

## Schedule A

### Standard Specification

### Battery Energy Storage System (BESS)

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Battery Energy Storage System (BESS)

St. Lucia Electricity Services Ltd.: Energy Storage System  
Vieux Fort, St. Lucia

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## 1. General

1.1.1.1 This document shall be read as part of a complete Specifications package including *St. Lucia Electricity Services Ltd. (LUCELEC)* documents and other technical appendices:

- *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 will be used for this Specification:

- 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 grounding grid, and connection of all cabling), and commissioning of quantity of one fully integrated (1) *Battery Energy Storage System (BESS)* to be used as part of a new *Energy Storage System (ESS)* to be installed in Vieux Fort, St. Lucia, beside the La Tournay Solar PV. This Specification provides the technical requirements for the *BESS*. The corresponding Battery *PCS* requirements are the subject of a separate Technical Specification, *Schedule B - Power Conversion System (PCS) Specification*.

- 1.1.1.4** The work called for is subject to the purchase order documents. They include the 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 *ESS* design. Any areas of the *ESS* 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**

- 2.1.1.1 The *BESS* shall comply with all applicable local regulations and codes for the local jurisdiction in which the *BESS* 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 electrical assemblies or sub-assemblies shall also bear such certification. All *BESS* subsystems shall either be listed or be field evaluated for installation in the St. Lucia by an approved agency.
- 2.1.1.3 *Proponents* shall clearly indicate in their *Proposals* the standards which the requested equipment meets. *Proponents* 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 *BESS* components, it is preferred that *Proponent* comply with any applicable *LUCELEC* requirements when possible. However, should complying with these requirements for the *BESS* lead to considerable added costs, *Proponents* may take exception. *Proponents* 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 regulations:
- International Electrotechnical Commission (IEC).
  - UK Electrical Industry British Standards (BS)
  - IET Wiring Regulations BS 7671:2018 OEGS 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
  - EN 50549-1: Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B
  - EN 50549-2: Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a MV distribution network - Generating plants up to and including Type B
  - 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
  - ISO 9001, QS 9000 and ISO 14000 (for manufacturing plants).
- 2.2.1.2 The ESS shall have a CE mark.
- 2.2.1.3 Battery cells shall be listed under **IEC 62619** – Secondary Cells and Batteries containing alkaline or other non-acid electrolytes – Safety Requirements for Large format Secondary Lithium Cells and Batteries, for use in Industrial Applications and **IEC 62620** - Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications
- 2.2.1.4 Battery shall be listed under **IEC 62485-1**, Safety requirements for secondary batteries and battery installations – Part 1: General safety information, **IEC 62485-2**, Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries, and **IEC 62485-5** Safety requirements for secondary batteries and battery installations - Part 5: Safe operation of stationary lithium-ion batteries.

- 2.2.1.5 The *ESS* system shall be compliant to **IEC 62933 – 5-1**: Safety considerations for grid-integrated *ESS* systems and **IEC 62933 – 5- 2**: Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based system
- 2.2.1.6 *Proponents* shall indicate the degree of compliance of the *ESS* system to **IEC 62897**: Stationary Energy Storage Systems with Lithium Batteries – Safety Requirements.
- 2.2.1.7 *Proponents* shall indicate the degree of compliance of the *ESS* system to **IEC 63056:2020**: Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems
- 2.2.1.8 *Proponents* shall indicate the degree of compliance of the *ESS* system to NFPA 855 shall be indicated in the *Contractor's Proposal*.
- 2.2.1.9 The *Contractor* is responsible for any on-site certification or other inspection requirements, if required.
- 2.2.1.10 *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 BESS Materials and Work Included

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

**Table 1 BESS Scope of Supply**

Item	Qty	Deliverable Brief Description
		<b>MATERIAL</b>
1.	1 lot	Fully assembled <i>Battery Racks</i> consisting of a number of parallel strings, each string comprising of a number of <i>Battery Modules</i> , and each module formed by Lithium-Ion battery cells to meet the power and energy requirements specified herein.
2.	1 lot	<i>Battery Management System (BMS)</i> systems including communication interface to the battery <i>PCS</i> .
3.	1 lot	Bipolar DC Bus Circuit Breaker or fused disconnect.
4.	1 lot	Local monitoring panel and remote supervision equipment.
5.	1 lot	Climate-Controlled Container(s) within which all components are integrated together with all the wiring interconnections inside the containers
6.	1 lot	Auxiliary Power and communication interfaces to <i>LUCELEC</i> field equipment per container.
7.	1 lot	Uninterruptible Power Supply
8.	1 lot	Thermal Management System for each container.
9.	1 lot	Fire detection and suppression system per container. Flammable gas detection system and management system.
10.	1 Lot	Special Equipment Any components not explicitly referenced within this Specification, but necessary for the safe and automated operation of the equipment.
11.	1 Lot	Hardware, special tools, gaskets, sealants, shims and all nuts and bolts required for field assembly and erection.
12.	1 Lot	Commissioning and Operating Spare parts for two (2) full years of operation as recommended by the <i>Contractor</i> .
		<b>SHIPPING</b>
13.	1 Lot	Packaging and Shipping to the La Tourney Solar PV farm in Vieux Fort, St. Lucia; the <i>Contractor</i> is responsible for the transportation to the site including all necessary insurances. The <i>Contractor</i> must also provide the necessary preparations and required packaging of the system for transportation.
		<b>ENGINEERING</b>
14.	1 Lot	Documentation The <i>Contractor</i> is to provide engineering drawings and documentation on scope of supply. Including, as applicable: <ul style="list-style-type: none"> <li>• Installation drawings.</li> <li>• Interconnection Drawings.</li> <li>• Electrical and Schematic Drawings.</li> <li>• Preliminary Site Layout</li> <li>• General Arrangement Drawings.</li> </ul>

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Item	Qty	Deliverable Brief Description
		<ul style="list-style-type: none"> <li>• Preliminary Electrical Layout</li> <li>• Electrical Single Line Diagram</li> <li>• Cable Schedules.</li> <li>• Installation and Operation Manual.</li> <li>• Maintenance Manual and Schedule.</li> <li>• Bill of material/Major Equipment List</li> <li>• Operating Software.</li> <li>• Software Architecture and Control logic.</li> <li>• As-built Drawings</li> </ul> <p>The <i>Contractor</i> shall be responsible for sealing all issue for construction or final drawings with an APESL (Association of Professional Engineers of St. Lucia) seal.</p>
15.	1 Lot	Specification of all <i>LUCELEC</i> Supplied materials, such as cables, for completing interconnections of <i>Contractor</i> supplied equipment.
16.	1 Lot	Certifications for <i>BESS</i>
<b>TESTING</b>		
17.	1 Lot	<i>Factory Acceptance Test (FAT)</i> plan to be submitted to <i>LUCELEC</i> and its representative for approval.
18.	1 Lot	A <i>Factory Acceptance Test (FAT)</i> must be completed at a facility of the <i>Contractor's</i> choosing before any equipment is shipped. The tests must be designed to prove compliance with all the Specifications described herein. A detailed <i>FAT</i> report must be provided to <i>LUCELEC</i> and its representative. <i>LUCELEC</i> or its representative may elect to witness the <i>FAT</i> .
19.	1 lot	<p><i>Factory Integration Test (FIT)</i> between the <i>BESS</i> and battery <i>PCS</i> and together with the <i>Contractor's Energy Management System</i>. The <i>Contractor</i> should allocate 1 week for the <i>FIT</i>. <i>LUCELEC</i> or its representative may elect to witness the <i>FIT</i>.</p> <p><i>FIT</i> should be offered as an optional service and priced out separately for <i>LUCELEC's</i> review.</p>
<b>SITE WORK</b>		
20.	1 lot	Installation of all <i>Contractor</i> supplied equipment.
21.	1 lot	Pre-Commissioning, Commissioning and Start-up of supplied equipment.
22.	1 lot	<i>BESS Site Acceptance Testing</i> to be completed at site to demonstrate <i>BESS's</i> capabilities with respect to the Specifications described herein. The <i>Contractor</i> is to assume a minimum of two days of site assistance to conduct <i>BESS</i> site acceptance tests.
23.	1 lot	<p>Operation and Maintenance Training and Documentation</p> <p>The <i>Contractor</i> must prepare operation manual for <i>LUCELEC</i> and provide training for <i>LUCELEC's</i> staff (both engineering and operations staff). The <i>Contractor</i> is to assume a minimum of one week of site training.</p> <p>The <i>Contractor</i> shall also provide documentation on recommended fire fighting strategies and plan to have a training session with the local fire department.</p>

## 4. Ratings and Functional Requirements

### 4.1 General

- 4.1.1.1 The *BESS* shall have the guaranteed ratings specified in Table 2 as a minimum and throughout the entire *BESS Calendar Life*. These ratings are considered for the *ESS* as a whole, measured at the contractual metering point at the scope of work battery limit.
- 4.1.1.2 The *BESS* shall be designed to have at minimum two fully redundant parallel systems, each with a 3.75 MW rating (accounting for losses). Each system shall have a discharge duration of 30 minutes (1.875 MWh), accounting for losses, serving the *ESS* auxiliary loads, and discharge limitations. 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 *Contractor* shall provide technical details on the battery cells and *Battery Modules* proposed in its *Proposal*. This information should be provided from the battery cell manufacturer (if different from the *Contractor*).
- 4.1.1.5 The *Contractor* shall account for losses in the *PCS* and the step-up transformer components and auxiliary loads in rating the *BESS* discharge power and energy capacity.

**Table 2 BESS Major Guaranteed Equipment Ratings**

Item	Total Rating
Rated Continuous Discharge Power (MW) at the <i>DC Bus</i> net of losses in the in <i>PCS</i> , Step-up Transformer, and auxiliary load	7.5 MW + losses
Rated Dischargeable Energy Capacity <sup>1</sup> [min] from maximum dischargeable SOC to minimum dischargeable SOC at rated continuous discharge power considering losses and auxiliaries (considering the duty cycle and life considerations stated herein)	30 minutes
Rated Continuous Charge Power (MW)	7.5 MW + losses

<sup>1</sup>The Dischargeable Energy Capacity is defined as the available energy that the complete ESS can store and produce at the contractual metering point, at the end of 20 years, given the duty cycle stated herein and the use case of the system.

The Contractor may propose a 20 year solution, with sufficient overbuild to accommodate 20 years of degradation, or a 10+ year solution, with sufficient overbuild to accommodate 10 years of degradation, and with augmentation in Year 10 or later to accommodate the remaining degradation over the next 10 years. The Contractor shall propose its preferred solution. If an augmentation plan is selected, the Contractor shall provide a detailed description on how the augmentation strategy is provisioned for in the initial design.

The Duty Cycle is defined in Section 4.2.2.

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Item	Total Rating
Discharge duty at contractual metering point	Approx. 680 - 1,370 MWh per year (approximately 182-365 cumulative cycles)
Target/Resting <i>State of Charge</i>	80-85%

- 4.1.1.6 A calculated time-series data of the example discharge and charge power values for the *BESS* is available and can be provided to the *Proponents* upon request.
- 4.1.1.7 In all *BESS* operating modes, the system shall be capable of being charged or discharged at power levels anywhere from 0 to 100% of the rated charge and discharge power, respectively.
- 4.1.1.8 The *Contractor* shall advise if there is any de-rating of the discharge capabilities below a certain *SOC*.
- 4.1.1.9 The *Contractor* shall advise if there is any de-rating of the charging capabilities above a certain *SOC*.
- 4.1.1.10 In all *BESS* operating modes, and the system shall be capable of being discharged or charged at the rated continuous power levels throughout the entire range of maximum dischargeable *SOC* to minimum dischargeable *SOC*. The *Contractor* is to advise if there are any price reductions possible by limiting the charge power at high *SOC* levels.
- 4.1.1.11 The *Contractor* is to advise the maximum allowable *SOC* range for operation.
- 4.1.1.12 The *Contractor* is to advise the recommended *SOC* operating range to maximize lifespan of the battery and reduce cycle associated degradation.
- 4.1.1.13 The *Contractor* is to advise the recommended range of the *SOC* during resting/idling to manage performance and minimize calendar aging. *LUCELEC* has set a current resting *SOC* of 80-85%; however, is open to adjustment of this setting to increase the lifespan, as long as the *BESS* functionality is not impacted.
- 4.1.1.14 *LUCELEC* shall have the capability to adjust the resting *SOC* of the *BESS* as desired, depending on operation, through the *HMI*. The *Contractor* shall advise the impact on *Calendar Life* or impact on the warranty or capacity retainment agreement.
- 4.1.1.15 The *BESS* must be capable of supporting the *DC Bus* when the inverter requests a 0-100% power draw that could occur with a rise time of 100 ms.
- 4.1.1.16 The *Contractor* shall indicate, both graphically and with a table, the ramp rate capacity of the battery in charging and discharging mode.
- 4.1.1.17 The *ESS* must be capable of completely automatic and unattended operation.

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- 4.1.1.18 Routine maintenance on the *BESS* will be performed by *LUCELEC*'s staff. As such the *BESS* design, must allow for easy access to all areas requiring regular maintenance. The *Contractor* should provide a manual for routine maintenance with detailed information, steps (and instructions) to complete and recommended schedule.
- 4.1.1.19 The *Contractor* shall have overall responsibility for the safety of the *ESS* design. Any areas of the *ESS* that pose a risk to the environment, personnel, or *LUCELEC*'s assets are to be clearly communicated to *LUCELEC* and its representative.
- 4.1.1.20 The *Contractor* supply shall include all components and accessories as required for the proper and safe operation of the complete system.
- 4.1.1.21 The *BESS* shall have a DC round-trip efficiency of > 90% when charged and discharged at 2 C (7.5 MW). The *Contractor* to indicate the efficiency of the system at the rated discharge and charge power levels and any degradation thereof as battery system ages.
- 4.1.1.22 The *ESS* shall have an AC round-trip efficiency of >85% (measured at the inverter's AC terminals) when charged and discharged at 2 C (7.5 MW). The *Contractor* to indicate the efficiency of the system at the rated discharge and charge power levels and any degradation thereof as battery system ages.
- 4.1.1.23 The *Contractor* shall indicate the degradation of the battery system as it ages based on cycles as a function of *Depth of Discharge*, temperature, as well as charge and discharge C-rate.
- 4.1.1.24 The self-discharge rate of the *BESS* shall be less than 5% per month. The *Contractor* is to indicate if the self-discharge rate changes with aging.
- 4.1.1.25 The *Contractor* shall provide a list of all auxiliary equipment per container and the consumption. The *Contractor* shall estimate the auxiliary load/station services per container and for the entire system during charging, during discharging, and during idling.
- 4.1.1.26 The *BESS* design must allow for easy replacement and access to the *Battery Modules* for maintenance.
- 4.1.1.27 Safety policy/features must be specified in the control and operation philosophy under normal operation and under emergency situations. Clear safety instructions must be provided to *LUCELEC* /Operators for safe handling of the *Contractor*'s equipment.
- 4.1.1.28 The *Contractor* must provide a description of all failure modes, failure impacts, and the fail-safe philosophy and explain the safety principles and implementation scheme for each component of the Battery system.
- 4.1.1.29 Emergency Response procedures must be provided by the *Contractor*, detailing the recommended strategy to fight a battery fire, to resolve gassing events, to manage a thermal runaway event, and the necessary PPE for the Fire Fighters.
- 4.1.1.30 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 Duty and Availability

- 4.2.1.1 The *BESS* shall consist of units that are part of the *Contractor's* standard product line which will continue to be supported for the life of the project. Preference will be given to *Proponents* that have demonstrable capability in supporting the *BESS* through its lifetime.
- 4.2.1.2 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.
- 4.2.1.3 The Battery Cells shall have a *Calendar Life* of a minimum of 10 years, and up to 20 years. The remaining components (container, *BMS*, thermal management system, etc.) shall have a *Calendar Life* of a minimum of 20 years. The *Contractor* should provide details on a replacement/augmentation plan for the cells after they reach their *End of Life (EOL)*, if they do not meet the 20-year requirement.
- 4.2.1.4 The *BESS* will have an availability of 98% or higher at full system capacity.
- 4.2.1.5 The dischargeable energy capacity value shall be warranted, at a minimum, for the first 10 years of operation of the battery, given a cumulative discharge of 680 – 1,370 MWh per year, under the stated duty cycle, without the need for refurbishment of *Battery Modules*. If possible, the *Contractor* shall indicate the price added for discharge capacity warranty for 15 years of operation and for 20 years of operation.
- 4.2.1.6 The *Contractor* shall indicate the *End of Life (EOL)*, in years, of the *BESS* battery cells (*EOL* defined as when system capacity drops to less than 30 minutes at rated power). If the *EOL* is less than 20 years project life at the specified yearly duty cycle, the *Contractor* shall include proposals indicating the cost structure and strategy to update/replace the *BESS* capacity for the remainder of the project life.
- 4.2.1.7 The *Contractor* shall indicate the preferred resting *State of Charge* of their battery cells to maximize lifespan.
- 4.2.1.8 The *Proponent* is to clearly state in its *Proposal* the duty cycle limitations of the *BESS* in terms of number of full power, full depth charge and discharge cycles per day and the period of downtime between them, and the duty cycle effect on the life of *BESS*.

### 4.2.2 Duty cycle

- 4.2.2.1 The *BESS* shall perform the following Duty Cycle:
- The *BESS* will support *LUCELEC* to manage grid stability, allow integration of new renewable generation and support optimized operation of the diesel generation fleet.
  - The Primary Use Case *ESS* will used to provide backup power/supplementary operating reserve during sudden downturns of thermal generation or load increases. This will allow *LUCELEC* to operate its engines at higher loading and carry operating Reserve on the *BESS*. This use case is to be used for bridging during the time it takes to start a diesel

genset, which is typically approximately 10 min. For reliable operation, the *BESS* should retain 30 min of operating reserve.

- The *BESS* will also be requested to respond to low or high frequency (up to 1.5 Hz deviation) to reduce grid instability. In low frequency events, the *BESS* would be used to reduce the need (or prevent load shedding). In high frequency events, the *BESS* would charge to act as a load if a major load/transmission line was lost, to absorb excess generation until it can be ramped down safely. *LUCELEC* shall be capable of setting and adjusting the dead band on the frequency response.
- Additionally, the *BESS* will be used to provide voltage support and reactive power support occasionally, if required.
- The *BESS* should be capable of self-energizing and leading the blackstart of the grid after an outage or for load restoration.
- The estimated usage of the *BESS* is 680 -1,370 MWh per year depending on the number of events (outages, operating reserve events, outage events, and grid stability, etc.) The cumulative cycling will be between 180-356 cumulative cycles per year (0.5 – 1 cycle per day). In reality the operation will consist of many shallow charge/discharge cycles where the *BESS* is only discharged/charged for short periods or is discharged/charged below its rated power for extended periods.
  - ◆ For the *Proposal*, sizing should be done assuming 1,370 MWh per year (1 cycle per day) of discharged energy.
- The planned resting *State of Charge* is between 80-85% of the 3.75 MWh of usable energy.

4.2.2.2 A calculated time-series data of the example discharge and charge power values for the *BESS* is available and can be provided to the *Proponents* upon request.

4.2.2.3 The Contractor shall model the anticipated degradation for the *BESS* based on the duty cycle for each year over a 20-year period.

- Augmentation is acceptable and should be included in the degradation curve if the Contractor elects to perform augmentation over the 20-year period.

### 4.3 Data Access Requirements

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

- Battery - Rack Level
  - ◆ Cell Voltage (Minimum, Maximum, and Average across the rack)
  - ◆ Cell Current (Minimum, Maximum, and Average across the rack)
  - ◆ Cell Temperature (Minimum, Maximum, and Average across the rack)
  - ◆ Rack Status
  - ◆ Min SOC (Minimum in the rack)
  - ◆ Max SOC (Maximum in the rack)

- ◆ Max Charging Current (Maximum rack charging current)
- ◆ Max Discharging Current (Maximum rack discharging current)
- ◆ String Statuses
- ◆ Faults/Alarms
- Battery - Lineup Level
  - ◆ Instantaneous discharge current limit
  - ◆ Instantaneous charge current limit
  - ◆ Lineup *DC Bus* Voltage
  - ◆ Lineup Measured DC Current
  - ◆ *State of Charge*
  - ◆ State of Health
  - ◆ Enclosure Humidity
  - ◆ Enclosure Temperature
  - ◆ Lineup Status
  - ◆ Contactor Status
- Point of Interconnection
  - ◆ Voltage
  - ◆ Current
  - ◆ Frequency
  - ◆ Active/Reactive/Total Power
  - ◆ Power Factor
  - ◆ Overall *State of Charge* (MWh/%)
  - ◆ Overall State of Health (%)
  - ◆ Availability (%)

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

#### **4.4 Battery Racking System**

4.4.1.1 The *Battery Racks* shall comprise of parallel strings consisting of *Battery Modules* connected in series. Each *Battery Module* comprised of a combination of Lithium-Ion battery cells

4.4.1.2 The *Battery Rack* system design must allow for easy replacement and access to the battery modules for maintenance The *Contractor* shall advise if there is any supplemental equipment required to remove *Battery Modules*.

- 4.4.1.3 The *Battery Rack* system should be designed to prevent propagation of fire or thermal runaway between the *Battery Racks*.

## 4.5 Enclosures

- 4.5.1.1 The *BESS* shall comprise of two or more weather-proof containers that completely house all components. The enclosure of each container shall be rated to IP 54/NEMA 3R or better painted steel container, free-standing with lockable hinged doors.
- 4.5.1.2 Container/building construction shall comply with requirements stated in *Schedule G-Containerized Building Requirements*.
- 4.5.1.3 The equipment within the container shall be enclosed in NEMA 1 or better painted steel enclosures.
- 4.5.1.4 Normal day-to-day operation of the battery shall be with all enclosure doors closed. Door opening shall only be required for performing system maintenance by authorized personnel.
- 4.5.1.5 Within each container the equipment shall be preferably serviceable by front access only. The *Contractor* is to indicate any deviations from this in its *Proposal*.
- 4.5.1.6 The *Contractor* is to indicate its standard paint colour for *LUCELEC*'s approval.
- 4.5.1.7 The *Contractor* should also indicate the added cost to paint the containers to match *LUCELEC*'s colour and add *LUCELEC*'s Logo.
- 4.5.1.8 The enclosure design shall be designed with materials that are generally low maintenance or maintenance free.
- 4.5.1.9 If the *BESS* is located in the same container as the *PCS*, there shall be a one (1) hour fire wall separating the two sections.

## 4.6 Uninterruptible Power Supply

- 4.6.1.1 The *Contractor* shall supply an *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/Gas Detection and Suppression System.
- 4.6.1.2 *UPS* Batteries shall have sufficient capacity to provide full rated output from its inverter for a period of 4 hours.

- 4.6.1.3 The inverter shall consist of a solid-state switching device that converts *UPS* 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.

## 4.7 Thermal Management System

- 4.7.1.1 Each *BESS* container must include a thermal management system required to regulate the environment around the batteries for exterior ambient air temperature for the range of 21 to 40 degrees Celsius, for operations. Temperature, humidity and other atmospheric characteristics are to be controlled within the safe operating range of the *BESS*, and within the range where the battery life is maximum.
- 4.7.1.2 The thermal management system will include insulation in the walls, roof, and floor of the containers, as well as an automatically controlled HVAC system for all containers.
- 4.7.1.3 Each sub-system of the *ESS* shall be self-protecting in the event of the failure of any other component (i.e., the *BESS* shall be able to maintain temperature in the event of failure of the *EMS* or *PCS*).
- 4.7.1.4 The *Contractor* shall indicate the behaviour of the system upon partial or complete loss of cooling or heating. The *BESS* shall be self protecting against failure of the heating or cooling system and temperature rise or fall. The *BESS* and battery cells shall survive upon complete loss of cooling system that will bring the temperature inside the container to the ambient temperature outside the container (an extreme of +40 degrees Celsius).
- 4.7.1.5 The *Contractor* is to provide the rated interior temperature range of the system and the details of thermal management system in its *Proposal*.
- 4.7.1.6 The thermal management system shall be powered by an auxiliary electrical supply over the full temperature range. Alternate external heat sources are not available and combustible energy sources will not be accepted. The *Contractor* is to state the max amperage requirements of the electrical supply voltage for thermal management system and the power consumption of the thermal management system under the range of design ambient temperature for operation at full load and no load (idling).
- 4.7.1.7 The thermal management system status shall be reported to *BESS* control system and available for monitoring by the *Contractor's EMS* and *HMI*, and the *LUCELEC System Control Center (SCC)*.

## 4.8 Fire Protection and Safety

- 4.8.1.1 The *Contractor* should indicate the degree of compliance to UL 9540 A and NFPA 855 and identify the deviations of its system from these standards.
- 4.8.1.2 Each *BESS* container must be equipped with a fire detection and suppression system and any other safety related systems specific to the battery cells, as specified by the related standards and local codes.

- 4.8.1.3 Each *BESS* container shall be separated from each other and from other equipment in accordance with applicable fire protection standards.
- 4.8.1.4 The system shall audibly alarm and automatically shut-down the *BESS* upon detection of smoke/heat. In addition, the fire system shall be wired to the *PCS* system to trip AC and DC breakers. Furthermore, ventilation system shall be turned off. The alarm shall be sufficient to be heard in other containers within the system.
- 4.8.1.5 All components of the battery should be designed to prevent the propagation of fire to other components.
- 4.8.1.6 Each *BESS* container must be equipped with a flammable gas monitoring and detection system, which can provide information to operators/local fire team in the event of a thermal runaway.
- 4.8.1.7 The *ESS* shall include the necessary flammable gas (any flammable gases that may evolve during a thermal runaway event) management systems and explosion prevention systems to prevent an explosion in the event of a thermal runaway and cell gassing event.
- 4.8.1.8 Under no circumstances should the battery self-ignite or explode. The battery should not release gases under any circumstance, except if for safety reasons the cells must release gases trapped inside. The manufacturer must demonstrate that any gas released is not noxious or explain the strategies in place to safely evacuate the gas from the container.
- 4.8.1.9 Each *BESS* container must have the ability to vent flammable gases safely if detected within the container through a remote or automated operation method (pressure relief valve, remote opening of louvers, etc.)
- 4.8.1.10 *Proponents* should provide technical details on its fire detection, fire protection and fire suppression systems in the battery containers.
- 4.8.1.11 *Proponents* should provide technical details on its flammable gas and hydrogen detection, protection and management systems.
- 4.8.1.12 *Contractor* shall provide the results of cell level, module level, and unit level fire testing conducted by a certified laboratory. Laboratory test results must be certified, signed and dated by the laboratory.
- 4.8.1.13 The fire protection system status shall be reported to *BESS* control system and available for monitoring by the *Contractor's EMS* and *HMI*, and the *LUCELEC SCC*.
- 4.8.1.14 Hard-wired Emergency Stop capabilities must be designed into the system for each container. 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 *PCS* equipment.
- 4.8.1.15 The fire and gas protection shall be tested after installation and documented in accordance with applicable standards.

## 4.9 Battery Management System (BMS)

- 4.9.1.1 Each *BESS* container must act as an independent unit and must include a dedicated *Battery Management System (BMS)* designed to manage all internal bank functions and internal protection. The system must be designed to interface and communicate with the corresponding *PCS* control system, the *Contractor's Energy Management System* through DNP3 protocols or equivalent. The *BMS* shall include the following control and real-time monitoring functions as a minimum. These parameters shall be accurately reported as they will be used for real time *EMS* decision-making, determination of the kW charge and discharge setpoints, and determine the dispatch of other energy sources, etc.
- Voltage at the *DC Bus* and individual cells.
  - Temperature, for enclosure and individual cells.
  - Current, by unit battery and individual cells.
  - Faults and alarm management including ability to acknowledge and reset.
  - Real time *State of Charge (SOC)* values, by unit battery and individual cells considering the aging, temperature, voltage and current.
  - Real time discharge and charge kW limits and any deviation from rated value.
  - Battery State of Health (SOH) monitoring as defined by the *Contractor*.
  - Charge balancing among cells and strings.
- 4.9.1.2 The *BMS* must protect the battery from operating outside of its safe operating area. Operating limits are to be coordinated with the *PCS* and *EMS*.
- 4.9.1.3 In the event that there is a section of the *ESS* in fault, the *BMS* shall be capable of operating the remainder of the *ESS* at a derated capacity, with only the affected section taken offline.
- 4.9.1.4 The *BMS* shall be capable of automated balancing of the battery cells. The *Contractor* shall provide technical details on the cell balancing strategy. If cell balancing is done during operation, the *Contractor* shall provide details on the impact of balancing on operation, cell life and auxiliary power demand. If cell balancing requires the system to be offline the *Contractor* shall provide details on the frequency at which cell balancing is required, based on the duty cycle, the duration of the balancing process, and the impacts on cell life.
- 4.9.1.5 Automated cell balancing, while the battery operates, is the required cell balancing strategy.
- 4.9.1.6 The *BMS* shall alert *LUCELEC* of failed or inadequately performing cells, when preventative maintenance should be performed, or when the system is in danger of failing to meet specified performance levels or when potential safety hazards exist.
- 4.9.1.7 The *BMS* is required to accurately track the battery *State of Charge* to within 3% of actual available energy and provide feedback to the supervisory control system. The *State of Charge* must be traceable for full range of power operation and must also account for self discharge losses as the *BESS* may be sitting idle for long time periods.

4.9.1.8 The *Contractor* shall state how the *BMS* estimates the *SOC*, and how the *SOC* measurement system calibrates itself and if any external periodic intervention is required by *LUCELEC*.

#### **4.10 BESS Control and Protection**

4.10.1.1 The *BESS* shall include an integrated control system. Each container shall include indicating lights for circuit breaker status and other core functions as required.

4.10.1.2 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.

4.10.1.3 Each string *Battery Modules* shall include a means of disconnecting the string from the rest of the system and providing over-current protection. The *BMS* shall isolate individual strings if required.

4.10.1.4 The *Contractor* is to supply complete technical documentation for the battery control system, describing parameters, protection schemes, system limitations and user operations. The *Contractor* is to specify the programming/configuration tools, data collection, monitoring and historian features.

4.10.1.5 Protection shall include a bipolar DC breaker or fuse disconnect on the battery *DC Bus*.

4.10.1.6 All breakers and disconnect switches used on DC components shall be 2-pole and disconnect or connect both positive and negative lines simultaneously.

4.10.1.7 The *Contractor* is to supply any specific or proprietary diagnostic and troubleshooting tool/software.

4.10.1.8 A local control panel must be provided to interface with the *BMS*. An operator must be able to monitor and operate the *BESS* in a local manual mode.

4.10.1.9 The *BESS* system shall be self protecting and shall include protective devices to avoid damage in case of abnormal system operation. The *BESS* is not to rely on the *PCS* for protection of the battery. The *BESS* shall include short circuit, over current, voltage surge/spike protection, over voltage and over temperature protection.

4.10.1.10 The *Contractor* must specify and include networking equipment, software and implementation scheme to allow remote monitoring of the *BESS*. This remote monitoring may be implemented through *LUCELEC*'s *SCADA* system.

4.10.1.11 When possible, it is preferred that *Proponents* supply the relays, panels, communications, etc. based on the design standards 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 *BESS* components/containers. *Proponents* to note any exceptions.

#### 4.11 Connections and Wiring

- 4.11.1.1 Each bank shall be complete with *DC Bus* isolation equipment, in the form of a DC circuit breaker or disconnect switch, with provisions for padlocking in the open position. The DC disconnect or circuit breaker to include auxiliary contact to monitor status.
- 4.11.1.2 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.
- 4.11.1.3 All cabling and wiring should follow the IET Wiring Regulations 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 *BESS* components/containers. The *Contractor* shall indicate if it is not possible to meet the *LUCELEC Design Criteria* in its *Proposal*.
- 4.11.1.4 Conductors shall be rated with insulation suitable for the application temperature and current, and not less than as follows:

**Table 3 Voltage Requirements for Conductors based on their usage**

Conductor	Voltage
Main current carrying conductors	1000 V
Systems up to 120 V	600 V
Systems 24 Vdc and below	300 V

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

**Table 4 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

## 4.12 Sound

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

## 4.13 Vibration

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

## 4.14 Electro-Magnetic Interference

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

4.14.1.2 The *Contractor* should indicate any Electro-Magnetic interference radiation generated by the *ESS* or other equipment, the system will be located within 1 km of an airport, and Electro-Magnetic interference studies may be required if there are concerns.

## 4.15 Materials

4.15.1.1 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.

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

4.15.1.3 Not all parts and materials are specified in this Specification. For those that are not specified, the *Contractor* shall use its 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.

## 4.16 Grounding

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

4.16.1.2 The *Contractor* shall indicate the ground fault detection methods used for the battery containers.

4.16.1.3 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.

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

4.16.1.5 Details on the grounding grid requirements are found in *Schedule E – Electrical Balance of Plant Specification*.

#### **4.17 Toxic Materials**

- 4.17.1.1 Polychlorinated biphenyls (PCBs) and polybrominated biphenyls (PBBs) shall not be used.
- 4.17.1.2 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.
- 4.17.1.3 Where applicable, the *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.

#### **4.18 Labelling**

- 4.18.1.1 Components or assemblies (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.
- 4.18.1.2 Labels shall be displayed to indicate presence of Lithium-Ion battery cells inside and presence of high voltages even when external power is off.

#### **4.19 Shipping and Storage**

- 4.19.1.1 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.
- 4.19.1.2 The *Contractor* shall provide the necessary preparations and required packaging of the system for transportation to the site.
- 4.19.1.3 The *Contractor* shall provide any special instructions for shipping and handling of equipment.
- 4.19.1.4 The *Contractor* is to specify short-term and long-term storage requirements.
- 4.19.1.5 The *Contractor* should specify any specific requirements for long-term storage over several months.
- 4.19.1.6 The *Contractor* is to specify the measures in place or needed to maintain the battery *State of Charge* above its minimum value during long term storage (on site), if the system has not been connected to the main power grid and/or commissioned.

### **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 *Contractor*-

- proposed facility at *LUCELEC* or 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 IEC testing protocol 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 tests, unless written authority to proceed with the tests in its absence has been received. All relevant routine tests shall be performed. *Proponents* shall identify in their *Proposals* 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 *ESS* system components.
  - Simulations of Alarms and Faults to the degree possible.
- 5.1.1.5 The *Contractor* shall provide certified copies of all test data. IEC certification is to be obtained.
- 5.1.1.6 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.
- 5.1.1.7 The *Contractor* is expected to cover all costs associated with the *FAT*, corrective actions and retesting.
- 5.1.1.8 The *Contractor* is 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)*.

- 5.1.1.9 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*.
- 5.1.1.10 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* testing report in Adobe PDF format.
- 5.1.1.11 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 + 1-2 BESS* containers). *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 the same *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* or 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 tests, unless written authority to proceed with the tests in its 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 *EMS* and system components including *Contractor* equipment.
  - Start and Stop of the *ESS*.
  - Open loop operation to follow P and Q setpoints from *EMS*.
  - Simulations of Alarms and Faults to the degree possible.
- 5.2.1.8 Any deficiencies observed during the *FIT* related to *Contractor* 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 the *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* testing 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 Subcontractor*. Installation will include unloading, placement on foundation, anchoring, reinstallation of any equipment shipped loose, connection to 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 Battery Energy Storage System**

6.1.2.1 The *Contractor* shall be responsible for the installation of the *BESS*, 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 *BESS* 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 DC bus work, cables and connections between the *BESS* containers and the *PCS*.

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*-installed equipment shall be tested on site after installation. The tests shall be used to identify possible damages or changes that have occurred since the factory testing 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 all commissioning tests.

6.2.1.2 Commissioning test procedures will be provided to *LUCELEC* in addition to any specific 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.
- 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 and Q 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 (3) 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 *BESS Vendor*. 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 three (3) months of operation with system availability of 98% or higher is required to meet acceptance testing standards.

## **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 define the classroom size for the training.

6.4.1.4 The *Contractor* should 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 fire fighting and safety training to the local fire department.

### **6.4.2 Asset Management**

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

6.4.2.2 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*).

6.4.2.3 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. Other than replacement or augmentation of battery cells after 10+ years of operation, 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 Maintenance, refurbishment, or replacement of the battery cells and *Battery Modules* shall be explained by the *Contractor* and suitable procedures, training, and service options shall be provided.
- 7.1.1.1 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.
- 7.1.1.2 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 the 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 all 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 indicate if any of these tools are proprietary.
- 8.1.1.7 The *Contractor* shall advise *LUCELEC* of any planned obsolescence in the *BESS* components, including the *Battery 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.

## 9. Contractor Data and Documentation Requirements

### 9.1 Information to be Supplied with the Proposal

9.1.1.1 The *Contractor Proposal* for *BESS* 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 in reference to this Specification, including the description of equipment design, operation and special features, the controls and battery management system functionalities.
- All applicable datasheets, technical specifications, and manuals for any equipment supplied
- Detailed description of all included protection systems including voltage unbalance, surge protection, overvoltage, overcurrent and ground fault.
- 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.
- Description of the civil and electrical interconnection requirements for site installation.
- Description of the *BESS* cycle life with respect to various *Depth of Discharge* levels and different rates of charge and discharge for the given End of Life Capacity using a graph or table.
- Information on thermal management system and system behaviour upon partial or complete loss of cooling/heating.
- Information on the integrated fire suppression system.
- Serviceability access details for *BESS* equipment.
- *BESS* auxiliary power and energy requirements. Estimated auxiliary consumption during idling, charging and discharging.
- Maximum Short Circuit Capacity at the *DC Bus* in kA from positive to negative terminal.
- Description of the *BESS* 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.
- Statement on compliance and certification with respect to the standards referenced herein.
- Warranty information- The *Contractor* shall state the cost structure for reestablishment of the battery capacity to rated values above for the 20-year life of the system.
- Battery 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 *BESS* 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 5 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,		x	x	x	x

**Battery Energy Storage System (BESS)**

 St. Lucia Electricity Services Ltd.:Energy Storage System  
 Vieux Fort, St. Lucia  
 Schedule A

 Section: S000001  
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	ITEMS	INFORMATION	30%	60%	90%	IFC
	CLEARANCES, CABLE ENTRY LOCATIONS AND FOUNDATION/MOUNTING REQUIREMENTS,					
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
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 OPERATION WITH PRICES	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

## Battery Energy Storage System (BESS)

 St. Lucia Electricity Services Ltd.:Energy Storage System  
 Vieux Fort, St. Lucia  
 Schedule A

 Section: S000001  
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	ITEMS	INFORMATION	30%	60%	90%	IFC
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* and its representative followed by 2 weeks for the *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. The *Contractor* shall submit drawings marked "For Construction" after receipt of its 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* or 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*'s 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* and its representative shall approve the *Contractor's* 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**