# EXHIBIT F-1
# SCOPE OF WORK (BESS)

## TABLE OF CONTENTS

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## 1.0 EXHIBIT INFORMATION

### 1.1 Project Description

1.1.1 See Attachment E (*Economic and Technical Data Input Form)*.

1.1.2 Contractor shall coordinate design with other engineering firms responsible for scope outside of this Agreement as set forth in Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*).

### 1.2 References

1.2.1 This Exhibit shall also be used in conjunction with Attachment F – Technical Specifications and Attachment E (*Economic and Technical Data Form).* This Exhibit and the documents in Attachment E (*Economic and Technical Data Form*) are intended to supplement, but not necessarily duplicate, each other; any Work exhibited in one and not the other shall be executed as if it had been set forth in both. In the event of any conflicts between the information in Attachment E (*Economic and Technical Data Form*) and this Exhibit, the more stringent requirement shall prevail.

### 1.3 Definitions

1.3.1 Unless defined in this Exhibit, terms that begin with an upper case shall have the meaning defined in the Agreement.

1.3.2 For purposes of this Exhibit the following words shall have the respective meanings set forth below.

- "**AC**" or "**ac**" means alternating current.
- "**Agreement**" means the Term Sheet between Owner and Contractor to which Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*) and this Exhibit are attached.
- "**AHJ**" means any Authority Having Jurisdiction for the BESS Project.
- "**Applicable Law**" has the meaning set forth in the Agreement.
- "**Applicable Permits**" has the meaning set forth in the Agreement.
- "**Applicable Standards**" means the minimum standards and industry codes by Supplier, including those set forth in Attachment 1 to this Exhibit.
- "**Auxiliary Loads**" means power consumption not directly associated with System Losses. These include but are not limited to EMS and other control systems, thermal management systems, communications equipment, and other miscellaneous equipment loads. The PCS auxiliary power requirements shall be included as a System Loss unless the PCS requires a separate auxiliary power feed (see definition of System Loss).

- "**As-Built Drawing**" means a complete set of drawings prepared by Contractor or a Subcontractor which accurately and completely represent the Work as constructed and installed.

- "**Battery Energy Storage System**" ("**BESS**") means the comprehensive energy storage system Equipment and Materials including the batteries, racks, purpose-built enclosures, cabling, power combiners, PCS including inverters and medium voltage transformers, collection system, and switchgear.

- "**Battery Management System**" "(**BMS**)" means an electronic system that manages a rechargeable battery (cell or battery pack), such as by protecting the battery from operating outside its safe operating area, monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and/or balancing it.

- "**Balance of Plant**" ("**BOP**") means all supporting components and ancillary systems necessary for completion of Project, other than the BESS itself, including but not limited to auxiliary power distribution equipment and cabling, communication systems, foundations and support structures, and civil site development.

- "**Business Day**" means any day except a Saturday, Sunday, or a Federal Reserve Bank holiday in the state that the Project is located. A Business Day begins at 8:00 a.m. and ends at 5:00 p.m. local time.

- "**Calendar Day**" or "**Day**" means any day that begins at 12:00 a.m. local time and ends 24 hours later.

- "**Collection System Circuit**" means the permanent electrical and communications infrastructure required to transmit energy and performance and operating data between the BESS and the Project Substation, or to the EMS control panel as appropriate.

- "**Communications System**" means the networking and communications hardware and software (including switches, routers, firewalls, patch panels) connecting the BESS, owner equipment, supervisory, control and data acquisition system (SCADA), and dispatching hardware, as well as all communications cabling and supporting devices within the Collection System Circuits.

- "**Contractor**" means the person, firm, or corporation with whom the Owner has entered into the Agreement to deliver the engineering, procurement, and construction of the Project.

- "**DC**" or "**dc**" means direct current.

- "**DC-DC Converter**" means the electrical equipment that adjusts the DC voltage on the input terminal to match a specified output voltage.

- "**Energy Management System**" "(**EMS**)" refers to a controls system that is responsible for control and/or monitoring of equipment, including but not limited to battery contactor, PCS, breakers, fire protection, HVAC, and metering. EMS also reports real-time site data along with relevant predicted, historical, and/or calculated data to operator or other entity for dispatching of the BESS or other generation unit with or without Operator interference.

- "**Equipment**" means all of the parts, components, materials, apparatus, structures, tools, supplies, consumables, goods, and other items required or appropriate for a complete, fully-functional Project or that otherwise form or are intended to form part of the Work or the Project, *including* all materials, apparatus, structures, tools, supplies and other goods provided and used by Contractor for performance of the Work, but that are not incorporated into the Project.

- "**Failure Modes and Effects Analysis**" "(**FMEA**)" means a systematic, proactive method for evaluating a process to identify where and how it might fail and to assess the relative impact of the different failures, in order to identify the parts of the process that are in need of change.

- "**Gen-Tie**" means the interconnection line that connects the Project to the interconnecting utility's power distribution network as provided by Owner in the Project Information Section of Attachment E (*Economic and Technical Data Form*).

- "**Hazard Mitigation Analysis**" "(**HMA**)" means the Failure Modes and Effects Analysis or other approved hazard mitigation analysis required by IFC and NFPA 855 to evaluate the consequences of various failure modes.

- "**HMI**" means Human Machine Interface and shall refer to the user interface for the Contractor and operator to interface with the EMS.

- "**HSSE Plan**" means collectively the health and safety plan, the security plan, and the environmental plan.

- "**HVAC**" means heating, ventilation, and air conditioning.

- "**Hertz**", or "**Hz**" means hertz.

- "**IGBT**" means insulated gate bipolar transistor.

- "**Inverter**" means Power Conversion System.

- "**kV**" means kilovolts.

- "**kW**" means a measure of power as measured in kilowatts. If not specified it shall be assumed to be in Alternating Current (AC).

- "**kWh**" means a measure of energy as measured in kilowatt-hours. If not specified it shall be assumed to be in Alternating Current (AC).

- "**Main Power Transformer**" "(**MPT**)" means the main transformer located in the Substation required to change the voltage to match the voltage at the POI. A BESS facility interconnected at a distribution level voltage may not require an MPT.

- "**Materials**" means products substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form a part of the Work.

- "**Mechanical Completion**" means completion of the battery PBE, including documentation of installation and pre-energization checks in accordance with the instructions set forth in the installation manual and any checklists provided by the Contractor.

- "**MSDS**" means Material Safety Data Sheet.

- "**MV**" means Medium Voltage.

- "**MW**" means a measure of power as measured in megawatts. If not specified it shall be assumed to be in Alternating Current (AC).

- "**MWh**" means a measure of energy as measured in megawatt-hours. If not specified it shall be assumed to be in Alternating Current (AC).

- "**NRTL**" means Nationally Recognized Testing Laboratory.

- "**NTP**" means Notice to Proceed.

- "**OEM**" means Original Equipment Manufacturer.

- "**Owner**" means Owner of the Project as provided in the Project Information Section of Attachment E (*Economic and Technical Data Input Form)*.

- "**Owner's Representative**" means a person, firm, or corporation with whom Owner has entered into a separate agreement.

- "**Overbuild**" means the desired excess energy of battery, in MWh, to be built at the beginning of the Project life at the POI.

1.3.3 "**Performance Guarantees**" means minimum Project performance requirements to be achieved as described in the Storage Section of Attachment E (*Economic and Technical Data Input Form)* or as defined in the Agreement.

- "**Performance Testing**" means testing per the requirements set forth in Section 2.0 of Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*) and Exhibit F-2 (*Performance Testing Procedures (BESS)*).

- "**Performance Tests**" means the tests listed in Section 2.1 of Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*) and Exhibit F-3 (*Performance Testing Procedures (BESS)*).

- "**Performance Test Procedures**" means the procedures required to adequately perform the Performance Tests listed in Exhibit 6 of Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*) and Exhibit F-2 (*Performance Testing Procedures (BESS)*).

- "**Performance Threshold**" means the minimum threshold required for a Performance Guarantee as set forth in the Storage Section of Attachment E (*Economic and Technical Data Form*).

- "**PLC**" means Programmable Logic Controller.

- "**Point of Interconnection**" "(**POI**)" means the point where the interconnection line connects to the interconnection facilities constructed as provided in the Project Information Section of Attachment E (*Economic and Technical Data Form*), or as otherwise defined in the Agreement.

- "**Power Conversion System**" "(**PCS**)" means a bi-directional AC/DC inverter typically combined with a step-up transformer, DC input connected to the battery system and/or PV system, and AC output interconnected typically to the Project Substation or interconnection point. If not specified otherwise, the medium voltage step-up transformer shall be assumed to be included with PCS. For DC-coupled solar plus storage configurations, a single direction inverter may be used.

- "**Project**" means the Project name as provided in the Project Information Section of Attachment E (*Economic and Technical Data Input Form)*.

- "**Project Site**" means the location of the Project as provided in the Project Information Section of Attachment E (*Economic and Technical Data Input Form*).

- "**Project Substation**" means the substation that connects the Project to the interconnection line and the interconnecting utility's grid. Note: Distribution level project may not have a traditional substation. Substation in this context may be interchangeable with POI as defined in the Project Information Section of Attachment E (*Economic and Technical Data Form*).

- "**Purpose-Built Enclosure**" "(**PBE**)" means the weather-proof battery equipment enclosure that can contain battery modules, battery racks, BMS, and integrated thermal management system. Dependent on supplier it can also contain inverters and local fire detection and/or suppression.

- "**Requirements**" means the Specifications in Project Exhibits, battery energy storage industry practices, Applicable Law, Applicable Permits, Applicable Standards, Project Schedule, interconnection agreement, utility specifications, Equipment manufacturers' requirements, AHJ requirements, and other requirements of the Agreement.

- "**Round-Trip Efficiency"** "(**RTE**)" means the percentage of electricity put into storage that is later retrieved. Both discharge and charge losses shall be included in round-trip efficiency. For the avoidance of doubt, this shall include all charging and discharging losses including and through the batteries, PBE, rack/string cabling, DC-DC converters, combiners, PCS (including inverters and medium-voltage transformers), cabling, main step-up transformer, and the interconnection line up to the Point of Interconnection.

- "**RTU**" means Remote Terminal Unit.

- "**SOC**" means State of Charge.

- "**Specifications**" means those portions of the Agreement consisting of written technical descriptions of the Work, and covering the Equipment, Materials, workmanship and certain administrative details applicable thereto.

- "**Subcontractor**" means an individual, firm, or corporation having a direct contract with Supplier, Contractor, or any other Subcontractor for the performance of a part of the Work.

1.3.4 "**Submittal Schedule**" means the schedule for Contractor's delivery of submittals, as set forth in Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*).

- "**Substantial Completion**" means the completion to the satisfaction of the Owner (or waiver in writing by Owner) per the requirements set forth in Section 4.13 of this Exhibit, or as otherwise defined in Attachment F – Technical Specifications or the Agreement.

- "**Supplier**" means the person, firm, or corporation with whom Contractor (or other subcontractor working for the Contractor) has entered into the Agreement. For the purposes of this Exhibit, "Supplier" means Equipment Supplier.

- "**System Loss**" or "**System Losses**" means power consumed by cables, buses, PCS, transformers, and transmission lines. Supplier shall specify if System Losses are inclusive of battery losses. Supplier shall include PCS auxiliary power as a System Loss if no separate auxiliary power feed to the PCS is required or Supplier shall include PCS auxiliary power as an Auxiliary Load if a separate auxiliary power feed to the PCS is required (Supplier shall determine if a separate auxiliary power feed to the PCS is required).

- "**UPS**" means Uninterruptible Power Supply.

- "**Work**" means all actions, capital, contracts, labor, Equipment, and Materials necessary to construct the proposed Project (including operating the Project) to provide to Owner at the specified delivery point.

## 2.0 GENERAL SERVICES

### 2.1 General Provisions

2.1.1 Contractor shall provide a distribution-scale Battery Energy Storage System (BESS) Project for the Owner at the specified power capacity and energy production. Batteries shall be electrically coupled to and charged from solar generation assets only. Provisions shall be included in the design to ensure the BESS does not charge from the connected power distribution network or utility grid.

2.1.2 Equipment shall be capable of operating safely and reliably in accordance with the terms and conditions of the Agreement, this "Scope of Work" and associated Exhibits.

2.1.3 Supplier shall design the Equipment in accordance with the Agreement and Requirements. Scope of Work shall consist of:

- Equipment design engineering, software models, and drawing packages for construction permitting, installation and "as-built" documentation.

2.1.4 Contractor will supply equipment submittal documents to Owner for integration into final Project design for approval. The submittal schedule is found in Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*).

- Pre-operational testing and startup, performance testing, and component equipment testing. Equipment commissioning and testing in accordance with these Exhibits and Supplier requirements, as approved by Owner.

- Operations and maintenance documentation and Equipment warranty documentation. Warranty information is found in Exhibit F-3 (*BESS Warranty*) and Attachment F – Technical Specifications – Exhibit 13 (*PV Module Warranty*).

- The Project shall have minimum and maximum design temperatures as provided in Attachment E (*Economic and Technical Data Input Form*). While in the design temperature range, the Project shall meet the Performance Guarantees as outlined in the Storage Section of Attachment E (*Economic and Technical Data Form*) and Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*).

2.1.5 Applicable standards in Attachment F – Technical Specifications – Exhibit 9 (*Approved Suppliers*) and Attachment 1 of this Exhibit shall be applied as applicable to BESS. Supplier shall provide all special tools, technical direction, and manufacturers' field services as necessary to Contractor for achieving Equipment operation.

2.1.6 Minimum design working life shall be as provided in the Project Information Section of Attachment E (*Economic and Technical Data Input Form)*.

2.1.7 Initial overbuild and augmentation design shall be as provided in the Storage Section of Attachment E (*Economic and Technical Data Form*).

2.1.8 Contractor shall prepare, implement, and manage a detailed quality assurance plan that is specific to the Project and Project Site. This plan shall conform to the minimum requirements set forth in the Agreement and Requirements.

2.1.9 Contractor shall prepare and maintain a documentation list for the Project. This list shall include, at a minimum, a listing of all Contractor deliverables and the status (including responsible party) and revision number of each. The naming and labeling conventions for all Contractor deliverables shall be coordinated with and approved by Owner. The documentation list shall be updated by Contractor each time a new or revised drawing or document is issued, at a minimum, including identifying any open and/or pending submittals for review.

2.1.10 Contractor shall upload electronic copies of all Contractor Deliverables (including drafts and final) to a web-based document management site shared with the Owner, i.e. Dropbox, SharePoint, etc. Contractor shall use Owner's file sharing portal. If Owner does not have a file sharing portal, then Contractor shall be responsible for setting up the file sharing portal.

2.1.11 Supplier shall prepare and conduct comprehensive training of Contractor and Owner and its operations and maintenance personnel in the safe operation and maintenance of the Equipment. Such training shall cover, at a minimum, the BESS including, battery system, BMS, EMS, and PCS.

2.1.12 Contractor shall provide and deliver all applicable Equipment to the Project Site.

2.1.13 Contractor shall provide their Emergency Response Plan, Health, Safety, and Environment (HSE) and Quality Assurance/Quality Control (QA/QC) corporate policies. If applicable, Supplier shall also provide their Experience Modifier Rate (EMR).

2.1.14 Contractor shall provide Long Term Service Agreement (LTSA) as part of this proposal. The LTSA may be a pass-through contract with the Equipment Supplier. The LTSA shall describe:

- Operations.

- Maintenance.
- Extended warranties.
- Fixed versus floating costs.
- Capacity at the POI throughout the Project operational life.
- Performance guarantees.
- Battery degradation and associated degradation curves throughout the Project operational life.
- Augmentation plan, which shall include capacity at POI which shall consider the additional System Losses and Auxiliary Loads after augmentation, year(s) of augmentation, AC or DC augmentation strategy if not specified, Auxiliary Load sizing, and space constraints.

2.1.15 Spare Parts

- Spare parts and special tools required for complete installation and commissioning shall be provided by the Contractor including spare parts recommended by Supplier.
- Supplier shall provide a complete recommended spare parts list, including a medium voltage transformer, for the Project's electrical works for a two-year period. Such list shall include recommended quantities, part / model numbers, and nominal pricing for a two-year period including recommendations for storage.

## 2.2 Coordination

2.2.1 Contractor shall coordinate weekly update meetings with Owner. Meeting content shall include, but not be limited to submittals, RFIs, design updates, general project progress. Contractor shall prepare meeting minutes after each meeting. If EMS is being supplied through a subcontract, EMS supplier shall be involved in these weekly meetings as necessary. Refer to Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*) for additional coordination items.

2.2.2 Contractor shall actively coordinate the sequence of Work with Owner to support the Project Schedule. For the avoidance of doubt, this shall include coordination with the Contractor's schedule for the delivery and commissioning of the BESS. Owner, and Contractor shall meet (a) on a weekly basis before BESS deliveries begin and (b) as required by Owner after BESS component deliveries begin; the purpose of such meetings shall be to coordinate schedule for delivery and commissioning of the BESS. On a weekly basis, a meeting shall be held to reconcile all demurrage and delays for all parties regarding deliveries and offloading of components. Contractor shall ensure Supplier support is provided on an as-needed basis for such meetings.

2.2.3 Contractor shall coordinate their on-site support with the Owner, any other Contractors, and other entities, to facilitate proper support for testing and commissioning. This includes all requirements specified in each Section of the Agreement.

- Contractor shall work with Owner to schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2.2.4 Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

2.2.5 Prepare similar memoranda for Contractor and separate contractors if coordination of their Work is required.

2.2.6 The following construction coordination meetings shall be held by Contractor:

Preconstruction Meeting

- A meeting led by the Contractor after Agreement execution to review items stated in the following agenda and to establish a working understanding between the parties as to their relationships during performance of the Work.

- Preconstruction meeting shall be attended by:

  (a) Representative(s) of Contractor.

  (b) Owner's Representative(s).

  (c) At Owner's option, representatives of principal Subcontractors.

- Location of meeting:

  (d) To be determined, Contractor shall prepare for on-site visit based on Project Site amenities at time of meeting.

- Reporting:

  (e) Contractor shall review meeting minutes for correctness.

Construction Progress Meetings

- A progress meeting led by Contractor at least weekly and at other times requested by Owner. Owner Representative's and Contractor shall be present at each meeting. Contractor or Owner may request attendance by representatives of Subcontractors, Suppliers, or other entities concerned with current program or involved with planning, coordination, or performance of future activities. All participants in the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.

- Contractor and each Subcontractor represented shall be prepared to discuss the current construction progress report and any anticipated future changes to the schedule. Each Subcontractor shall comment on the schedules of Contractor and other Subcontractors and advise if their current progress or anticipated activities are compatible with that Subcontractor's Work.

- If one Subcontractor is delaying another, Contractor shall issue such directions as necessary to resolve the situation and promote construction progress.

- Location of meetings:

(f) At Project Site.

- Reporting:

(g) Supplier shall review meeting minutes for correctness.

## 3.0 STRUCTURAL WORKS

### 3.1 General Provisions

3.1.1 Contractor shall submit all design study, calculations, and simulation reports to the Owner. The Contractor shall prepare the following study reports:

- The Contractor shall provide live load, dead load, and collateral load calculations for all equipment and structural supports.
- The Contractor shall provide a seismic qualification report in accordance with the requirements of IEEE 693 or Owner-approved equivalent using site-specific seismic information provided in Attachment F for all Equipment provided under the Agreement including but not limited to the following:

(a) PBEs

(b) Batteries and battery racks

(c) Step-up transformers

(d) Inverters

(e) DC/DC converters

### 3.2 Structural Loading

3.2.1 Supplier shall provide loading information according to the following information and in accordance with the locally adopted version of the IBC and ASCE 7 as modified by the applicable AHJ Local Additions and Addenda:

- Dead Loads

(a) Dead loads shall include all vertical loads due to weight of permanent structural and nonstructural components, including permanent hung loads.

- Live Loads
- Snow Loads

(a) Snow design data shall be as provided in Attachment F.

- Wind Loads

(a) Wind design data shall be as provided in Attachment F.

- Seismic Loads: Seismic load values from the final geotechnical report take precedence over those referenced below.

  (a) Seismic design data shall be as provided in Attachment F.

### 3.3 Equipment Foundations

3.3.1 Supplier shall provide drawings showing Equipment dimensions, system weight, support locations, anchoring details, location of center of gravity, cable entry locations, and lifting diagram. Contractor is responsible for the review and validation of all Supplier provided drawings.

### 3.4 Corrosion Protection

3.4.1 In general, all exposed carbon steel surfaces shall be treated for corrosion protection, if applicable. Contractor is responsible for ensuring Supplier's design meets corrosion protection requirements as set forth in the Agreement. Supplier shall design and specify corrosion protection systems in accordance with International Organization for Standardization (ISO) 12944, which shall include surface preparation measures, for the following conditions:

- Carbon steel exposed to ambient environmental conditions.
- Refer to Section 8.5 of Attachment F – Technical Specifications (*Corrosion Protection*)

3.4.2 Structural steel shall have a minimum ISO corrosivity category as provided in Attachment F.

3.4.3 Stainless steel and galvanized steel shall not be painted.

3.4.4 Corrosion protection for structural steel shall be designed for a Project life as provided in of the Storage Section of Attachment E (*Economic and Technical Data Form*).

## 4.0 BATTERY ENERGY STORAGE SYSTEM (BESS)

### 4.1 General Provisions

4.1.1 Contractor shall design and furnish the Project in accordance with the Agreement and Requirements.

4.1.2 Contractor shall provide all relevant Project information in Attachment E (*Economic and Technical Data Form*).

4.1.3 BESS equipment shall be designed, constructed, and sited in accordance with applicable standards and codes including but not limited to UL 9540, NFPA 855, IFC, other applicable local AHJ requirements, and as required by the approved Hazard Mitigation Analysis (HMA) based on large scale fire testing performed in accordance with UL 9540A.

- The HMA shall be provided to the Owner and AHJ for review and approval.
- PBE hazard mitigation systems shall be designed based on the data generated by the UL 9540A fire and explosion testing.
- Where there is a conflict between the codes and standards referenced above, the most restrictive shall govern unless otherwise approved by AHJ.

4.1.4 BESS shall be rated for the MWac and duration (or MWh) as provided in the Project Information Section of Attachment E (*Economic and Technical Data Form*) measured at the POI, defined in Section 1.3.3. This measurement should be net of any System Losses and Auxiliary Loads unless otherwise specified in the performance acceptance test. The POI requirements shall be met for the entirety of the Project life starting at Substantial Completion.

4.1.5 Supplier shall provide battery degradation curves and a capacity guarantee for the Project.

4.1.6 Contractor shall size the BESS in order to comply with applicable regulatory requirements at the POI.

4.1.7 Contractor shall provide the final POI location and associated metering to meet the intent of these Specifications, the Scope of Work defined in this Exhibit, and the intent of the overall application.

4.1.8 BESS, composed of all Equipment and Materials, shall be fabricated and assembled to the maximum extent to allow for turnkey shipping and installation. Supplier shall identify all Equipment and Materials not fully assembled or installed that require field assembly by Contractor.

- Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully functional, and safe BESS.

4.1.9 Contractor shall design the system such that the total RTE, measured from the Point of Interconnection (POI) to the battery to the POI, shall be as provided in Attachment E (*Economic and Technical Data Form).* Reference Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*) for RTE testing procedures. In addition, refer to Attachment F – Technical Specifications, please refer to Exhibit F-2 (*Performance Testing Procedures*).

4.1.10 Efficiencies and losses (real and reactive) associated with the batteries, PCS, DC/DC converters, and cabling in between shall be determined by the Contractor and/or Supplier and provided in the proposal. Auxiliary power shall be determined by the Contractor and/or Supplier and included in sizing. Any assumptions for losses outside of the Contractor's scope shall be provided.

4.1.11 Design, manufacture, test, package, and deliver all BESS Equipment and Materials in accordance with the requirements of the Agreement. The Equipment and Materials include but are not limited to the following which are listed for Owner's convenience in understanding the scope of the Work. Proposals shall identify and provide all other additional equipment necessary for a fully functional BESS and overall plant to meet the nameplate POI requirements. Supplier to provide PSS/E and PSCAD models of their proposed modules for use in verifying that the POI rating is met.

- System design, manufacture, delivery, and commissioning of BESS, inverters or prefabricated PCS(s), DC/DC converters, all controls, thermal management system, UPS, and all structures required to house the BESS, inverter and related equipment.

- EMS system as specified in this Exhibit.

- Short circuit model of the BESS in Aspen OneLiner (.OLR) format or in PSS/E (.seq) format which supplies equivalent Thevenin impedances and maximum per unit fault current time curves.

- The proposal shall include, but not be limited to, engineering, design, fabrication, testing, packing, delivery, startup, commissioning, and performance acceptance testing of the overall BESS.

- Contractor shall ensure that Supplier shall provide field personnel and support to the Project Site from equipment delivery to the completion of commissioning.

- The Equipment and Materials furnished under the Agreement shall be designed for outdoor installation and outdoor storage.

- All other accessories needed for a fully functioning system.

4.1.12 All Work shall be designed to meet the requirements specified in the Agreement and Requirements herein.

4.1.13 All Equipment and Materials shall be fabricated into shippable modules and/or enclosures to the maximum extent possible to minimize field installation and labor.

4.1.14 BESS shall be provided with a UPS designed to maintain critical systems upon a primary power failure.

- Supplier shall provide a critical systems load list, i.e. cooling, control, explosion prevention, etc., for the BESS.

- During a primary power failure incident, the batteries shall not be permitted to be charged or discharged; however, the thermal management system shall still be required to maintain adequate temperatures and provide battery cooling if the failure occurs during a charge or discharge scenario.

- Critical systems shall include but not necessarily be limited to explosion control, BMS, EMS, and thermal management system. Fire alarm system shall be furnished with separate secondary power supply as required by NFPA 72 and as specified below.

- UPS shall be adequately sized to provide power to the critical systems for a 2-hour duration.

### 4.2 Purpose-Built Enclosures (PBEs)

4.2.1 General

- PBEs and penetrations shall be designed and constructed to be wind resistant and shall be sealed to prevent infiltration of water, rain, snow, and dust when the doors are closed. PBEs shall meet or exceed the NEMA/IP rating as specified in the Storage Section of Attachment E (*Economic and Technical Data Form*).

- Walk-in type units are not permitted. All equipment and components requiring testing, service, and maintenance shall be accessible externally.

- PBEs shall meet the design requirements and site location requirements as specified in this Exhibit.

- PBEs shall be of noncombustible construction.

4.2.2 Thermal Management System

- Thermal management system equipment shall comply with all battery manufacturers' requirements for internal air temperatures, chilled water temperatures (if utilizing liquid cooled batteries), and module/cell temperatures. The thermal management system shall be adequately designed for the location of the project as specified in the Project Information Section of Attachment E (*Economic and Technical Data Form*).

- Thermal management system control circuitry for an air cooled or ventilation system shall include a smoke detector and fire suppression shutdown provision.

- Thermal management shall be able to accept read/write commands remotely in order to troubleshoot, adjust system setpoints, and initiate ventilation in case of fire/smoke event to evacuate smoke.

- HVAC/Ventilation shall require interlock to the PBE's fire alarm system for shutdown.

- Inlet louver(s) shall be sized with a free area velocity of not more than 75% of the point of water penetration for the louver and shall include a wind driven rain louver or similar device. Inlet louver(s) to be located at minimum distance from obstructions and mechanical exhaust per local code and manufacturer recommended clearances.

- HVAC/ventilation design shall comply with applicable codes, local ordinances, and Contractor standards.

- Thermal management system shall require process flow diagram which clearly depicts air flow and control equipment.

- A computational fluid dynamic (CFD) model of the thermal management system shall be completed and submitted to Contractor to verify the system's effectiveness.

    (a) An acceptable CFD model shall be accompanied by a summary report of the results that clearly communicates the results which shall include but not be limited to all parameters and inputs clearly called out and defined, air temperature results showing instantaneous maximum, minimum, and temperature differential requirements from battery OEM are met, air velocity and pressure results that exhibit sound fluid dynamic properties, a discussion of the scenario modeled and why this provides the best means for confidence that the system meets temperature requirements, and convergence results that show acceptable computation results within the model.

- Installation & Owners Manuals describing routine maintenance shall be provided along with Thermal Management design. The Supplier shall perform repairs or replacements for equipment that is not performing as designed.

- Final design calculations and drawings sealed by a Professional Engineer (PE) registered in the state where Project is located shall be provided that meet the ASHRAE temperature conditions and site design criteria as specified in the Project Information Section of Attachment E (*Economic and Technical Data Form*):

- HVAC and ventilation systems shall be adequately braced/anchored. Seismic forces shall be calculated per ASCE 7.

- HVAC Equipment and refrigerants in the system shall meet all 40 CFR Part 82 requirements for Ozone Depleting Substances.

- Refrigerant information, specifications, and quantities shall be provided to Contractor.

4.2.3 Fire Protection & Explosion Control

- An Emergency Management Plan shall be included as well as training for local fire authorities to outline hazards and recommended actions in the event of a fire.

- Contractor shall include the design and furnishing of a complete fire protection system that conforms to national and local codes.

- Fire protection and explosion control systems shall be designed for specific battery technology hazards demonstrated by UL 9540A tests; as required by applicable standards/codes including UL 9540, NFPA 855, NFPA 72, IFC, and any other AHJ requirements; and as a result of the HMA.

- PBEs shall be equipped with a UL-864 listed fire alarm control panel to power, monitor, and control initiating devices, notification devices, release devices, and any other emergency control functions in accordance with NFPA 72.

    (a) PBEs shall be equipped with smoke detection or radiant energy sensing systems in accordance with NFPA 72, unless otherwise approved by Owner and AHJ.

    (b) All required annunciation means shall be located as required by the AHJ to facilitate an efficient response to the situation.

    (c) Fire alarm control panels shall be fully addressable and capable of fiber optic networking to allow for alarm signals from detection systems to be transmitted to a supervising station in accordance with NFPA 72.

    (d) All fire alarm devices shall be addressable. Refer to Sections 5 and 6 of Attachment F – Technical Specifications *(Fire Protection)* and *(Communications Shelter)*.

- PBE shall be equipped with explosion prevention system designed in accordance with NFPA 69 or deflagration venting installed in accordance with NFPA 68, unless otherwise approved by Owner and AHJ based on fire and explosion testing and a deflagration hazard study.

    (a) Explosion prevention systems designed in accordance with NFPA 69 shall be designed to activate the combustible gas concentration reduction system upon detection of flammable gases at no more than 10% of the LFL of the gas mixture or of the individual components.

    (b) Gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.

    (c) Gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA.

(d) Gas detection system shall be monitored by the local fire alarm system and allow for annunciation at an approved central, proprietary, or remote station in accordance with NFPA 72.

(e) Compartmentalization created by cold and hot aisle arrangements within the PBE shall be addressed in accordance with the following:

1. For NFPA 69 designs, the performance of ventilation systems shall be independently verified for a thermal runaway event in either aisle/subcompartment.

2. For NFPA 68 designs, the placement of explosion relief panels shall ensure that the explosion hazard is addressed for both hot and cold aisles/subcompartments.

3. Gas detection system shall be designed to activate on detection of flammable gas in either aisle/subcompartment.

(f) Protection design shall demonstrate that deflagrations are not propagated to interconnected or adjacent cabinets, PBEs, or rooms.

- Fire protection system and explosion control details and components shall be included in the proposal and be subject to Owner review and approval.

4.2.4 Electrical System

- Equipment arrangement shall be as indicated on drawings or Owner approved modifications as required by Owner. Working space, access aisleways, and means of egress shall comply with NEC, Life Safety Code, and Owner preferences. Any equipment relocations shall be coordinated with Owner.

- Grounding:

(a) Except as otherwise indicated, provide electrical grounding and bonding systems necessary to comply with all applicable codes and standards. Provide an assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type of component product meets indicated requirements, selection is Supplier's code-compliance option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications.

(b) Connect each battery rack from the battery OEM specified rack grounding location to the ground bus with a conductor compliant with Applicable Standards.

(c) Copper ground pads configured for NEMA two-hole connectors shall be provided on two opposite, non-adjacent corners of the PBEs on the exterior of the PBE.

- Lighting:

(a) Interior Lighting:

1. Provide PBEs with UL-listed twin tube, rapid start, LED lighting fixtures that are 120VAC controlled via three-way wall SPST switches to be located at each entry/access door so that the light fixture comes on automatically when the door is opened.

2. Design interior light levels to provide a minimum 30 foot-candles of light the full length of the front of the battery racks and at working height for other equipment.

(b) Receptacles:

1. Provide one (1) 120VAC power strip mounted to the rear of the communication/telecom rack with sufficient duplex type receptacles for all telecom equipment in the rack.

(c) Contractor and/or Supplier shall not use wire smaller than No. 12 AWG.

(d) Size and install proper wire size, as required, such that the voltage drop from the power or lighting panel to the farthest luminaire or receptacle does not exceed 3%.

- Provide the following equipment/systems:

(a) DC Ground Fault Detection:

1. Supply, install, and connect a DC ground-fault monitor measuring across the DC bus at the main DC disconnect using a ground-reference module, or Owner approved equal.

(b) Temperature and Humidity Sensors

(c) Emergency Stop

(d) PLC System for HVAC and auxiliary BESS systems:

1. Provide Owner the opportunity to witness testing of the PLC logic and provide report summarizing the results.

2. Provide Owner the ability to make changes to the PLC in the future.

3. Provide O&M manual for PLC system that includes full logic diagrams and schematics.

(e) UPS:

1. UPS supply sized to operate PLC, BMS, 24VDC, network switch, and server computer for minimum of 120 minutes and as required by the battery OEM for a controlled shut-down sequence. Supplier to size UPS to meet backup power & duration requirements defined by battery OEM to meet warranty terms, including required data collection.

(f) Auxiliary power supplies:

1. Supplier shall specify all Auxiliary Load power requirements to the Owner and Contractor. Contractor shall properly size all distribution equipment to meet the Auxiliary Load power requirements.

2. Supplier shall provide low voltage distribution equipment internal to the PBEs necessary for Auxiliary Loads.

3. Contractor shall provide primary and backup external power auxiliary power feeds at the voltage levels specified by Supplier.

4. Supplier shall provide the following Auxiliary Load information to the Contractor:

    a. Total connected Auxiliary Load.

    b. Total peak Auxiliary Load at maximum ambient design conditions as provided in the Storage Section of Attachment E (*Economic and Technical Data Form*) (charge, discharge, and rest/idle).

    c. Total peak Auxiliary Load at 25˚ Celsius (charge, discharge, and rest/idle).

    d. Total peak Auxiliary Load at minimum ambient design conditions as provided in the Storage Section of Attachment E (*Economic and Technical Data Form*) (charge, discharge, and rest/idle).

    e. Average Auxiliary Load based on 365 annual cycles.

### 4.3 Batteries

4.3.1 Battery Requirements:

- Battery system shall be a proven technology that can meet the capacity requirements at the POI under all ambient conditions throughout the project life. Battery shall have proper protection and coordination with the inverter.

- Battery shall consist of lithium-ion cells of proven technology designed for the type of service described in this Exhibit. For the purposes of this Specification, proven technology shall be defined as cells that have been in successful commercial service in similar type applications for a period of time sufficient to establish a service life and maintenance history. Only cells that are commercially available or for which suitable (not necessarily identical) replacement cells can be supplied on short notice throughout the project life shall be allowed.

- Battery system shall be listed to UL 1973 and the battery manufacturer shall provide UL certificate prior to shipment to Project Site.

- Battery information and specifications shall be included in the proposal. This information shall include but is not limited to battery chemistry, battery datasheet, and MSDS.

- No part of the BESS shall have any exposed live parts in the PBEs. All busbars, terminals, switches, etc. shall have permanent, non-conductive covers to protect personnel from shock hazards during inspection and maintenance.

- Modules shall have cable terminations utilizing manufacturer provided quick disconnects or allowing for NEMA standard connections. Any cables provided by manufacturer shall be sized in accordance with NEC Article 310.

- Modules shall be designed to be easily inserted and removed from the battery rack. This may include non-tooled locking mechanisms, handles or lifting points, and/or track sliding.

- BESS shall be UL 9540 listed. Provide documentation indicating compliance with UL 9540 with proposal.

- The BESS shall be tested at the cell level for UL 9540A and at the module, unit, or installation level until it demonstrates acceptable performance criteria as specified in UL 9540A. Provide documentation of the UL 9540A test results and associated test reports with the proposal.

    (a) Installation configuration of the Equipment shall match the representative cell, modules, and units tested, including any optional integral fire suppression system.

- Battery subsystem as a whole and as individual cells shall be designed to withstand seismic events as described in this Exhibit.

- Battery system shall operate at a voltage no higher than allowed by the PCS or at 1500VDC, whichever is lower.

- Supplier shall provide information on the impact that weak or failed cells have on the life and performance of the entire string. The Supplier shall specify critical parameters, such as temperature variation limits between cells of a string. The Supplier shall provide a means of monitoring critical parameters to ensure the limits are being met.

- Cells, wiring, switchgear and all DC electrical components shall be insulated for 2000VDC.

- Supplier shall have overall responsibility for the safety of the electrical design of the battery.

- Battery system shall include a monitoring/alarm system and/or prescribed maintenance procedures to detect abnormal cell conditions and other conditions that may impair the ability of the Project to meet performance criteria.

- BMS shall be capable of balancing the voltages across cells and modules automatically and independently without any input from the operator or the EMS.

- Cell monitoring system shall be specified to alert the proper personnel in a timely manner that an abnormal cell condition exists or may exist. Abnormal cell conditions shall include all types of cell failures that are commonly known to occur for the type of cell used.

- Monitoring/alarm system shall record data on the number and general location of failed modules, to expedite maintenance and cell replacement. This data shall be stored in non-volatile memory. Such monitoring/alarm system shall be integrated into the overall control system.

- Battery system shall include racks or shall consist of stackable modules. As applicable, the racks shall provide sufficient clearance between tiers to facilitate required module maintenance, including module testing, inspection, and replacement. Racks shall be secured against movement due to seismic activity.

- Rack-mounted modules shall have all connections located on the front of the PBE. Modules shall not be required to be removed from the racks during regular maintenance.

- All racks and metallic conductive members of stackable modules shall be solidly grounded. Racks shall be seismically qualified in accordance with IEEE 693 High Seismic Qualification Level and shall include means to restrain cell movement during seismic events. Rack anchorage and supports shall be designed for seismic events as described in this Exhibit.

4.3.2 Battery Usage

- See the Storage Section of Attachment E (*Economic and Technical Data Form*) for the planned use case(s) for the BESS annually to be included in degradation calculations. Any and all other restrictions to guaranteeing the capacity at the POI shall be included in the proposal. Supplier to provide with the proposal the impact in degradation if the operation of the BESS were to exceed the equivalent cycles per year as provided in the Storage Section of Attachment E (*Economic and Technical Data Form*).

4.3.3 Battery Performance

- Supplier shall provide yearly performance curves or tables for battery modules & BESS system including, but not limited to, the following information for the Project life, accounting for degradation and in the case of (i) no LTSA/augmentation and (ii) with proposed LTSA/augmentation:

  (a) Energy Capacity.

    1. Expected shipped retention after delivery to Project Site.

  (b) Round-Trip Efficiency.

  (c) Charge/Discharge Rates.

  (d) Cycle Life/Energy Throughput.

    1. If the proposed lithium-ion batteries are sensitive to depth of discharge, the manufacturer shall state the limitations and the product shall be sized such that the limitations are included in the battery sizing.

    2. Base the degradation calculations on the specified planned use case for the BESS. Any and all other restrictions to guaranteeing the capacity at the POI shall be included.

(e) Heat Loads.

(f) Operating Voltage.

(g) Self-Discharge.

(h) Average State of Charge (ASOC) requirements.

(i) Maximum and Minimum State of Charge (SOC) requirements.

(j) Depth of Discharge (DOD).

(k) Charge Losses.

(l) Discharge Losses

- Supplier shall provide warranty information regarding cycling the BESS more than the equivalent cycles per year as provided in the Storage Section of Attachment E (*Economic and Technical Data Form*).

- Curves and tables shall present performance data under multiple variables such as:

  (a) Ambient Temperatures

  (b) C-Rates

  (c) Cycle Life/State of Health (SOH)

  (d) Age of Battery

4.3.4 Battery Management System (BMS):

- BMS shall be capable of automatically balancing voltage levels at the cell, module, and string level as required by the battery manufacturer to optimize battery health.

  (a) Supplier shall provide documentation of how battery state of charge is calibrated over the Project life.

- BMS shall provide electrical and manual disconnects at the individual rack level and enclosure level. A manual disconnect for each string shall be provided with padlock provisions that prevents an automatic override of the disconnect.

- BMS shall provide both electrical protection and thermal protection for the battery modules in each string.

- BMS shall be included to manage the operational health of the Project and assure its safe, warranted, and optimal performance as an interconnected asset to Owner's electrical system. Primary functions include but are not limited to:

  (a) Monitoring

    1. State of Charge.

2. State of Health.
    a. String.
    b. Module.
    c. Cell.
3. Voltage/Current.
    a. String.
    b. Module.
    c. Cell.
4. Temperature.
    a. Module/Cell Internal.
    b. Module/String Ambient.
    c. Module Internal Temperature Differential within a String.
5. Status.
    a. Energy Throughput.

(b) Charge/discharge management.

(c) Balancing.

1. Cell voltage.
2. Module voltage.
3. String voltage.

(d) Warning and alarms.

(e) Internal protective measures.

(f) Logs of operations.

(g) Management of any software versions.

(h) Cybersecurity management of the device itself.

(i) Provide data exchange to the project SCADA.

(j) Contribute to functional safety of overall Project.

### 4.4 Controls

4.4.1 Supplier shall coordinate with Contractor on guidance regarding system configuration, e.g. integration of the BESS/substation SCADA/EMS, jump server, firewall, connectivity, and related standards for the remote monitoring of the system.

4.4.2 BESS system shall include an EMS that interfaces with the individual components of the BESS and solar generation to collect alarms, performance data, and to serve as an interface between the BESS and the SCADA system.

4.4.3 Battery Supplier shall procure, program, and commission the EMS.

4.4.4 The EMS shall ensure charging of the BESS only occurs from local solar generation.

4.4.5 EMS shall be able to communicate with SCADA system via a standard protocol such as DNP3 via TCP or serial or as otherwise required.

4.4.6 EMS shall be able to communicate with the power dispatch entity via a standard protocol such as DNP3 via TCP or serial or as otherwise required by the Owner. Dispatch communication shall come from a single source.

4.4.7 EMS shall be capable of running completely automatically and without operator intervention.

- Upon loss of utility power interconnection or failure of utility power, restart of the instrumentation and control system to a standby state condition should require no local manual operations.

- Synchronization shall be performed automatically.

4.4.8 EMS shall include the following operating modes at a minimum, which shall operate automatically with no operator input:

- Real power (P) setpoint mode.

- Reactive power (Q) setpoint mode.

- Voltage (V) droop mode.

- Power factor (pf) mode.

    (a) System design shall be capable of a leading or lagging power factor at the POI while operating at the specified MW of charge or discharge at the POI, as provided in the Storage Section of Attachment E (*Economic and Technical Data Form*).

4.4.9 In addition to operating modes above, EMS shall provide any ancillary services specified in the Storage Section of Attachment E (*Economic and Technical Data Form*) at a minimum, which shall operate automatically with no operator input.

4.4.10 Additionally, EMS in combination with the other electrical equipment shall provide any other services specified in the Storage Section of Attachment E (*Economic and Technical Data Form*) at a minimum, which shall operate automatically with no operator input.

4.4.11 System and EMS shall meet all regulatory requirements as required by the system operator.

4.4.12 EMS shall balance SOC across all BESS subcomponents.

4.4.13 EMS shall include the ability for an operator to take manual control of site and individual components. Operator shall be able to control site and PCS setpoints, open and close breakers and battery contractors, and fully start and stop equipment for maintenance and other purposes.

4.4.14 EMS shall include a fully operational historian for long-term and short-term storage of all site data. Historized data shall consist of all the following database points:

- Field inputs and outputs.
- Gateway inputs and outputs.
- Serial communication inputs and outputs.
- Internal composed, calculated, controlled, and monitored variables.
- Internal digital or logical points or data bits.
- Performance calculations, including data required to audit performance of EMS.

4.4.15 Historian shall include dedicated hardware and software for the historical data storage.

- System shall provide an alarm whenever the drive capacity exceeds 80% full.
- Historian shall be capable of storing three (3) years of historical data.
- Historian shall include data storage redundancy. No single drive failure shall result in loss of data.

4.4.16 Historical data shall be stored upon change of value or at a maximum of 1 second increments.

4.4.17 Historian shall be capable of online addition and definition of points without the loss of data.

4.4.18 Sampling of historical data shall be enabled or disabled without requiring addition or deletion of points and without disrupting the historical data storage function.

4.4.19 Historical data shall be exportable into readily available formats, such as Microsoft Access (.accdb) or Microsoft Excel (.xlsx).

4.4.20 Historical data shall be natively viewable in the EMS HMI or user interface.

4.4.21 EMS shall include capability of all monitoring and control to be performed via Owner-provided ISP connection. Operation of the EMS shall not require use of Internet or cloud-based functionality. Loss of networking shall not prevent EMS from continuing to operate the BESS.

4.4.22 EMS shall interface with the power dispatch entity and provide and accept all required data to and from the power dispatch entity.

4.4.23 Design and installation of the EMS shall be provided with all hardware, telemetry, communication, and other requirements as required by the interconnection utility.

4.4.24 Communications System shall include the necessary equipment (hardware and software) for the exchange of signals with Project Substation equipment to support grid monitoring.

4.4.25 Communications System shall include the necessary equipment (hardware and software) for the exchange of signals and integration of any required reactive compensation devices (e.g., capacitor banks, reactors).

- Contractor shall provide an interface using Owner's preferred protocol for communication with Owner's historian. Contractor is responsible for providing all hardware, software, and licensing required to install this interface.

4.4.26 A register map containing all available parameters shall be provided to Owner. Any programming of the EMS necessary to implement the Owner's required dataset shall be included.

4.4.27 EMS design shall include configuration files and a comprehensive data points list and protocol specification for communications between all Project components requiring communications, data transfer, and control monitoring using the network integrated into the network. Such configuration files shall have the ability to be configured by Owner, and Contractor shall furnish development application software for each configurable device.

4.4.28 HMI:

- EMS shall include an HMI viewable locally and remotely and allowing the monitor of all devices and control of all allowable functions.

- Supplier shall coordinate with Contractor to include equipment within scope of BESS HMI, including access to data and control of high voltage equipment.

- EMS shall be provided with the following supervisory screens, at a minimum:

  (a) Project Substation one-line diagram, including all breakers, switches and transformers and the real-time status of each (current, power, voltage, power factor, and reactive power, as applicable).

  (b) Project Substation alarms and notifications, including status of all relays and status of all alarms and notifications.

  (c) Main power transformer status, including the following for each main power transformer:

    1. Operation and fault status, including alarms.

    2. Relay statuses.

    3. Temperatures, including winding and oil.

    4. Tap changer position.

  (d) Breaker status, including the following for each medium- and high-voltage breaker:

    1. Operation and fault status, including alarms.

2. Relay statuses.

3. Breaker readings of current, power, and voltage, including the Collection System Circuit.

(e) BESS unit wide control functionality including the following:

1. Frequency Control.

2. Voltage Droop Control.

3. Manual/Local Control.

4. Remote/Auto Control.

5. BMS Control.

6. PCS Control.

(f) BMS control functionality including the following:

1. System start/stop/restart.

2. Operation and fault status including alarms, power limits, rack voltages, rack currents, and rack temperatures.

(g) PCS control functionality including the following:

1. System start/stop/restart.

2. Operation and fault status including alarms, and power limits.

(h) Balance of Plant status, including the following:

1. Operation and fault status, including alarms.

2. Enclosure alarms (fire/smoke alarm status, enclosure temperature, intrusion, explosion control system status, etc.).

3. UPS battery charger voltage and status.

4. Intrusion detection.

5. HVAC status.

(i) EMS status, including the following:

1. State of Charge.

2. Dispatch program with a rolling view over 24 hours or as requested by Owner.

3. Customized screens for targeted key performance indicators on BESS operation.

- All major components (e.g., breakers, transformers, BESS, PV system) shall be listed separately.
- Alarms and faults shall be color-coded based on priority where applicable (e.g., green, yellow, red).
- Fault notification shall be provided through real-time text messaging or e-mail alerts, as determined by Owner. Fault notification messages and recipients shall be specified by Owner.

4.4.29 Testing

- Verify all alarms, indications and analog quantities are communicated and received properly by the RTU and displayed correctly on the HMI.
- Provide entire Project Site testing to ensure proper operation of all data points into the component gateways and testing of all data points provided to third parties with that party.

### 4.5 Networking

4.5.1 General

- Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully functional, and safe network configuration.
- Network shall be designed with data continuity and reliability as priority.
- Network shall be designed with redundancy so that there is no single point of failure to prevent control and monitoring of the BESS.
- All layer 2 network devices shall be connected to a layer 3 device. No daisy chain shall be allowed between switches.
- Network shall be designed to maintain a minimum of one (1) gigabit per second (Gbps) bandwidth throughout the backbone of the network.
- Maximum propagation delay through the network shall be no greater than 500ms for control and 1 second for monitoring.
- Communications System shall be compliant with all Applicable Standards. Further, the Communications System shall comply and be designed to work in accordance with applicable system operator approved protocols, operating guides, standards, business practice manuals, and/or approved rules. Design should include parameters for operating under conditions specified by rules stated hereto as well as capability to function on an evidentiary basis.
- Network connected systems shall be segmented using network access controls such that only required communications for operation are permitted.

- Contractor shall provide a complete bill of materials of all control and networking equipment, including make, model, firmware version, operating system version, and where applicable IP address(es) and MAC addresses(es). Supplier shall allow Owner to provide a selected vendor and model.

- Contractor shall provide network diagrams that show all network cabling interconnections of all devices connected via an IP or serial protocol.

- Contractor shall provide network diagrams that show the communication between devices, including source, destination, port, media type, and protocol.

- Contractor shall provide complete configuration files or exports of all network communication devices.

- Contractor shall allow Owner to provide available IP network addresses for assignment.

- Contractor shall furnish and install all network and communication devices, including programming and configuration, necessary for the Communications System, excluding the programing of the Owner RTU equipment.

4.5.2 Security

- Network shall be designed per and adhere to Owner cybersecurity standards which shall be communicated by Owner during the bidding phase. Exceptions shall be formally obtained from Owner.

- Owner's network shall be logically separated via firewalls from network where a 3rd party needs access.

- Firewalls or security gateways shall be placed between the supplied products and any external networks, including the Owner network and any remote access networks. The Communication System architecture design shall be non-linear such that networks are segregated.

- Supplied products which do not need to communicate with each other shall be placed on separate physical or virtual network segments. In case of virtual network segments, the configuration and enforcement shall be isolated to the layer two network equipment.

- All routing and switching devices shall supply SPAN ports for cybersecurity monitoring.

4.5.3 Network Cabling

- All communications cables, including fiber cables, shall be appropriately labeled with a permanently attached label at both ends. Labels shall be sequentially numbered.

- Fiber system shall be designed for a minimum of five (5) dB system margin.

- Fiber system design shall be a fiber ring topology such that the system utilizes redundancy to prevent outages due to cable or equipment failures.

- Maximum attenuation of fiber cabling shall be:

(a) 0.35 dB/km at 1310 nm.

(b) 0.25 dB/km at 1550 nm.

- Fiber type multimode (OM1/2/3/4) shall be submitted for Owner approval.
- Ethernet cabling shall follow TIA-568 standard.
- Contractor shall provide 50% spares for fiber.
- Contractor shall terminate all spare fibers.

4.5.4 Submittals

- Contractor shall prepare configuration files and a comprehensive data points list and protocol specification for communications.
- Refer to Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*).for additional Communications System submittals.
- Contractor shall submit manufacturer's product sheets (material cut sheets) for all permanently installed equipment and materials.
- Contractor shall design, furnish, construct, and install the Communications System in conformance with the minimum requirements set forth in this Exhibit and Attachment E (*Economic and Technical Data Form*).

4.5.5 Testing and Quality Control

- Contractor, shall test, commission, start-up, and place into successful operation the network, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall be in conformance with the following minimum requirements:

(a) Communications cables shall be tested by Contractor where provided and installed by Contractor.

(b) All network equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(c) All testing shall be performed as specified in the Applicable Standards, including NETA.

(d) All testing shall be performed as reasonably recommended or required by the applicable equipment Contractors.

(e) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(f) All fiber optic cable shall be visually inspected by Contractor prior to installation/termination.

### 4.6 Power Conversion Systems/Inverters

4.6.1 Provide inverters, disconnects, inverter master controller, and ancillary components of types, sizes, and ratings as required for the application, which comply with manufacturer's standard materials and with the design and construction in accordance with published product information. Where types, sizes, and ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

4.6.2 Inverters shall be listed to UL 1741 when operated with standard settings. Provide grid-tie, bi-directional, utility interactive inverters with capabilities of voltage and frequency ride-through. The features shall be compliant with regulatory requirements. Mono-directional inverters for BESS solutions DC coupled to PV generation may be considered. PV coupled BESS solutions shall also comply to Section 3.6 of Attachment F – Technical Specifications (*Inverter Assembly*).

4.6.3 Inverters shall have the capability of islanding and grid shaping operations as detailed in IEEE 1547.

4.6.4 Inverters shall be capable of Fast Frequency Response (FFR).

4.6.5 Inverters shall always recover and operate following any sequence of power cycles, such as recovering from voltage or frequency excursions.

4.6.6 Inverters shall have reactive power (VAR) control (4-quadrant inverter) that is capable of voltage regulation at the Point of Interconnection.

4.6.7 Inverters shall have dynamic power factor adjustment capabilities, via control system, such that the inverters at their AC terminals operate at the power factor at the POI as specified in the Storage Section of Attachment E (*Economic and Technical Data Form*).

4.6.8 Dynamic power response shall be completely configurable based on pre-set capability curves (VAR vs kW, kW vs Hz).

4.6.9 Inverter shall have ground fault protection with capability to detect an earth fault, indicate that a ground fault has occurred, and automatically disconnect all conductors or cause the inverter to automatically cease serving power to the faulted circuits.

4.6.10 Inverter shall have DC insulation monitoring functionality in addition to ground fault protection. Provisions shall be in place for the insulation monitor to operate daily.

4.6.11 PCS/Inverter NEMA/IP rating shall be as specified in the Storage Section of Attachment E (*Economic and Technical Data Form*).

4.6.12 The output shall be fused or protected by a circuit breaker to protect from overcurrent and to keep the loss of a semiconductor from causing a cascading failure. Inverter shall be supplied with an integrated DC load break disconnect for each inverter module to provide isolation, and an output AC circuit breaker to provide overall protection for the inverter. This circuit breaker shall be externally operated, capable of remote operation and be capable of lockout tagout.

4.6.13 The inverter shall have built-in protection against undervoltage, overcurrent, and overvoltage or transients. Inverter shall be provided with UL certified surge suppression devices on both the DC input and AC output.

4.6.14 Inverters shall meet IEEE 519 version 2014 for harmonic content. Total harmonic distortion (THD) of an individual inverter shall not exceed 2%.

- Non-fundamental-frequency current components, at any given frequency, injected into the system by the inverter(s) shall be less than the values specified below. The per-unit base is the rated current of the inverter when delivering the rated maximum real power at a power factor of 0.95 at nominal voltage. The RSS metric is the square root of the sum of the squares of the individual current frequency components from harmonic orders 2 to 50.

| | Harmonic Order | | | | |
|---|---|---|---|---|---|
| | h<17 | 17≤ h < 23 | 23 ≤ h < 35 | 35 ≤ h | RSS |
| Current Limit | 2.0% | 1.5% | 0.6% | 0.3% | 3.0% |

4.6.15 Current distortion specifications are applicable to all frequency components above 120 Hz and less than or equal to 3 kHz. Interpolation of the weighting factors shall be used for non-integer harmonics.

- Harmonic current limitations specified in this section apply to the currents caused by the inverter, not inclusive of harmonic currents caused by background harmonic voltages existing in the system exclusive of the inverters.

- Harmonic voltage limits

  (a) Resource shall not cause an incremental increase in voltage distortion at any non-fundamental order from harmonic orders 2 to 50 by greater than 1% of the nominal voltage.

  (b) Voltage TIF, as defined in IEEE-519, caused by the inverter(s), shall be less than 25.

  (c) Voltage distortion specifications are applicable to all frequency components above 120 Hz and less than or equal to 3 kHz. Interpolation of the weighting factors shall be used for non-integer harmonics.

  (d) These voltage distortion limitations apply to active contribution by the resource, and exclusive of voltage distortion amplification caused by resonances of passive circuit components.

4.6.16 Inverter shall have a short circuit withstand rating compatible with the battery system to which it is connecting.

4.6.17 Inverters shall be rated as 98% or greater efficiency at full load.

4.6.18 AC output shall not clip at any value below its nameplate while operating within the operating temperature range.

4.6.19 In the event of a grid failure or large disturbances, the inverters shall automatically disconnect from the grid. The inverters shall be capable of detecting an "islanding" situation by both passive (over and under voltage or frequency) measures and at least one active measure. Islanding function shall be capable of being disabled or turned off.

4.6.20 Inverter voltage and frequency ride-through capabilities shall be compliant with regulatory requirements.

4.6.21 Inverter shall be provided with a front panel display. The display should provide read capability for all parameters and incorporate password-protected write capability. A cover shall be provided to protect the display from sunlight.

4.6.22 Inverter shall support bidirectional data exchange for EMS commands to the inverter. The controls shall be the manufacturer's standard package and shall include, but not be limited to, the following:

- Emergency power off.
- Emergency power off reset.
- Inverter on/off.
- Power factor control.
- Reactive power (VAR) control.
- Power output curtailment.
- Power and VAR ramp rate.

4.6.23 Inverter shall provide, at a minimum, the following data to the EMS:

- Inverter status, alarm states and faults.
- Instantaneous input and output power.
- Energy production.
- DC and AC voltage.
- DC and AC current.
- DC current zone-level monitoring.
- Internal component and cooling system temperatures.

4.6.24 Inverter shall have a hard-wired emergency stop button on the external face of the inverter or on the exterior wall of the enclosure if the inverter is located indoors.

### 4.7 DC/DC Converters

4.7.1 If DC-coupled BESS is proposed by Contractor, the DC/DC converter shall be designed to integrate solar generation and BESS systems.

4.7.2 Provide disconnects, master controller, and ancillary components of types, sizes, and ratings as required for the application, which comply with manufacturer’s standard materials and with the design and construction in accordance with published product information. Where types, sizes, and ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

4.7.3 The DC/DC shall be listed to UL 1741 when operated with standard settings.

4.7.4 The DC/DC converter shall be rated as 98% or greater efficiency at full load.

4.7.5 The DC/DC converter shall have built-in protection against undervoltage, overcurrent, and overvoltage or transients.

4.7.6 The DC/DC converter shall have a short circuit withstand rating compatible with the battery system and inverter to which it is connecting.

4.7.7 The DC/DC converter shall include overcurrent protection devices in accordance product listing standards and code requirements.

4.7.8 The DC/DC converter shall provide, at a minimum, the following data to the EMS:

- Inverter status, alarm states and faults.
- Instantaneous input and output power.
- Energy production.
- DC input and output voltage.
- DC input and output current.
- Internal component and cooling system temperatures.

4.7.9 The DC/DC converter shall have a hard-wired emergency stop button on the exterior of the enclosure.

### 4.8 Medium Voltage Transformers

4.8.1 Contractor and/or Supplier shall include a medium-voltage, liquid-filled transformer or dry-type transformer. Such transformer shall be sufficiently sized to allow the full battery array/PBE capacity to be delivered. Pad-mount transformers shall be in accordance with the requirements set forth in this Exhibit, at a minimum. Transformer must be approved by Minnesota Power.

4.8.2 Sizes and ratings as required by inverter selection and configuration.

4.8.3 Transformer(s) shall be manufactured to meet all special considerations and technical requirements as required by inverter supplier.

4.8.4 Liquid-Filled Transformers

- Shall comply with the following latest standards:

  (a) IEEE C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

  (b) IEEE C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers.

(c) IEEE C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers.

(d) IEEE C57.159 - IEEE Guide on Transformers for Application in Distributed Photovoltaic (DPV) Power Generation Systems.

(e) IEEE C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

(f) NEMA CC 1 - Electric Power Connection for Substations.

(g) NEMA TR 1 - Transformers, Step Voltage Regulators and Reactors.

- Pad-mount transformers shall be fitted with in-line, medium-voltage rated, current-limiting fuse protection per phase utilizing suitably rated, oil-immersed, current-limiting fuses. The selection of these fuses shall be such as to ensure (a) compliance with the requirements of IEC 62655 or ANSI/IEEE equivalent; (b) short circuit protection of the MV transformer winding; (c) that degradation of the fuses does not occur as a result of the flow of repeated transformer magnetizing in-rush currents; and (d) ease of replacement following an in-service operation.

  (a) Equivalent medium-voltage circuit breaker protection may be used in place of current-limiting fuse protection.

- Pad-mount transformers shall be fitted with a low-side disconnect with visible open with means to take a BESS offline without taking an entire Collection System Circuit offline.

- Enclosure:

  (a) Pad-mount transformer shall include a fully enclosed, transformer mounted, MV and LV termination, steel cabinet, suitable for outdoor installation, as per IEEE C57.12.28. The cabinet shall be so designed as to fully enclose all cable tails, cable terminations, grounding tags and transformer fittings within a tamper and rodent resistant, secure enclosure.

  (b) Cabinet shall extend to floor level, fully shrouding all cable tails, having the facility for being directly bolted to the supporting pad.

  (c) MV and LV compartments shall be partitioned such that access to each compartment is via a separate door. External access shall be available through the LV compartment door only, with access to the MV compartment door lock being available within the LV compartment. The doors shall be fitted with an all steel, robust, tamper-proof, three point (i.e., top, mid, and bottom) integral locking system. Each door shall have the capability of being securely locked shut via the application of a dedicated pad lock.

  (d) Transformer nameplate and all transformer indication fittings (e.g., oil level indicator, oil temperature indicator) shall be located within the LV compartment, while all transformer operational fittings (e.g., tap changer switch, isolation switch etc.) shall be located within the MV compartment.

(e) Cabinet doors shall be fitted with anti-close stays designed such that both doors can be held open at right angles. The anti-close stay design shall be sufficiently strong enough to withstand the prevailing wind conditions.

- Percent impedance voltage shall be according to the inverter manufacturer's recommendation, otherwise 5.75% ± 0.75%.
- Noise Level: Per NEMA Standards TR-1 (quote 55 dB as an option).
- Duty Cycle for energy storage application.
- Transformer shall be of the compartmental pad-mount design with dead front and loop feed features.
- Transformer kVA rating shall match or exceed PCS combined inverter rating at an equivalent temperature that meets project site design requirements. Impedance shall match inverter manufacturer requirements.
- Cooling class: KNAN or KNAF.
- Low voltage: Matched to selected inverter.
- High voltage: As specified in the Storage Section of Attachment E (*Economic and Technical Data Form*).
- High efficiency: 99.2% or greater at nameplate output.
- No-Load losses shall be limited to 0.15% of full KVA rating.
- BIL ratings: To be stated in data sheet for Owner review.
- Winding insulation: 65ºC rise over 45ºC ambient.
- Number of windings: Maximum of three.
- De-energized tap changer with high voltage taps: two (2) 2.5% above and below nominal position, fully rated.
- Hook stick disconnect switch shall be located external to the transformer cabinet such that Arc Flash protection is not required for operation.
- Overcurrent and short circuit protection:

  (a) Selected to provide protection for the inverter step-up transformer, current carrying connections and conductors, and the inverter. Coordinated with the transformer damage curve to prevent damage.

(b) Provided with short circuit, interrupting, and close and latch capabilities according to the definitions of IEEE C37.04 – IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers, and meeting the requirements of IEEE C37.06 – IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000V. Provide ratings exceeding the available short circuit current of 30 kA or higher if determined by Supplier calculations and studies.

(c) May consist of one of the following:

1. Bayonet fuse (with holder) in series with partial range current limiting fuse, or

2. Internal expulsion fuse in series with oil immersed current limiting fuse, or

3. Electrically operated vacuum circuit breaker in a metal-clad construction according to the requirements of IEEE C37.20.2 – IEEE Standard for Metal-Clad Switchgear, or

4. Electrically operated load interrupter switch meeting the standards of IEEE C37.20.4 – IEEE Standard for Indoor AC Switches (1 kV to 38 kV) for use in Metal-Enclosed Switchgear and in a metal-clad construction according to the requirements of IEEE C37.20.2 with current limiting fuse provided for short circuit protection, or

5. Owner approved equal.

- Top powder coat of ANSI 70 light grey or other color as approved by Owner.

- Oil level, pressure/vacuum and oil temperature gauges. All instrumentation shall be read into SCADA. Oil temperature gauge to be furnished with two alarm contacts (warning and trip). Oil temperature and pressure transmitters shall provide binary outputs. Transformer shall have sudden pressure protection and associated output relay. Oil level gauge to be furnished with alarm contacts. Instrument gauges shall be located such that gauges can be read without requiring Arc Flash protection. Access to the Equipment shall be provided in accordance with NEC and OSHA standards.

- Drain valve with oil and dissolved gas analysis sampling provisions, readily accessible in normal operation. Valve shall be located external to the high voltage and low voltage compartments in a pad-lockable cover.

- NEMA 2-hole ground terminal pads.

- Transformer mounting pad design may be required to incorporate features for secondary containment of oil. Supplier shall conform to AHJ requirements and design shall be reviewed and accepted by Owner.

- Transformer insulating/cooling liquid shall be non-hazardous and environmentally friendly such as FR3 or Owner approved equivalent.

- In addition to all routine factory testing per most recent standard of ANSI/IEEE standard C57.12.90 and C57.12.00, the following tests shall be conducted:

  (a) Full ANSI impulse test on one (1) unit, preselected during production by Owner.

  (b) Heat run test on one (1) unit, preselected during production by Owner.

### 4.9 System Protection Requirements

4.9.1 Supplier shall coordinate with Contractor on protection relay design as indicated in Attachment F – Technical Specifications – Exhibit 2 (*Contract Deliverables*).

4.9.2 Protection and coordination for the "plant-side" system including batteries, DC combiner panels, inverters, AC combiner panels, transformers, auxiliary systems, PV coupled generation, and switchgear (where applicable) shall adhere to IEEE 242.

4.9.3 Protection relays for the interconnection shall be utility grade and shall meet the minimum requirements specified in IEEE C37.90 including requirements for EMI and surge withstand according to applicable standards for the intended location of the Project.

4.9.4 A complete protective relaying system based on industry standards shall be a part of the AC system. The protective relaying and metering shall be integrated with the Project control system and communications channel to Owner's SCADA system. However, integration into the Project control system shall not circumvent normal protective relaying functions.

4.9.5 All protective equipment and schemes shall be properly coordinated with the protection of the utility substation or distribution network protective devices where the Project is connected. Considerations for micro-grid or islanding applications shall be considered as required in the Storage Section of Attachment E (*Economic and Technical Data Form*) for protection scheme capabilities.

4.9.6 Supplier shall use microprocessor type protection equipment.

4.9.7 Low side bus and cable shall be protected by overcurrent relays.

### 4.10 BESS Construction Support

4.10.1 Installation Support

- Supplier shall meet with Contractor and Owner prior to installation of the BESS to participate in an in-person page turn of the BESS integrated solution installation, including EMS.

- Supplier to provide offloading, storage, and erection instructions, including critical lift plans.

- Mechanical Completion of battery PBE, including documentation of progress on battery PBE Supplier-furnished forms, shall be successfully achieved in accordance with the instructions set forth in the installation manual and Mechanical Completion checklists provided by the Supplier.

- All rigging utilized for the transportation, offloading, or erection shall be rated, inspected daily, and load tested in accordance with Applicable Standards or other more rigorous requirements set forth in the HSSE Plan. Inspection reports shall be maintained at the Project Site and available for review by Contractor.

- Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Contractor.

### 4.11 Testing and Quality Control

4.11.1 Contractor shall test, commission, start-up, and place into successful operation the BESS, including the electrical infrastructure and communications infrastructure. Integration of PV coupled BESS solutions shall be validated to ensure proper load flow between the BESS and PV generation. At a minimum, testing shall be in conformance with the requirements defined in this Exhibit as well as Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*).

4.11.2 Factory Acceptance Tests: Contractor shall require the following equipment to be tested for functionality, operability, and performance in the factory and prior to shipment. The Contractor or a Contractor's Representative reserves the right to witness all tests. Supplier shall provide Contractor with two weeks minimum notice prior to factory acceptance testing.

- Batteries

  (a) Supplier shall provide manufacturing and testing schedule to Contractor. Test plan shall be provided to Contractor thirty (30) Calendar Days prior to test start for review.

  (b) Test plan shall include energy capacity tests.

- Enclosures

  (a) Supplier shall provide manufacturing and testing schedule to Contractor. Test plan shall be provided to Contractor thirty (30) Calendar Days prior to test start for review.

  (b) Plan shall include evaluation of thermal management system and detection/suppression system.

- Inverters & Converters

  (a) Supplier shall provide manufacturing and testing schedule to Contractor. Test plan shall be provided to Contractor thirty (30) Calendar Days prior to test start for review.

  (b) Factory tests shall be performed according to manufacturer's standard recommendations and NEMA and IEEE Standards to ensure proper function and operation.

  (c) Factory test reports shall be available upon request. Witness test shall demonstrate the following, at a minimum:

1. Run for a duration at rated current for burn-in equal to the BESS duration as specified in the Project Information Section of Attachment E (*Economic and Technical Data Form*).

2. Normal and failure mode operating sequence and protective functions.

3. Verification of accuracy of measured input/output voltage and currents.

4. Verification of dynamic power factor control via EMS (ex. Modbus).

5. Verification of power curtailment via EMS (ex. Modbus).

- MV Transformers

(a) Liquid-Filled Transformers

1. Minimum factory testing on all units unless expressly noted otherwise.

2. All tests identified as "routine" in IEEE Std C57.12.00 and performed in accordance with IEEE Std C57.12.90.

3. Resistance measurements of all windings.

4. Polarity and phase relation.

5. Ratio at rated voltage on all taps.

6. No-load losses and excitation current.

7. Load losses and impedance voltage.

8. Lightning impulse test on first unit produced.

9. Audible sound emissions on first unit produced.

10. Dissolved gas analysis on all units *prior* to temperature rise test.

11. Temperature rise test on first unit produced.

12. Dissolved gas analysis on tested unit *after* temperature rise test.

13. Dielectric tests.

14. Oil testing on all units shall be completed and approved by Contractor *prior* to energization.

(b) Dry-Type Transformers

1. All tests shall conform to IEEE C57.12.91 for dry-type power transformers. The manufacturer shall state by which method the test was made if method is not specifically stated below.

2. Insulation Resistance: Each winding to ground and to other windings.

3. Insulation Resistance: Core-to-ground, core form transformers only.

4. Winding ratio test on normal and all tap positions.

5. Winding polarity and phase relation.

6. No load loss at rated voltage.

7. Load loss at rated voltage.

8. Exciting current at rated voltage and on the rated voltage connection.

9. Impedance.

10. Applied potential tests.

11. Induced potential tests.

12. Other manufacturers' standard factory tests on transformer and surge arresters.

- EMS Controls/HMI/SCADA

  (a) Verification of performance: Compliance with specified criteria defined in this Exhibit, including any Owner cybersecurity requirements.

4.11.3 Requirements for the BESS functional testing shall be as follows:

- Equipment shall be tested for performance prior to commercial operation. This process shall verify the installed system is performing per the design.

- Contractor shall ensure manufacturer site acceptance testing is completed for inverters and battery enclosures with completed reports.

- Contractor shall ensure manufacturer Mechanical Completion checklists are completed for inverters and battery enclosures prior to energization.

- Contractor shall start up and commission each of the inverters and ensure they are running in the full DC voltage range for optimal performance.

- Prior to the performance test, the Contractor shall perform functional tests. As part of the commissioning process of the newly constructed BESS, the Supplier shall perform a functional test on each of the circuits to verify that they are all operating as expected and designed.

  (a) As applicable, system software should be installed, updated, and confirmed operational.

  (b) Verification of interconnected battery rack functionality.

  (c) Safety system verification, confirming communication of smoke, gas, fire, heat, and other sensors and alarms with controls system, ensuring automatic emergency shutdown or ventilation as applicable.

(d) Verify proper and reliable electrical performance given environmental conditions and system DC power input per the Supplier recommendations.

(e) Confirm communications between cell, module, rack, and battery management system (BMS).

(f) Confirm communications between meters/monitors/sensors and the BMS as applicable.

(g) Compare and validate functionality against the factory acceptance test criteria for installation in the field, as applicable.

- Prior to the performance test, the Contractor shall perform Testing, Adjusting and Balancing (TAB), as well as functional testing on the thermal management system and ensure it is operating as designed.

  (a) TAB shall be performed and verified to be operating within design specifications.

  (b) TAB shall be performed by a Contractor that is certified by the Testing, Adjusting and Balancing Bureau (TABB).

  (c) Contractor shall develop a thermal management functional testing plan and execute tests to verify the thermal management system operates as designed. Functional testing of the thermal management system shall at the minimum do the following:

    1. Verify the control wiring, power wiring, is installed and operating as expected.

    2. Verify proper performance of all motors, actuators, dampers, valves and mechanical devices.

    3. Verify refrigerant piping has no leaks and system is adequately charged.

    4. Verify the system operates as designed and explained within the sequence of operations.

- Contractor shall verify proper meter operation and installation per manufacturer specifications. When open loop control is used, power losses from PCS terminals to the site meter at the medium or high voltage point, due to transformer losses, should be compensated by this calibration.

  (a) Verify proper wiring and installation per manufacturer specifications and/or design documents.

  (b) Verify proper current and voltage transformer (CT/VT) selection based on required accuracy classification.

  (c) Verify CT current readings are all the same to confirm orientation.

  (d) Verify proper CT & VT ratio programming into meter.

  (e) Verify meter date and time are set or linked to GPS clock.

(f) Verify meter is accurately capturing and recording performance data.

(g) Verify meter is properly communicating with EMS / SCADA system.

- Contractor shall perform an infrared scan to confirm site DC system health prior to conducting the performance tests. The Supplier shall perform repairs or replacements for each BESS that is not performing as designed.

- Contractor shall develop a testing plan and execute tests to verify functionality of all functions and operations.

(a) Test plan shall be submitted for approval by Owner prior to commencement of tests.

(b) Using the EMS / SCADA system, Supplier shall initiate commands to each PCS to evaluate proper functionality of each function and operating mode.

- Contractor shall develop and submit to Owner a test plan to clearly establish the scope of the testing for the fire alarm, signaling, suppression, and explosion protection system.

(a) Supplier shall test fire alarm and signaling systems in accordance with NFPA 72 and local jurisdictional requirement to verify system operation in accordance with the design documents.

(b) Supplier shall test fire suppression and explosion protection system in accordance with NFPA 72 and local jurisdictional requirements.

4.11.4 Requirements for the BESS performance testing:

- Supplier shall perform performance testing after Supplier verifies impedance calculations from the Contractor.

- Reference Exhibit F-2 (*Performance Testing Procedures (BESS)*) and Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*) for performance testing procedures and details.

4.11.5 Central inverter testing at the Project Site shall be performed in coordination with the inverter manufacturer field engineer. Testing shall include all testing recommended by the central inverter system manufacturer and testing required to maintain the central inverter system warranty. Any deviation from this requirement shall be approved by Owner. Testing shall confirm the inverter performance including power outputs, heat rejection, communications, etc. Copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within ten (10) Business Days of completing such test.

- Inverter manufacturer shall provide the following documentation from a certified NRTL:

(a) UL 1741 Test Report.

(b) UL 1741 Certification.

(c) UL 1741 SA Test Report.

(d) UL 1741 SA Certification.

(e) IEEE 1547/519 Harmonics Test Report (including raw test data), current THD < 3 percent.

(f) NERC PRC-024-2 Voltage and Frequency Ride-Through Test Report.

- Inverter manufacturer shall provide the following documentation from type testing (or from a certified NRTL) to show the inverter meets the specifications outlined in the data sheet. The documentation shall include, at a minimum: active power, reactive power, frequency, DC voltage/current, AC voltage/current, and critical component temperatures (for ambient temperature testing).

(a) Active Power

1. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the nameplate power rating (including any "overdrive" or 110% functionality).

(b) Reactive Power

1. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the maximum reactive power capabilities.

2. Minimum Requirement: As documented in the Interconnection Agreement or, at a minimum, 0.95 lead/lag in 0.01 intervals.

(c) Plant Controller Response

1. Inverter manufacturer shall provide test documentation showing the inverter can receive active and reactive commands from a simulated plant controller interface.

2. Inverter manufacturer shall provide test documentation showing the inverter can operate at the maximum and minimum ramp rates for both active and reactive power variation.

(d) DC Voltage

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated DC voltage operating range.

2. Inverter manufacturer shall provide active power vs. DC voltage de-rating curves.

(e) AC Voltage

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated AC voltage operating range.

2. Inverter manufacturer shall provide active power vs. AC voltage de-rating curves from 0.9 to 1.1 p.u. terminal voltage and 0.9 lead/lag power factor.

(f) Ambient Temperature

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the entire ambient temperature range (minimum duration to match BESS duration as specified in the Project Information Section of Attachment E (*Economic and Technical Data Form*) at each test condition).

2. At a minimum, the test documentation shall include the following operating conditions: 25°C, 45°C, maximum operating temperature, minimum operating temperature, and any "corner points" on ambient temperature de-rating curves.

3. Inverter manufacturer shall provide active power vs. ambient temperature de-rating curves.

(g) Reliability

1. Inverter manufacturer shall provide test documentation summarizing the accelerated life testing (ALT) and highly accelerated life testing (HALT) that has been completed.

2. Inverter manufacturer shall provide mean time between failures (MTBF) and mean time to failure (MTTF) rates for critical components such as IGBTs, DC switches/contactors, AC contactors/breakers, DC link and AC filter capacitors, communications boards, and cooling system components (fans, pumps, etc.)

- At a minimum, the following tests shall be performed on each inverter during production testing:

(a) Calibration of all DC and AC voltage, current, and power circuitry/sensors.

(b) UL 1741 production testing such as hi-pot and PE/ground testing.

(c) Ground fault detector/interrupter (GFDI).

(d) Emergency stop (fast stop).

(e) Remote start/stop.

(f) Burn-in (minimum duration to match BESS duration as specified in the Project Information Section of Attachment E (*Economic and Technical Data Form*) per inverter). Burn-in testing should be completed under elevated ambient temperature and high DC current conditions at maximum rated power.

(g) Harmonic content verification (during burn-in tests).

(h) Efficiency verification.

(i) Verify inverter efficiency at multiple DC voltages and power levels which shall be consistent with the levels tested during CEC testing.

(j) The official CEC test procedure is not required.

(k) Reactive power control range as documented in the Interconnection Agreement or, at a minimum, across a range of 0.95pu lead/lag.

(l) Voltage and frequency ride-through verification per IEEE 1547 and/or PRC-024-2.

### 4.12 Commissioning

4.12.1 Contractor shall test, commission, start-up, and place into successful operation the BESS, including the electrical infrastructure and communications infrastructure. Commissioning activities shall be executed under a phased approach, as identified below.

4.12.2 Design Phase

- Commissioning & Testing Plan: A project-specific Commissioning & Testing Plan shall be developed and issued by Supplier. The Commissioning & Testing Plan shall outline the proposed personnel and/or company, tasks, processes, procedures, and deliverables required to prove the function and performance of the Work. It shall include a section on deficiencies and resolution procedures for each phase and the Commissioning & Testing Schedule. The Commissioning & Testing Plan shall also reference safety requirements for start-up and commissioning, including electrical safety and lock-out/tag-out procedures. The Commissioning & Testing Plan shall be submitted to the Owner for review and approval.

- Commissioning Log: A detailed commissioning log shall be developed and issued by Supplier for the tracking of all commissioning activities, issues, observations, and deficiencies.

4.12.3 Construction Phase

- Meetings: Commissioning meetings shall be held on-site on a periodic basis. A commissioning kick-off meeting shall be held with the project team at the commencement of project construction. The commissioning kick-off meeting shall include Supplier's commissioning lead, project manager, design team representative, construction team representatives, and the Owner's Representative.

- Inspections: Equipment delivery inspections shall be carried out by Contractor during construction based on Supplier's installation and QA/QC requirements.

- Functional Tests and Inspections: Equipment-specific functional checklists shall be developed and implemented by Supplier. The functional checklists shall address proper installation methods, vendor/manufacturer requirements, applicable codes and standards, and design requirements. Functional testing and inspections shall be required as pre-requisite of Mechanical Completion, including the following:

  (a) Mechanical and electrical installation of the BESS, DC-DC converter (if applicable), inverter, MV transformer, and MV switchgear as applicable including associated Supplier cabling per design drawings and equipment manufacturers' recommendations.

(b) Functional tests of the battery PBE, including batteries, BMS, thermal management system, explosion control, fire detection, and fire suppression systems as applicable and per manufacturers' requirements.

(c) Installation of the PCS skid equipment, including inverters, transformers, EMS, and auxiliary equipment per the design drawings and equipment manufacturers' requirements.

1. Inverter functional checks per inverter manufacturer requirements.

(d) Functional checks and tests of the MV transformers as required by NETA-ATS, including but not limited to megger tests, hi-pot tests, oil sampling tests, grounding tests, confirmation of tap changer settings, insulation resistance of open load break switch, insulation resistance of windings, and turns ratio testing.

(e) Verify that EMS Equipment is installed per design drawings and manufacturers' recommendations.

(f) Verify proper installation of all medium voltage fault indicators and surge arrestors.

(g) Inspect and test each low and medium voltage switch or breaker in accordance with NETA-ATS.

(h) Confirm all equipment is properly bonded to earth ground per NETA-ATS 7.13.

(i) Confirm all enclosures are clean and free of debris.

(j) Verify that all warning signs and safety labels are installed.

(k) Confirm proper settings of all adjustable trip circuit breakers.

- BESS shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(a) As described in this and related Specifications.

(b) Continuity testing of all installed wire, cables, and bus.

(c) Megger all power cables and bus.

(d) Power testing of all enclosure circuits (i.e. lights, receptacles, etc.).

(e) Functional testing of all HVAC and thermal management equipment.

(f) Functional testing of all fire alarm and suppression equipment and systems.

(g) Functional testing of DC Ground Fault Detection device.

(h) Functional testing of PLC logic.

- All testing specified in the Applicable Standards including NETA-ATS.

- All testing reasonably recommended or required by the applicable equipment manufacturers.

- All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

- EMS and communications system testing and commissioning in conformance with the following minimum requirements. Contractor shall notify Owner of all testing schedules at least thirty (30) Calendar Days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within ten (10) Business Days of completing such test.

    (a) All Communications System line equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

    (b) All testing specified in the Applicable Standards.

    (c) All testing reasonably recommended or required by the applicable equipment manufacturers.

    (d) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

    (e) Verify all alarms, indications and analog quantities are communicated and received properly by the RTU and displayed correctly on the HMI.

    (f) Verify all communication channels (intra- and inter-Project Substation), including Project Substation LAN, operate as expected.

    (g) Verify fiber optic system performance (power losses, splice, or connector losses, etc.) using OTDR. All such testing shall be done with an OTDR in both directions of the strands. For single-mode fiber, test both directions at 1310 nm and 1550 nm. A successful test result shall be (a) less than 0.35 dB per connection and (b) (i) less than -50 dB if UPC and (ii) less than -65 dB if APC.

    (h) All fiber optic cable shall be visually inspected and OTDR-tested prior to installation / termination.

    (i) Provide system functionality and compatibility at the control room / O&M Building.

    (j) Test each cable and strand on every fiber run from termination to termination.

    (k) Provide entire Project Site testing to ensure proper operation of all data points into the component gateways and testing of all data points provided to third parties with that party.

### 4.13 Substantial Completion

4.13.1 The following are conditions required to achieve Supplier Substantial Completion:

- All requirements of Mechanical Completion have been completed to the satisfaction of the Owner.
- Successful functional testing of the BESS system, including:
  (a) Capacity testing to achieve the project minimum guaranteed capacities as indicated in the Storage Section of Attachment E and Attachment F – Technical Specifications – Exhibit 6 (*PV Capacity Test*).
  (b) Demonstrated operation of the EMS.
- All Contractor submittals have been received and approved to Owner's satisfaction.
- Contractor has delivered all applicable lien waivers to Owner.

**ATTACHMENT 1 TO EXHIBIT F-1**
**APPLICABLE STANDARDS**

Without limiting the information summarized herein, the purpose of this attachment is to summarize the applicable industry codes and standards for Contractor's Work.

A. General Requirements

1. Applicable Standards shall include (a) each of the standards and industry codes listed below and (b) each of the relevant standards and codes issued by the organizations listed below. For the avoidance of doubt, any standards or industry codes not identified herein but pertinent to the Work shall also apply.

2. Unless otherwise specified, all engineering, procurement, and construction associated with the Project shall comply with the applicable codes and standards including, but not limited to, those listed herein. Any departure from the referenced codes and standards shall be fully explained in writing and submitted for Owner's review and approval prior to implementation.

3. All specific standards applicable to pieces of equipment, structures, and/or buildings may not be listed herein. Specifications may describe the specific standards that may apply.

4. Any general standard or organization listed below shall be understood to include all relevant codes, standards, and/or guidelines under that particular standard or organization. For example, ACI shall include ACI 301, ACI 305, ACI 306, ACI 318, etc.

5. Unless otherwise specified herein, in the case of conflict between any Applicable Standards, the more stringent requirement shall apply.

B. Applicable Standards

1. Publication Dates: Comply with standards in effect as of date of the Agreement unless otherwise indicated.

2. Applicable state requirements, including State Department of Transportation

3. Aluminum Association ("AA")

4. American Association of State Highway and Transportation Officials ("AASHTO")

5. American Institute of Steel Construction ("AISC")

6. Association of Iron and Steel Engineers ("AISE")

7. American Iron and Steel Institute ("AISI")

8. American National Standards Institute ("ANSI")

9. American Society of Civil Engineers ("ASCE")

10. American Society of Heating, Refrigeration, and Air Conditioning Engineers ("ASHRAE")

11. American Society of Mechanical Engineers (“ASME”)
12. American Society of Nondestructive Testing (“ASNT”)
13. American Society of Testing and Materials (“ASTM”)
14. American Water Works Association (“AWWA”)
15. American Welding Society (“AWS”)
16. Code of Federal Regulations (“CFR”)
17. Crane Manufacturer Association of America (“CMAA”)
18. Department of Transportation (“DOT”)
19. United States Environmental Protection Agency (“EPA”)
20. Federal Aviation Agency, Department of Transportation (“FAA”)
21. Federal Communications Commission (“FCC”):
22. Federal Energy Regulatory Commission (“FERC”).
23. Federal Highway Administration (“FHWA”)
24. International Air Transport Association (“IATA”)
25. Illuminating Engineering Society (“IES”)
26. Institute of Electrical and Electronic Engineers (“IEEE”)
27. Instrumentation Society of America (“ISA”)
28. Insulated Cable Engineering Association (“ICEA”)
29. International Building Code (“IBC”)
30. International Fire Code (“IFC”)
31. International Electrical Testing Association (“NETA”)
32. International Electrotechnical Commission (“IEC”)
33. International Energy Conservation Code (“IECC”)
34. Illuminating Engineering Society of North America
35. International Maritime Organization (“IMO”)
36. International Safety Equipment Association (“ISEA”)
37. International Organization for Standardization (“ISO”)

38. Metal Building Manufacturers Association (“MBMA”).

39. National Electric Code (“NEC”)

40. National Electrical Contractors Association (“NECA”)

41. North American Electric Reliability Corporation (“NERC”)

42. National Electric Safety Code (“NESC”)

43. National Electrical Manufacturers Association (“NEMA”)

44. National Electrical Testing Association (“NETA”)

45. National Fire Protection Association (“NFPA”)

    a. NFPA 1 – Fire Code

    b. NFPA 68 – Standard on Explosion Protection by Deflagration Venting

    c. NFPA 69 – Standard on Explosion Prevention Systems

    d. NFPA 72 – National Fire Alarm and Signaling Code

    e. NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems

46. National Safety Council (“NSC”)

47. Occupational Safety and Health Administration (“OSHA”)

48. Scientific Apparatus Makers Association (“SAMA”)

49. Steel Door Institute (“SDI”)

50. Sheet Metal and Air Conditioning Contractors National Association (“SMACNA”)

51. Society for Protective Coatings (“SPC”)

52. Telecommunications Industry Association/Electronic Industries Association (“TIA/EIA”)

53. Underwriter’s Laboratories (“UL”)

    a. UL 864 – Standard for Control Units and Accessories for Fire Alarm Systems

    b. UL 1741 – Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources

    c. UL 1973 – Standard for Safety Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications

    d. UL 9540 – Standard for Safety Energy Storage Systems and Equipment

    e. UL 9540A – Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

**ATTACHMENT 2 TO EXHIBIT F-1**
**PREFFERED SUPPLIERS**

Without limiting the information summarized herein, the purpose of this attachment is to summarize the Preferred Suppliers for BESS vendors for Contractor's Work. Contractor shall include supporting documentation and basis for Supplier selection to Owner for review and acceptance. Alternate Suppliers not listed below may be considered upon approval by Owner. Refer to Attachment F – Technical Specifications – Exhibit 9 (*Approved Suppliers*) for an additional list of Suppliers suitable for PV sites with optional storage.

A. Suppliers

1. ABB
2. BYD
3. Canadian Solar
4. CATL
5. Caterpillar
6. ELM
7. Evesco
8. EVLO
9. FlexGen
10. Fluence
11. Generac
12. Hitachi
13. Hithium
14. KOREPower
15. Samsung
16. Socomec
17. Stark Tech
18. Sungrow
19. Symtech Solar
20. Tesla
21. TMEIC

22. Trina

23. Wartsila