *Energy Management System* Specifications
- Electrical Balance of Plant and Installation Specifications
- Site Works and Civil Balance of Plant Specifications
- Containerized Building Specification
- Packaging and Shipping Requirements

1.1.1.2 Following definitions and abbreviations will be used for this Specifications:

a.) ***Balance of Plant*** or ***BOP*** – electrical and site works for the entire facility, excluding the *ESS* equipment and *EMS*

b.) ***Battery Energy Storage System*** or ***BESS*** – A lithium-ion electrochemical storage device capable of delivering or absorbing electrical energy at its *DC Bus*

c.) ***Battery Management System*** or ***BMS*** – the control and monitoring system for the *BESS* designed to manage all internal bank functions and internal protection. The *BMS* shall communicate with the *PCS* and *EMS*

d.) ***Battery Module***- An assembly of rechargeable battery cells with a convenient mechanical arrangement and a degree of protection

e.) ***Battery Rack*** – a free standing assembly of battery modules, integrated as part of an overall *BESS*

f.) ***Calendar Life*** – The expected number of calendar years that the battery is expected to last independent of charge and discharge cycles

g.) ***Contract*** – The agreement resulting from this RFP process

h.) ***Contractor***– the successful *Proponent* with whom the *LUCELEC* may enter into a *Contract*

i.) ***Current Transformer*** or ***CT*** - an instrument transformer used to step down a measured current for metering, control or protection purposes

j.) ***DC Bus*** – the direct current connection between the *PCS* and *BESS* capable of carrying rated system power

k.) ***Depth of Discharge*** or ***DOD*** – the ratio of the amount of energy discharged from the *BESS* to the maximum dischargeable energy capacity of the *BESS*

l.) ***End of Life*** or ***EOL*** – the defined remaining *BESS* capacity as a percentage of the amount of initial *BESS* capacity at which the *BESS* system becomes not functional as initially designed

m.) ***Energy Storage System*** or *ESS* – - consists of a *Battery Energy Storage System (BESS)* and a *Power Conversion System (PCS)*

n.) ***Energy Management System*** or *EMS* – the *Contractor* supplied power plant control system that communicates to the *PCS* and coordinates plant functions;

o.) ***Factory Acceptance Testing*** or *FAT* – performance testing of all equipment at the factory to ensure it meets the specifications and requirements prior to shipment to site

p.) ***Factory Integration Testing*** or ***FIT*** - performance testing at the factory of an integrated system, consisting of the *ESS, PCS* and *EMS* to ensure interface between components is functional prior to shipment to site

q.) ***Input/Output*** or ***I/O –*** refers to the input or output signals associated with a control system or component of the control system such as a programmable logic controller.

r.) ***Inspection and Test Plan*** or ***ITP*** – the plan for managing the quality control and assurance of a particular the construction work providing information on the requirements, overview of the method(s) to be used, responsibilities of relevant parties, and documentary evidence to be provided to verify compliance

s.) ***Human Machine Interface*** or ***HMI*** – A user interface that serves as the main point of interaction between an operator of the battery plant and the settings, functions and commands associated with the plant

t.) ***Low Voltage Bus*** – the alternating current connection between the *PCS* inverter and the step-up transformer

u.) ***LUCELEC –*** St. Lucia Electricity Services Ltd.

v.) ***LUCELEC's Representative*** – The person appointed by the *LUCELEC* who has responsibility for managing the *Contract* and, unless *Contractor* is expressly advised otherwise, *LUCELEC's Representative* (1) has full authority to act on behalf of and bind the *LUCELEC*, and (2) may, in writing, delegate any or all of his or her authority to any other person

w.) ***Power Conversion System*** or *PCS* – The Battery *PCS* is the power interface from the battery system to the AC electrical grid

x.) ***Proponent*** or ***Tenderer***– Each company receiving this *Request for Proposal*

y.) ***Proposal*** – Documents submitted by *Proponents* in response to this *RFP*

z.) ***Potential Transformer*** or ***PT*** - also known as a Voltage Transformer, an instrument transformer used to step down the main connection voltage for metering, control or protection purposes

aa.) ***Programmable Logic Controller*** or ***PLC*** – A ruggedized industrial computer on which the core logic of the control system resides

bb.) ***Primary Frequency Response*** or ***PFR –*** The first stage of frequency control in response to a disturbance on the power system frequency. Traditionally provided by fast acting governor systems.

cc.) ***Request for Proposal*** or ***RFP –*** This Request for Proposal including all attached and referenced documents and subsequent addenda

dd.) ***Remote terminal unit*** or ***RTU -*** A controller that interfaces with a physical system or sub-system of the plant and transmits information to the SCADA network.

ee.) ***Supervisory Control and Data Acquisition System*** or ***SCADA*** – the plant Supervisory Control and Data Acquisition system supplied by *LUCELEC*

ff.) ***SCADA Network*** – the communications network that facilitates the communication between *PLCs* and other networked components within the *BESS*

gg.) ***Site Acceptance Testing*** or ***SAT*** – performance testing of all installed equipment at site to ensure it meets the specifications and requirements and that there was no damage during shipment or installation

hh.) ***State of Charge*** or *SOC* – the ratio of present dischargeable energy storage capacity to maximum dischargeable energy storage capacity expressed either in percentage or MWh

ii.) ***Subcontractor –*** Any firm/individual that the *Contractor* may contract with to perform a portion or all of the *Work* and for which the *Contractor* assumes liability

jj.) ***System Control Center*** or ***SCC*** – The *LUCELEC* control center that dictates power system commands to distributed generators through the *LUCELEC SCADA*

kk.) ***Uninterruptible Power Supply*** or ***UPS*** - an electrical apparatus that provides emergency power to a load when the input power source or mains power fails.

ll.) ***Work*** or ***Supply –*** All or any part of the services and obligations required to be performed under the *Contract*.

1.1.1.3 This Specification is for the supply of all labour, materials and services required for the design, engineering, detail, fabrication, supply, packaging, testing, delivery, installation (including delivery, unloading, placement on foundation, anchoring, connection to the grounding grid, and connection of all cabling), and commissioning of quantity one (1) Lot of Battery *Power Conversion System* (*PCS*) equipment to be used as part a new *Energy Storage System (ESS)* to be installed in Vieux Fort, St. Lucia, beside the La Tourney Solar PV. This Specification provides the technical requirements for the Battery *PCS*. The

corresponding *BESS* requirements are the subject of the separate Technical Specifications, *Schedule A – Battery Energy Storage System (BESS) Specification.*

1.1.1.4 The work called for is subject to the purchase order documents. They include this Specification, the general conditions of contract, any specific conditions and any other attachments, all of which form an integral part of the contract. The *Contractor* shall be responsible for and be governed by all requirements therein. **Any exceptions to this Specification shall be stated in writing by the *Contractor* and a suitable alternative can be priced as an option.**

1.1.1.5 The supplied equipment shall be designed for continuous operation and all components shall be of a robust, industrially proven design.

1.1.1.6 The *Contractor* supply shall include all components and accessories as required for the proper and safe operation of the complete system.

1.1.1.7 Compliance with this Specification does not relieve the *Contractor* of the responsibility to provide safe and reliable equipment. The *Contractor* shall have overall responsibility for the safety of the *PCS* design. Any areas of the *PCS* and its subsystems that pose a risk to the environment, personnel, or *LUCELEC*'s assets are to be clearly communicated to *LUCELEC* and its representative.

1.1.1.8 The equipment shall be complete in every aspect and ready to operate after installation and connection.

2. Codes and Regulations

2.1 General

2.1.1.1 The *PCS* shall comply with all applicable local regulations and codes for the local jurisdiction in which the *PCS* is to be installed.

2.1.1.2 All electrical components shall meet all National Building Code, and UK Electrical Industry British Standards (BS) requirements and bear a recognized certification mark such as one of CE Mark, IEC, ANSI, UL, FM, etc. All *PCS* subsystems shall either be listed or be field evaluated for installation in St. Lucia by an approved agency.

2.1.1.3 The *Contractor* shall clearly indicate in their *Proposal* the standards which the requested equipment meets. The *Contractor* shall clearly indicate if field certification is required for any necessary standards.

2.1.1.4 Certification of equipment shall be at the *Contractor*'s expense.

2.1.1.5 In case of conflict between these standards and this Specification, the *Contractor* shall notify *LUCELEC* and its representative in writing of such conflicts as soon as they become known.

2.1.1.6 *LUCELEC*'s standard design and material requirements are included in *Schedule H – LUCELEC Design Criteria and Standards*. For the *PCS* components, it is preferred that *Proponent*s comply with any applicable *LUCELEC* requirements when possible. However,

should complying with these requirements for the *PCS* lead to considerable added costs, *Proponent*s may take exception. *Proponent*s shall note any exceptions.

2.2 Standards

2.2.1.1 The supplied equipment shall be designed, manufactured and tested in accordance with the most current revision of the following applicable standards, codes and regulatory bodies:

- International Electrotechnical Commission (IEC).
- UK Electrical Industry British Standards (BS)
- IET Wiring Regulations BS 7671:2018
- OECS Building Code Grenada, St. Vincent & the Grenadines, St. Lucia, Montserrat, latest version (National Building Code)
- Underwriters Laboratory (UL).
- CE Mark
- Institute of Electrical and Electronics Engineers (IEEE).
- EMC Directive (2014/30/EU) and IEC 61000 Electromagnetic Compatibility, specifically IEC 61000-1-2 and IEC 61000-6-7
- IEC 61508-1 - Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
- IEC 62477 – Safety requirements for power electronic converter systems and equipment
- IEC TS 62786: Distributed energy resources connection with the grid
- UN 38.3 Transport of Dangerous Goods Manual: Lithium Metal and Lithium Ion Batteries or IEC 62281 Safety of primary and secondary lithium cells and batteries during transport

2.2.1.2 The *ESS* and *PCS* shall have a CE mark.

2.2.1.3 The *PCS* shall be compliant to **IEC 62477** – Safety requirements for power electronic converter systems and equipment

2.2.1.4 The *Contractor* is responsible for any on-site certification or other inspection requirements.

2.2.1.5 *Proponents* may propose *ESS* which have UL equivalent certifications. *Proponents* shall indicate the equivalent IEC and UL standard, if electing to supply UL certified equipment.

3. Scope of Supply

3.1 *PCS* Materials and Work Included

3.1.1.1 The *PCS* scope of supply includes but is not limited to the items identified in Table 1.

Table 1 *PCS* System Scope of Supply

Item	Qty	Deliverable Brief Description
		MATERIAL
1.	1 lot	IGBT-based AC-DC Grid-Tie inverter line-ups with full 4-quadrant functionality preferably made from modular units, complete with AC line filters, surge protection, cooling system. The converter will be connected to the *BESS* on DC side and through a step-up transformer to the 11 kV system There shall be at minimum two parallel inverter line-ups, each with a minimum of 4.2 MVA capacity. Additional parallel inverter line-ups may be proposed by the *Contractor* to maintain the short circuit level within the acceptable limit.
2.	1 lot	DC protection and isolation system for connection to the *BESS DC Bus*, suitably sized for the entire range of operation and the required fault duty. This solution must include both isolation and protection elements, such as a fused disconnect or bipolar DC breaker.
3.	1 lot	3-phase AC breaker between the inverter and the transformer with remote operation provision and with adjustable trip curves, suitably sized for the entire range of operation and the required fault duty. The number of breakers shall match the number of inverters and transformers.
4.	1 lot	Low voltage bus work, cables and all connections.
5.	1 lot	Complete measurement system including instrument transformers. The secondaries of one 3-phase set of *PTs* and one set of 3-phase *CTs* on the AC side of the converters and outputs of waveform sensing devices for DC side voltage and current (e.g., LEM-based devices) should be made available for use by the *Contractor*'s *EMS*.
6.	1 Lot	Auxiliary power transformer and circuits connected between the transformer and inverter (behind the connection point) to supply auxiliary power requirements for the *Contractor*'s scope of supply
7.	1 Lot	Integrated *PCS* control and protection system. The *PCS* control system shall communicate with the *EMS* and *SCADA Network.*
8.	1 lot	Remote monitoring equipment
9.	1 lot	*Uninterruptible Power Supply*
10.	1 lot	Climate-Controlled Container(s) or suitably sized self-supporting enclosures within which all *PCS* components are integrated together with all the wiring interconnections inside the container
11.	1 Lot	Special Equipment Any components not explicitly referenced within this Specification, but necessary for the safe and automated operation and maintenance of the equipment.

Item	Qty	Deliverable Brief Description
12.	1 Lot	Hardware, special tools, gaskets, sealants, shims and all nuts and bolts required for field assembly and erection.
13.	1 Lot	Commissioning and Operating Spare parts for two full years of operation as recommended by the *Contractor.*
		SHIPPING
14.	1 Lot	Packaging and Shipping to the La Tourney Solar PV farm in Vieux Fort, St. Lucia; the *Contractor* is responsible for the transportation to the site including all necessary insurances. The *Contractor* must also provide the necessary preparations and required packaging of the system for transportation.
		ENGINEERING
15.	1 Lot	Documentation The *Contractor* is to provide engineering drawings and documentation on scope of supply. Including, as applicable: • Installation drawings. • Interconnection Drawings. • Electrical and Schematic Drawings. • General Arrangement Drawings. • Preliminary Electrical Layout • Preliminary Site layout • Electrical Single Line Diagrams • Interconnection Protection Philosophy and Concept. • Cable Schedules. • Data Communication Diagrams • Installation and Operation Manual. • Maintenance Manual and Schedule. • Bill of Materials/ Major Equipment List. • Data Systems, Networks and Software Architecture and Control logic. • Conceptual Design for *SCADA* System • As-built Drawings. The *Contractor* shall be responsible for sealing all issue for construction or final drawings with an APESL (Association of Professional Engineers of St. Lucia) seal.
16.	1 Lot	Specification of all *LUCELEC* Supplied materials, such as cables, for completing interconnections of *Contractor* supplied equipment.
17.	1 Lot	Equipment Certification for scope of supply
		TESTING
18.	1 Lot	*Factory Acceptance Test (FAT)* plan to be submitted to *LUCELEC* and its representative for approval.
19.	1 Lot	A *Factory Acceptance Test (FAT)* must be completed at a facility of the *Contractor*'s choosing before any equipment is sent to site. The tests must be

Item	Qty	Deliverable Brief Description
		designed to prove compliance with all the Specifications described herein. A detailed *FAT* report must be provided to *LUCELEC* and its representative. *LUCELEC* or its representative may elect to witness the *FAT*. *LUCELEC* or its representative may elect to witness the *FIT*.
20.	1 lot	*Factory Integration Test* (*FIT*) between the *BESS* and *PCS* and together with the *Contractor*-supplied *EMS*. *FIT* should be offered as an optional service and priced out separately for *LUCELEC's* review.
		SITE WORK
21.	1 lot	Installation of all *Contractor* supplied equipment.
22.	1 lot	Pre-Commissioning, Commissioning and Start-up of supplied equipment.
23.	1 lot	*PCS Site Acceptance Testing* to be completed at site to demonstrate *PCS* capabilities with respect to the Specifications described herein. The *Contractor* is to assume a minimum of two days of site assistance to conduct *PCS* acceptance tests.
24.	1 lot	Operation and Maintenance Training and Documentation The *Contractor* must prepare an operation manual for *LUCELEC* and provide training for *LUCELEC*'s staff (both engineering and operations staff). The *Contractor* is to provide a minimum of one week of site training.

4. Ratings and Functional Requirements

4.1 General

4.1.1.1 The *PCS* shall be comprised of a line-up of multiple inverters with a total rated capacity of a minimum of 8.4 MVA. The *PCS* shall operate at a power factor of 0.9 for typical operations.

4.1.1.2 The *PCS* shall be designed to have a minimum of two fully redundant parallel systems, each with a minimum 4.2 MVA rating. The configuration will be such that each parallel system can operate independently. Additional parallel systems shall be considered to maintain the short circuit level on the low voltage side of the transformer within acceptable limits.

4.1.1.3 The redundant systems shall be sized such that the short circuit current on the secondary of the transformer does not exceed 40 kA.

4.1.1.4 The *PCS* shall consist of multiple identical units, with the following overall guaranteed ratings as a minimum:

Table 2 Converter Ratings and Parameters

Parameter	Unit	Total System Value
Continuous AC power rating (+/-)	MW	>=8.4
Continuous AC reactive power (+/-) at 0 MW	MVar	>=8.4
Apparent Power Rating (+/-)	MVA	>=8.4
DC voltage Operational range	V DC	To suit battery DC bus voltage
Total one-way efficiency at maximum current and at nominal DC bus voltage (excluding the transformer)	%	>97
A: Reaction time of the PCS measured as the time between receiving a setpoint and the start of initial reaction on the inverter terminals.	ms	<100
B: MW and Mvar rise time from the initial start of reaction to a power setpoint to reaching 100% of the target setpoint.	ms	<100
C: The total response time of the PCS which represents the summation of A + B.	ms	<200
Accuracy of P and Q value for a given P and Q command provided by the *EMS*		Within +/- 2%, within +/-1% preferred

4.1.1.5 The *PCS* shall be capable of delivering the full MVA rating for the entire *BESS* DC voltage operating range.

4.1.1.6 The *PCS* shall be capable of providing all power and reactive power values within the following capability curve, in Figure 1, and for the bus voltage levels and frequency levels stated in Table 3.

4.1.1.7 The *PCS* shall be capable of providing full 4-quadrant operation, offering 8.4 MVA (up to 8.4 MW at 0 MVar and up to 8.4MVar at 0 MW) to provide reactive power support in all operating temperatures.

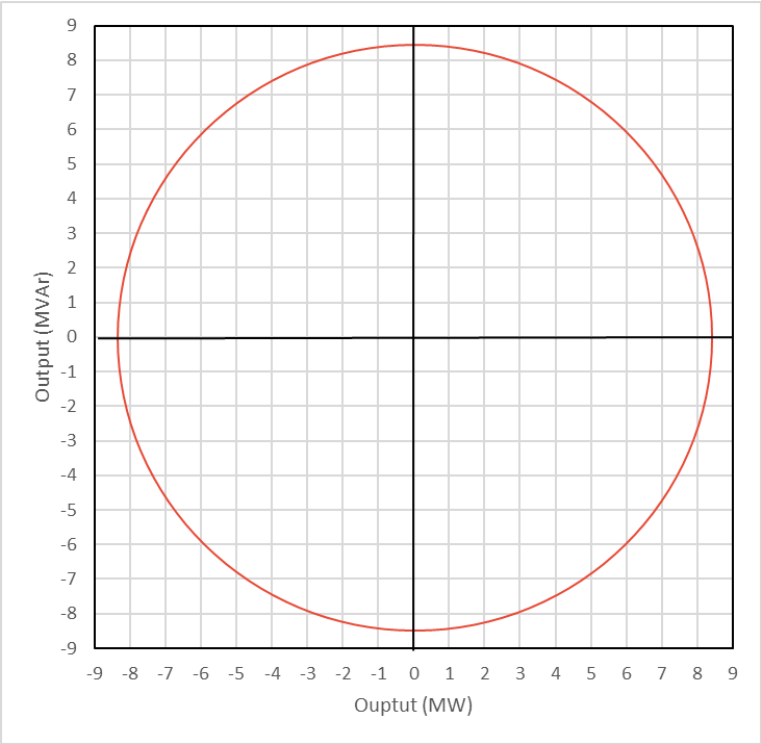

Figure 1 Minimum PQ Capability Graph for one *PCS*

4.1.1.8 Momentary voltage variations outside the +/-10% range are possible. The *Contractor* is to indicate the deliverable and absorbable P and Q limitations while outside the +/-10% voltage range.

4.1.1.9 All *PCS* equipment must be capable of completely automatic and unattended operation.

4.1.1.10 The *PCS* system shall be capable of delivering power from battery (discharging) or absorbing power into the battery (charging) at any value between 0% to 100% of its rated power continuously.

4.1.1.11 The *PCS* shall be capable of energizing from either side, providing black start power to the DC grid from the battery, or providing power from the grid to the battery at zero *SOC*. This is to allow pre-charge of a fully discharged battery system.

4.1.1.12 All breakers and disconnect switches used on DC components shall be bipolar and disconnect or connect both positive and negative lines simultaneously.

4.1.1.13 The *PCS* shall include any required DC and AC filters, capacitors and surge protection systems as required.

4.1.1.14 The *Contractor* shall provide a list of all auxiliary equipment per *PCS* lineup and the consumption. The *Contractor* shall estimate the auxiliary load/station services per *PCS* lineup and for the entire system during charging, during discharging, and during idling.

4.1.1.15 Routine maintenance on the *PCS* will be performed by *LUCELEC*'s staff. The *PCS* design must allow for easy access to all areas requiring regular maintenance. The *Contractor* shall prepare written documentation and provide training to *LUCELEC*'s staff on maintenance procedures.

4.1.1.16 The *Contractor* supply shall include all components and accessories as required for the proper and safe operation of the complete system.

4.1.1.17 The *PCS* design must allow for easy replacement and access to the inverter modules for maintenance.

4.1.1.18 The *Contractor* shall provide a preliminary site layout for all *Contractor* supplied equipment. This layout shall indicate any mandatory clearance requirements (e.g. for access, fire safety, etc.). The layout shall also indicate preliminary cable connections (i.e. identify which containers are connected).

4.2 Site Electrical Conditions

4.2.1.1 The supplied equipment shall be designed to operate to operate when connected to the 11 kV electrical system conditions listed below.

Table 3 11 kV Bus System Conditions

Item	Characteristic
Nominal Voltage	11 kV+/-5%
Nominal Frequency	50 Hz +/- 1.5 Hz
Short Term Power System Variations in Frequency	Frequency: 48.5 to 51.5 Hz df/dt:4 Hz/sec
Grounding	High-Resistance
Phases/Wires	3/4
Three-phase short-circuit level	<= 64.257 MVA_{sc} and <= 3.596 kA

4.3 Duty and Availability

4.3.1.1 The supplied equipment shall be designed and constructed to operate continuously, 24 hrs per day, 365 days per year without excessive maintenance or direct operator supervision.

4.3.1.2 The equipment shall have a service life of minimum 20 years.

4.3.1.3 The *PCS* will have an availability of > 98% at full system capacity.

4.4 Data Access Requirements

4.4.1.1 *LUCELEC* requests a logging system and access to the following data points for the *ESS*:

- Inverter Level (Lineup)

- AC Voltage
- DC Voltage
- AC Current
- DC Current
- Frequency
- Active Power
- Reactive Power
- Total Power
- Desired Setpoint
- Operating Mode
- Power Limited
- Max Possible Charging Current
- Max Possible Discharging Current
- Max Possible Charging Power
- Max Possible Discharging Power
- Availability (%)

- Point of Interconnection
  - Voltage
  - Current
  - Frequency
  - Active/Reactive/Total Power
  - Power Factor
  - Overall State of Charge (MWh/%)
  - Overall State of Health (%)
  - Availability (%)

4.4.1.2 The *Contractor* shall provide a tag list indicating all tags that will be available for data logging.

4.5 Packaging and Enclosures

4.5.1.1 The containerized solution shall include the necessary HVAC systems and appropriate insulation to maintain the required operating environment inside the containers for all expected atmospheric conditions.

4.5.1.2 Container/building construction shall comply with requirements stated in *Schedule G - Containerized Building Requirements and* shall be free-standing with lockable hinged doors.

4.5.1.3 Each *PCS* subsystem shall be completely housed within an enclosure. These enclosures shall be NEMA 1 or better painted steel cabinet, free-standing or wall mounted.

4.5.1.4 For each of the *PCS* units, the *Contractor* is asked to provide equipment fully assembled and wired within a *Contractor*-supplied climate-controlled painted steel container with lockable hinged doors.

4.5.1.5 Where doors are required on the *PCS* panels, they shall be hinged and lockable. Normal day-to-day operation of the *PCS* equipment shall be with doors closed. Door opening shall only be required for performing system maintenance by authorized personnel.

4.5.1.6 All *PCS* equipment shall be preferably serviceable by front access only. The *Contractor* is to indicate any deviations from this in their *Proposal*.

4.5.1.7 A minimum of 1 m clearance shall be provided in front of each piece of equipment for operations and maintenance access.

4.5.1.8 The *Contractor* is to indicate their standard paint colour for *LUCELEC*'s approval.

4.5.1.9 The *Contractor* should also indicate the added cost to paint the containers to match *LUCELEC*'s colour and add *LUCELEC*'s Logo.

4.5.1.10 The *PCS* indicating lights shall be installed on the front of enclosures so they are visible without need to open enclosure cabinet doors. The *Contractor* is to state any deviations in their *Proposal*.

4.5.1.11 For all panels and equipment, cables entering or exiting *PCS* containers shall be bottom entry. Sufficient space for bending radius and entry points shall be provided inside the *Contractor* enclosure.

4.5.1.12 The *Contractor* shall allocate appropriate space to accommodate the containers for the *EMS* cabinet (*EMS* also supplied by the *Contractor*).

4.5.1.13 If the *PCS* is located in the same container as the *Battery Modules* and *Racks*, there shall be a one (1) hour fire wall separating the two sections.

4.6 *PCS* Control and Protection

4.6.1.1 The *PCS* together with *BESS* shall operate as a participating distributed resource, where power is supplied by renewable generation, and/or thermal generators.

4.6.1.2 *ESS* protection coordination study report shall be submitted to *LUCELEC* for acceptance review before the interconnection.

4.6.1.3 *PCS* protective relaying and controls should only operate on physical equipment limitations or specifications. Protection functions should be set as wide as possible while ensuring equipment safety and reliability.

4.6.1.4 The *PCS* shall have the capability to be used either as a current source or voltage source. The *Contractor*'s *EMS* will select the mode of operation. Both modes shall be available to use by the *EMS.*

4.6.1.5 The *PCS* shall include an integrated control system that communicates to the *EMS*.

4.6.1.6 The *PCS* control system shall communicate with *BESS* control system. The provided control system must coordinate the inverter module(s) in each line-up and the *BESS BMS* system and provide a single point of interface to the *Contractor*'s *EMS*.

4.6.1.7 *PCS* control system shall provide to the *EMS* the maximum discharge and charge power allowable by the *BESS* in real time. It is expected that these real-time maximums will be equal to rated *BESS* power, unless at limits of *State of Charge*, or when *BESS* equipment becomes partially unavailable. The external *EMS* will be designed to send the MW commands that are below or at these real-time values. However, if the commands are beyond the allowable real time MW maximums at any point, the *PCS* system shall limit the commands to the maximums allowed and protect the *PCS* and *BESS* from excessive charge and discharge.

4.6.1.8 The *PCS* system will check the status and availability of *BESS* and breakers and provides a ready signal to the *EMS*.

4.6.1.9 The *PCS* must communicate over DNP3 or equivalent to the *EMS* system supplied by the *Contractor*. All important system parameters, such as measured voltage/current/power and component status and operating modes and conditions shall be made available for monitoring. In addition, the climate status within the *PCS* enclosure should be available for monitoring.

4.6.1.10 *PCS* shall be capable of receiving and closely following the MW and MVar setpoints provided by the *EMS* and to provide the required P and Q on the 11-kV side of the step-up transformer.

4.6.1.11 The *PCS* shall be able to be commanded into a disable gating mode, in which the *PCS* draws and injects zero current on the *DC Bus* regardless of actual MW and MVar setpoints. Upon removal of the gate disable command the *PCS* shall be able to follow MW and MVar setpoints immediately.

4.6.1.12 The standard *PCS* anti-islanding feature shall be available, but an option shall be provided to disable the anti-islanding feature at site as required during commissioning.

4.6.1.13 In addition to DNP3 communications, the *PCS* control system shall be able to receive the setpoint power and the setpoint reactive power, and other critical commands remotely via hardwired *I/O.*

4.6.1.14 All *I/O* points and controls at local system control interface must be available and inclusive to the *EMS* for monitoring and control. The *Contractor* shall supply all *I/O* available to the interface point. *LUCELEC* or its representative will provide a standard data map of address ranges per data type within *LUCELEC*'s gateway devices.

4.6.1.15 The *PCS* shall be self-protecting and not rely on the battery protection systems for protection. In addition, the *PCS* control system shall include protective functions as required, including but not limited to the following:

- AC Overcurrent (timed and instantaneous).
- DC Overcurrent (timed and instantaneous).
- AC Overvoltage.
- AC Undervoltage.
- DC Overvoltage.
- DC Undervoltage.
- DC voltage bus ground fault or insulation monitoring protection
- *DC Bus* voltage unbalance (between positive to ground vs negative to ground).
- Under frequency.
- Over frequency.

4.6.1.16 The *PCS* shall be equipped with *DC Bus* voltage monitoring system. In the event of an imbalance on the battery side between the bus voltages, indicative of *DC Bus* ground fault or other conditions, suitable protective action must be taken by the *PCS* control system.

4.6.1.17 The *Contractor* is to indicate how the *PCS* will behave during an unbalanced fault (for example a single line to ground fault) on the AC side, and whether it contributes to the zero-sequence fault current.

4.6.1.18 The *Contractor* is to supply complete technical documentation for the *PCS* control and protection system, describing parameters, protection scheme, system limitations and user operations. The *Contractor* is to specify the programming/configuration tools, data collection, monitoring and historian feature.

4.6.1.19 *Contractor* shall specify the isolation and protection equipment for the DC and AC Bus. An AC breaker is mandatory and a DC breaker is preferred.

4.6.1.20 The *PCS* shall include indicating lights for status indication and other core functions such as faults, as required.

4.6.1.21 Hard-wired Emergency Stop capabilities must be designed into the system. The push-button shall be suitably protected to prevent accidental operation. This push-button hardwired action shall de-energize and safely shutdown the system in coordination with the *BESS* equipment as required.

4.6.1.22 In each container, the E-stop button and indicating lights shall be installed on the front of enclosures so they are visible without need to open enclosure cabinet doors.

4.6.1.23 *PCS* shall include a local *HMI* with full status, diagnostics, manual parameter and setpoint entry functionality. Commands including power and reactive power setpoints and parameters

of fault ride through curves including LVRT (Low-Voltage Ride-Through), ZVRT (Zero Voltage Ride Through), HVRT (High Voltage Ride Through), FRT- (Frequency Ride-Through) shall be also accessible through the *HMI.*

4.6.1.24 The *Contractor* must specify and include networking equipment, software and implementation scheme to allow remote monitoring of the *PCS*.

4.6.1.25 The *PCS* control system must include a droop-based voltage and frequency control module with settable droop curves and deadbands. (The *Contractor* is to state if any external *CT/PT* signals are required for this mode).

4.6.1.26 When possible, it is preferred that *Proponent*s supply the relays, panels, communications, etc. based on the design criteria outlined in *Schedule H – LUCELEC Design Criteria and Standards*. However, if the *Proponent*'s design is previously integrated or certified, this is not mandatory within the *PCS* components/containers. *Proponent*s to note any exceptions.

4.7 Uninterruptible Power Supply

4.7.1.1 The *Contractor* shall supply *Uninterruptible Power Supply (UPS)* to service critical loads. Critical loads at the site include equipment such as:

- Communication equipment, Ethernet Hubs, and Monitors.
- Control Equipment.
- Analog and Digital Instrumentation.
- Protection and coordination equipment.
- Fire Detection and Suppression System.

4.7.1.2 Batteries shall have sufficient capacity to provide full rated output from the inverter for a period of 4 hours.

4.7.1.3 The *UPS* inverter shall consist of a solid-state switching device that converts battery power to 50 Hz output voltage having less than 5% total harmonic distortion at full load at 1.0 PF. The inverter shall be sized for 150% of the maximum estimated load.

4.8 Wiring and Connections

4.8.1.1 Main DC Power Connection terminals for the DC system shall be provided for positive, negative and ground.

4.8.1.2 Main AC connection terminals for the main AC system shall be provided

4.8.1.3 The auxiliary power system shall consist of two (2) auxiliary transformers connected to the main switchgear in a redundant configuration. One (1) on each side of the main switchgear TIE breaker. The entire system shall be fully functional while one of them is off-line.

4.8.1.4 The *Contractor* shall describe in their *Proposal* the details on the *PCS* auxiliary power supply.

4.8.1.5 All cabling and wiring should follow the BS 7671. Where possible, it is preferred that the (*LUCELEC* Design Criteria attached in *Schedule H – LUCELEC Design Criteria and Standards*) is followed within the *PCS* components/containers. The *Contractor* shall indicate if it is not possible to meet the *LUCELEC* Design Criteria in its *Proposal.*

4.8.1.6 Conductors shall be rated with insulation suitable for the application temperature and current and not less than as follows:

Table 4 Insulation and Current Requirements for Conductors

Conductor	Specification/Requirement
Main incoming connection	11 kV underground connection, Sizing TBD
Medium Voltage Bus (if applicable)	*Contractor* to propose safe and reliable design based on selected voltage level
Main current carrying conductors (Low voltage AC and *BESS* DC)	1000 V
Systems up to 120 V	600 V
Systems 24 Vdc and below	300 V

4.8.1.7 All wiring sizes shall be as per the BS 7671 and *LUCELEC* Design Criteria. Standard colours are preferred as follows:

Table 5 Colouring Standards for Wiring

Service	Wire Description	Colour
Insulated ground conductor	Any	Green or Green/Yellow
1-phase ac or dc (2-wire)	Zero (0)One (1)	Black Red
1-phase ac or dc (3-wire)	One (1) Two (2) Three (3) Neutral	Red Yellow Blue Black

4.9 Sound

4.9.1.1 Emission sound pressure level shall not exceed 80 dBa at 1 m away.

4.10 Vibration

4.10.1.1 The *PCS* design shall accommodate the anticipated vibrations and shocks associated with the transportation and installation at site.

4.11 Electro-Magnetic Interference

4.11.1.1 The *PCS* equipment shall not create Electro-Magnetic interference (EMI) with other equipment.

4.11.1.2 *Contractor* should indicate any EMI radiation generated by the *ESS* or other equipment, the system will be located within 1 km of an airport, and EMI studies may be required if there is concerned.

4.12 Materials

4.12.1.1 The equipment shall be the *Contractor*'s standard, robust, heavy-duty design. The design shall have been proven effective and reliable under similar operating conditions. No new or unproven design is acceptable.

4.12.1.2 All material shall be new and not previously built or used.

4.12.1.3 Not all parts and materials are specified in this Specification. For those that are not specified, the *Contractor* shall use their standard parts and materials, which will be subjected to the approval of *LUCELEC* and its representative. All parts and materials shall suit the specified duty.

4.13 Grounding

4.13.1.1 The *Contractor* shall provide all Equipment with grounding interface points (grounding details), as well as Interface details to *LUELEC*. *LUCELEC* requests the *Contractor* consider connecting the grounding interface to the Solar PV grounding grid, if possible, based on the grounding study.

4.13.1.2 The *Contractor* shall indicate the ground fault detection methods used for the *PCS* containers, switchgear and transformer.

4.13.1.3 The system shall have a suitable equipment grounding system to be able to tie to the site grounding system through a bare copper conductor brought to the enclosure.

4.13.1.4 All exposed non-current carrying metal parts shall be solidly grounded.

4.14 Toxic Materials

4.14.1.1 Polychlorinated biphenyls (PCBs) and polybrominated biphenyls (PBBs) shall not be used.

4.14.1.2 If a significant amount of toxic substance can be emitted from the equipment during a failure, fire or emergency/protective operation, an alarm system to alert personnel shall be included in the equipment. Description of the toxic nature of the substances as well as treatment for exposure to it shall be included in the O&M manual.

4.14.1.3 Where applicable, *Contractor* should identify any spill risks that are credible for the types of cells used. The *Contractor* shall mitigate against any spills that are credible for the types of cells used. The design shall include features that contain any spills and prevent discharge to the surrounding environment. The O&M manual shall include procedures to contain and cleanup spills as applicable.

4.15 Labelling

4.15.1.1 Components and enclosures (as applicable) shall be fitted with metal nameplates, permanently engraved in English showing manufacturer's name, address, date of manufacture, description or title, model and serial numbers, standards built and tested to, limiting values of ambient temperature, temperature rise, voltage, current, power, short circuit rating etc.

4.15.1.2 On each enclosure, labels shall be displayed to provide warning on presence of high voltages in the equipment that may be present when power is off (for example on capacitors).

4.15.1.3 On each enclosure, labels shall be affixed to enclosures to warn of the presence of the multiple sources of power.

4.16 Shipping and Storage

4.16.1.1 Delivery of *BESS* to the La Tourney Solar PV (13.74, -60.96); the *Contractor* is responsible for the transportation to the site including the insurances.

4.16.1.2 The *Contractor* shall provide the necessary preparations and required packaging of the system for transportation.

4.16.1.3 *Contractor* to provide any special instructions for shipping and handling of equipment.

4.16.1.4 *Contractor* to specify short-term and long-term storage requirements.

5. Factory Testing

5.1 Factory Acceptance Testing (FAT)

5.1.1.1 For all *Contractor* equipment either type test or factory test certificates shall be presented according to applicable standard. Provision shall be made to witness testing at the *Contractor*-proposed facility at *LUCELEC*'s/its representative's option. *LUCELEC* or one of its representatives shall witness all test, unless written authority to proceed with the tests in their absence has been received. *LUCELEC* and its representative shall be notified at least two weeks in advance of the commencement of the tests to permit arrangements to be made for the witnessing of the tests.

5.1.1.2 The *Contractor* must prepare a *FAT* plan describing the tests to be completed, procedures and pass/fail criteria by design. The tests to be completed must be aligned with the performance criteria as specified. The *FAT* plan is to be submitted to *LUCELEC* and its representative for review and approval. It is expected at minimum all IEC testing protocols will be included, as well as industry standard testing for batteries, inverters, controls, and Protection and Coordination.

5.1.1.3 The *Contractor* shall advise if there are any training requirements for *LUCELEC* Staff or its representative that must be completed prior to attending the *FAT* testing.

5.1.1.4 *LUCELEC* or one of its representatives shall witness all test, unless written authority to proceed with the tests in their absence has been received.

5.1.1.5 All relevant routine tests shall be performed. Manufacturer shall identify in their *Proposal* which tests will be performed for major equipment. These tests shall include as a minimum:

- Verification of sensors, metering and alarms.
- Verification of all control functions, including automatic, local and remote control.
- Verification of performance criteria.
- Verification of all modes of operation.
- Verification of power system components, including insulation and grounding.
- Communication functionality of all *PCS* system components.
- Simulations of Alarms and Faults

5.1.1.6 The *Contractor* shall provide certified copies of all test data. IEC certification is to be obtained.

5.1.1.7 A *FAT* report is to be submitted to *LUCELEC* and its representative documenting all tests performed. For any items that do not meet the expectations outlined in the pass/fail criteria a corrective action plan must be submitted for approval prior to implementation. Once the changes are approved and implemented, a test report demonstrating compliance shall be submitted to *LUCELEC* and its representative.

5.1.1.8 The *Contractor* is expected to cover all costs associated with the *FAT*, corrective actions and retesting.

5.1.1.9 The *Contractor* to facilitate the connection of *LUCELEC* or its representative's non-invasive monitoring and measurement equipment for data gathering during *FAT* or *Factory Integration Testing (FIT).*

5.1.1.10 The *Contractor* is to propose *FAT* procedures to validate the full system rating. Any limitations on the testing facility should be communicated to *LUCELEC* and its representative with the *Proposal*.

5.1.1.11 The *Contractor* shall provide three paper copies of the *FAT* report and Test Results, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the *FAT* report in Adobe PDF format.

5.1.1.12 The *Contractor* shall record the version of control software and firmware installed on the control and protection equipment throughout the time of the *FAT*. If the *Contractor* deems it necessary to install newer control software during or after the completion and acceptance of the *FAT*, the *Contractor* shall submit a software and software variance report to *LUCELEC*:

- Reason for change

- Details of change
- Potential impacts to other elements of the control and protection Equipment which was not changed
- Details of how the change was validated and tested
- Results of the validation and testing

5.2 Factory Integration Testing (FIT)

5.2.1.1 The objective of the *Factory Integration Testing (FIT)* is to deliver a mostly assembled and tested *ESS* to site, requiring minimum site assembly and site testing. Testing will involve the integration of the complete *ESS* (*BESS* + *PCS*) in addition to interfacing to the *Contractor*'s *EMS*. Given the size of the *ESS*, *LUCELEC* will accept *FIT* testing of a single lineup (*EMS* + 1 *PCS* + 1 *BESS* container). *LUCELEC* and its representative shall be notified at least two weeks in advance of the commencement of the tests to permit arrangements to be made for the participation in the tests.

5.2.1.2 The *FIT* is to be performed immediately after the *FAT* at a *Contractor*-proposed facility and facilitated by the *Contractor*. The *FAT* must be completed before the initiation of the *FIT*.

5.2.1.3 Factory Integration Test Procedures shall be provided by the *Contractor* for *LUCELEC*'s and its representative's input in advance of the commencement of the tests. Test results shall be documented by the *Contractor*.

5.2.1.4 The *Contractor* shall advise if there are any training requirements for *LUCELEC* Staff or its representative that must be completed prior to attending the *FIT* testing.

5.2.1.5 *LUCELEC* or one of its representatives shall witness all test, unless written authority to proceed with the tests in their absence has been received.

5.2.1.6 Testing at the facility will be to simulate actual operating conditions. The testing bay will have sufficient capabilities for all tests including a three phase, 50 Hz power source suitable for the functional tests, as well as adequate control power.

5.2.1.7 As a minimum, the integration testing shall include:

- Communication between the *BESS* and the *PCS*.
- Communication between the *EMS* and the *PCS*.
- Start and Stop of the *BESS*.
- Open loop operation to follow P and Q setpoints from the *EMS*.
- Simulations of Alarms and Faults to the degree possible.

5.2.1.8 Any deficiencies observed during the *FIT* related to the *Contractor*'s equipment must be addressed before being shipped to *LUCELEC*'s location.

5.2.1.9 The *Contractor* is to include the cost for facilities and *Contractor* representatives (including *PCS* and *BESS*) for one week exclusive to *FIT*.

5.2.1.10 The *Contractor* shall provide three paper copies of the *FIT* report and Test Results, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the *FIT* report in Adobe PDF format.

5.2.1.11 The *FIT* Report may be included with the *FAT* Report, if applicable.

5.2.1.12 *LUCELEC* requests the *FIT* testing as an optional service and it should be priced out separately for *LUCELEC*'s review.

6. Site Work

6.1 Installation

6.1.1.1 The factory-assembled system with *Contractor* equipment will be shipped to site and will be installed by the *Contractor* or the *Contractor*'s S*ubcontractor*. Installation will include unloading, placement on foundation, anchoring, reinstallation of any equipment shipped loose, connection to the grounding grid and connection of all cabling.

6.1.1.2 The *Contractor* is responsible of offloading all equipment supplied by the *ESS* scope.

6.1.1.3 The *Contractor* shall install all equipment identified in the scope of work, in locations shown on the applicable layout drawings.

6.1.1.4 The *Contractor* shall prepare an installation and test plan for all equipment installed, which shall be submitted to *LUCELEC* as part of the construction package.

6.1.1.5 Upon completion, the *Contractor* shall provide *LUCELEC* an Installation Report.

6.1.1.6 The *Contractor* shall provide three paper copies of the installation report, each bound in a neat and professional manner complete with dividers and a table of contents. The Contractor shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the installation report in Adobe PDF format.

6.1.2 Installation of Power Conversion System

6.1.2.1 The *Contractor* shall be responsible for the installation of the *PCS*, which includes unloading, placement on foundation, anchoring, connection to grounding grid and connection of all cabling for each container.

6.1.2.2 In the event that any *PCS* equipment is shipped loose, the *Contractor* shall be responsible for the installation of such equipment.

6.1.2.3 The *Contractor* shall be responsible for all low voltage bus work, cables and connections between the *PCS* and the transformers.

6.1.2.4 The *Contractor* shall install all applicable monitoring, metering and indication equipment including fault recording device.

6.1.2.5 The *Contractor* shall install all applicable communications cabling.

6.2 Commissioning Tests

6.2.1.1 All *Contractor* equipment shall be tested on site after installation. The tests shall be used to identify possible damages or changes that have occurred since the *FAT*/*FIT* as well as to verify the field interconnections and interfaces to *LUCELEC*'s equipment and to ensure the suitability of equipment for site energization. The *Contractor* shall include time to participate in commissioning tests.

6.2.1.2 Commissioning test procedures will be provided to *LUCELEC* in addition to any specific Commissioning tests required by *LUCELEC*.

6.2.1.3 The tests shall include:

- Mechanical integrity checks.
- Grounding verification.
- Point to point power and control interconnection verifications to the field wiring.
- Operational tests on devices as required.
- Instrument transformer interfacing tests.
- HVAC system tests.
- Phasing and polarity verification.
- Start and Stop Testing.
- Tests of interlocks.
- Pre-energization inspection and Checklist completion.
- Start-up.
- Hot commissioning tests:
  - Open loop operation to follow P, V, I setpoints.
  - Closed loop operation.

6.2.1.4 Any deficiencies that are identified during commissioning are expected to be remedied by the *Contractor* before system sign off.

6.2.1.5 Upon completion, a Commissioning Report shall be provided by the *Contractor.*

6.2.1.6 The *Contractor* shall provide three paper copies of the commissioning report, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the commissioning report in Adobe PDF format.

6.2.1.7 The commissioning report may be integrated with the installation report, if applicable.

6.3 Site Acceptance Testing

6.3.1.1 After the installation and commissioning of the *ESS* equipment, *LUCELEC* shall conduct *ESS Site Acceptance Tests,* with the co-operation and assistance of the *Contractor*. The requirement and procedures will be specified after the award of contract.

6.3.1.2 The *Site Acceptance Tests* shall include:

- Safe and reliable operation of the system under normal operation and anticipated contingency/fault scenarios.
- Rated power throughput test (MW and Mvar) and performance fine tune.
- Energy cycling performance tests (including efficiency).
- Demonstrate the performance of the ESS to meet the production guarantees (7.5 MW at 0.9 PF (8.4 MVA) discharge for 30 min at the point of connection).
- Special control function tests.
- Protection schemes tests.
- ESS can perform all use cases outlined in the RFP.
  - Respond to PQ setpoints from LUCELEC System Operations
  - Respond to a frequency deviation on the grid based on its configured deadband and droop curve
  - Respond to a voltage sag/deviation on the grid based on its configured deadband and droop curve
  - Provide reactive power to the grid based on PQ setpoint from LUCELEC Operations
  - Initiated blackstart of the grid, including self-energizations, energization of the switching station, and energization of the underground distribution connection to Vieux Fort Substation.

6.3.1.3 A minimum of 3 months of compliant operation with system availability of > 98% is required to complete *Site Acceptance Testing*.

6.4 LUCELEC Staff Training

6.4.1.1 The *Contractor* shall provide Training to *LUCELEC*'s staff, both engineering and operations and maintenance staff, to the level that is sufficient for operation and maintenance of the system.

6.4.1.2 The *Contractor* shall define the training agenda for engineering, operations and maintenance staff along with the duration of training as *LUCELEC* will need to make personnel available. The agenda will be expected to be different for the various levels of *LUCELEC* personnel.

6.4.1.3 The *Contractor* shall also define the classroom size for the training.

6.4.1.4 The *Contractor* shall also provide detailed routine maintenance plan and instructions for *LUCELEC*'s staff to complete the day to day operation and maintenance.

6.4.1.5 A draft of the Operation and Maintenance Manuals shall be delivered to *LUCELEC* for review, prior to training. The *Contractor* shall subsequently update and revise the Operation and Maintenance Manual, when and as necessary.

6.4.1.6 Three paper copies and an electronic copy of all training material including the Operation and Maintenance Manuals, shall be provided as part of project turnover package

6.4.1.7 Each member of *LUCELEC* Personnel shall be provided with all Training Materials and the Operation and Maintenance Manuals.

6.4.1.8 All training costs are part of the fixed price and borne by the *Contractor.*

6.4.1.9 The *Contractor* shall provide Training to the local fire department to manage any fire relating the *PCS* or *BESS*.

6.5 Asset Management

6.5.1.1 The *Contractor* shall assist *LUCELEC* with asset criticality ranking for Asset Management Planning.

6.5.1.2 The *Contractor* shall provide any requested information to be entered into *LUCELEC's* Enterprise Asset Management System (completion of *LUCELEC* data sheets to be provided to selected *Contractor*).

6.5.1.3 The *Contractor* shall provide a compiled list of all maintenance tasks and activities, and their frequency for the entire system to *LUCELEC*.

7. Performance and Maintenance

7.1.1.1 The equipment will be installed as part of a 20-year project. It is expected that no interventions are required on the system provided it is maintained as per the recommended annual maintenance schedule and operated within its normal operating parameters.

7.1.1.2 All enclosures, auxiliaries, and controls are expected to last for the project life.

7.1.1.3 The *Contractor* shall indicate if the control system (*BMS, PCS* controls, *EMS,* and any other system controls) is forward compatible with any augmentation plan. The *Contractor* shall indicate any foreseen concerns with this future compatibility if a battery augmentation plan is proposed. The *Contractor* shall indicate any foreseen additional upgrades that may be required if a battery augmentation plan is proposed.

7.1.1.4 The *Contractor* shall provide a detail O&M manual as well as detailed lock out procedures for the equipment. The *Contractor* shall provide three paper copies of the manual and lock out procedures, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB

or another suitable method (as approved by *LUCELEC*) of the O&M Manual and Lock Out Procedure in Adobe PDF format.

8. Spare Parts

8.1.1.1 The *Contractor* shall evaluate its design with regard to failure rates, effects and system reliability.

8.1.1.2 The *Contractor* shall provide a recommended spare including, part number, supplier, location, prices and availability. Recommended list should consider the site is on an island and resultant delivery time of spares; this may differ from spare parts recommendation for a site on mainland.

8.1.1.3 The *Contractor* shall identify any spare parts that require configuration.

8.1.1.4 The *Contractor* shall indicate the storage requirements for the spare parts. The *Contractor* shall indicate the mass and dimensions of all spare parts.

8.1.1.5 The *Contractor* shall identify any special tools required for installation of spare parts recommended.

8.1.1.6 The *Contractor* shall identify if any of these tools are proprietary.

8.1.1.7 The *Contractor* shall advise *LUCELEC* of any planned obsolescence in the *PCS* components, including the inverter modules during the project life. In this situation, the *Contractor* shall offer provisions for *LUCELEC* to purchase suitable spares to reach the end of project life.

8.1.1.8 The *Contractor* shall identify if any local/regional spare parts inventories can be accessed and, if so, what inventory is available in what time duration.

9. Contractor Data and Documentation Requirements

9.1 Information to be Supplied with the *Proposal*

9.1.1.1 The *Contractor Proposal* for *PCS* equipment shall include the following information at a minimum:

- Completed *Contractor* submission.
- Manufacturing and delivery schedule including major milestones and equipment delivery, as well expected duration for site work.
- Detailed description of *Contractor* scope of supply complete with equipment datasheets in reference to this Specification, including the description of equipment design, control system, operation and special features.
- Detailed description of all included protection systems including voltage unbalance, surge protection, overvoltage, overcurrent and ground fault.

- All applicable datasheets, technical specifications, and manuals for any equipment supplied
- Meantime between failure of converter modules and service process.
- Detailed description of all disconnecting means, indicating lights and E-stop.
- Physical layout, required clearances around equipment, dimensions and weights of major equipment including any take-over points.
- *PCS* auxiliary power and energy requirements. Estimated auxiliary consumption during idling, charging and discharging.
- Integrated *PCS* control system detailed description complete with control architecture drawing.
- Information on HVAC system and system behaviour upon partial or complete loss of cooling/heating.
- Description of the civil and electrical interconnection requirements for site installation;
- Description of the *PCS* maintenance requirements including anticipated equipment replacement.
- Preliminary Single Line Diagram.
- Major Equipment List/Bill of Materials, including identification of the manufacturer, model, type, ratings and number of all major components.
- Cooling Load and operating losses from the equipment.
- Serviceability access details for *PCS* equipment.
- Statement on compliance and certification with respect to the standards referenced herein.
- Warranty information.
- Inverter Product Roadmap/Development Plan
- Data system Architecture
- Description of decommissioning requirements.

9.2 Information to be Supplied After Award

9.2.1.1 After the award the *Contractor* shall supply full documentation. Documentation shall be sufficient for the integration of the *PCS* system into *LUCELEC*'s power system and shall be supplied in a timely manner as described in the table below.

9.2.1.2 The *Contractor* shall be responsible for sealing all issue for construction or final drawings with an APESL (Association of Professional Engineers of St. Lucia) seal.

9.2.1.3 All Drawings shall be supplied in PDF and AutoCAD files (preferred AutoCad 2010 files if possible).

9.2.1.4 Three paper copies and an electronic copy of the following documentation will be provided:

- *FAT* and *FIT* Report
- Installation and Commissioning Report
- Operation and Maintenance Manual
- Detailed Lock-out Procedures
- Issue for Construction and As Built Drawing Package.

9.2.1.5 Paper copies of any Documentation shall be printed on, and/or electronic copies of any Documentation shall be formatted for, standard sized paper, which is limited to the following dimensions:

- Letter: 8 ½" x 11";
- Drawings: A1 or 11" x 17"

Table 6 Documents and Drawings Required

	ITEMS	INFORMATION	30%	60%	90%	IFC
1	DRAWING AND DOCUMENT SUBMISSION REGISTER C/W SCHEDULE OF SUBMISSIONS	x	x	x	x	x
2	ENGINEERING, PROCUREMENT & MANUFACTURING CONTROL SCHEDULE (LEVEL 3)	x	x	x	x	x
3	GENERAL ARRANGEMENT DRAWING INCLUDING OUTLINE DIMENSIONS, CLEARANCES, CABLE ENTRY LOCATIONS AND FOUNDATION/MOUNTING REQUIREMENTS,		x	x	x	x
4	CROSS SECTION WITH PARTS DESCRIPTION			x	x	x
5	BILL OF MATERIALS ITEMIZED PARTS LIST FOR SCOPE OF WORK			x	x	x
6	SHOP FABRICATION AND ASSEMBLY DETAIL DRAWINGS			x	x	x
7	SINGLE LINE DIAGRAM, SCHEMATICS, TERMINAL WIRING DIAGRAMS, AND P&ID DRAWINGS		x	x	x	x
8	NAMEPLATE DRAWING AND DETAILS			x	x	x
9	EQUIPMENT DATA SHEET			x	x	x
10	DESIGN CALCULATIONS			x	x	x
11	ANCHORAGE AND LOADING DIAGRAMS (STATIC AND DYNAMIC)			x	x	x
12	CONTROL SYSTEM DESCRIPTION		x	x	x	x
13	COMMUNICATION INTERFACE MAP		x	x	x	x
14	LIST OF FAULTS AND ALARMS		x	x	x	x
15	PROTECTION & CONTROL FOR BESS			x	x	x
16	PROTECTION SYSTEM PARAMTERS AND SETTINGS			x	x	x

	ITEMS	INFORMATION	30%	60%	90%	IFC
17	LIST OF SPECIAL TOOLS RECOMMENDED FOR ERECTION, TESTING, AND MAINTENANCE	x				
18	LIST OF SPARE PARTS RECOMMENDED DURING COMMISSIONING WITH PRICES	x				
19	LIST OF RECOMMENDED SPARE PARTS FOR TWO YEARS OF	x				
20	COMPLETE PARTS LIST INCLUDING SELLER'S AND ORIGINAL MANUFACTURER'S PART NUMBER	x				
21	FACTORY TEST PROCEDURES (FAT/FIT)				4 Weeks Before Testing Starts	
22	EQUIPMENT TEST CERTIFICATES					2 Weeks after Test Completion
23	FACTORY TEST REPORTS					2 Weeks after Test Completion
24	SITE TEST, COMMISSIONING & START-UP PROCEDURES				4 Weeks Before Testing Starts	
25	SITE TEST, COMMISSIONING & START-UP REPORTS					2 Weeks after Test Completion
26	PACKING LIST C/W SIZES, WEIGHTS AND SPECIAL HANDLING INSTRUCTIONS	4 Weeks Before Shipping				
27	INSTALLATION, OPERATION AND MAINTENANCE MANUALS	4 Weeks Before Shipping				

9.2.1.6 The *Contractor* shall indicate if the proposed submission and review schedule allows for delivery within the needed timeline.

9.2.1.7 The *Contractor* shall submit drawings for review by *LUCELEC* and its representative in a timely fashion. Submission dates of drawings and documents required for manufacturing shall be at least 4 working weeks before the start of manufacturing or ordering parts such that there are at least 2 weeks of review time for *LUCELEC* /its representative followed by 2 weeks for *Contractor* to respond to changes if necessary.

9.2.1.8 Where electronic files are required, the *Contractor* shall submit the files in PDF format unless otherwise noted.

9.2.1.9 Drawings and documents submitted to *LUCELEC* and its representative will be stamped and returned to indicate review results. The stamp will be marked with one of the following results. *Contractor* shall submit drawings marked "For Construction" after receipt of their drawings from *LUCELEC* or its representative noted "Code 1" or "Code 2".

- **Code 1** "Proceed, No Exception Taken" – This indicates that the *Contractor* may proceed.

- **Code 2** "Proceed, with Exceptions as Noted and Re-submit" – This indicates that the *Contractor* may proceed after actioning the exceptions. The *Contractor* may proceed before re-submitting.
- **Code 3** "Do not Proceed, Revise as Noted and Re-submit" – This indicates that significant changes are required as noted on the drawing or document and the *Contractor* is to re-submit after changes or corrections are made. When drawings or documents are returned with Code 3, the *Contractor* shall make the necessary corrections required by *LUCELEC* or its representative, consistent with the Purchase Order and shall submit revised drawings or documents to *LUCELEC* and its representative for review.
- **Code 4** "Information Only" - This indicates that the submittal was for information not review and no response is required from *LUCELEC* or its representative.

9.2.1.10 Drawings and documents shall be re-submitted for review if the *Contractor* revises them after they were sent for review by *LUCELEC* and its representative.

9.2.1.11 *LUCELEC* and its representative's review of drawings will be for general design only and shall not relieve the *Contractor* from responsibility for deviations from drawings and specifications, unless the *Contractor* has in writing called *LUCELEC* and its representative's attention to such deviations at the time of submission and secured written approval of the deviation, nor shall it relieve the *Contractor* from responsibility for errors in shop drawings.

9.2.1.12 *LUCELEC* or its representative shall approve drawings before start of manufacturing. Approval of the *Contractor*'s drawings, by *LUCELEC* or its representative, shall not relieve the *Contractor* of the responsibility for the correctness thereof, nor for the results arising from errors or omissions, nor any fault or defects, nor for the failure in the matter of guarantee which may become evident during erection or subsequent operation.

9.2.1.13 The *Contractor* shall submit all final design and record drawings in digital form.

9.2.1.14 For all *Contractor* equipment either type test or factory test certificates shall be presented per applicable standard.

9.2.1.15 All documents shall be in English language.

END OF SECTION