ATTACHMENT D - Technical Scope & Specification

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2. INTRODUCTION

BLPC intends to install BESS at the locations in Table 2.1 of which locations 1 to 4 are Transmission connected at Substation sites and Locations 5 to 9 along Distribution Feeders. The proposed Battery Energy Storage System (the "BESS" or the "System") will have the following major components, packaged as a coordinated single system:

1. DC-side batteries and Balance of Plant components with energy capacity of at-least the megawatt-hour(MWh), value stated in Table 2,1 including the Battery Management System (BMS) and safety systems by location.
2. AC-side inverter system, or power conversion system (PCS), with sufficient power capacity to deliver the megawatts (MW) ac value stated in Table 2.1 at the POI net of all losses and auxiliary loads, with inverter system controls by location
3. BESS Plant Controller and/or energy management system (EMS) to dispatch BESS based on monitoring grid frequency, voltage, power factor, and other relevant grid parameters at the POI; and to manage functional requirements of BESS Project safely and reliably.

Table 2.1

Major Component	1. Megawatt-hours	2. Megawatts
Location 1	40	10
Location 2	40	10
Location 3	40	10
Location 4	40	10
Location 5	4	1
Location 6	4	1
Location 7	4	1
Location 8	4	1
Location 9	4	1

The proposed BESS will serve the following functions:

- Energy time shifting, or arbitrage, implemented via scheduled dispatch;
- Provide grid flexibility by responding to direct P/Q control setpoints issued by BLPC control center;
- Provide a dispatchable firm capacity equal to the Rated Power Capability for a continuous duration of 4 hours;
- Provide Grid frequency and voltage support by sensing and responding to grid fluctuations; and
- Be capable of serving as a spinning reserve dispatchable by BLPC
- Provide blackstart capability and functionality
- Provide microgrid capability at specific sites within constraints provided by the vendor

Proponents are requested to provide proposals which include both the necessary alternating current (ac) and direct current (dc) battery equipment and the control systems. Each offer must meet the scope of work and technical specifications defined herein.

2.1 Project Scope

The Vendor shall be responsible for procurement, assembly, and installation of all components required to furnish a fully functioning BESS with associated power conversion system (PCS), Plant Controller, low voltage to medium voltage transformer, and mechanical, civil, and electrical Balance of Plant components. All components shall comply with the technical requirements defined herein. The Vendor scope of work includes:

- BESS solution for outdoor installation (Outdoor rated insulated enclosure, e.g. Containerized)
- Bi-directional Inverter(s)
- Controls hardware and software, including both SCADA and Plant Controller
- BESS thermal management system and all associated components
- LV:MV transformer and associated components
- All Telemetry, metering and power quality monitoring equipment
- All Balance of Plant components for the BESS including HVAC, gas detection, fire protection equipment, etc
- Provision of spare parts, as recommended by BESS manufacturer
- Integration of the BMS, Plant Controller, and SCADA systems with the BLPC SCADA system, and electrical power system protection equipment
- Installation, commissioning and testing of all aspects of the system
- Provision of operational manuals, emergency response plan, and BLPC operator training
- Providing and supporting Performance Guarantees for the installed BESS
- Installation of auxiliary power for BESS HVAC and other quiescent loads required for equipment operation, e.g., for SCADA, Plant Controller, Inverter controller, if needed, and control house

Vendor is responsible for all electrical, mechanical, and civil engineering and design. All design drawings, specifications, and other technical documents produced by the Vendor for this Project shall be approved by a Registered Engineer in Barbados. Vendor shall include in the design documents a general arrangement drawing, to scale, indicating the location of all major equipment including dimensions of key site features to a suitable baseline location. Vendor shall perform all engineering and design work within the scope defined and in accordance with all applicable building, electrical, safety and fire codes as identified herein.

Vendor shall designate an engineering manager who shall be responsible for the overall management and administration of engineering and design work. Vendor shall apply for and obtain all required construction permits in order to construct the Project. Power generated by the Project shall be compatible with BLPC Interconnection requirements described in the BLPC Grid Code.

All engineering and design calculations prepared by Vendor during the design of the Project shall be available to the Owner for review electronically. Such calculations shall include structural, electrical, mechanical and instrumentation and control details.

Vendor is expected to provide all equipment and facilities necessary for a fully functioning BESS interconnected to the Owner's electrical grid. Vendor shall provide a schedule of any equipment or facilities not included in Vendor's proposal.

2.2 Procurement and Shipping

- All materials shall be new and conform to applicable law and prudent industry standards, such as UN/DOT 38.3.
- Vendor shall be responsible for all transportation, shipping, loading, unloading, customs, and insurance etc. requirements associated with the components listed in this scope. The shall adhere to Incoterm 2020 DAP (Delivered At Place)

. The Owner shall provide intended battery sites for delivery on selection of the Vendor.

- Vendor shall provide a list of all materials with long delivery lead times.

- Vendor shall submit a shipping and delivery plan for approval by BLPC no less than sixty days before any materials are shipped. Transportation and delivery plan shall include routing plan for any oversized or heavy loads from point of landing in Barbados to project site and shall include all permits required by Barbados requirements.
- Vendor shall prepare materials and equipment for shipment to protect them from damage while in transit.
- Vendor shall be responsible for any special permits and arrangements required for transportation.
- Vendor shall include all rigging and lifting arrangements for transportation and setting the equipment on the foundations or site prepared by BLPC through the Vendors specification.

3. DEFINITIONS

All defined terms shall have the meaning prescribed to them as listed in Attachment C - Definitions.

4. INDUSTRY STANDARDS AND CODES

The latest active version of all specified codes and standards as adopted in Barbados, shall be met in the design, manufacture and construction of the Project and all associated equipment. Standard years are provided only as a minimum acceptable reference. In the event of a conflict, disagreement or issue between any codes, standards and requirement, the Vendor shall notify the Owner and closely collaborate with the Owner to arrive at a reasonable solution of Owner's preference. A list of relevant codes and requirements can be found in Attachment M – Industry Standards & Codes.

5. PROJECT DETAILS

This section provides Project information and detail to support the engineering, design, and construction of the Project. The Vendor shall be responsible to commission all necessary studies and field testing for final design.

5.1 General information

BESS are expected to be installed at four (4) substation locations (Locations 1 to 4 in Table 2.1 with capacity and energy as listed in the table) connecting at the 24.9kV transmission voltage. Each substation will have an existing 24.9kV bus and MV switchgear for connection.

On the Distribution system BESS are expected to be installed at five (5) locations (Location 5 to 9 in Table 2.1 with capacity and energy as listed in the table) connecting at the 11kV distribution voltage. BLPC will provide switchgear at 11kV for connection of each BESS.

5.2 Design conditions

5.2.0 Minimum Design Life: 20 years

5.2.0.1 The systems and equipment provided by Vendor shall be suitable for the environment in which they will be located and shall be designed for a Minimum Design Life after COD. The equipment and infrastructure provided shall be capable of starting, running reliably and efficiently, and delivering full name plate power and energy provided in Table 2.1 in accordance with the specified criteria and ambient conditions given herein. The Minimum Design Life refers to the engineering, design, specifications and construction of the Facility such that no major replacements or repairs will be needed to the Facility within the given Design Life period except for augmentation. Design Life includes life of enclosures and life of major Equipment excluding battery modules and inverters.

5.2.0.2 If battery modules and/or inverters are expected to be replaced during the lifetime of the Project, the initial enclosure design shall accommodate Vendor's recommended Capacity Augmentation of the battery modules for the Minimum Design Life period to maintain nameplate capacity. The initial design of the thermal management solution shall be sufficient for the duration of the Minimum Design Life, given ambient conditions, and Capacity Guarantee, Degradation, and Capacity Augmentation described in Sections 9.1.6, 9.1.6.7, and 9.1.6.8.

5.2.0.3 A reliability, availability, and maintainability study shall be completed and specify any components having a design life of less than 20 years. These components shall be identified in a schedule, in

proposal documents, stating the anticipated design life of each such component, replacement quantities required and the associated cost for supplying replacement components and performance of any maintenance that BLPC is not certified by the Vendor to provide.

5.2.0.4 All parts shall be made accurately to standard gauge when possible so that renewals and repairs may be made when necessary with the least possible expense.

5.2.0.5 All facilities shall be designed for ease of maintenance and access in the replacement of components and equipment, Vendor to include lifting equipment and access plan for components that exceed safe handling limits.

5.2.1 BESS Nominal Sizing:

5.2.1.1 The BESS shall be designed to have a "Rated Power Capability" indicated in Table 5.1 described in MW ac net of all system losses and auxiliary loads, as measured at the POI.

Table 5.1

Location	Rated Power Capability (MW ac)
Location 1	10
Location 2	10
Location 3	10
Location 4	10
Location 5	1
Location 6	1
Location 7	1
Location 8	1
Location 9	1

5.2.1.2 At the time of COD, the BESS systems shall be designed to have a "Rated Energy Capability" that will facilitate continuous discharge at the Rated Power Capability for a duration of four (4) hours.

5.2.2 Warranties:

5.2.2.1 Vendor shall include all standard warranty periods for any equipment, including workmanship warranties. Optional warranty periods and associated costs for additional warranty periods shall also be listed where available.

5.2.2.2 Vendor shall provide a minimum of a ten (10) year warranty coverage for all BESS components, and a cost breakdown for additional years of coverage.

5.2.2.3 All equipment shall be new, unused, of recent manufacture and shall carry the manufacturer's standard warranty, unless otherwise specified.

5.2.2.4 All equipment Warranties shall be transferrable to BLPC upon project commissioning and formal turnover and acceptance of facilities by BLPC.

5.2.2.5 Vendor shall explicitly describe any equipment that has a less than 10-year manufacturer's Warranty period.

5.2.2.6 Vendor shall clearly identify and highlight any warranty exceptions and conditions of all warranties provided as part of the Project.

5.2.2.7 Vendor shall list any O&M plans included with the Project, otherwise provide a pricing breakdown for all O&M plans provided by the Vendor at additional cost

5.2.2.8 Beyond the ten (10) year warranty, Vendor shall provide a pricing breakdown for a long-term service agreement (LTSA) and for optional warranty extensions.

5.2.3 Capacity Guarantee

5.2.3.1 Vendor shall provide a ten (10) year guarantee of the useable energy capacity of the BESS "Capacity Guarantee", as defined by a degradation curve, Guaranteed Energy Capacity, and associated usage limits with reference the Owner provided usage profile requirement of 15330 GWh/year for 10MW capacity rated systems and 1533 GWh for 1MW capacity rated systems. The Capacity Guarantee shall be extendable up to twenty (20) years.

- The BESS shall be capable of discharging at Rated Power Capability a minimum of 4 hours at COD, as measured at the POI using a testing procedure as agreed with Owner.
- The BESS shall be capable of discharging at Rated Power Capability for a minimum of 3 hours and 0 minutes, 10 years after COD, as measured at the POI.

5.2.3.2 The Capacity Guarantee shall be evaluated as described in Section 11.4

5.2.3.3 The Capacity Guarantee shall include flexibility for usage outside of the Owner provided usage profile requirement, and explicitly define the corresponding adjustments.

5.2.3.4 Vendor shall additionally provide a pricing break down for a Capacity Guarantee that includes battery augmentation and/or capacity overbuild that results in the maintenance of the Rated Energy Capability (5.2.1) for a ten (10) year period, extendable up to twenty (20) years.

5.2.4 Round Trip Efficiency Guarantee

5.2.4.1 Vendor shall provide a minimum Round Trip Efficiency Guarantee, “RTE Guarantee”, of 87% as measured at the POI as of COD. For avoidance of doubt, the RTE Guarantee shall not include BESS auxiliary loads.

5.2.4.2 The RTE Guarantee shall be evaluated as described in Section 11.4.2

5.2.4.3 Vendor shall provide a detailed calculation of BESS auxiliary load expectation on a monthly basis for a typical year. Vendor shall also indicate the maximum expected BESS auxiliary load.

5.2.5 Availability Guarantee

5.2.5.1 Vendor shall guarantee that the BESS will be online and available at-least 98.50% of time annually through out the warranty period.

5.2.6 The Vendor is expected to complete and submit a final site-specific study as required for the delivery of the Project equipment selection and design. Representative site specific design provided below is for informational purposes only:

5.2.6.1 Maximum ambient design temperature: 41° C

5.2.6.2 Minimum ambient design temperature: 16° C

5.2.6.3 Maximum Relative humidity: 100%

5.2.6.4 Minimum Relative humidity: 60%

5.2.6.5 Average Annual Rainfall: 198cm

5.2.6.5 Soil classification: To be determined per site

5.2.6.6 Subsurface soil conditions: To be determined per site.

5.2.6.7 Peak Wind Gust: 48 km/h

5.2.6.8 Maximum steady wind velocity: 241 km/hr (CAT 3 storm per ASCE rating)

5.2.6.9 Lightning, Strokes/sq. km/year: 0.93

5.2.6.10 Earthquake: Design Seismic Zone No.2

5.2.6.11 Ground resistivity: Site Specific

5.2.6.12 Solar radiation level: 6.8 kWh/m^2

5.3 Project special conditions

5.3.0 Structural analysis for all foundations must account for soil conditions at Project sites.

5.3.1 The Vendor will be required to coordinate certain aspects of the interface between Vendor's Work and the facilities provided by Owner and the Vendor. Such interface shall include (but may not be limited to):

5.3.1.1 Collaborate with Owner to complete interconnection process

5.3.1.2 Specify final POI interface agreements

5.3.1.3 Specify the number/type of communications required by the Vendor between the BESS supervisory control and data acquisition (SCADA) system and Owner

5.3.1.4 Coordinate on the final SCADA points list, notably on signals to be communicated and their relevant channels.

5.3.2 BESS equipment is provided by Vendor. The Vendor shall coordinate to ensure all equipment necessary to operate the BESS is provided, including dc-side subsystem, ac-side subsystem, control system, relaying, synchronization equipment, metering and SCADA equipment.

5.3.3 The BESS equipment shelter must be designed and constructed according to the OEM prescribed recommendations and requirements, and industry best practices following permits, codes, and regulations as may be applicable. If a building solution is provided, it must conform to local revision of the Barbados Planning and Development Act, 2019, including applicable occupancy, fire- and life-safety, and structural requirements. Vendor shall provide general description of materials and construction of building roof and envelope details.

5.4 Vendor BESS Project Attributes

5.4.0 Power Capability: As described in Section 5.2.1

5.4.1 Energy Capacity: As described in Section 5.2.1

5.4.2 System availability: Referenced in Section 5.2.5.

5.4.3 Approximate weight: No requirements, except as necessitated by Site conditions to be determined by Vendor.

5.4.4 Approximate size: No containerized or skid-mounted equipment greater than 16 m in length, 2.6 m in width, or 2.9 m in height, not including HVAC and other equipment. All equipment shall be transportable by standard land and sea shipping modes without the need for oversize load trailers or other specialty transportation arrangements.

5.4.5 Outdoor installation is intended. BESS to be housed in its own climate-controlled enclosure or shelter, if required by the vendor design for the location climate.

5.4.6 Vendor is responsible for securing all equipment per all permit requirements.

5.4.7 Any fault originating within BESS, i.e., before the BESS POI, will not cause an adverse event on the rest of interconnected electric grid.

5.5 BESS Plant Controller

5.5.0 The BESS Plant Controller shall be an integrated hardware/software solution that provides supervisory control and monitoring of the BESS, BMS, energy management system (BESS EMS), SCADA system, and individual equipment control systems.

5.5.1 The BESS Plant Controller shall be able to provide BESS energy management functionality, directly or via communication with other equipment control systems.

5.5.2 Manage disconnect/reconnect operations of BESS as appropriate to ensure safe, reliable and resilient operation.

5.5.3 Have the capability to detect and isolate faults within the BESS.

5.5.4 The BESS Plant Controller shall be the single point of contact between the Owner's control center and full plant control. As such, the BESS Plant Controller shall have visibility and control of all plant subsystems, including the fire and gas detection / suppression and ventilation, safety, and individual equipment control, including the EMS (in the event the EMS is provided separately). Owner requires all controllers at the BESS level to have hot back-up redundancies and UPS. At minimum, the owner requires the main data aggregator on site to be dually backed up. The UPS supply duration should be a minimum of 15 minutes.

5.5.5 The BESS Plant Controller shall also act as the single data aggregator on site, and allow the Owner to access the data in real-time, as well as store historical data, in a format that is usable by the Owner and other third party for asset management and study.

5.6 Data collection and access

5.6.0 Human Machine Interface (HMI) with monitoring and control access to BESS should be available at the following locations: 1) BESS control house on-site, 2) Owner remote control centre, The BESS will normally be operated via SCADA from BLPC's operation control centre.

5.6.0.1 The control system shall be capable of both local and remote operation.

- Local control mode: Commands from the remote location (BLPC Control Center) are blocked but monitoring information shall be transmitted to the remote location.
- Remote control mode: The BESS is operated from the remote location (via SCADA interface). Commands from the local BESS control room are blocked, but monitoring information is displayed.

5.6.0.2 Failure of a PC-based local operator interface system shall not interrupt remote control and monitoring via SCADA.

5.6.0.3 Provide the ability to switch from local to remote available at both the local and remote location.

5.6.1 System data acquisition shall record data within at most 1-second time interval and storage shall record data within - and at least 1-minute time interval.

5.6.1.1 Owner may require that certain measurements be recorded at 10 to 100 millisecond intervals and potentially at 1 millisecond resolution for recording alarms or events. Vendor shall coordinate with Owner to provide such functionality where needed.

5.6.2 Data should be measured, recorded and stored at a minimum at the following locations: 1) Battery management system cell and module data; 2) Battery dc-bus data; 3) Battery inverter and ac-bus data; 4) BESS main ac inter-tie; 5) enclosure HVAC system; 6) enclosure fire suppression system, and 7) enclosure gas detection and ventilation system.

5.6.3 At a minimum, the following data should be measured, recorded and stored: 1) Battery module and rack voltage, current, state-of-charge, temperature; 2) dc-bus voltage and current; 3) ac-bus phase voltage, current, real power, reactive power and power factor; 4) main ac intertie phase voltage, current, real power, reactive power, apparent power, power factor, frequency; 5) BESS state of charge; 6) status alarms, temperature and monitoring output from enclosure HVAC system; 7) status, alarms and monitoring output from enclosure fire detection / suppression and gas detection systems.

5.6.4 Historian data over project life shall be readily available for access and download.

5.6.5 Real time operations and performance of the system shall be available for monitoring and controls through a Graphical User Interface (GUI) provided through an HMI.

5.6.6 Vendor shall design the system to align with the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0 including all firewalls, access control and data protection requirements.

6 GENERAL REQUIREMENTS

This section provides explanation and an overview of the requirements of the Technical Specifications. The intent of this section is to illustrate that the Vendor is responsible for all activities to complete the Project except for those items specifically identified as outside of scope.

The BLPC transmission system consists of 69kV and 24.9kV circuits with a combination of both overhead and underground installations. There are seventeen (17) major Transmission & Distribution (T&D) substations and one (1) minor T & D substation.

Our main distribution voltage is 11kV with three (3) distribution circuits at 24.9kV. There are sixty-six (66) 11kV distribution circuits and two (2) 11kV station service circuits feeding from BLPC substations. BLPC's system frequency is 50Hz.

BLPC operates approximately 150.2km of transmission lines operating at voltages of 24.9kV and 69kV, and 2800km of distribution line operating at 11kV.

6.1 Scope of Work

6.1.0 Vendor shall execute all engineering, design, and construction in accordance with the Technical Specifications.

6.1.1 Vendor's Scope of Work is to engineer, design, procure, construct, assemble, oversee on-site installation of, commission, startup, test, and provide training and operational support for the Project's BESS. The BESS shall be built to the capacity and metering functionality as indicated in these Technical Specifications and shall meet commissioning and testing requirements identified in Section 11 herein.

6.1.2 Vendor is responsible for commissioning the BESS including the BESS Plant Controller.

6.1.3 Vendor shall design all aspects of the Project in its scope, to meet the Minimum Design Service Life defined in Section 5.2.0. All major equipment and subsystems except BESS dc-side components, shall meet the Minimum Design Life.

6.1.4 It is the Vendor's sole responsibility to ensure that all aspects of Project design and construction in its scope comply with all local code requirements and all industry codes and standards. This includes, but is not limited to, the list specified in Section 4 and throughout the remainder of the document.

6.1.5 Professional Engineers registered or licensed in [Barbados], shall be in responsible charge of the engineering design work, and sign and seal all documents required for submittal to any applicable legal authority.

6.1.6 Vendor shall perform, supply, or cause to be supplied all equipment, materials, labor, services, supervision, testing devices, drawings, calculations, specifications, and manuals required for the execution of its Scope of Work.

6.1.7 Vendor shall comply with as-requested inspection of materials, documents, equipment, or any other information related to the Project by the Owner or Owner's agent during construction.

6.1.8 Vendor shall provide training, and related manuals and guides, on System installation, commissioning, operations, maintenance, decommissioning, and emergency and fault management.

6.1.9 Major components of the Work include:

6.1.9.1 Project management including, but not limited to:

- Site safety and environmental management for Vendor's personnel
- Project administration
- Scheduling
- Quality assurance and control

- Weekly and monthly progress reporting
- Meetings and teleconferences, as identified in RFP
- Coordination of Vendor's personnel and sub-contractors and suppliers
- Training and guideline provision

6.1.9.2 Engineering including, but not limited to, detailed design of:

- Electrical systems
- Control and instrument systems
- Civil, geotechnical and structural systems
- Site fencing, access and security plans
- Mechanical systems
- BESS modeling study
- Calculations, analyses, and review, where required, of all engineering documents
- Comprehensive design manual including all engineering drawings, calculations, and analyses performed
- Comprehensive operation and maintenance manuals for the Project
- Detailed design includes development of all drawings and specifications required by Owner to procure construction services for on-site construction by local contractors of work within Owner's scope of work, drawing numbering system to be provided by Owner
- Foundation design for Battery enclosures, inverters, transformers, and other skid-mounted or packaged equipment
- Electrical design, wiring diagrams, cable termination schedules, conduit design, interconnection requirements for Vendor's equipment, and grounding system design
- Design for other systems and equipment as appropriate

6.1.9.3 Storage and preservation requirements prior to shipment of all equipment, including the BESS, in accordance with manufacturer specifications

6.1.9.4 Shipping and logistics arrangements, which shall be provided as a separate commercial offering in the pricing sheets

6.1.9.5 Procurement of equipment, materials, and services including but not limited to:

- Procurement of all materials, including but not limited to, BESS modules and racks, BESS inverters, BESS site master control system, disconnect switches, circuit breakers, fuses, current transducers, potential transducers, fuses, meters, communication equipment, hardware and fasteners, conduits and raceways within the battery containers, conductors, junction boxes, bonding and grounding equipment, and all related materials
- Providing or procuring services including, but not limited to, subcontracted services required to prepare, install, construct, connect equipment, and conduct component testing at the Site.
- Development of specifications and proposal packages for any subcontracted Work listed under Vendor's scope
- Proposal evaluation and selection for any subcontracted Work
- Quality assurance and control (QA/QC) material inspections
- Obtaining all datasheets, relevant technical notes, installation, operations and maintenance (O&M) manuals for all Project Equipment

- Obtaining Manufacturing Record Books for the manufacture of all major system components and subsystem assemblies
- Price list of critical and recommended operating spare parts with manufacturer-recommended quantities based on the quantity installed at the Project.
- Construction of Project facilities including, but not limited to:
- Construction management and supervision for installation of the BESS and associated control system hardware
- Training of local construction labor, especially in the installation of battery modules
- Construction and installation of all supplied equipment
- HSE program, which shall comply with BLPC standards and policies and Barbados OH&S requirements
- Quality program, which shall comply with BLPC standards and policies and ISO standards
- Specialty construction equipment or tools as required for installation, assembly, testing, and commissioning of the BESS. At a minimum, any specialized construction equipment or tools shall be provided with one extra furnished component in case of loss or damage.

6.1.9.6 Inspection, testing and commissioning activities as required in Section 11.

6.1.10 Vendor shall procure and construct the following in accordance with permits, codes, regulations and Owner's requirements, as may be applicable:

- 6.1.10.1 Station electrical service The Vendor shall also provide service panels and any protective equipment for BESS containers and other outdoor equipment. As noted in the Technical Specification, 9.4.2.5, the container(s) will allow for main and auxiliary power, as well as communications lines, to attach to the appropriate components and connections. Vendor will provide distribution panel(s), protection, and internal wiring for the control house in accordance with BESS requirements.

6.1.10.2 SCADA, control, and protection systems

- Upgrades / modifications to existing Owner SCADA hardware and software, with oversight provided by Owner
- On-site SCADA equipment and secure connection
- Cabling from site master control system or other Vendor control system panel to Owner's SCADA network (inside control house)
- CCTV cameras and security network

6.1.10.3 Control house, to be designed per BESS and site requirements, including:

- Housing for energy management system and other BESS controls, relays, monitoring and other low voltage equipment
- Lighting, electric power, HVAC

6.1.10.4 Site civil infrastructure is expected to be designed by the Vendor and may be optionally managed by the Owner considering the remoteness to island of most vendor offices and the Owner's knowledge of local site conditions.

- Concrete foundations for the BESS, enclosure, and appurtenant structures
- Where required, containment under transformers and oil leak detection systems
- Site drainage and containment

- Site security and fencing (BLPC standard to be provided).
- Outdoor lighting
- Access and turning lane from main road adjacent to sites
- Roadways suitable for large delivery trucks and heavy equipment (e.g., semi-trucks, cranes, excavators)
- Lay-down yard
- Crane pads

6.1.10.5 Electrical

- Grounding grid
- Electrical duct banks for all on-site cabling
- Duct banks will typically be provided with risers stubbed up adjacent to battery containers, inverters, etc.
- Materials and labor to connect riser conduits above ground level and make entrance into exterior electrical panel or penetration through building, as needed

6.1.10.6 Other site utilities

- Electrical service to control house and all other site facilities
- Lighting
- Security equipment (cameras, signage, etc)

6.1.11 Any site facilities and equipment not listed above but required for proper operation of the system shall be supplied by Vendor.

6.2 Owner-Provided Facilities

6.2.0 The Owner will procure, construct, operate, and maintain the following facilities in support of the BESS facility. Owner will design the facilities in accordance with Vendor's specifications and designs and in accordance with permits, codes, and regulations as may be applicable. Any site facilities and equipment not listed below but required by Vendor for proper operation of Vendor's system shall be supplied by Vendor. Vendor shall provide all specifications and design drawings as may be required in order for Owner to confirm the design of site civil and other infrastructure required for the Project.

6.2.0.1 Gen-tie transmission or distribution line as required.

- Electrical cables from MV switchgear to the transformer MV terminals of the step up transformer in accordance with the requirements of the vendor for the BESS connection
- Terminations of electrical cabling between the BESS switchgear and the transformer high side.

6.2.0.2 Switchgear and Point of Interconnection ("POI") for BESS

- MV switchgear for interconnection of the BESS plant to the Barbados grid
- Protection devices at MV switchgear

6.3 Safety

6.3.0 Vendor shall comply with BLPC HSE Policy, Barbados Barbados Safety & Health at Work Act 2005-12 and the BLPC Contractor Management System provided in Attachment I1, I2 and J respectively.

6.3.1 Within ninety (90) days prior to site mobilization, Vendor shall provide to Owner a Site-specific Safety Plan for the Work (including Emergency Response Plan) to ensure that appropriate measures are taken to support safe construction.

6.3.2 Vendor's Safety Plan shall be reviewed and accepted by Owner.

6.3.3 Vendor shall provide safety supervision to maintain safe working conditions.

6.3.4 Vendor shall perform arc-flash calculations, and utilize appropriate personal protection equipment (PPE), for work performed in or near any live electrical components.

6.3.5 Vendor shall perform daily safety briefings and risk assessments and inform all workers of relevant hazards involved in the Work.

6.3.6 Vendor shall develop lock-out-tag-out (LOTO) procedures for performing the Work and operation of the Project to be accepted by the Owner in conformance with Owner LOTO procedures.

6.3.7 Vendor shall develop Safe Work Practices (SWP) for all site activities and train all personnel in their use and competency

6.3.8 Station electrical service

- Station electrical service will be provided by Owner. Owner will design, procure, and construct redundant (primary and auxiliary) station service equipment, including transformer, protective relays, 400V service panel, and conduit ductbank and cabling to the control house and Vendor's battery containers.
- Owner will provide an automatic transfer switch (ATS) and synchronization equipment to transfer between the primary and auxiliary power sources.
- Owner will provide electrical service to the battery enclosures/shelters, in accordance with the BESS electrical service requirements.

6.4 Permits and environmental compliance

6.4.0 Vendor shall comply with BLPC environmental requirements, site environmental control and compliance monitoring as provided by Planning Authority or Environmental Protection Department (EPD).

6.4.1 Vendor shall be responsible for providing all required engineering plans, design, and documents as needed for it to obtain all building and construction permits necessary to complete the Work including, but not limited to: a) Environmental Review approval or alike; b) Building permits issued through the AHJ; c) Electrical permits and right-of-way encroachment/access permits; d) fire safety permitting and e) Temporary construction power, water, fire, and sanitation permits. Owner shall reasonably assist Vendor as necessary, to obtain such Vendor permits that are applicable. Vendor shall develop a Permit Plan and maintain a Permit Register outlining all permits, responsibility, lead time and forecasted dates required.

6.4.2 Vendor shall comply with all Conditions of Approval and all mitigation measures required by the Planning Authority or EPD and demonstrate compliance as required by the Planning Authority or EPD. This includes but is not limited to: appropriately siting the equipment in compliance with best practices related to safety, sufficiently and permanently securing the equipment to prevent access by unauthorized personnel, and incorporating permanent fire protection measures if deemed necessary by the Planning Authority or EPD.

6.5 Vendor Engineering

6.5.0 Vendor is responsible for all electrical, structural, mechanical, geotechnical and civil engineering and design for equipment furnished by Vendor. Vendor shall also provide all specifications and design drawings as may be required in order for Owner to review the design of site civil and other infrastructure required for the Project.

6.5.1 All drawings, studies, and documentation submitted to any AHJ shall be under the responsible charge of and signed and sealed by a professional engineer registered in Barbados. In response to any requests for clarification or other written communications from the AHJ or Owner's local professional engineer(s), Vendor shall submit timely responses, including design revisions, on an as-needed basis and copy Owner on any such communications.

6.5.2 The design basis for the Project shall be the Project specific information included in Section 5.

6.5.3 Vendor shall include in the Design Documents a general arrangement drawing, to scale, indicating the location of all major Project Equipment including dimensions of key Site features and a suitable baseline location. The general arrangement drawing(s) shall include, at a minimum:

6.5.3.1 BESS dc-side system

6.5.3.2 BESS ac-side system

6.5.3.3 BESS Plant Controller

6.5.3.4 Inverters and transformers

6.5.3.5 Circuit breakers, fuses and disconnect switches

6.5.3.6 Relays

6.5.3.7 Meters

6.5.3.8 Control and communication infrastructure

6.5.3.9 Data monitoring, storage and other IT equipment

6.5.3.10 Electrical cabling including but not limited to; low voltage dc and ac cable runs, cable tray, conduit and/or direct buried

6.5.3.11 Underground cables and duct banks if any

6.5.3.12 Grounding grids

6.5.3.13 Site drainage and control

6.5.3.14 Point(s) of interconnection

6.5.3.15 Fencing

6.5.3.16 Staging, laydown areas

6.5.3.17 Building access and adjacent public roads

6.5.4 An up-to-date printable index (Vendor Document Register) listing of all Vendor Design Documents including specifications, drawings, calculations, and as-built revisions organized by document number, title and, revision shall be maintained by Vendor and shall be available to Owner at all times.

6.5.5 All engineering and design calculations prepared by Vendor during the design of the Project shall be available for Owner to review electronically. Such calculations shall include structural, geotechnical electrical, mechanical, instrumentation and control details. Vendor shall make calculations available for Owner review no later than two weeks from the dates permit submittals are to be made to the AHJ.

6.5.6 All manufacturer documents received by Vendor shall be maintained by Vendor and available to Owner at all times. Manufacturing Record Books shall be provided for all tagged equipment outlining Vendors manufacturing and testing data,

6.5.7 Vendor shall make all engineering documentation available in Portable Document Format (PDF).

6.5.8 Vendor shall make all drawings and documentation available in DWG (AutoCAD) or as well as in PDF.

6.5.9 All documentation submitted for Owner review will be through the Owner's document control system.

6.5.10 All documents shall be in the English language.

6.6 Procurement

6.6.0 Vendor shall be responsible for the procurement, handling, shipping costs, and delivery of all equipment, materials, and services, including, without limitation, locating, negotiating, inspecting, expediting, shipping, shipping permits, unloading, receiving, verifying, and claims.

6.6.1 Vendor shall be responsible for the equipment delivery receiving, storage, preservation and handling of the BESS at Project Site per the requirements provided by the BESS manufacturer (if a subcontract on the project). Vendor shall document this in a Procurement Plan that lists all equipment and materials, supplier details as well as the schedule for procurement.

6.6.2 Packing lists shall be maintained by Vendor at the Project and shall be available for Owner review. Invoice, Packing list and Bill-of-Lading shall be supplied once the BESS shipment leaves the port.

6.6.3 Vendor shall update a schedule of values maintained in electronic format that accurately describes the quantities of all Project Equipment received at the Project. The schedule of values shall be updated within seven (7) days after each delivery of equipment. The schedule of values shall be available for Owner review.

6.6.4 For the system, the expenditures as follows:

6.6.4.1 All freight costs for all equipment shall be the responsibility of the Vendor.

6.6.4.2 All applicable taxes, tariff fees, and import duties shall be the responsibility of the Vendor. However the Owner will provide any necessary documentation to facilitate waiver of any such duties, tariffs, etc.

6.6.4.3 All customs documentation and fees in the nation(s) where shipments originate or make intermediate stops shall be the responsibility of the Vendor.

6.6.5 All equipment stored at the Site shall be in accordance with good industry practices and manufacturer's recommendations. Vendor shall use all reasonable measures to keep the equipment free from dirt and debris.

6.6.5.1 The BESS shall be shipped in compliance with any applicable regulations, including UN 38.3, as appropriate.

6.6.5.2 The BESS shall be stored according to manufacturer recommendations. Storage conditions of the BESS should include, at a minimum, the following considerations:

- Avoid exposure to heat and sun
- Avoid exposure to high humidity (e.g., greater than 95% humidity) or wet conditions
- Keep away from combustibles
- Have a robust fire extinguishing system
- Do not tilt, vibrate, drop, puncture, stack, or expose to the elements
- Request details of storage and preservation requirements from the vendor particular to the technology

6.6.5.3 Vendor shall perform all inspection and pre-installation maintenance activities to ensure compliance with manufacturer's recommendations. Vendor shall maintain a log of such maintenance activities, such log to include the date of such activities and the names and signatures of the personnel performing such activities. Such log shall be available to Owner for review.

6.6.6 Vendor shall obtain all warranty information for all Project Equipment. All Key Equipment warranties shall permit assignment to Owner without consent.

6.6.7 Vendor shall obtain all installation, operations and maintenance manuals for all Project Equipment, as well as appropriate emergency response manuals.

6.7 Quality Assurance and Control

6.7.0 Vendor is responsible for ensuring those performing the installation are trained to install the system in line with specifications, the BLPC Grid Code, Government Electrical Engineering Requirements, and all other applicable requirements, to an appropriate level of quality. To this end, the following items are within the Vendor's responsibility:

6.7.1 Vendor shall implement a QA/QC program to ensure the necessary measures are taken to support successful execution of the Agreement.

6.7.2 Vendor shall provide appropriate site and manufacturing QA/QC supervision to maintain quality control in line with industry standards for similar work.

6.7.3 Within sixty (60) days following contract award, or the Limited Notice To Proceed Date, Vendor shall provide to Owner a Site-specific, detailed QA/QC Plan for the first project site. The QA/QC Plan, at a minimum, shall address all aspects of the following as related to Vendor's scope:

6.7.3.1 Procurement of Equipment, including inspections

6.7.3.2 Construction of the Project, including inspection and testing procedures to verify the construction complies with the AHJ-approved design and permit conditions

6.7.3.3 Commissioning and testing of the BESS system, enclosures and control building.

6.7.3.4 Corrective action procedures that address defective materials, chain of supply, discrepant system components and field issues.

6.7.3.5 Plan to address non-compliance to project quality requirements which includes a Non-Compliance Register (NCR) for identifying and tracking issues with disposition to address for acceptance and closure.

6.7.4 Vendor shall have the QA/QC Plan reviewed by Owner or the third-party Owner's Engineer as applicable, to ensure all testing and inspection procedures satisfy Applicable Standards and regulations.

6.7.5 Owner may perform an audit of the QA/QC Plan at any point during the Work. Owner and Vendor to agree to a plan which Owner is notified to attend inspections of the Work and other certain hold points where Owner will witness and sign-off inspections that Owner deems critical to the Work.

6.7.6 The QA/QC Plan shall include a continuous improvement program. All improvements shall be logged as lessons learned and made available to the Owner.

6.7.7 Vendor shall perform inspections and field quality control testing as related to the Vendor's scope throughout the construction process including:

6.7.7.1 Assessing existing conditions

6.7.7.2 Construction installation placement and qualification measurements

6.7.7.3 Final inspections and tests

6.7.8 Testing shall comply with good industry practices, Applicable Laws and Applicable Standards.

6.7.9 Testing shall include, but is not limited to:

6.7.9.1 Commissioning and testing requirements in Section 11.1

6.7.9.2 International Electrical Testing Association Acceptance Testing Standards

6.7.9.3 Underground cabling for burial depth, spacing, tape placement and insulation resistance, if applicable

6.7.9.4 Photographs shall be taken of each open trench with all conductors prior to backfill

6.7.9.5 Any other tolerance requirements as outlined in the approved engineering drawings and/or manufacturer's recommendations

6.7.10 Torque

6.7.10.1 Vendor shall ensure all fasteners are torqued properly according to the manufacturer's instructions.

6.7.10.2 Torque marks shall be provided on all structural fasteners and electrical terminations to indicate torque has been verified.

6.7.10.3 Proper torque shall be achieved through the use of non-powered, calibrated torque wrenches. Electric and air-driven tools shall not be relied upon to provide final torque without Owner approval.

6.7.10.4 Vendor shall compile a torque chart for the Project that includes the required torque settings for all fasteners and electrical terminations.

6.7.11 Vendor shall coordinate and document all QA/QC requirements, inspections, and test results.

6.7.12 Vendor shall provide sixty (60) days' written notice to Owner prior to the following events for Owner review of the QA/QC inspection and testing results required of each:

6.7.12.1 Installation of inverters and transformers

6.7.12.2 Installation of BESS

6.7.12.3 Installation of BESS Plant Controller

6.7.12.4 Energization of the main power transformer.

6.8 Commissioning

6.8.0 A minimum of ninety (90) days prior to start of commissioning, a Commissioning Plan shall be provided by Vendor to the Owner for review and acceptance. The schedule date will be shown in the project baseline schedule which will be coordinated with BLPC.

6.8.1 Commissioning shall be performed in accordance with the manufacturer's installation, commissioning and O&M manuals, and in accordance with the commissioning requirements in Section 11.

6.8.2 BESS commissioning shall be conducted by Vendor in coordination with manufacturer representatives, as applicable, and Owner.

6.9 Manuals for Owner review and approval

6.9.0 Vendor shall provide comprehensive Project Manual which shall contain the following as a minimum:

6.9.0.1 Final Contract Agreements

- BESS Agreement (including Exhibits)
- Completion Certificates
- Warranties
- Capacity Guarantee
- Capacity Maintenance Agreement
- Remote Monitoring and Maintenance Support Agreement

6.9.0.2 Project Overview

- BESS database with model number, serial number, power and voltage rating, test data, etc. for all dc-side and ac-side components in BESS.
- Site master control system data base with model number, serial number, power and voltage rating, test data for all components
- Balance of Plant Database complete with model number, serial number, applicable rating for all Equipment including but not limited to inverters, transformers, switchgear and breakers.

6.9.0.3 Specification sheets for all subcomponents

6.9.0.4 Studies and Reports

6.9.0.5 Manufacturing Record Books documenting the manufacture of all major system components and subsystem assemblies

6.9.0.6 Commissioning Reports, Test Reports, Inspection Reports and QA/QC Documentation

6.9.0.7 Acceptance Test Reports

6.9.0.8 All Factory Test Results

6.9.0.9 Independent Laboratory Test Results

6.9.0.10 Test Reports, Inspection Reports and QA/QC Documentation including NCR Register with all non-conformance actions closed.

6.9.0.11 Other project documentation that would reasonably be required for BLPC to document the construction of the BESS and operate the BESS in the future.

6.9.1 Vendor shall provide comprehensive Operating Manual, detailing all services to be provided through the duration of the life of the system.

6.9.2 Complete Project Manual and Operating Manual, as well as an emergency management guide, shall be submitted to Owner no later than substantial completion. Vendor will provide formal training on all operational requirements to Owner personnel.

7 ELECTRICAL REQUIREMENTS

7.1 General

7.1.0 It is the Vendor's sole responsibility to ensure that all aspects of electrical design for the Project comply with all local code requirements and Applicable Standards, including, but not limited to, the BLPC Grid Code and requirements of the Government Electrical Engineering Department and all service and interconnection requirements of Owner.

7.1.1 All electrical design including conductors and equipment design attributes shall comply with the codes and standards listed in Section 4, including, but not limited to, ampacity rating, jacket type, conditions of use, conductor color conventions, labeling, terminations, conduit fill, protection and isolation, disconnecting means, signage, and labeling requirements. The electrical design shall be prepared under the responsible charge of an appropriately registered or licensed Professional Engineer (P.Eng.) and verified by an appropriately registered Engineer in Barbados.

7.1.2 Equipment specifications shall comply with Sections 9, and 10.

7.1.3 Vendor is responsible for electrical system studies for the design of all electrical components and systems, including but not limited to, touch and step potential, dc and ac short circuit studies, load flow study, protective device coordination, arc-flash hazard, grounding studies, dc and ac voltage drop calculations, cable sizing and thermal ampacity calculations for conditions of use and shall be signed and sealed by an appropriately licensed P.Eng. or registered engineer in a jurisdiction deemed appropriate by the AHJ. It is expected that the Vendor shall provide an ETAP model for each BESS such that the Owner may optionally perform load flow, short circuit, transient and protective device coordination studies. The ETAP model shall include the various operating modes of the BESS and associated control or transfer functions.

7.1.4 In addition to the requirements in 7.1.3 above, Vendor shall be responsible for the overall system engineering studies and detailed design for all elements, systems, facilities and equipment to verify that the specified performance criteria are met for the full range of system conditions. At a minimum the below described studies would be expected. The Vendor shall clearly indicate to the Owner if any of the below studies can not be provided,

7.1.4.4 Insulation coordination Study for ac and dc equipment, including limiting events that define ratings of arresters, and demonstrating required margins are met for the relevant equipment.

7.1.4.5 Detailed Interference Study

7.1.4.6 Audible Noise Study and calculations

7.1.4.7 Plant protection design, showing required coordination and redundancy within the BESS. BLPC will perform its own protection/coordination study to determine protection devices needed at the POI.

7.1.4.8 Losses report

7.1.5 Reports shall be provided to Owner justifying main circuit equipment protection and confirming equipment ratings.

7.1.6 Vendor is responsible to engineer all aspects necessary for a fully functional Project, including but not limited to, the following items:

7.1.6.1 BESS ac and dc side components: cabling, complete grounding design, surge/lightning protection, and inverters.

7.1.6.2 Site master control system

7.1.6.3 Balance of Plant: Transformer(s), switchgear, cabling, protection, and isolation devices, SCADA, surge/lightning protection, as applicable.

7.1.7 Arc fault circuit protection shall be provided in accordance with the IEC 62606

7.1.8 T he BESS or equipment shall not create Electromagnetic Interference.

7.1.9 The BESS or equipment sites may have low fault levels, potentially below 500MVA with x\r less than 3. The Vendor is responsible to confirm the maximum and minimum three phase and single phase short circuit design level for each project.

7.1.10 Clearances and access ways shall comply with latest revision of the National Fire Protection Association NFPA 855 Standard for the Installation of Stationary Energy Storage Systems.

7.2 Study Tools and Software

7.2.0 Vendor shall provide a ETAP model for the specific BESS proposed within 2 months of contract award to enable BLPC to perform studies including the BESS on the BLPC system

7.2.1 Vendor shall provide for future compatibility of ETAP model for ten years. The model provided shall be compatible with future revision ETAP.

7.3 BESS

7.3.0 BESS shall be assembled and installed in accordance with applicable international standards which should be referenced.

7.3.1 BESS shall be housed in its own building(s) or enclosure(s) supplied by the Vendor.

7.3.2 The following BESS requirements applicable to the Vendor are provided to guide the Vendor for its Design:

7.3.2.1 Batteries with exposed live parts shall be kept in a room or enclosure accessible only to authorized personnel.

7.3.2.2 Batteries shall not be subjected to ambient temperatures greater than 45 °C or less than the freezing point of the electrolyte.

7.3.2.3 Battery trays, racks, and other surfaces shall be level, protected against corrosion from electrolyte and covered with an insulating material having a dielectric strength of at least 1500 V.

7.3.2.4 Installation of wiring and equipment in a battery room shall be in accordance with the requirements for a dry location.

7.3.2.5 Overcurrent dc protection for conductors connected to batteries shall be provided in accordance with the applicable ANSI/IEEE standard referred to in Attachment M or any other applicable standard.

7.4 BESS Plant Controller

7.4.0 Hardware specific to the BESS Plant Controller, if required, will be housed in a room or enclosure accessible only to authorized personnel.

7.4.1 BESS Plant Controller shall have a dual power system rated and specified to be fed from a UPS which shall provide backup power long enough to safely monitor and shutdown system during emergency.

7.4.1.1 All network switches will be supplied by dual power system rated and specified to be fed from UPS.

7.5 Ride Through

7.5.0 The BESS and all associated equipment shall meet voltage and frequency ride-through and fault requirements for a generating facility as specified in the BLPC Grid Code.

7.6 Vendor Protective Relaying

7.6.0 BESS shall have a protective relaying scheme, for protecting the dc and ac side of the BESS from faults, Including line to ground faults, as well as abnormal voltage and frequency conditions.

7.6.1 All protective relays shall be utility-grade and shall have the required ANSI protection functions (e.g., 25, 32, 27, 67N, 67, 59, 81u, 81o, 50/51, etc.) as prescribed in IEEE 1547-2018 and Owner's technical protection requirements (in case of conflict between the two, Owner's requirements take precedence).

7.6.2 The protection devices, including circuit breakers and fuses, in the BESS should be capable of adapting to different short circuit levels based on the configuration of the Owner Electric Power System, and tolerating maximum available fault levels.

7.6.3 BESS inverters shall be sized to provide sufficient zero sequence and/or negative sequence fault current (to the extent possible) to provide protective relays with adequate selectivity and sensitivity. The control system shall have the capability to control the sequence current in an unbalance fault event. If the control system doesn't have sequence current controller, the proponent shall explain the methodology used to avoid any undesirable outcome in the event of unbalanced fault.

7.6.4 Closing of Project main breaker to reconnect with Electric Power System should require appropriate synchronization check elements and should consider all possible system configurations including islanded and grid-connected modes. Synchronization check relay should be set according to the results of detailed protection and control study (which should consider all operational conditions of the project) and in consultation with Owner.

7.7 Digital Fault Recorder Function (DFR)

7.7.0 The DFR shall record all significant signals to enable post event trouble-shooting and analysis. The DFR or sequence of events recorder shall also record critical digital (contact-type) inputs for all protection/trip functions.

7.7.1 DFR traces and trending analysis shall be remotely accessible.

7.7.2 T The vendor shall supply and include in their price 5 copies of all required remote client software compatible with Windows 10 , for downloading and analysis of DFR data. The proposal price shall include all required software licenses for these 5 copies including Software Assurance for 5 years.

7.8 Protection and Isolation Devices

7.8.0 Vendor shall protect all the equipment within their scope of work against all over-voltages including the dc, fundamental, dynamic, harmonic, ferro-resonance, switching type, lightning type and fast front over-voltages under all steady state, dynamic and transient conditions caused by disturbances in the ac and dc systems and/or control mal-operation.

7.8.1 Overcurrent protection devices shall be appropriately rated for the expected continuous operating voltages and currents as required by Owner as applicable to the equipment and work.

7.8.2 Overcurrent protection devices shall be rated for reverse flow.

7.9 Lightning Protection

7.9.0 Vendor shall provide all measures of protection including surge arresters and surge capacitors to protect all ac and dc equipment from any type of stress for all modes of operation, power levels and control modes.

7.9.1 Vendor shall evaluate the need for lightning protection using an NFPA 780 risk analysis; as appropriate components use shall be listed to UL 96.

7.9.2 Lightning protection system shall meet the standards of CAN/CSA B72

7.9.3 Lightning arresters shall be provided to protect any transformers.

7.9.4 Lightning arresters shall be provided at each inverter station on the ac side.

7.9.5 Where lightning arresters are installed inside a building, they shall be located well away from all equipment other than which they protect and from passageways and combustible parts of buildings.

7.9.6 Lightning arresters shall be provided on above-ground electrical power line poles.

7.10 Telecommunication/Telecontrol Interference

7.10.0 Vendor shall take the necessary precautions to ensure that there will be no misoperation, damage or danger to any equipment, system, or personnel due to interference effects. Neither shall the BESS disturb, damage or cause misoperation of its control or protection systems.

7.10.1 Vendor shall take all means necessary to avoid any interference with power line carrier systems operating with a frequency range of 10 kHz to 500 kHz. Noise shall be limited to 1 mV into 600Ω impedance at the PLC equipment.

7.10.2 The contribution of the BESS to the RF noise level measured in the vicinity of transmission lines and substations shall be negligibly low, within a frequency range of 150 kHz to 300 MHz. Noise measuring method shall be used to evaluate the additional noise quantity generated by the BESS within a frequency range of 10 kHz to 300 MHz. Measurement shall be performed on the 138 kV network at a site within an approximate distance of 1 km from the BESS for Company acceptance against previously established baseline measurements.

7.11 Electrical Grounding

7.11.0 Grounding system design and testing shall be performed in accordance with Owner's grounding and safety requirements as well as applicable ANSI/IEEE or IEC standards.

7.11.1 Grounding design shall comply with requirements of the BLPC Grid Code and IEEE Std 80 for switchyards/substations and major equipment pads. All metallic objects, likely to be energized shall be grounded. This list includes (but not limited to): module frames, all racking structure members, metal conduit, metal enclosures, fencing, equipment pads, skids, etc.

7.11.2 Grounding system design shall be based on site soil electrical resistivity test data and modelling performed per I EEE Std 81

7.11.3 Vendor shall provide an overall electrical grounding schematic of the Project. The grounding schematic shall indicate the primary connections to earth and the manner in which all components are grounded.

7.11.4 The Project shall include remote ground fault detection within each inverter block.

7.11.5 All grounding and bonding conductors shall be stranded copper.

7.11.6 Hardware utilized in grounding design shall avoid risk of galvanic corrosion from contact of dissimilar metals.

7.11.7 All ground lugs and ground terminations shall be UL Listed for use in the environment installed. Grounding connections terminated below grade shall be UL Listed specifically for direct burial applications.

7.11.8 Equipment grounding conductors shall be routed with the associated phase conductors.

7.12 Auxiliary & Backup Power

7.12.0 Site master control system, electrically operated switches, relays and protection equipment, inverter control systems shall have two sources of dc power – a UPS and the installed BESS.

7.13 Site Lighting

7.13.0 Vendor shall be responsible for lighting during construction phase only. Site lighting shall be in accordance with OSHA requirements.

7.14 Signage

7.14.0 Signs shall be posted in English indicating:

7.14.0.1 the presence of electrical equipment

7.14.0.2 the presence of multiple power sources

7.14.0.3 the presence of battery energy storage systems (and any chemistry specific hazards)

7.14.0.4 that entry is restricted to authorized personnel only

7.14.0.5 trespassing is not allowed

7.14.0.6 the Site is monitored by a security system

7.14.1 A sign shall be posted at agreed upon location with contact information for the Owner and Operations and Maintenance Vendor, as well as an Emergency Management 24/7 call in number.

7.14.2 A dc and ac single line diagram shall be posted, that clearly identifies the ac and dc disconnect locations. If not apparent from the single line diagrams, a Project map shall also be provided indicating the approximate locations of the disconnect switches. Ac and dc disconnect switch designations shall match the electrical drawings, device labels and LOTO procedures.

7.15 Equipment Marking and Labeling

7.15.0 General Requirements

7.15.0.1 Marking and labelling shall be in accordance with Owner and BLPC Grid Code requirements.

7.15.0.2 Signage and labels shall be weather-proof, corrosion-proof, UV-stabilized and fade-resistant and shall be capable to last the duration of the minimum Design Life.

7.15.0.3 Signs shall be attached using mechanical means or non-corrosive materials suitable to meet the Design Life.

7.15.0.4 All combiners, inverters, transformers, disconnect switches and circuit breakers shall have an engraved permanent identification label visible and readable from distance of 48" that provides the unique equipment identification number as indicated on the electrical drawings and in the LOTO procedure.

7.15.0.5 All conductors shall bear permanent cable labels at each end that uniquely identify the cables and are traceable to the electrical drawings.

7.15.0.6 DC wire color-coding shall be consistent and identified by permanent labels on associated equipment

7.15.1 Inverters, transformers, and disconnects

7.15.1.1 The metering cabinet and main distribution panel/switchgear containing main disconnect switch shall be properly marked "WARNING – POWER FED FROM MORE THAN ONE SOURCE" or equivalent.

7.15.1.2 Each transformer shall have a proper label identifying its rating, configuration, and specifications.

7.15.1.3 All ac and dc disconnecting means shall be marked "Battery Energy Storage System DISCONNECT MEANS – AC DISCONNECT" and "Battery Energy Storage System DISCONNECT MEANS – DC DISCONNECT" or equivalent.

7.15.1.4 A single-line diagram of the as-built system shall be posted permanently to both the supply authority disconnecting means and on the metering cabinet.

7.15.1.5 All transformers and disconnect switches shall have an engraved permanent identification label visible and readable that provides the unique identification number as indicated on the electrical drawings and in the LOTO procedure.

8 CIVIL, GEOTECHNICAL AND STRUCTURAL REQUIREMENTS

8.1 General

8.1.0 It is the Vendor's sole responsibility to ensure the Project civil, structural and architectural facilities comply with all local code requirements and all industry codes and standards.

8.1.1 Vendor is responsible to determine all Site data necessary for the design and construction of the Project, in line with Owner's specification. This includes, but is not limited to, determination of geotechnical conditions, local environmental design considerations (wind, rain and ashfall from volcanic eruption which is has a low probability of occurrence), seismic design coefficients, flood design criteria, and any areas restricted from construction.

8.1.2 Vendor shall perform all necessary studies of the Sites to establish all required design-related parameters related to civil, structural and geotechnical of BESS, including foundations.

8.1.3 The Vendor shall determine if any further geotechnical study or drainage study needs to be performed for the BESS.

8.1.4 Vendor shall comply with the recommendations of Site studies performed as provided by Owner. If in the event Vendor finds apparent conflict with Owner supplied data, Vendor is to formally notify Owner of the matter and reason for such determination.

8.1.5 The Vendor shall provide all structural calculations and drawings to the Owner, with the 30% Design Documents.

8.1.6 The drawings, calculations, and documents to support the design of all civil and structural elements shall include, but are not limited to:

8.1.6.1 Inverter foundations, BESS foundations, transformer foundations, and any other ancillary structures and foundations if needed.

8.1.6.2 Access/entry roads, retaining structures, soil stabilization measures.

8.1.6.3 Product specifications, installation manual, operations and maintenance manuals and other commissioned or forthcoming reports

8.1.7 The Owner and Owner's Engineer will review drawings, calculations, and documents and submit comments. The Vendor shall address in writing any and all comments received from Owner.

8.2 Drainage

8.2.0 The Vendor shall perform all necessary hydrological and drainage studies of the Site to establish all design-related parameters and mitigation measures related to the 1 in 100 year storm event's impacts including, but not limited to, flood inundation depths to all electrical equipment, structures and scour potential to Project roadways and all foundations.

8.2.1 The Vendor shall provide a 1 in 100 year final storm water drainage report that provides a discussion on potential Increased post construction permeability, scour potential and mitigation, flood depth elevation, electrical equipment flood depth freeboard, road side drainage, culvert and drop inlets, C-value, descriptions of pre and post development basins and flows, mapped or known flood zones, snow melt (if any), retention, detention or overland flow recommendations, quantity control, on-site quality control, conveyance and end-of-pipe control, temporary and permanent sediment and erosion control recommendations, existing and proposed drainage structures, and hydrologic volume calculations to assess the volume of total containment required within the transformer foundations, if applicable.

8.2.2 Vendor shall develop, install, maintain and finalize all necessary Storm Water Pollution Prevention Program documentation to be in compliance with all federal, local, and district codes and regulations.

8.2.3 Finish grades shall be sloped to deter surface ponding and promote positive surface drainage away from equipment, structures and general site. Grading within the BESS project area shall meet the requirements specified by the geotechnical and hydrologic recommendations and the manufacturer of the BESS systems. All grading and drainage shall be per the approved civil engineering plans.

8.2.4 Vendor shall provide a site grading and drainage plan that shall prevent scour and flood inundation, Consistent with:

8.2.4.1 Local laws and regulations.

8.2.4.2 The design assumptions and criteria of the foundations.

8.2.4.3 Pollutant discharge and other environmental permitting restrictions on construction and the finished Project.

8.2.4.4 Consideration of the safety of personnel and wildlife through the construction work.

8.2.4.5 Batters and steep slopes that are disturbed in the course of the Project shall have a suitable means of stabilization applied.

8.2.4.6 Erosion control measures shall be installed in accordance with Local standards and regulations.

8.2.4.7 Appropriate means of energy dissipation shall be incorporated into the site drainage.

8.2.4.8 Vendor shall provide drainage for a 25-year return period flood event for road and road-side drainage infrastructure.

8.2.4.9 Vendor shall engineer for sufficient freeboard to the BESS and auxiliary building to the 100-year return period flood.

8.2.4.10 The natural drainage patterns of the Site shall be maintained, and ponding shall be prevented, other than explicitly where small scale ponding is specifically designed to minimize erosion during drainage. Any pre-existing drains which are damaged in the Work shall be restored.

8.2.4.11 Access road drainage shall be integrated to promote positive drainage, prevent water flow on the roads and avoid scour potential.

8.2.4.12 Excavations shall be fully drained prior to any construction work within them.

8.3 Geotechnical Requirements

8.3.0 General

8.3.0.1 All geotechnical investigation work shall be prepared, conducted and supervised by experienced Civil/Geotechnical Engineer, who are legally qualified and licensed to practice Civil/Geotechnical Engineering and satisfy all local requirements.

8.3.0.2 It is the Geotechnical Engineer's sole responsibility to ensure that all borings, field tests, laboratory tests, and engineering computations be conducted and interpreted in accordance with all local code requirements and all applicable industry codes and standards.

8.3.0.3 All Site data necessary for the design and construction of the Project should be determined based on the results of geotechnical investigation. This includes, but is not limited to, determination of soil parameters for foundation design, seismic design coefficients, flood design criteria, seismic hazard evaluation, site drainage, potential geologic/geotechnical hazards and any areas restricted from construction.

8.3.0.4 Geotechnical Engineer shall perform all necessary subsurface investigations to establish all soil parameters for design of the Project and document the investigations and results in a Geotechnical Report.

8.3.0.5 The Geotechnical Engineer shall perform analysis to verify, but not limited to, the proposed foundation suitable for the BESS, and any other structures.

8.3.0.6 The Geotechnical Engineer shall assess the soil infiltration rates required for design of the retention pond as required and site drainage (as required).

8.3.1 Document Review

8.3.1.1 Review of available geologic maps and reports for the project site and vicinity shall be performed and the reviewed geologic information shall be documented in the Geotechnical Report.

8.3.3 Field Boring Program

8.3.3.1 The Vendor shall provide the results of boring tests.

8.3.3.2 Preliminary soil classifications are to be made visually in the field and verified by further inspection in the laboratory and from test results. The information shall be compiled on the respective boring logs.

8.3.4 Geotechnical Analysis

8.3.4.1 Geotechnical Engineering analyses shall include, but not limited to, the following:

8.3.4.1.1 Evaluation of soil/rock engineering properties and strengths.

8.3.4.1.2 Evaluation of pile drivability (if applicable) and/or excavation characteristics.

8.3.4.1.3 Evaluation of geologic/geotechnical hazards.

8.3.4.1.4 Evaluation of suitability of proposed Project site based on the results of geotechnical exploration.

8.3.4.1.5 Evaluation of the geotechnical resistance factor to be incorporate in the foundation stability analysis, in accordance with CFEM and IBC. The latest version of the IBC adopted by the AHJ shall be utilized for assessment of the geotechnical resistance factor.

8.3.4.1.6 Evaluation of pile design axial capacity (skin friction and end bearing), lateral pile capacity, potential total and differential settlement, and pile downdrag loading (negative skin friction) if applicable.

8.3.4.1.7 Evaluation of pile responses to axial tension and compression loading, as well as lateral loading.

8.3.4.1.8 Evaluation of shallow foundation bearing, overturning, and sliding capacity.

8.3.4.1.9 Evaluation of seismic hazards to the project, including seismic shaking, liquefaction. seismically induced settlement, lateral spreading, earthquake induced landslide, tsunami, and fault rupture.

8.3.5 Geotechnical Report

8.3.5.1 Hard copies and an electronic (*.pdf) copy of the geotechnical report shall be submitted and shall include, but not be limited to, the following items.

8.3.5.1.1 The report shall be suitable for independent engineer review, local agency review, and other applicable regulatory agencies.

8.3.5.1.2 A description of the field investigation and laboratory-testing programs.

8.3.5.1.3 A description of the subsurface conditions, and the logs of all borings. If applicable, each boring log shall note ground water depth with data and time of depth reading.

8.3.5.1.4 A summary of groundwater measurements as determined during the geotechnical investigation.

8.3.5.1.5 Discussions of test procedures and results shall be presented for each specified laboratory test by following the appropriate ASTM or other standards. All of the test data and reduced parameters shall be included in an appendix. The uncorrected and corrected blows per foot from the Standard Penetration Test shall be reported for reference.

8.3.6 Evaluation of geological/geotechnical hazards to the project including, but not limited to, the following:

8.3.6.1 Seismic site class and site response parameters.

8.3.6.2 Geotechnical impacts of soft deposits with low load bearing and high shrink/swell potential.

8.3.6.4 Geotechnical impacts of hurricane/storm surge.

8.3.6.5 Geotechnical impacts of seismicity, including liquefaction, lateral spreading, seismically induced settlement, earthquake induced landslide, ground rupture, and other seismic effects.

8.3.6.6 Geotechnical impacts of flooding and scour.

8.3.6.7 Geotechnical impacts of groundwater and groundwater fluctuation.

8.3.6.8 Corrosion potential of concrete in contact with on-site soils.

8.3.6.9 Corrosion potential of buried metal.

8.3.6.10 Any other pertinent geotechnical hazards identified by the Geotechnical Engineer.

8.3.7 Geotechnical Engineering recommendations including, but not limited to, the following:

8.3.7.1 Foundation design for BESS facilities.

8.3.7.2 Foundation design for Control House, if applicable.

8.3.7.3 Mitigation of geologic/geotechnical hazards, if applicable.

8.3.7.4 Mitigation of liquefaction and seismic impacts, if applicable.

8.3.7.5 Earthwork and compaction.

8.3.7.6 Recommendations on depth of frost penetration and mitigating measures regarding foundation types.

8.3.7.7 Recommendations for mix design of concrete in contact with on-site soils.

8.3.7.8 Recommendations for metal components in contact with on-site soils.

8.3.7.9 Recommendations for project site access roads, including subgrade preparation. road structural section material and compaction requirements.

8.3.7.10 Geotechnical recommendations for drainage.

8.3.7.11 Any other pertinent geotechnical recommendations for the project as identified by the Geotechnical Engineer.

8.4 Groundwater Monitoring Program

8.4.0 Groundwater levels shall be observed and measured during and after the drilling operation. Special techniques must be used if drilling slurry is used to advance the borehole.

8.5 Structural steel and fasteners

8.5.0 Design and construction of structural steel shall be in accordance with CSA-S16 or equivalent standard such as BS316S16, BS-4449 for reinforcement bars. Structural steel shall be of Grade 43C and conform to BS 4360.

8.5.1 Any structural or miscellaneous steel shall meet the requirements of the applicable CSA or ASTM standard based on the application and CSA requirements for welded materials.

8.5.2 Stainless steel hardware shall conform to ASTM F593.

8.5.3 Mechanical fasteners used in any structural or support system shall meet the requirements of ASTM A325 or A490 for bolts nominally 12 mm diameter and larger, or ASTM A449 for bolts smaller than 12 mm diameter.

8.5.4 Anchor bolts used to secure any structural member to the ground or a foundation shall be galvanized and specifically identified by the structural engineer and include installation requirements, minimum projection, material grade, appropriate ASTM standard and torque specification. Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36, or A307. Anchor bolt sleeves shall conform to ASTM A501.

8.6 Aluminum

8.6.0 Design of structural and miscellaneous aluminum shall be in accordance with the latest edition of CSA S157, the Aluminum Association – “Aluminum Design Manual” and “Aluminum Standards and Data.”

8.6.1 Materials for structural and miscellaneous aluminum, including structural shapes and plate, shall conform to ASTM B209 and ASTM B308.

8.6.2 All structural aluminum welding shall conform to the requirements of the latest revision of the CSA W59.2.

8.7 Corrosion prevention

8.7.1 All Project Equipment shall be protected from corrosion due to known or expected atmospheric and soil conditions local to the Site in accordance with the Design Life and recommendations by the civil or structural engineer.

Consideration shall be given to humidity, salinity, acidity, condensation, air particulates and other conditions likely to cause or accelerate corrosion of materials.

8.7.2 A service life analysis shall be completed by a civil or structural engineer that takes into account atmospheric conditions at the Site in order to estimate corrosion rates. The service life shall meet or exceed the required minimum Design Life.

8.7.3 Structural design calculations shall be based on the reduction in steel thickness over the Design Life of the Project as determined by the civil or structural.

8.7.4 Contact of dissimilar metals and finishes shall be avoided or intentionally managed to prevent premature galvanic corrosion.

8.7.4.1 Aluminum shall not be in direct contact with concrete or copper.

8.7.5 Support structure components in contact with soil shall be protected from detrimental subsurface corrosion for the Design Life of the Project.

8.7.6 Fasteners and hardware shall be stainless steel (300 series, if available with required mechanical strength) or hot-dipped galvanized steel.

8.7.7 Galvanizing of steel products shall conform to the requirements of ASTM A123, ASTM A153, or ASTM F2329, as appropriate.

8.7.8 Zinc-aluminum-magnesium alloy coated sheet steel shall conform to the requirements of ASTM A1046.

8.7.9 For any components where the galvanization is disturbed due to factory processing or during installation, those surfaces shall be repaired in accordance with ASTM A780 and A780M-09.

8.8 Structural design requirements

8.8.0 Structural design loads

8.8.0.1 The design loads and other information pertinent to the structural design – including, but not limited to, wind design data seismic design criteria, dead loads, – shall be indicated on the construction documents. The latest or local version of the IBC adopted by the AHJ shall be utilized for generation of design loads.

8.8.0.2 Load combinations shall be determined in accordance with IBC, Design Loads for Buildings and Other Structures, and from appropriate material codes. The latest version of the IBC adopted by the AHJ shall be utilized for generation of load combinations.

8.8.0.3 Dead loads shall include all gravity loads due to self-weight of permanent structural and non-structural components, including permanent hung loads.

IBC8.8.0.4 Seismic and wind loads shall be in accordance with the local revisions of the IBC.The Site classification of soil shall be as indicated in the geotechnical report for the site.

8.8.0.5 Structural design shall account for thermal loads including thermal expansion, contraction and cycling. Buildings and structures shall be designed for forces and/or displacements resulting from changes in ambient temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.

8.8.1 Structural design calculations

8.8.1.1 The structural analysis shall conform to the local version of the IBC, and any referenced material design codes.

8.9 Concrete equipment foundations

8.9.0 Design of structural concrete shall be in accordance with the latest version of the Canadian Standards Association (CSA) A23.3. All concrete formwork shall conform to CSA-S269.3-M92 or equivalent BS standard.

8.9.1 Construction of the concrete shall be in accordance with CSA A23.1, A23.2, and A283 or equivalent BS standard.

8.9.2 Steel reinforcement shall be minimum 500 MPa and conform to CSA G30.18. Welded steel mesh shall conform to CSA G30.5. Placement shall be in accordance with CSA A23.3 and the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.

8.9.3 Concrete shall conform to CSA A23.1, A23.2, and A23.3 with a 28-day compressive strength of 35 MPa minimum, or strength as required per design.

8.9.4 Aggregates for normal weight concrete shall conform to CSA A23.1.

8.9.5 Concrete mix proportions, including documentation of materials, admixture product information, and compressive strength of mix, shall be submitted and approved by the Owner prior to placing concrete.

8.9.6 Water used for concrete shall be clean and potable.

8.10 Roads

8.10.0 Access paths or temporary roads, erosion control and drainage systems shall comply with the site Geotechnical Report.

8.10.1 For permanent roads, protection of equipment from impact events from vehicles should be considered to protect equipment from damage.

8.10.2 Access roads shall include a compacted sub-base with aggregate rock driving surface, a minimum width of 6.1 m and designed for proper drainage and expected vehicular traffic loading, including heavy loads and loading from heavy equipment deliveries during the project. Consideration shall be given to facilitate access and turning radii for large vehicles used during project deliveries.

8.10.3 Use of Geosynthetics shall be designed by a licensed Civil Engineer.

8.11 Trenches

8.11.0 Cables and conduits installed in trenches shall comply with NEC requirements and cable spacing shall be supported by the ampacity studies.

8.11.1 Directly buried cables shall not directly cross, rest or touch adjacent cables, except in a single circuit tri-foil arrangement.

8.11.2 Directly buried or ducted cables shall have a minimum of 150 mm of approved backfill material between layers and shall have a minimum depth of 800 mm.

8.11.3 All buried cables and conduits shall include a marker plastic cable protection covers 800 mm below grade continuously over the conductors.

8.11.4 Trench backfill shall be compacted in accordance with project drawings and specifications, and comply with the recommendations of the Site studies.

8.11.5 A sand bed or other approved aggregate of at least 100 mm depth shall be used as the base layer for all trenches housing direct buried cables. The sand bed shall be clean natural sand, clay, organic matter and should not include other objectionable materials. Bedding material shall be free of aggregate exceeding 10 mm.

8.11.6 Trench shall be backfilled with clean fill material free from aggregate, debris, organic material and stones. An engineered fill shall be used if required based on the cable ampacity calculations.

8.11.7 Trenches shall be backfilled in layers of no more than 150 mm each and mechanically compacted to 95% of maximum density at optimum moisture content per ASTM D698, or as recommended by the geotechnical engineer.

8.11.8 Contractor shall take appropriate measures to minimize the time that trenches are left open.

8.11.9 Trenches shall not be backfilled while there is any standing water in the trench.

8.11.10 Owner shall inspect and repair sand beds in open trenches after rainfall events.

8.11.11 Conduit stub-ups and sweeps shall be used for all conductors entering and exiting a trench.

8.11.12 Open conduit ends shall be equipped with bushings and approved sealant to reduce intrusion of water, rodents and insects.

8.11.13 Trenches shall be designed and constructed, to the extent possible, in straight lines and not routed below Project Equipment.

IBC9 EQUIPMENT SPECIFICATIONS – BESS

9.1 General

9.1.0 BESS shall comply with functional requirements in Section 5

9.1.1 BESS includes any dc-side subsystems, ac-side subsystems, BMS, EMS, and other software and hardware components required to electrically and mechanically interconnect to, communicate with, and operate in coordination with Owner facilities and electric grid.

9.1.2 Systems shall meet all applicable safety, health, environment, electrical, and fire codes and standards, as detailed in Section 4.

9.1.3 Systems shall be rated in terms of net delivered power and energy, as measured (or calculated, if not measured) at the BESS interconnection and metering point. Loss rates (for thermal management or other internal systems) must be accounted for in this calculation.

9.1.4 The system shall be capable of providing or absorbing reactive power at 100% of the real power rating, regardless of real power output or state of BESS charge cycle

9.1.5 The BESS must be designed to meet the ratings that follow below, with warrantied capacity retention in line with industry norms, and operational for the entirety of the Design Life. Power, energy, and ampacity ratings are assumed to apply throughout the full operating temperature range and various states of charge. If this is not the case, the Vendor must supply documentation detailing changes with respect to these variables. If system requires oversizing or an O&M plan to meet such specifications, this should be identified and explained by Vendor, with additional costs identified as a separate line item.

9.1.6 Capacity Guarantee: Shall be as described in Section 5.2.3.

9.1.6.1 In support of the Capacity Guarantee, Vendor shall provide: warranty (along with any limitations, exclusions and conditions), annual guaranteed energy capacity curve, and testing protocols. BESS Capacity Test shall be performed as described in Section 11.4.

9.1.6.2 Owner shall perform annual battery capacity performance test in accordance with Vendor's test protocol. Vendor shall have the option to witness this annual test to review results and procedures.

9.1.6.3 Annual Capacity Test shall demonstrate the capability to discharge the guaranteed energy capacity at the Rated Power Capability.

9.1.6.4 Annual Capacity Test shall be used to calculate the round trip efficiency (RTE) of the BESS. The RTE shall meet the specification listed in Section 5.2.4.

9.1.6.5 If Capacity Test performance does not meet capacity guarantee, Vendor is obligated to restore system energy capacity in accordance with Capacity Guarantee.

9.1.6.6 Vendor shall maintain an on-site data historian that records and audits all BESS operating information necessary to evaluate compliance with Capacity Guarantee; such records to be made available to Owner in real-time and subject to audit.

9.1.6.7 Degradation: Vendor shall provide a degradation curve applicable to expected use case. In case the degradation curve does not meet the required energy retention, Vendor shall provide a maintenance plan including capacity refresh schedule for maintaining energy capacity through system life.

9.1.6.8 Capacity Augmentation: The Owner may desire to further augment the battery beyond the levels guaranteed by the Capacity Guarantee. To support this, the Owner requires submission by the Vendor of a price list for all dc-side and ac-side components.

9.1.6.9 The BESS design shall be coordinated with the Owner to allow for various schemes of capacity maintenance; such as allocating extra space in the battery container for future system upgrades.

9.1.7 Approved battery manufacturer: All batteries shall be new and shall be purchased from the same battery manufacturer.

9.1.8 Design criteria

9.1.8.1 Power capacity: As described in Section 5.4.0

9.1.8.2 Energy capacity: As described in Section 5.4.1

9.1.8.3 Technology: Vendor to specify

9.1.8.4 Approximate weight: As described in Section 5.4.3

9.1.8.5 Approximate size: As described in Section 5.4.4.

9.1.8.6 BESS shall have a risk category (for determination of flood, wind, and earthquake loads) assigned to it that is consistent with its makeup of hazardous materials, with reference to ASCE 7-16.

9.1.9 Regardless of actual installed energy capacity, the BESS must be able to provide charge and discharge from 0 – 100% SOC for any operating year in accordance with the Capacity Guarantee.

9.1.10 Round trip efficiency: ac-ac roundtrip efficiency expectations must be provided by the Vendor, including all losses under worst case conditions. The RTE shall meet the specification listed in Section 5.2.4.

9.1.11 Self-discharge: All losses the system experiences during normal operation, stand by, or while shut down shall be defined.

9.1.12 Isolation/Disconnect: In case of fault, surge, or other emergency, the BESS disconnect shall be able to exceed the full-rated power of the system.

9.1.13 BESS shall be protected against uncontrolled reverse current flow under fault conditions.

9.1.14 System life: The BESS must be capable of operating daily for extended periods of time, cycling per application requirements, for the Minimum Design Life. Any system limitations during normal operation should be disclosed by the Vendor, demonstrating the relationship to depth of discharge and cycle life for the life of the system. The system should be sized to account for these limitations.

9.1.15 The BESS shall be primarily utilized as a grid connected BESS. However, vendor shall provide microgrid functionality and pricing. Microgrid functionality shall include grid-following and grid-forming capabilities

9.1.16 BESS grid interconnection point shall meet all Project requirements including any requirements outlined in the BLPC system impact study.

9.1.17 Grid code and system operating conditions (e.g., power quality and reliability requirements) as prescribed by Owner.

9.1.18 In order to meet the requirements of its intended applications, the BESS shall include an Energy Management System (EMS). The EMS may be integrated with the Plant Controller or provided separately. In the event it is provided separately the EMS shall comply with the requirements of the BESS Plant Controller as stated in Section 5.5. The BESS EMS/Plant Controller shall, at a minimum:

- Communicate with Owner's SCADA system and control the BESS to operate within the Owner's specified control envelope
- Connect to BMS and inverters to allow both charging and discharging of the battery.
- Communicate with and, if necessary, provide power to external control systems such as a BESS Plant Controller.
- Monitor and report on the BESS, including information such as state of charge (SOC), state of health (SOH), voltage, current, frequency, temperature, and status
- Control the BESS within constraints of these variables for safe operation of the batteries
- Provide warnings or alarms in case of issue
- Provide fault and surge detection and protection, as appropriate
- Support autonomous operation, including stand-by mode, start-up, shut-down and disconnection, in case of communication failure or emergency.
- Provide operator over-ride capabilities to all automatic control functions if manual intervention is requested.

9.1.19 The BESS shall be capable of operation in the environmental conditions detailed in Section 5, whether with support of auxiliary systems, a suitable container, or by component design. The Vendor is responsible for the independent thermal management system of the BESS. By the utilization of these systems, the BESS and related components will be able to maintain the environment to a range where optimal performance of the system is possible. This will prevent high temperatures that could produce thermal runway, and humidity-induced shorts.

9.1.20 All equipment shall be new, fit for purpose, and of the specified quality.

9.1.20.1 All components and workmanship must be free from physical and electrical flaws and imperfections. The design shall not only be effective in engineering characteristics, but it must also comply with the finish requirements stated herein.

9.1.21 The maximum sound level generated from the BESS system and any associated equipment supplied by the Vendor under any output level within the BESS operating range, shall be limited to 50 dBA at the station boundary.

9.1.22 All audible noise lasting less than one minute and occurring not more than 2 times in any one-hour period shall be limited to the above value plus an additional 10 dBA.

9.2 Inverter

9.2.0 The inverter(s) shall be tested and demonstrated to be able to interface effectively with the batteries and BESS Plant Controller, such that the system can perform safely and to the performance levels of the required design.

9.2.1 Inverters shall have an ac disconnect capable of electronic operation optionally by a remote ground fault relay

9.2.2 The inverter will be capable of communicating with the BESS Plant Controller over standard communication protocols such as Modbus, DNP 3.0, DNP 3.0 over TCP/IP or IEC 61850.

9.2.3 The inverter shall be capable of operating in all four power quadrants at rated power (kVA). Any combination of kW and kVAR output shall be possible that is consistent with the systems rated power.

9.2.4 Voltage regulation: At POI, the BESS must be capable of regulating voltage per ANSI C84.1 Range A at specified utilization points.

9.2.5 The inverter must be capable of receiving and interpreting commands from the BESS Plant Controller to control the battery power flow in magnitude and direction.

9.2.6 The inverter must be capable of operating in grid-following mode, following the grid frequency and phase, and in grid-forming mode to control voltage and frequency in concert with the BESS and BESS Plant Controller.

9.2.7 The inverter shall be capable of implementing voltage and frequency ride-through based on utility interconnection requirements for a generating facility when operating while providing grid forming as required. Ride-through set points must be field adjustable to allow optimization of microgrid operation.

9.2.8 The inverter must be capable of remote software updates to meet new system requirements should they arise. Such updates must be approved by the certifying NRTL prior to field implementation.

9.2.9 The inverter shall meet IEEE 519 - Recommended Practices and Requirements for Harmonics Control in Electrical Power Systems, as a source of generation, with a limit of 5% at its output terminals. Harmonic requirements relative to the padmount or integrated MV transformers associated with the inverter are covered in the following Transformers section 9.3.

9.3 Transformers

9.3.0 Transformers shall comply with all applicable standards and requirements, including IEEE Std C57 series, and be appropriate for interconnection to the grid and with the associated equipment.

9.3.1 Transformers shall comply with IEEE 519-2014 IEEE Recommended practices and requirements, for harmonics control in electrical power systems for harmonics. Transformer K factor rating.

9.3.2 The transformer K-Factor rating for the harmonic content for the non-linear load shall be minimum K-4.

9.3.3 Transformer shall be installed in accordance with the Barbados Grid Code and the Information and Requirements – Covering Installation of Electric Services and Meters.

9.3.4 Transformers shall provide deadfront, elbow-type bushings with suitable voltage ratings to connect to the Owner's medium voltage distribution grid.

9.3.5 Pad mount transformers shall include a suitable thermography (Infra-Red scan) window to allow for temperature measurements of terminations via an IR thermal imaging camera.

9.3.6 To ensure minimum harmonic generation, the saturation flux density of the transformer shall be higher than the maximum flux density reached during normal operation.

9.3.7 Pad mount transformers shall provide an electrostatic shield between LV and HV winding to isolate the HV winding from the effect of the fast rising voltage on the LV. The shield shall act as an additional dv/dt filter and filters the voltage gradient of the pulsed inverter output.

9.3.7.1 The electrostatic shields shall have single point earthing only.

9.4 BESS Enclosure/Shelter design

9.4.0 The BESS shall be designed with efficient space usage in mind

9.4.1 The BESS, inverters, and related system components are planned to be mounted on a concrete or equivalent pad or piers, as specified by the Vendor or original manufacturer, as appropriate. The Vendor should indicate how the installation will be affected for each case.

9.4.2 The outermost container for the BESS, BESS Plant Controller, inverters, and related components, whether an overall container (e.g., shipping container) or individual system component containers (e.g., for the batteries or inverter), must meet the following standards:

9.4.2.1 BESS Enclosure(s)/Shelter(s) must be provided with appropriate tools and instructions to allow on-site movement and installation.

9.4.2.2 All equipment located outdoors shall have BESS Enclosure(s)/Shelter (s) complying with IEC and/or and NEMA requirements for wet locations.

9.4.2.3 The BESS Enclosure(s)/Shelter(s) will have an IP or NEMA rating appropriate for exterior installations in corrosive environments.

9.4.2.4 There will be no dc cabling required to be installed external to the BESS system and components.

9.4.2.5 The BESS Enclosure(s)/Shelter(s) will allow for main and auxiliary power, as well as communications lines, to attach to the appropriate components and connections.

9.4.2.6 Where applicable, the system should be designed to minimize any potential risks of fires. However, in the case of a fire, the container(s) will be equipped according to applicable fire safety standards. This includes a detection and alarm system, documentation or training on safe firefighting methodology for the technology, and, if demonstrated as necessary by testing or if noted as required by AHJ, internal fire suppression equipment.

9.4.2.6.1 Where applicable, an active fire suppression system shall be used within the BESS Enclosure(s)/Shelter(s). Where applicable, the system should be designed to minimize any potential risks of explosion. However, in the case of an explosion, the BESS Enclosure(s)/Shelter(s) will be equipped according to applicable explosion prevention standards. This includes a detection and alarm system, documentation or training on safe ventilation or explosion prevention methodology for the technology, and, if demonstrated as necessary by testing or if noted as required by AHJ, internal ventilation equipment or deflagration panels. All BESS safety aspects shall be in line with Section 9.6.

9.4.2.7 The BESS Enclosure(s)/Shelter (s) shall be equipped with appropriate heating and cooling mechanisms operating in concert with or supplemental to the thermal management system of the BESS, to maintain operation within the optimal temperature ranges for the system, given the environmental conditions noted in Section 5.

9.4.2.8 The BESS Enclosure(s)/Shelter (s) shall be equipped with lockable doors, with master key(s) provided, or with a door that can be fitted with a padlock.

9.4.2.9 The BESS Enclosure(s)/Building) must have grounding points available suitable for connection up to 4/0 copper conductor.

9.4.2.10 Where applicable, BESS Enclosure (s)Building/floors will be nonconductive.

9.4.2.11 Where applicable, BESS Enclosure(s)/Building should provide lighting.

9.4.2.12 Comply with all local requirements for modular structures.

9.4.2.13 Provide and bear costs associated all required factory inspections or special inspections required by the AHJ.

9.5 Equipment marking and labelling

9.5.0 All equipment marking and labels shall be in accordance with BLPC Grid Code and Sections 7.14 and 7.15 of this document.

9.5.1 Safety signage shall be provided

9.5.1.1 On all electrical equipment in accordance with requirements of IEC TS 62548, 2016 or later and ANSI Z535 2016 or later, and for identification of hazardous materials in accordance with NFPA 704.

9.5.1.2 At the entrance to the area and battery containers, indicating the type of energy storage system, any chemical specific hazards, and 24/7 emergency contact information.

9.5.2 All high voltage installations shall have warning notices in accordance with BLPC practice.

9.5.3 Signage shall be weather-proof, corrosion-proof, UV-stabilized and fade-resistant and shall be capable to last the duration of the minimum Design Life.

9.5.4 Signs shall be attached using non-corrosive materials suitable to meet the Design Life, or with a planned replacement schedule.

9.5.5 A nameplate which meets the requirements of IEEE C57.12.00 shall be provided on all equipment similar to that required for transformers including:

- Manufacturer name
- Connection diagram

As applicable: Ratings for power, energy, voltage, basic insulation level, etc.

- Serial number, date of manufacture

9.6 BESS Safety

9.6.0 Contractor shall engineer and construct the Project in compliance with all Applicable Laws, local building codes, requirements adopted by the applicable authorities having jurisdiction, and Governmental Approvals and all mitigation measures required by the Governmental Authority and demonstrate compliance as required by the Governmental Authority. This includes but is not limited to: appropriately siting the equipment in compliance with best practices related to safety, sufficiently and permanently securing the equipment to prevent access by unauthorized personnel, and incorporating permanent fire protection measures if deemed necessary by the Governmental Authority.

9.6.1 Battery cells, modules, and racks shall meet the latest electrical and/or safety code and standard requirements including:

9.6.1.1 UL 1642 - Standard for Lithium Batteries

9.6.1.2 UL 1973 - Standard for Batteries Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

9.6.1.3 UN 38.3 - UN Transportation Testing for Lithium Batteries

9.6.2 Battery containers shall be of noncombustible construction and insulation and meet the latest code requirements of the following:

9.6.2.1 NFPA 855-2020

9.6.2.2 Enclosures shall meet NEMA 3R/4 rating

9.6.3 The BESS shall meet the latest requirements of the following electrical, fire, and safety codes:

9.6.3.1 UL 9540 - Standard for Energy Storage Systems and Equipment

9.6.3.2 Requirements of the AHJ in Barbados for example the Barbados Fire Service

9.6.3.3 UL 1973 and UL 1741, for the battery modules and inverter/power converters, respectively

9.6.3.4 NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems

9.6.3.5 Container separation per NFPA 855: BESS shall be separated by at least 10 ft from boundary lines, public ways, buildings, etc.

9.6.3.6 Spacing between containers: Typical recommendation is at least 10 ft horizontally and between row spacing to facilitate adequate space for container doors to fully open and to be acceptable for AHJ access lanes for fire apparatus access from more than one direction to all areas of the facility

- Design: Spacing between containers and exposures shall be determined based on the results of an installation level UL9540A test. Between row spacing to be acceptable for AHJ access lanes for fire apparatus access from more than one direction to all areas of the facility.

9.6.3.7 Max container size per NFPA 855: Containers shall not exceed 53 ft x 8 ft x 9.5 ft (L x W x H). Containers may not be stacked vertically.

9.6.3.8 Egress provisions per NFPA 855: Containers shall be separated from any means of egress by at least 10 ft

9.6.3.9 Rack spacing per IFC 2021 Supplement

9.6.3.10 NFPA 855 requires the following for compliance:

- Large Scale fire test data shall be conducted on a representative energy storage system (ESS) in accordance with UL 9540A or equivalent test standard

- Installation level testing in accordance with UL 9540A, "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems" is required.

9.6.3.10.11.1 A hazard mitigation analysis shall be conducted and provided to Customer for review and approval. The analysis shall evaluate the consequences of the following failure modes:

- Thermal runaway condition in a single module, array, or unit
- Failure of an energy storage management system
- Failure of a required ventilation or exhaust system
- Failure of a required smoke detection, fire detection, fire suppression, or gas detection system

9.6.3.12 The BESS shall be stored according to manufacturer recommendations. Storage conditions of the BESS should include, at a minimum, the following considerations:

9.6.3.12.1 Avoid lengthy exposure to heat and sun.

9.6.3.12.2 Avoid exposure to high humidity (e.g., greater than 95% humidity) or wet conditions

9.6.3.12.3 Keep away from combustibles

9.6.3.12.4 If required, have a robust fire extinguishing system

9.6.3.12.5 Do not tilt, vibrate, drop, puncture, stack, or expose to the elements

9.6.3.12.6 Request details of storage from the vendor particular to the technology

9.6.3.13 Setbacks and access ways shall comply with local revision of the International Fire Code (IFC), and per the local zoning and building code and all Applicable Laws.

9.6.3.14 Where applicable, the system should be designed to minimize any potential risks of fires and explosions. However, in the case of a fire or explosion, the container(s) will be equipped according to applicable fire and explosion safety standards (See IFC and NFPA 855). This includes a detection and alarm system, documentation or training on safe suppression methodology for the technology, and if demonstrated as necessary by large scale testing (aligned with UL 9540A or similar) or if noted as required by the Governmental Authority, internal fire suppression equipment (e.g. sprinkler) and explosion mitigation equipment (e.g. emergency ventilation or deflagration panels). Some jurisdictions may require battery spacing per NFPA requirements and egress and space requirements per the IBC depending on the occupancy rating of the enclosure/building to which the BESS solution shall be in compliance. Gaseous or clean agent extinguishing systems shall not be provided, unless the design accounts for simultaneous operation of the suppression system and emergency venting systems, if any, with adequate performance of both systems. If there is no ventilation system, then clean agent system may be permitted as fire suppression systems.

9.6.3.15 The Contractor shall provide comprehensive training and training material to ensure optimal safety and performance through installation, O&M, and emergency response procedures.

9.6.3.16 As applicable, instruction shall include operation of safety system including fire detection/suppression.

9.6.3.17 Decommissioning plan shall be provided both in the case of normal end of life decommissioning and in the case of an abnormal failure or fire event.

10 EQUIPMENT SPECIFICATIONS – COMMUNICATIONS AND CONTROL

10.1 General

10.1.0 Communications and control system requirements include design, engineering, labor, material, products, guarantee, training and services for, and incidental to, the complete installation of a new and fully functional site master control system that satisfies the functions as described in Section 10.5

10.1.1 Vendor shall be responsible for all hardware, software, communications and programming for all Equipment to serve the functions of site master control system/BESS control system.

10.1.2 The BESS control system shall include all instrumentation, hardware and capability to support the required data acquisition of the Project.

10.1.3 Vendor shall provide the following BESS Control System submittals

10.1.3.1 Hardware and software manufacturer and specification sheets

10.1.3.2 Single line drawing, including devices, interconnection of devices, wiring types and protocols used

10.1.3.3 Data list with device name and individual addresses of data points

10.1.3.4 Installation, Operation and Maintenance manual

10.1.3.5 Software manuals

10.1.4 The BESS Plant Controller / BESS EMS shall be rated and specified to be fed from the system ac-supply, a UPS and the BESS.

10.1.5 The BESS Plant Controller / BESS EMS shall be appropriate for the safe operation of the system, allowing verification of status remotely, to identify any safety risks and shut down the system to mitigate issues as appropriate.

10.1.6 In expectation of future needs, the controls shall allow for easy and rapid additions of additional supplementary control signals and modular expansion as necessary.

10.2 Control House

10.2.0 A local HMI will be installed on-site to facilitate commissioning, trouble shooting and local control when required.

10.2.1 Control House shall be an on-site building or a dedicated enclosure to house BESS communication and control equipment, as applicable.

10.2.2 Control House shall be furnished by Vendor and shall be designed in coordination with Owner.

10.2.3 All BESS control and telecommunication systems, including Site Master Controller, HMI, SCADA, and telecommunication equipment, alarms, etc. shall be installed in the Control House.

10.2.4 If applicable, Control House shall also include:

10.2.4.1 Lighting, electric power, restroom facilities

10.3 Hardware equipment

10.3.0 Any specific hardware for the BESS Plant Controller / BESS EMS within enclosures located outdoors shall be NEMA 4 rated or better.

10.3.1 Fuse holders shall be touch safe.

10.3.2 Any outdoor equipment related to site master control system shall be rated for continuous operation at temperatures mentioned in Section 5.2.6.1 and 5.2.6.2 unless located in a controlled environment building.

10.4 Acceptable manufacturers

10.4.0 Equipment manufacturer and software vendors shall be approved by Owner.

10.5 Communication system

10.5.0 Vendor shall be responsible for interfacing the Vendor-provided communication network to the Owner Communications and Control System.

10.5.1 At nodes in the network, managed switches shall be used.

10.5.1.1 Switches shall be approved by Owner.

10.5.1.2 Switches shall have a minimum of one spare port.

10.5.2 The communication protocol between the BESS Plant Controller, SCADA, BESS, inverter control systems, and all relays or protection equipment shall be Ethernet TCP/IP with MODBUS/TCP and MODBUS/RTU interfaces. Communications via DNP3.0 over ethernet and TCP/IP shall also be supported.

10.5.2.1 Vendor shall program and test the communication protocol. Vendor shall conduct BESS remote operation tests in cooperation with BLPC.

10.5.3 Data connection to Owner's SCADA system shall be at a minimum via secure DNP3.0.

10.5.3.1 Communication protocol shall be approved by Owner

10.5.3.2 Alternate communication protocol may be suggested by Vendor to be approved by Owner.

10.5.4 The BESS Plant Controller will interface and be capable of accepting data and status signals from Owner control system, BESS and protection relays in the Electric Power System.

10.5.5 The BESS Plant Controller should be capable of operator over-ride for all automatic control functions if manual intervention is required.

10.5.6 BESS Plant Controller hardware and software vendors shall be approved by Owner.

10.6 BESS Plant Controller Functionality and Modes of Operation

10.6.0 Droop Control. BLPC is transitioning to a low inertia system with the potential for large rates of change of frequency and frequency deviations may be significant. The facility shall be able to operate in frequency droop mode whereby active power/output/input is adjusted as a result of system frequency. The droop characteristic shall be configurable with a compensation gain parameter to allow for modification of system response over the lifespan of the facility.

10.6.1 Grid forming and grid following modes shall be provided. The controls should allow for smooth transition between grid forming and grid following modes.

10.6.2 Islanding Functionality

10.6.2.1 The BESS shall island with a neighbouring critical or manufacturing/commercial load for system events and manual switching by BLPC. The response time of the inverter shall have sufficient speed to smoothly transition from charging at 10MW to supplying the island at up to 5MW of load in no more than 100ms.

10.6.2.2 The trigger to island mode may be from a protection relay or HMI.

10.6.3 The BESS Plant Controller shall facilitate BESS operation in coordination with Owner Communications and Control System:

10.6.4 The BESS and BESS Plant Controller shall directly communicate with Owner Communications and Control System to provide coordinated grid-connected operation.

10.6.5 Owner Communications and Control System shall provide active (P) and reactive (Q) power setpoints to the BESS Plant Controller. BESS Plant Controller and BESS EMS shall operate the BESS too meet the P/Q setpoints as defined below:

10.6.5.1 Active or Reactive power priority: The control system shall have the capability to prioritize the active or reactive power during the normal operation and Voltage Ride-Through events. The selection of active power and reactive power priority shall be available for the Operator.

10.6.5.2 The BESS shall continue to operate, with complete control functionality as defined in this specification, without protective tripping or equipment damage, for the following overvoltage and undervoltage event sequences at the interconnected bus voltage. Proponents should note that auxiliary supplies will simultaneously be subjected to these same over and under voltages. BESS over and undervoltage settings shall be adjustable to align with international standards such as IEEE1547-2018 and VDE-ARN 4105.

Overvoltage Event Sequence	
Time after Event (ms)	Voltage (pu)
0 – 200	1.2
1000	1.10
Undervoltage Event Sequence	
Time after Event (ms)	Voltage (pu)
0	0
500msec – 1200	20 < V ≤ 40
1200	40 < V < 90

10.6.5.3 Low Voltage Ride-Through (LVRT) Iq injection: The BESS shall have the capability to inject reactive current swiftly in an event of LVRT. To support the power system to maintain the voltage during a remote or close-in fault, the BESS shall inject reactive current (capacitive) of at least 2% of the maximum rated current of the BESS for each 1% reduction of the connection point voltage from the voltage level prior to the fault event. This reactive current injection shall be in addition to the pre-fault reactive current injection. The rise time for the reactive current response shall not be more than 40 ms.

The BESS shall commence the additional reactive power injection when the connection point voltage drops below 90% of the nominal voltage. However, this threshold value shall be able to change as required.

10.6.5.4 High Voltage Ride-Through (HVRT) Iq injection: The BESS shall have the capability to absorb reactive current swiftly in an event of HVRT. To support the power system to maintain the voltage during a remote or close fault, the BESS shall absorb reactive current (inductive) of at least 2% of the maximum rated current of the BESS for each 1% increment of the connection point voltage from the voltage level prior to the fault event. This reactive current absorption shall be in addition to the pre-fault reactive current absorption. The rise time for the reactive current response shall not be more than 200 ms.

The BESS shall commence the additional reactive power absorption when the connection point voltage rises above 120% of the nominal voltage. However, this threshold value shall be able to change as required.

10.6.5.5 Rise time/settling time requirements: The BESS response for an active power set point change shall have a rise time of 1.0 s and settling time of 2.0 s. The response for reactive power (or voltage) set point change shall have a rise time of 0.5 s and settling time of 1.0 s. The response for the voltage disturbance at the POC shall have a rise time of 0.5 s and settling time of 1.0 s.

The active and reactive power recovery after LVRT/HVRT event shall have a rise time of 100 ms and settling time of 500 ms.

10.6.5.6 AC Voltage Control: When operating in ac voltage control mode, the ac voltage of the regulated ac bus is controlled with an adjustable reference voltage setting that can be selected between the specified minimum and maximum continuous bus voltages. An adjustable droop setting shall be provided between 0% and 10% based on the rating of the converter unit. It shall be possible to set the reference voltage and the droop from the local and from remote control.

10.6.5.7 Reactive Power Control: When operating in reactive power control mode, the reactive power into or out of the converter ac bus shall be controlled within the reactive power capability limits of the BESS converter unit. If the ac voltage goes outside the minimum and maximum limits set by the operator, control will revert to ac voltage control to prevent the ac voltage exceeding the limits. The maximum and minimum voltage limits shall be settable from the local Operator workstation.

10.6.5.8 P and Q set points are provided as:

- A real time P and Q setpoint that can override any scheduled behavior.

10.6.5.9 In the event of a communications system failure, the most recently received P and Q setpoints shall be maintained until BESS energy limits are reached or communications are restored. If communications are lost while the BESS is in a grid-forming mode, voltage and frequency shall be maintained until BESS energy limits are reached or communications are restored.

10.6.5.9.1 Receive additional parameters such as:

- Ramp rate
- Droop curves
- Fault behavior
- Operational thresholds

10.6.6 The Plant Controller shall facilitate BESS operation in grid-connected mode, following grid voltage and frequency. For microgrid functionality, Plant Controller shall facilitate BESS operation in grid-forming mode, supplying customer load, and maintaining grid voltage and frequency.

10.6.7 BESS Plant Controller shall be provided with a communication port capable of DNP3 communications with the Owner's SCADA/EMS.

10.6.8 The Plant Controller, in coordination with SCADA, shall receive Owner provided BESS plant operating instructions.

10.6.8.1 Owner provided communications shall pass through a firewall, and use the Owner operations network to reach the BESS Plant Controller.

10.6.8.2 The onsite BESS Plant Controller shall communicate the control set points to downstream equipment such as relays and BESS EMS

10.6.8.3 The BESS EMS is responsible for receiving the set points and distributing them to the inverter controllers and BMS.

10.6.9 A hierarchical control structure will be implemented:

10.6.9.1 The lower-level controls will be responsible for keeping the system within their operating/safety thresholds.

10.6.9.2 Higher level controllers (such as the EMS) will be responsible for operating the system according to the parameters set by the BESS Plant Controller.

10.6.9.3 The lower level controls shall have the priority in order to manage system safety and compliance, for instance:

10.6.9.3.1 BESS Plant Controller shall not override the temperature safety thresholds on the battery modules controlled by the BMS

10.6.9.3.2 BESS Plant Controller may set the P and Q set points, but if the EMS senses that the event might cause an overvoltage event, the EMS will ramp down the level of Q set point, and issue a warning to the BESS Plant Controller.

10.6.10 Vendor shall furnish a BESS Plant Controller capable of providing the BESS required functionality described in this Technical Specifications. The required Project functionality includes at a minimum:

10.6.10.1 Active and Reactive Power Control

10.6.10.2 Undervoltage and Overvoltage Ride-Through

10.6.10.3 Transient Stability Ride-Through

10.6.10.4 Underfrequency and Over frequency Ride-Through

10.6.10.5 Primary frequency response

10.6.10.6 Fast frequency response

10.6.10.7 Inertia response

10.6.10.8 Monitoring and control of BESS:

10.6.10.9 Charge and discharge rates

10.6.10.10 Throughput

10.6.10.11 State of charge

10.6.10.12 Ramp rate

10.6.10.13 Response time

10.6.11 BESS Plant Controller shall at a minimum:

10.6.11.1 Be capable of both local and remote operation.

10.6.11.2 Possess a physical selectable control selector switch to determine the remote/local operation of the BESS Plant Controller.

10.6.11.3 Ensure that failure of local control shall not impact the operation of the remote control of the plant and vice versa.

10.6.11.4 Be appropriate for the safe operation of the BESS facility, allowing verification of status remotely, to identify any safety risks and shut down the system to mitigate issues as appropriate.

10.6.11.5 Permit operator dispatch under default, manual and scheduled operating modes.

10.6.11.6 Owner or Owner designated Operator(s) shall be able to input charge, discharge and SOC set-point targets.

10.6.11.7 Owner or Owner designated Operator(s) shall be able to program combinations of different battery control modes through time-based or event-based scheduling.

10.6.11.8 Owner or Owner designated Operator(s) shall be able to provide time-varying real or reactive power control setpoints.

10.6.11.9 Allow BESS ramp rate to be adjusted by a local operator or remotely by Owner or BLPC .

10.6.11.10 Connect to and coordinate with bi-directional BESS inverters to facilitate charging and discharging of the battery.

10.6.11.11 Communicate with and, if necessary, provide power to external control systems such as the SCADA system.

10.6.11.12 Monitor and report on the BESS, including information such as state of charge, state of health, voltage, current, battery temperatures at the module and cell level, and status.

10.6.11.13 Control the BESS within design constraints for safe operation of the batteries.

10.6.11.14 Facilitate battery O&M procedures such as cell balancing in coordination with BMS.

10.6.11.15 Provide safety related and operation related warnings and alarms.

10.6.11.16 Provide fault and surge detection and protection, as appropriate.

10.6.11.17 Support autonomous operation, including stand-by mode, start-up, shut-down and disconnection of BESS from rest of Facility, in case of communication failure or emergency.

10.6.11.18 Provide operator over-ride capabilities to all automatic control functions if manual intervention is requested.

10.6.11.19 Act as a data historian/repository for easy access, storage and retrieval of BESS operational data as well as external signal data (such as future BLPC AGC signal) for analysis and reporting purposes.

10.6.11.20 Have a bi-directional communications and monitoring interface with system inverters, converters, BMS, and thermal management system.

10.6.11.21 Manage disconnect/reconnect operations of BESS as appropriate to ensure safe, reliable and resilient operation.

10.6.11.22 Have the capability to detect and isolate faults within the BESS

10.6.12 BESS State-of-Charge (SOC) management: The BESS Plant Controller will monitor and manage BESS State-of-Charge to ensure that sufficient energy capacity or headroom is available to support BESS applications. State of Charge management will prioritize and manage charge-discharge operations such that Vendor depth-of-cycling conditions are followed as much as possible.

10.6.12.1 The aggregate BESS SOC reported by the BESS Plant Controller and BESS EMS shall exactly match the useable energy capacity of the aggregate battery units. The useable energy capacity shall be as described in the Capacity Guarantee in any given operating year, and the corresponding energy capacity shall be able to be discharged from 100% SOC to 0% SOC.

10.6.13 Manage BESS asset life: The BESS Plant Controller and BESS EMS will administer BESS degradation by managing the energy throughput, cycling depth of charge and discharge and number of cycles within recommended BESS Manufacturer conditions.

10.6.14 Support delivering of inertial response to the grid: The BESS Plant Controller shall be capable of delivering inertia similar to thermal generator output to help mitigate grid instability. The BESS Plant Controller as a minimum shall support short-duration frequency deviations by providing inertia response equivalent to a Synchronous Generator with an inertia factor (H) of at least 3.0 MWs/MVA for a period of at least 10 seconds. The battery power output shall have an additive response proportional to the first derivative of grid frequency during active and inactive power modes. The inertia constant should be calibrated at the site controller and is not required to be remotely set. Control settings for rate of response for varying trigger levels will be modifiable over the lifetime of the facility via SCADA.

10.6.15 If a Plant Controller with microgrid functionality is provided, microgrid control hardware and software operation and testing shall be in line with the requirements of IEEE std. 2030.7 and IEEE std. 2030.8. The following core microgrid control functionality shall be provided:

10.6.15.1 Dispatch function

- Dispatch Battery System within operating limits under grid-connected mode
- Dispatch Battery System within operating limits under islanded mode

10.6.15.2 Transition function

- Planned islanding - upon request, dispatch BESS to achieve proper balance within the microgrid and reduce active and reactive power (P, Q) to zero at POI; send open command to POI breaker.

10.6.15.2.1 Reconnection - dispatches BESS to help synchronization of microgrid-side voltage to the grid-side voltage before closing the POI breaker

10.7 Component Level Communication

10.7.0 Communication between fiber nodes and equipment at each node (such as inverters and data loggers) shall be copper Ethernet.

10.7.1 Transmission speed shall be 100BASE-T (copper 100Mbit).

10.7.2 Ports shall be standard Ethernet RJ-45.

10.7.3 Cabling shall be a minimum of category 5E with a jacket rating of Communications Multipurpose Cable, Riser (CMR) or Communications Multipurpose Cable, Plenum (CMP).

10.7.4 Communication between components such as data loggers, sub meters, inverters, weather station and sensor input/output components shall comply with the component manufacturer's installation instructions.

10.7.5 The cable shield shall be grounded on one end of the cable only.

10.7.6 Termination resistors shall be used at each end of any daisy chain connections in accordance with device manufacturer instructions.

10.7.7 Components that have a proprietary communication protocol shall be ordered with conversion devices to connect them to the network.

10.8 Sensor Level Communication

10.8.0 Cabling shall be specified by the component manufacturer or provided with the sensors.

10.8.1 Sensor cabling that is not completely contained within enclosures and conduit shall be outdoor and UV rated.

10.8.2 Sensor cabling shall not exceed the manufacturer's recommended maximum length.

10.9 Metering

10.9.0 Facility metering shall be provided by Vendor with approval from Owner and located at the POI.

10.9.1 LV and MV metering shall be installed by Vendor, as specified and approved by Owner.

10.9.2 Component level AC metering shall be provided by the Vendor to record real and reactive power at the BESS interface.

- Component level AC metering will be at a minimum time-interval of 1-min. Higher resolution metering is preferred.
- Vendor will make available 3-phase current transformers and potential power transformers for all component level power meters to monitor
- The CTs may have a rated secondary current of 1A, and be ANSI Class 0.2s or better accuracy with burden 15VA.
- The PT voltage measurements must provide 3-phase + a grounded neutral, in the range of 120-400 Vac L-N . The PT Class shall be 0.5 and burden of 50VA

10.10 SCADA server and Human Machine Interface

10.10.0 Vendor shall provide redundant HMI hardware and operation station installed on site, within the Control House, comprising of industrial grade computer(s) suitable for foreseeable environmental conditions

10.10.0.1 SCADA server and HMI station shall allow full viewing, analysis, reporting, fault diagnosis, fault resetting, inverter and BESS control functionality.

10.10.1 Vendor shall set up Secured VPN connection from the SCADA server to a replica SCADA server at the main Owner control room, in accordance with BLPC's existing cyber security requirements (Attachment O).

10.10.1.1 Owner shall provide access to SCADA server via web-client (pending cybersecurity risk review).

10.10.2 Owner shall allow remote connection to BESS SCADA server and visualization client using secure VPN connection for remote maintenance and technical support.

10.11 Time synchronization

10.11.0 A GPS satellite receiver shall be installed to provide time synchronization signals. This device shall provide time synchronization signals for the BESS SCADA system, main SCADA server, and all devices communicating with the SCADA system.

10.11.1 As an alternative, BESS SCADA system can use time synchronization source at grid interconnection source if it exists.

10.12 BESS SCADA data collection and storage:

10.12.0 Data recorded shall be time series data (e.g., voltage, current, power, temperature) and event data (e.g., faults, warning, errors, operator initiated changes)

10.12.1 Time series data shall be recorded with an averaging period of four seconds to one minute and shall include mean, min, max and standard deviation. Owner should have the ability to control/set the data recording period by data point.

10.12.2 Data sampling rates for time series data shall be independent of site communications network. Sampling rates shall be 2 Hz or higher for time series data.

10.12.3 Processed data shall be stored locally in queue so that no data is lost if site communications network is temporarily lost. When communication is regained, the queue shall be downloaded to the SCADA computer/server

10.12.4 If any inverter is switched off, monitoring, communication and data collection with other inverters will not switch off

10.12.5 All data shall be stored in an industry standard relational database. Any Open Database Connectivity (ODBC) compliant database may be used. The data shall be time-stamped and searchable with a range of data access query functions provided. It shall be possible to store user generated query functions.

10.12.6 The query-returned data shall be capable of graphical or tabular presentation. It shall be capable of being exported to external analysis programs in appropriate formats, e.g., comma-separated values (CSV) and Excel.

10.12.7 The SCADA system shall back-up all recorded data, on-site and in remote data-bases. Vendor shall coordinate with Owner regarding all data storage, handling, and security requirements.

10.12.8 Backups shall be written to standard media using open, non-proprietary file formats.

10.12.9 Historical data shall be stored for at-least three years.

10.12.10 Historical data shall be capable of interface with a Pi Historian database.

***10.13 BESS SCADA* monitoring:** At a minimum, the BESS SCADA system shall monitor, record and store the following measurements:

10.13.0 For each inverter enclosure:

10.13.0.1 Alerts and alarms

10.13.0.2 Enclosure temperature

10.13.0.3 Heat sink temperature

10.13.0.4 Enclosure HVAC status

10.13.0.5 Enclosure door/lock position

10.13.1 For BESS

10.13.1.1 State of Charge

10.13.1.2 Operating mode

10.13.1.3 Power consumption kW, KVAr, KVA charging and discharging

10.13.1.4 Frequency

10.13.1.5 Voltage (phase and rms)

10.13.1.6 Current (phase and rms)

10.13.1.7 Lifetime energy throughput

10.13.1.8 Status and fault codes

10.13.2 For DC-side BESS

10.13.2.1 Module and rack current

10.13.2.2 Module and rack voltage

10.13.2.3 Module state of charge

10.13.2.4 String and cell voltages

10.13.2.5 Cell, String, Module temperatures

10.13.2.6 Module state of charge

10.13.2.7 Status and fault codes

10.13.3 For Inverter AC-side and DC-side

10.13.3.1 kW, kVAr, KVA (as applicable)

10.13.3.2 Voltage (dc, phase and rms as applicable)

10.13.3.3 Current (dc, phase and rms as applicable)

10.13.3.4 Frequency

10.13.3.5 Power factor

10.13.3.6 Status, fault codes and diagnostics

10.13.4 Transformer

10.13.4.1 Oil and winding temperature

10.13.4.2 Pressure/vacuum

10.13.4.3 Oil level

10.13.4.4 Tap changer position

10.13.4.5 Status, fault codes and diagnostics

10.13.5 AC disconnect switch

10.13.5.1 Switch points with position

10.13.5.2 Protection relaying feedback and alarms

10.13.6 Energy meters

10.13.6.1 Voltage (phase, rms)

10.13.6.2 Current (phase, rms)

10.13.6.3 kW, kVA, kVAR

10.13.6.4 Total imported kW, kVA

10.13.6.5 T otal exported kW, kVA

10.13.6.6 S tatus and fault codes

10.13.7 Status, alarms and diagnostics from fire protection system and UPS

10.14 Vendor Data reporting

10.14.0 User shall be able to view and interrogate time-series and event database to query the data and events for any time-periods. Common selections and queries shall be catered for in pre-developed drop-down menus.

10.14.1 User shall be able to trend and plot concurrently selected data-sets and comparison of data-sets

10.14.2 Monitoring and reporting platform will have multiple dashboard to monitor complete plant, as well as sub-systems such as dc-side batteries, and inverters.

10.14.3 Visualization platform will show system status in real time via single line diagram that shows interconnected elements of the system, such as BESS, ac-intertie, loads, transformer(s), and circuit breaker(s).

10.14.3.1 The system shall allow different views of the single line diagram as schematic or a synoptic to check behavior of all devices in top-down hierarchy

10.14.3.2 The user shall be able to interact with subsystem one-line displays to perform any associated user interactions in monitoring and control

10.14.4 The system shall provide multiple views to organize alarms, events and tickets grouped by active, deactivated, allocated.

10.14.5 The system shall implement an event log and event tracker.

10.15 Vendor Information security

10.15.0 Vendor shall design the BESS system to align with the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 4.0 including all firewalls, access control and data protection requirements.

10.15.1 The Vendor will provide a cybersecurity plan, in accordance with BLPC's cyber security requirements (Attachment O), to mitigate critical vulnerabilities in hardware and software, such that where possible, no single point of failure exists within the systems.

10.15.2 Multiple login accounts shall be allowed, in order to allow for differing levels of access to data, settings, and operational algorithms.

11 FUNCTIONALITY AND OPERATION OF SYSTEM

11.1 Factory Acceptance Testing (FAT)

11.1.0 The Vendor shall provide a comprehensive list of all test steps included in the FAT to the Owner for review and approval at least 6 weeks prior to the planned FAT date that meets the testing requirements in this section.

11.1.1 The Vendor shall provide all FAT reports, demonstrating that the systems passed all applicable tests. Test reports shall be provided within 14 calendar days after completion of tests.

11.2 Vendor Commissioning

11.2.0 General

11.2.0.1 Commissioning shall be performed in accordance with the manufacturer's installation, commissioning, and O&M manuals, and in accordance with the Commissioning Requirements laid out in this section and the Commissioning Plan developed by the Vendor.

11.2.0.2 BESS commissioning shall be conducted by the Vendor in coordination with the manufacturer and BLPC representative(s).

11.2.0.3 BESS Plant Controller and SCADA system commissioning shall be conducted by the Vendor in coordination with the appropriate subject matter experts.

11.2.0.4 Fire and smoke detection, fire suppression, and fire and smoke containment systems shall be tested as part of the commissioning procedure.

11.2.0.5 Ventilation and thermal management systems shall be tested as part of the commissioning procedure.

11.2.0.6 Electrical safety and emergency shutoff devices shall be tested as part of the commissioning procedure.

11.2.0.7 The Vendor shall develop and provide a detailed Commissioning Plan for the Project. The Commissioning Plan shall include inspection and verification of all safety aspects of the BESS. For this purpose, Vendor shall provide a check list for Owner approval. The inspected items shall include, but are not limited to:

- Emergency Response Plan
- Signage
- Area Completions: Egress, access, and physical security illumination

11.2.0.8 The Commissioning Plan specifications should define the minimum requirements for field inspection and testing of electrical equipment for the Project.

11.2.0.9 The latest edition of codes and standards, in effect at the time the work is executed, shall be used.

11.2.0.10 The Commissioning Plan shall include all relevant testing required to demonstrate compliance with the Project's interconnection.

11.2.0.11 Owner has the right to perform any additional tests at the Site, including Vendor support, to confirm Vendor results.

11.2.0.12 In addition to these requirements, the Commissioning Plan to be provided by Vendor in accordance with the Agreement, and referenced industry standards, all testing shall be conducted in accordance with any instructions provided by the equipment manufacturer. Any conflict between these requirements shall be brought to the Owner's attention for resolution.

11.2.0.13 The Vendor shall be responsible for fully commissioning the Project and shall furnish all labor, equipment, tools, and materials required to perform the Commissioning Tests.

11.2.0.14 Technicians performing the work shall be qualified by virtue of training and experience for the type of work performed, and shall be familiar with the equipment under test. They shall be trained in the nature of the hazards involved and shall be capable of judging the serviceability of the equipment.

11.2.0.15 Test instruments shall be calibrated by an accredited calibration laboratory, and will be in good working order. Calibration records shall be available to Owner upon request.

11.2.0.16 Vendor shall provide for Owner review and approval, a complete set of commissioning test forms at least sixty (60) days prior to commencing the Commissioning Tests.

11.2.0.17 A complete report (Commissioning Test Report) of all testing shall be provided. As a minimum, the report shall include all information described in 2017 NETA-ATS section 5.4 and copies of all testing records. The Commissioning Test Report shall be submitted within ten (10) Business Days after the last Commissioning Test is completed.

11.2.0.18 Test results that fall within the guidelines of NETA-ATS are considered acceptable, unless otherwise specified.

11.2.1 BESS Plant Controller Commissioning

11.2.1.1 Commissioning of the BESS Plant Controller shall be performed for each BESS subunit consisting of a PCS and all connected batteries.

11.2.1.2 Commissioning of the BESS Plant Controller shall be also performed for the overall BESS plant.

11.2.1.3 Successful Plant Controller Factory Acceptance testing shall be demonstrated prior to shipment of control equipment to site.

11.2.1.4 The time window of the full Commissioning of the BESS Plant Controller tests shall be set by the Owner. Commissioning of the BESS Plant Controller shall, at minimum, include the following tests:

11.2.1.4.1 Active Power Closed Loop Tuning –. This test needs the permission of utility, plant operator and stakeholders. Typical testing ranges are 0 – 75% nameplate for active power. All inverters shall be fully online and capable of producing active power.

11.2.1.4.2 Reactive Power Closed Loop Tuning – This test needs the permission of utility, plant operator and other stakeholders. Typical testing ranges are +/- 75% reactive power nameplate reactive power. All inverters shall be fully online and capable of producing reactive power.

11.2.1.4.3 Absolute Active Power Test – Test shall validate the closed loop active power logic using inverter controls to produce the desired POI measurement in a reasonable amount of time, which is performed by adjusting the BESS Plant Controller Active Power Setpoint value. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements of 100% to 105% at the POI at the time of commissioning.

11.2.1.4.4 Absolute Reactive Power – Test shall validate the closed loop reactive power logic using inverter controls to produce the desired POI measurement in a reasonable amount of time, which is performed by adjusting the BESS Plant Controller Reactive Power Setpoint value. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.2.1.4.5 Reactive Power Voltage Reference (AVR) Test – Test to validate the Reactive Power Voltage Reference control mode using inverter controls to produce the desired POI measurement in a reasonable amount of time, which is performed by adjusting the BESS Plant Controller Reactive Power Voltage Reference setpoint. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.2.1.4.6 Absolute Reactive Power Test with Capacitor Banks – Test to validate the closed loop reactive power logic using inverter and capacitor bank controls to produce the desired POI measurement in a reasonable amount of time, which is performed by adjusting the BESS Plant Controller Reactive Power Setpoint value with Capacitor Bank Controls enabled. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.2.1.4.7 Reactive Power Voltage Reference (AVR) Test with Capacitor Banks – Test to validate the closed loop automatic voltage regulation logic, using inverter and capacitor bank controls to produce the desired POI measurement in a reasonable amount of time, which is performed by adjusting the BESS Plant Controller Reactive Power Voltage Reference setpoint value with Capacitor Bank Controls enabled. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.2.1.4.8 Overfrequency and Underfrequency Active Power Response Test - Test to validate the closed loop active power logic in response to grid overfrequency and underfrequency events, which is performed by adjusting the alternate grid frequency data source's value. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.2.1.4.9 Ramp Rate Control Test – Test to determine whether the POI ramp rate is observed under varying load conditions and preserves to the maximum extent possible the harvest of the available energy over a ramp period. Test procedure and acceptance criteria shall be verified per Owner interconnection requirements. Test may be performed concurrently with BESS Tests discussed in Section 11.4.3.

11.2.1.4.10 Automatic Voltage Regulation (AVG) Test – Test which involves letting the controller respond to a voltage step change. The BESS Plant Controllers' voltage reference will be stepped and the kVA and Voltage will be measured, and the plant performance will be monitored for a period to observe the plant's response to naturally occurring voltage fluctuations. In closed loop voltage regulation mode, the system must maintain a voltage regulation accuracy of +/- 1.0% of the controlled voltage at the PCC (assuming the grid is in steady state condition) over the range of controllability the controller has at the site. The voltage regulation system shall achieve 90% of its final value no later than 1 second following a step change in voltage at the BESS Plant Controller. The response should be overdamped (no overshoot). Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.2.1.4.11 The Power Factor Control Test, - Test which involves measuring plant step change and steady state performance in fixed power factor control mode. Ideally, in response to a step input, the plant responds without oscillation; without overshoot and can maintain a fixed PF setting within the given steady state tolerances at the Point of Common Coupling. The procedure for performing the test requires iteration through several step changes that vet the controllers' ability to control leading and lagging power factors in compliance with limits on the PCC power factor in the range (+/- 0.85). Test procedure and acceptance criteria shall be verified per Owner interconnection requirements.

11.3 Site Acceptance Testing

11.3.0 The Vendor shall provide a Site Acceptance Test Plan at Contract Execution.

11.3.1 The Site Acceptance Test Plan shall be used to verify that:

11.3.1.1 All components of the Project meet or exceed the minimum target capacities, for the BESS.

11.3.1.2 The BESS Plant Controller can communicate with the inverters, meters, and BESS.

11.3.1.3 The BESS can be commanded to charge and discharge, and does so without faults.

11.3.1.4 The BESS can meet all functional requirements as described in Section 10.6.

11.3.1.5 The components of the project can meet ride-through and fault requirements for an asynchronous generating facility as specified in the BLPC Grid Code.

11.3.1.6 The BESS can meet all tests demonstrating successful operation with regard to asynchronous plant technical requirement in the BLPC Grid Code at the point of interconnection

11.3.1.7 Site Acceptance Test Plan shall include the BESS Tests described in Section 11.4 herein.

11.3.2 Testing shall comply with Good Industry Practices, Applicable Laws, and Applicable Standards.

11.3.3 The Site Acceptance Plan will include a schedule and comprehensive test procedure detailing the timeline and plan for all site acceptance testing activities, no less than 12 weeks prior to the initiation of work. This plan will include:

11.3.3.1 Overall time frame, including key milestones

11.3.3.2 Site testing and commissioning plan, including detailed schedule, procedures, necessary tools required on Site, testing criteria, and acceptance criteria

11.3.3.3 Progress reports if any delays are identified

11.3.3.4 Remediation plans in the event of a component or system failure

11.3.4 Owner has final approval of the testing procedures identified by the Vendor.

11.3.5 Owner shall have the right to request specific tests, if necessary, provided such test do not delay the production process or cause significant cost increase to the agreed test plan. These tests may include BESS factory testing with the BESS Plant Controller.

11.3.6 Owner shall have the right to witness all tests. As such, the Vendor will notify Owner of test dates no less than 2 weeks prior to each test. Any delays due to scheduling these tests will be accommodated on a case-by-case basis.

11.3.7 The Vendor shall provide all necessary facilities and equipment for all tests.

11.3.8 A draft Test Report shall be submitted to the Owner by the Vendor within five (5) Business Days following the end of the Acceptance Test. The Owner shall have ten (10) Business Days to accept or reject the results of the draft Test Report, and provide in writing any comments of Owner on such draft Test Report. In the event that Owner rejects all or any part of the draft Test Report, Vendor shall, within five (5) Business Days thereafter address any comments of Owner and re-submit the draft Test Report to Owner. This procedure shall continue until Owner accepts the draft Test Report.

11.4 BESS Tests

11.4.0 General

11.4.0.1 Prior to Commercial Operations and at semi-annual intervals, unless waived by the Owner, Vendor shall perform the BESS Tests described in this section, and meet the required metrics described in the Agreement.

11.4.0.2 Testing shall be performed at a time reasonably requested by the Owner in its sole discretion.

11.4.0.3 Vendor shall coordinate with Owner for each test. Owner has the right to witness the BESS Tests.

11.4.0.4 Vendor shall provide all equipment necessary to conduct all tests.

11.4.0.5 Vendor shall provide the results of each BESS Test including time stamped graphs of system performance to Owner no later than three (3) Business Days after the performance of such BESS Test.

11.4.1 BESS Capacity Test

11.4.1.1 The "BESS Capacity Test" is a performance test to demonstrate that the BESS energy capacity, maximum charge and discharge power, and roundtrip efficiency are in compliance with operating requirements and contractual obligations.

11.4.1.2 The "BESS Capacity Test" further demonstrates that the BESS maintains the output as defined in Section 5.2.1, as measured at the Point of Interconnection (POI), and is able to continuously dispatch the full BESS Contract Capacity, in kW or MW, as defined in the Agreement.

11.4.1.3 The procedure for the BESS Capacity Test is as described below. The test scope includes all BESS components, including batteries, BMS, EMS, DC/DC converters, and inverters, and the interconnection to the Metering Point and Utility.

11.4.1.4 The BESS Capacity Test should be conducted under environmental conditions included in the design specifications and deemed to be appropriate by battery manufacturer. If required by the battery manufacturer, Vendor shall conduct the test with the presence of the manufacturer representative.

11.4.1.5 The BESS Capacity Test shall be completed according to the following procedure:

11.4.1.5.1 Turn on datalogging, record all parameters at 1 second intervals (or faster), and confirm data is being saved in a n appropriate location.

11.4.1.5.2 Execute the following Cycle Steps:

11.4.1.5.3 Command BESS to discharge until it reaches 0% rated SOC to prepare for the first full charge-discharge cycle.

11.4.1.5.4 Command BESS to idle (zero power set point) for 1 hour, or time adjusted by Vendor based on battery technology and reviewed in advance with the Owner.

11.4.1.5.5 Command BESS to charge at the maximum rated power until 100% SOC is reached, or battery power is derated by the BMS below 98% of maximum rated power.

- The SOC value, cumulative energy, and time at the beginning and end of the charge cycle shall be recorded.
- The maximum AC power at the Metering Point during this charge cycle shall be recorded as the Maximum Charging Rate.
- The cumulative energy from this charge step shall be recorded as the Charged Energy.

11.4.1.5.6 Command BESS to idle (zero power set point) for 1 hour, or time adjusted by Vendor based on battery technology.

- The SOC value, cumulative energy, and time at the beginning and end shall be recorded.

11.4.1.5.7 Command BESS to discharge at the maximum rated power. The discharge cycle shall be stopped at the earlier of the BESS reaching 0% SOC or battery power being derated below 98% of maximum rated power, as limited by the BMS.

- The SOC value, cumulative energy, and time at the beginning of the discharge cycle shall be recorded.
- The maximum AC power at Metering Point during this discharge cycle shall be recorded as the Maximum Discharging Rate.
- The cumulative energy during the discharge cycle, shall be recorded as the BESS Discharged Energy.

11.4.1.6 BESS Capacity Test acceptance criteria and performance indicators:

11.4.1.6.1 No critical warning/alarm thresholds shall be exceeded for the entirety of the test, including voltages and currents per the Interconnection Agreement, communication failures, temperatures per the component specifications, or safety-related alarms.

11.4.1.6.2 BESS charging capability is found as the Maximum Charging Rate in 11.4.1.5.5 , and BESS discharging capability is found as the Maximum Discharging Rate in 11.4.1.5.7. Verify that the BESS power capability is within operating requirements, Rated Power Capability, and contractual obligations, as applicable.

11.4.1.6.3 BESS discharge capacity is calculated from data recorded in 11.4.1.5.7 . Verify that the discharge capacity is within operating requirements, Guaranteed Energy Capacity, and contractual obligations, as applicable.

11.4.1.6.4 BESS Capacity Test is deemed “passed” or “satisfied” if the BESS Capacity Ratio is not less than 100%. BESS Capacity Ratio is calculated using the Discharged Energy as shown in the equation below. Where, the Guaranteed Energy Capacity is as defined in the Capacity Guarantee of Section 5.2.3.

BESS Capacity Ratio = (Discharged Energy) / (Guaranteed Energy Capacity)

11.4.2 Round-trip Efficiency Test

11.4.2.1 The "Round-trip Efficiency Test" (RTE Test) is a performance test to demonstrate the charging and discharging requisite to satisfy the performance standard set forth in the PPA.

11.4.2.2 RTE Test shall be conducted concurrently with the BESS Capacity Test.

11.4.2.3 RTE Test acceptance criteria and performance indicators:

a) RTE ratio is calculated using the average cumulative energy across multiple cycle steps as shown in the equation below. Verify that the BESS RTE is within operating requirements, Guaranteed Roundtrip Efficiency, and contractual obligations, as applicable.

RTE Ratio = (Discharged Energy) / (Charged Energy)

Where:
"Discharged Energy" is calculated during the discharging step of the BESS Capacity Test
"Charged Energy" is calculated during the charging step of the BESS Capacity Test The RTE Test is deemed "passed" or "satisfied" if RTE Ratio is not less than the requirements in the Agreement.

11.4.3 Response Time, Ramp Rate and Settling Time Test (RRS Test)

11.4.3.1 The RRS Test is a performance test to measure the response time, ramp rate and settling time of the BESS to reach rated power during charge or discharge from initial measurements taken when the BESS is at rest, per applicable agreements.

11.4.3.2 The procedure for the BESS RRS Test is described below. The test scope includes all BESS components and interconnection to the Utility.

11.4.3.3 The BESS RRS Test should be conducted under environmental conditions included in the design specifications, and deemed to be appropriate by battery manufacturer. If required by the battery manufacturer, Vendor shall conduct the test with the presence of the manufacturer representative.

11.4.3.4 The BESS Response Time, Ramp Rate and Settling Time Test shall be completed according to the following procedure:

11.4.3.4.1 Turn on datalogging, record all parameters at 1/4 second intervals or faster, and confirm data is being saved in an appropriate location. Typical communication latency and response time is under several seconds; as such, manual recording of response times may not be possible, and results should be evaluated from SCADA data log.

11.4.3.4.2 The response time shall be measured starting at T_0 when the command signal is received and continue until the BESS discharge power output reaches its rated power capacity T_2.

11.4.3.4.3 The BESS shall be resting at approximately 50% SOC and shall be prepared to receive a control command.

11.4.3.4.4 The SCADA shall be programmed to record the time instance T_0 immediately following the initiation of the signal command requesting to change the BESS status from rest state to a discharge state.

11.4.3.4.5 The SCADA shall be programmed to record the time instance T_1 immediately following the BESS physical change in state.

11.4.3.4.6 The SCADA shall be programed to record the time instance T_2 immediately following the BESS reaching a minimum of 98% threshold of the rated power capacity.

11.4.3.4.7 The power capacity of the BESS at T_2 shall be recorded as PT_2.

11.4.3.4.8 The BESS shall be programmed to increase/decrease its power output/input per the battery manufacturer recommendations.

11.4.3.4.9 The SCADA shall be used to start the response time test and shall be used to signal and record T_0, T_1, T_2, and PT_2.

11.4.3.4.10 Response Time = $T_2 - T_0$

11.4.3.4.11 Ramp Rate = Rated Power/Response Time (Ramp Rate shall be calculated by the power setpoint over the time between the ESS starting to act upon the received signal and when it reached within 98% of the power setpoint.)

11.4.3.4.12 Settling Time = $T_3 – T_2$ (Settling time shall be calculated as the difference between the power not varying outside of 2% of the setpoint and the first time the power reached within 2% of the setpoint.)

11.4.3.4.13 BESS Response Time Test Acceptance Criteria

I. No critical warning/alarm thresholds are exceeded for the entirety of the test, including voltages and currents per any applicable contractual agreements, communication failures, temperatures per the component specifications, or safety-related alarms.
II. Verify that the response time is within operating requirements, Guaranteed Response Time, and contractual obligations, as applicable.
III. The Acceptance Criteria for the Response Time and Settling Time shall be the minimum, or shortest duration, of 500ms, the Manufacturers specifications, project requirements, Agreement requirements, and relevant market requirements.

IV. The Acceptance Criteria for the Ramp Rate shall be the minimum, or shortest duration of 500ms, Manufacturer's specifications, Agreement requirements, and the relevant market requirements unless the project specifies a maximum ramp rate in which case that maximum shall be complied with.

11.5 Final Acceptance and Completion

11.5.0 Vendor shall complete all activities related to Commissioning and Acceptance testing, and submit to Owner a Final Acceptance Certificate.

11.5.1 The Vendor shall be fully responsible for the sufficiency of the work and ensuring all work is completed in compliance with applicable laws, standards, permits, equipment manufacturer requirements, industry practices, and these technical specifications. Any departure from referenced codes must be fully described and submitted at an appropriate time earlier in the project (formal Deviation Request) for Owner's consideration, review and possible acceptance.

11.6 Training

11.6.0 Because the Owner will be responsible for operating the Site functions, the Vendor shall provide comprehensive training and training material to ensure optimal safety and performance through installation, O&M, and emergency response procedures. The training will further go into detail about, BESS technology, SCADA system, BESS Plant Controller and all related components. This will ensure that the trained staff has the appropriate competencies to safely perform system assessments, for both standard operations and maintenance and failure maintenance and response, without the Vendor's assistance.

11.6.1 Training of BLPC personnel shall also be provided as a part of the Work as follows

11.6.1.1 Two sessions of a multi-day seminars in Barbados on general topic of BESS, within four months of contract award. This seminar shall be aimed at BLPC's engineering and planning personnel as well as BLPC's System Dispatch. All seminar materials and equipment will be provided by Vendor.

11.6.1.2 Contractor shall organize and conduct on site where appropriate, thorough training programs for operating and maintenance personnel prior to the substantial completion date.

11.6.2 As applicable, training instructions shall include:

11.6.2.1 Identification of any specialized maintenance and test equipment and tools required/supplied

11.6.2.2 Description of the electrical system layout including details of high-voltage (HV), medium-voltage (MV), and low-voltage (LV) data cable routes

11.6.2.3 Location of plant and equipment including points of isolation and grounding

11.6.2.4 Operation of the switchgear/breakers

11.6.2.5 Operation of inverter systems

11.6.2.6 Operation of BESSs

11.6.2.7 Operation of battery management system

11.6.2.8 Operation of safety system including fire detection/suppression, HVAC and interlocks

11.6.2.9 Identification of protection relays and equipment

11.6.2.10 Review of protection relay settings

11.6.2.11 Safe operation, safe access, maintenance of nominal and safe performance where special procedures are Required which would not be familiar to experienced, qualified, or registered personnel.

11.6.2.12 A simple assessment to demonstrate comprehension.

11.6.2.13 Documentation (hard copies, electronic files, video as appropriate) of all training materials.

11.7 O&M

11.7.0 Vendor shall provide a comprehensive O&M manual, and training as necessary to enact the tasks therein by Owner personnel as necessary. This manual shall describe in detail all relevant operational and maintenance procedures required to keep each component at optimum performance throughout the design life of each item of equipment supplied. The manuals will address, at minimum:

11.7.0.1 Equipment specification and description

11.7.0.2 Operational procedures

11.7.0.3 Maintenance procedures

11.7.0.4 Preventative maintenance and routine inspection requirements

11.7.0.5 Test certification

11.7.0.6 As built drawings

11.7.0.7 Performance criteria

11.7.0.8 State of health (SOH) monitoring

11.7.0.9 Testing requirements and limitations

11.7.0.10 Specialized equipment

11.7.1 Vendor shall provide a comprehensive list of components that need maintenance, what that maintenance entails, and a schedule of how frequently each task should be attended to. Further, the testing and performance criteria by which it can be determined that the system continues to operate as originally claimed, or to identify any issues.

11.7.2 Critical and Recommended Operating Spare Parts list

11.7.2.1 Vendor shall submit to Owner, a priced list of Critical Spare Parts and recommended Operating Spare Parts, for the operation of the Project.

11.7.2.2 The recommended Operating Spare Parts list shall incorporate manufacturer-recommended components for all Project Equipment.

11.7.2.3 The recommended Operating Spare Parts list shall incorporate consumable items required to perform the manufacturer-recommended preventative maintenance for Project Equipment.

11.7.2.4 If Operating Spare Parts require special storage requirements, special tools, vehicles, or other non-standard equipment in order to replace such Operating Spare Parts, these conditions shall be noted on the Operating Spare Parts list.

11.7.2.5 If Operating Spare Parts require calibration while in storage, the calibration requirements shall be noted on the Operating Spare Parts list.

11.7.2.6 Operating Spare Parts quantities shall be based on the quantity required for the first five years of operation, and based on the quantity of associated equipment installed at the Project.

11.8 Decommissioning

11.8.0 The Vendor will provide the decommissioning plan, including a recycling plan for the BESS components and projected costs.

11.8.1 The decommissioning plan will include a contingency plan in the case that the Vendor is, at the point of decommissioning, unable to perform the services noted.

11.8.2 The Vendor shall provide a cost for decommissioning at the Owner's request.

11.8.3 Decommissioning plan shall be provided both in the case of normal end of life decommissioning and in the case of an abnormal failure or fire event.

End of Attachment