# Book 3

# Technical Specification and Requirements of Battery Energy Storage System (BESS)

ร่างเอกสารประกวดราคา

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ร่างเอกสารประกวดราคา

# Technical Specification and Requirements of BESS for Microgrid Development Project at Betong District, Yala Province Provincial Electricity Authority (PEA)

## 1. GENERAL

### 1.1 The system shall confirm to the following specification.

BESS shall consist of:

1) A power conversion system (PCS) suitable for indoor installation on a user-furnished concrete pad or the user-furnished box pad;
2) An energy storage unit of at least 4 MW/at least 4 MWh at 15%-90% SOC (**Note** % SOC means % SOC of installation capacity), at least 1 hour at 4 MW to load as described in Fig. 1.
3) Lithium-ion battery with life expectancy rating of 10 years (minimum installation energy capacity requirement is 5.4 MWh at begin of life (BOL)) under normal operating conditions (ambient temperature of 23°C inside battery room, constant power charge and discharge with rated 1C rate, and 1 cycle/day), suitable for indoor installation, and a battery management system (BMS).
4) Specification requirements of the PCS are further discussed in Section 4.0. Specification requirements of the energy storage unit and BMS are further discussed in Sections 5.0 and 6.0, respectively.

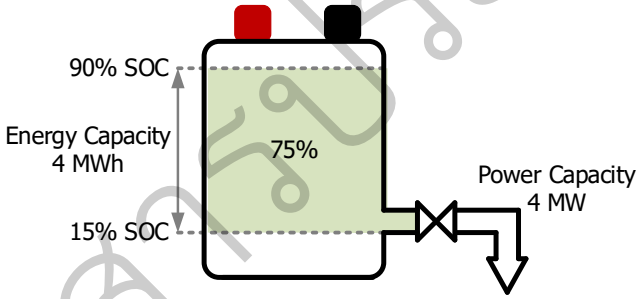


Figure 1: Requirement of energy storage capacity (energy and power capacity).

### 1.2 Electrical grid connection

The BESS shall be connected to the medium voltage 33 kV AC three phase distribution line at a frequency of 50 Hz. A step-up transformer shall be provided to allow connection between the BESS and the 33 kV distribution line. The contractor shall provide and make connection power cable between BESS with PEA substation. Rating of a step-up transformer is at least 5 MVA. The winding type of transformer can be defined by bidder. The vector group of transformer shall be YNd group. The PCS shall be designed to operate under the following condition:

| | |
|---|---|
| Phase | 3 |
| Rated voltage | 33 kV |
| Voltage range | Max 34.65 kV, Min 31.35 kV |
| Voltage fluctuation/Flicker | According to PEA regulations |
| Rated frequency | 50 Hz |
| Frequency range | 50 $\pm$ 0.5 Hz |
| Harmonics | According to PEA regulations |
| Voltage unbalance | < 2% |

### 1.3 Operation

In normal operation, BESS shall operate in current-source mode, providing such functionality as voltage regulation, power factor correction, peak shaving and load following. It shall have the ability to perform four-quadrant control.

If the utility power source is interrupted, the BESS shall have **low-voltage ride through (LVRT)** capability according to PEA Grid connection code 2016 as shown in Fig. 2 to support the transition from grid connected to islanded condition. The energy storage unit and converter shall then power the islanded 4 MW load for at least 1 hour, or until utility service is resumed for the energy storage unit is depleted.

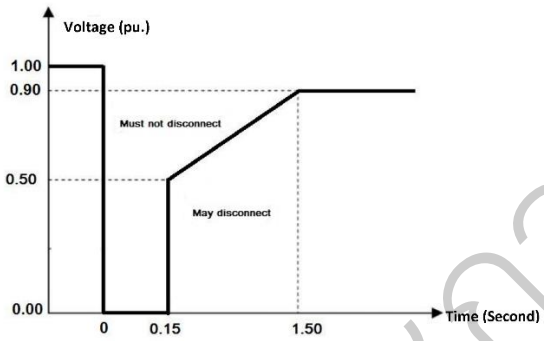


Figure 2: LVRT requirement according to PEA Grid connection code 2016.

### 1.4 Communications

The BESS shall be capable of communicating over a standard protocol, like DNP 3.0 over IP or IEC61850 protocol, furnished and installed by the system manufacturer, which shall permit - communication to the microgrid controller (MGC). This will allow PEA to monitor and control such parameters as battery voltage, current, temperature, state of charge and state of health at the cell/module/tray and rack levels; as well as allow to control charging, discharging and other functions of BESS, as necessary. Battery Management System (BMS) shall connect and transfer data to MGC/ADDC.

The PCS shall communicate with the energy storage unit controller via a standard protocol defined by vendor, e.g. Modbus RTU or Modbus TCP, etc. In case of Modbus communication, all Modbus detail shall be provided.

The BESS shall have a maintenance port (serial, WiFi, Bluetooth, etc.) to allow monitoring and control of BESS at local level via a PC.

The BESS shall have security access for maintenance battery system room.

## 2. STANDARDS AND CODES

Equipment furnished shall meet the guidelines defined in the applicable sections of the standards and codes listed below.

- ANSI/IEEE Standard C2-2007: National Electrical Safety Code
- ANSI C57.12.28-2005: Pad-mounted Equipment Enclosure Integrity
- ANSI Z535.4-2002: Product Safety Signs and Labels

- ANSI C62.41.2-2002: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits
- IEC 62103: Electronic equipment for use in power installations
- IEC 60664-1: Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests
- IEC 60947.1: Low-voltage switchgear and controlgear Part 1: General rules
- IEC 62053-22: Electricity metering equipment (a.c.) - Particular Requirements - Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)
- IEC 61000: Electromagnetic compatibility (EMC)
    - EN61000-6-2 EMC immunity
    - EN61000-6-4 EMC emission
    - Reference - FCC Sections 15.109&15.209: FCC Code of Federal Regulations Radiation Emission Limits
- IEC 62619 or UL 1973 - Safety Requirements for Secondary Lithium Cells and Batteries or Standard for Stationary Batteries
- IEC62109 or UL 1741: Safety of power converters for use in photovoltaic power systems or Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
- IEEE Standard 519-2014: IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
- IEEE Standard 1547.1-2005: IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
- IEEE Standard 1547.3-2007: Guide for Monitoring, Information Exchange, and Control of Distributed Resources with Electric Power Systems
- IEEE C37.90.2-2004: IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE Standard C37.90.1-2002: IEEE Standard for Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI)
- International Building Code: Applicable to seismic rating, requirements, location and design of mounting pad (designed by others).
- NISTIR 7628: Guidelines for Smart Grid Cyber Security
- PEA Grid Connection Code 2016.
- UL 1642 Lithium Batteries
- ISO 1496-1: Series 1 freight containers - Specification and testing – Part 1: General cargo containers for general purposes
- EN54 – 7:2000: Fire detection and fire alarm systems - Part 7: Smoke detectors - Point detectors using scattered light, transmitted light or ionization
- EN 12094-1 : Fixed firefighting systems - Components for gas extinguishing systems - Part 1: Requirements and test methods for electrical automatic control and delay devices
- EN54-2 : Fire detection and fire alarm systems - Part 2: Control and indicating equipment
- EN54-4 : Fire detection and fire alarm systems - Part 4: Power supply equipment
- NFPA 72: National Fire Alarm and Signaling code

## 3. ENVIRONMENTAL REQUIREMENTS

The system shall be designed for use in the following environment

| | |
|---|---|
| Operating temperature | 0°C – 45°C without derating |
| Humidity | 5 – 95% non-condensing |
| Maximum altitude | 1,000 m without derating |
| Seismic Rating | Uniform Building Code Zone 4 |
| Audible Noise | Audible Noise shall be complied with Thailand environmental standard;<br>Indoor: the noise level inside room shall not be more than 70 dBA.<br>Outdoor: the noise shall not increase more than 10 dBA. |

Supplier must provide sufficient information specific to their particular product to facilitate utility personnel training and communications with emergency response and environmental agencies. Material Safety Data Sheets (MSDS) shall be provided as applicable.

## 4. POWER CONVERSION SYSTEM (PCS)

### 4.1 General

Grid-tied energy storage units are predominately DC in nature. To utilize the energy storage capability on the AC electric grid, the energy from batteries must be converted to a standard AC level and regulated through a converter, generally known as the Power Conversion System (PCS). The PCS serves as the interface between the DC battery system and the AC system, providing bi-directional conversion from DC to AC (for discharging batteries) and AC to DC (for charging batteries). The PCS may consist of one or more parallel units. The PCS shall be bi-directional converter that can be operated in inverting mode for battery discharging and rectifying mode for battery charging.

The PCS shall be cooled, with final rejection of waste heat to the ambient air. The air-handling systems shall include filtering that is adequate to keep dust from the interior of the PCS system. Replacement of filter shall not require special tools or involve more than two hours of labor at the site.

The PCS shall consist of a converter area, user-accessible AC termination area, user-accessible DC termination area, and user-accessible control area.

1. Converter area:

Converter shall be modular type. The failure of a converter module within the BESS shall not prevent the operation of the remaining converter modules. The converter area shall contain an AC circuit breaker/disconnector, converter and DC circuit breaker/disconnector.

- AC circuit breaker/disconnector – The AC circuit breaker/disconnector shall isolate the power unit from the utility source if needed.
- Converter – Upon opening of the AC circuit breaker/disconnector in response to interruption of the utility source, the three-phase converter shall power the islanded load until utility service is resumed or energy in the battery pack is depleted.
- DC circuit breaker/disconnector – The DC circuit breaker/disconnector shall provide isolation of the battery pack, permitting routine maintenance to be performed on PCS.

2. AC termination area

The user-accessible AC termination area shall include bus terminal pads for connection of utility source.

3. DC termination area

The user-accessible DC termination area shall include terminations for cables from the battery pack.

4. Controls area

The user-accessible controls area shall contain the master controls and associated circuitry to support operation. Within the control area shall be the following:

- Control panel – The control panel shall include a three-position rotary switch for selecting the control mode of the power unit (MGC or ADDC-enabled, MGC or ADDC-disabled, and Remove from Service).
- Master control board – The master control board shall provide the main processing and control functions of the converter.
- Power supply – The power supply shall provide the necessary DC control power for the system controls.

## 4.2 System Operation

### 4.2.1 Start/stop characteristics

The PCS starts or stops by pushing buttons “RUN” or “STOP”, respectively, or receiving control commands from a local HMI, or MGC (or ADDC in case MGC fails).

### 4.2.2 Operation during normal condition

The following functions shall be required with the PCS for the grid-connected and islanded (off grid) operation.

1. The AC power transformed efficiently from the DC power of the battery arrays shall be bi-directionally transferred to or from the distribution line without causing harmonics higher than the PEA regulation.
2. The following operation modes shall be provided:
   a. Virtual synchronous generator
   b. Active and reactive power control
   c. Voltage and frequency control
   d. Voltage and frequency droop for parallel operation (BESS may be paralleled with Diesel Gen Set, existing VSPP, and future VSPP)
3. Black start capability
4. The PCS shall contain a remote synchronization feature, as well as the standard synchronization used when starting the PCS online. The remote synchronization feature allows the PCS to synchronize its voltage and frequency to any other remote AC bus or generator.

5. PCS shall be stable against the usual change in voltage and frequency of the grid.

Mode selection and control parameter setting shall be done by local HMI, or control command from MGC (or ADDC in case MGC fails).

In addition, the PCS shall have the following capability:

- The PCS shall have the ability to perform four-quadrant control.
- The PCS shall be able to perform load following. Voltage shall be maintained at +/- 5% nominal under normal operating conditions and +/- 10% under emergency conditions.
- The PCS shall have low-voltage ride through capability to support the transition from grid connected to islanded condition. Please state your compliance to the latest draft of IEEE 1547.
- The PCS shall have the synchro-check function to allow parallel operation with the grid, diesel and VSPPs.

**Operation Mode Definition**

- ***Virtual synchronous generator:*** This mode of operation makes the PCS work as a voltage source converter. Under this mode, the BESS shall be able to provide its own voltage and frequency to an islanded grid, or to work in parallel with the utility grid in the grid-connected mode.
- ***Active and reactive power control:*** In this mode of operation, PCS controls the output active and reactive powers supplied to the grid following their reference values which may be set locally or remotely.
- ***Voltage and frequency control:*** In this mode of operation, PCS controls its own voltage and frequency, enabling it to create an islanded grid. Voltage and frequency control is possible when the PCS is in the voltage source operating mode.
- ***Voltage and frequency droop for parallel operation:*** The voltage droop allows reactive power sharing when the BESS is in an islanded mode or paralleled with other voltage sources. The frequency droop allows active power sharing when the BESS is in an islanded mode or paralleled with other voltage sources.
- ***Black Start:*** During Blackout of the grid, based on operator command through control system, the BESS shall carry out a black start and energize the load. In Black Start mode, the BESS system shall be able to form grid without presence of utility voltage or any external generation sources. It shall control voltage and frequency of system.

### 4.2.3 Operation during abnormal condition

The PCS shall operate as follows during abnormal operation:

- The PCS stops automatically when serious abnormal conditions are detected.
- When not-serious errors are detected, the PCS continues operation with error signals which shall be reported to MGC and ADDC.

### 4.2.4 Operation condition for Black Start

The following shall be taken care for proper black start:

- UPS back-up shall be sized to ensure proper black starting of BESS system until 2 hours from grid outage.
- BESS shall be able to safely shutdown, in case BESS is not able to perform successful black start due to transformer inrush currents in the system. The PCS shall operate as follows during abnormal operation.

In the event of a black start, controller shall be able to detect a black bus and bring up BESS system automatically if configured to do so. In this mode, control system shall manage the loads based on the energy available in the battery using load shedding schemes to avoid tripping of BESS system on under-frequency.

## 4.3 Detailed Technical Specifications

Table 1 Summarizes PCS technical specifications.

Table 1. PCS technical specifications

| Details | Technical requirement |
|---|---|
| **AC ratings** | |
| Total rated output power to load @ nominal voltage | − 4 MW (charge) to + 4 MW (discharge)<br>Full four quadrant (P, Q) operation ensuring bi-direction power flows |
| Reactive power @ nominal voltage | ≥4 MVAR |
| Rate output power of each unit | ≥ 500 kW |
| Real and reactive power control accuracy | ±1% |
| Voltage range | ±10% |
| Type of output | AC three-phase system |
| Frequency | 50 Hz ±1% |
| VAR production | Full VAR production at rated voltage |
| Harmonics | according to PEA standards |
| **DC input ratings** | |
| Voltage range | as defined by bidder |
| Ripple voltage | Less than 4V RMS |
| Ripple current | Less than 10% of full current peak to peak |
| **Environmental ratings** | **See 3. ENVIRONMENTAL REQUIREMENTS** |
| **Functions/Features** | |
| Power flow operation | Yes, support four-quadrant control |
| Real power control | Yes, positive and negative |
| Reactive power control | Yes, capacitive and inductive |
| Combination of real and reactive power control | Yes, with real power taking priority |
| Load following (renewable smoothing) | Yes, allowing renewable smoothing |
| Low-voltage ride through | Yes, supporting transition from grid connected to islanded operation |
| Synchro-check function | Yes, supporting parallel operation with the grid, PV and diesel generator |
| **Operation modes** | |
| Black start | Yes, external command |
| Commanded power | Yes, external command |
| Commanded VAR | Yes, external command |
| Frequency regulation | Yes, external command |

| Details | Technical requirement |
|---|---|
| Frequency response | Yes, automatic |
| Islanding | Yes, automatic (when utility source is lost) or external command (from MGC) |
| Renewable smoothing | Yes, automatic |
| Scheduled power | Yes, preconfigured time/date of work power profiles |
| Voltage regulation | Yes, external command |
| Response time of PCS to the command received | < 20 ms |
| **Communications** | |
| Communications with MGC | Yes (Described in Book 4) |
| Communications with ADDC | Yes (Described in Book 4) |
| **Physical systems** | |
| Protection class | The PCS shall be provided in a standard ISO enclosure with suitable access doors that minimize the amount of space required. Enclosure external color shall be [RAL 9010] |
| Cooling system | Air Cooling/ Liquid cooling (Liquid cooled system shall not require any external chiller units and coolant lines) |
| **Time source** | |
| Time source | Propose to PEA by Contractor |
| **Monitoring and control** | |
| Interface, status and control panel | Yes |
| Battery voltage (AC/DC) | Yes |
| Battery current (AC/DC) | Yes |
| Active power (AC/DC) | Yes |
| Reactive power | Yes |
| Energy (AC/DC) | Yes |
| Capacity (Ah) | Yes |
| Power factor | Yes |
| Fault | Yes |
| Battery information | Yes |
| Audible alarm | Yes |
| Battery temperature (average/extreme) | Yes |
| State of Charge (SOC) | Yes |
| Warning messages | Yes |
| UPS backup for control system 2 hours | Yes |
| **Efficiency** | |
| Efficiency of power conversion | ≥ 98% |
| **Protection system** | |
| Under/over voltage (DC and AC) | Yes |
| Under/over frequency | Yes |
| Over current protection | Yes |
| Ground fault protection | Yes |
| Over heat protection | Yes |
| Smoke detection (Trip/Alarm) | Yes |
| Surge protection (DC and AC) | Yes |
| Automatic AC & DC open circuit when fault detection | Yes |
| Insulating monitoring | Yes |
| **Function Features** | |
| Overload capability of 4 MW<br><br><br>Switching frequency | 110% 10 minutes<br>125% 10 seconds<br><br>>= 1 kHz |

| Details | Technical requirement |
|---|---|
| Insulation resistance | Over 3 M-Ohm at DC 1000 V (exclude the circuit less than DC 60V) |
| Withstand voltage | AC 2000V 1 minute (exclude the circuit less than DC 60V) |
| Withstand impulse voltage | $\pm$ 5000V 1.2 x 50$\mu$S each 3 times |
| **Noise level** | **See 3. ENVIRONMENTAL REQUIREMENTS** |

### 4.4 Standards

PCS shall be supplied from a manufacturer with ISO 9001:2015 certification or better. PCS manufacturer shall ensure that any sub-suppliers supplying equipment that will form part of the PCS have appropriate levels of quality assurance. The metallic materials for supporting the PCS system shall be resistant to corrosion.

The PCS shall comply with IEC62109 or UL 1741: Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.

### 4.5 PCS Electrical Protection

The PCS shall be protected against thermal overload, over-current and over-voltage. Insulating monitoring ground fault detection shall be provided. The following protective function shall be provided:

- DC over-voltage
- DC under-voltage
- DC over-current
- AC over-voltage
- AC under-voltage
- AC over-current
- Anti-Islanding
- Battery protection
- Internal fault (over temperature, logic failure, etc.)

The electrical shield cable shall be adopted for the signal and control cable. The surge absorber shall be connected on both sides.

EMC requirement shall meet IEC 61000 or equivalent standard.

## 5. BATTERY

### 5.1 Battery Type

Battery shall be off Lithium-Ion type suitable for utility scale BESS. Different chemistry of Lithium-Ion batteries, such as Lithium Manganese (LMO), Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Nickel Cobalt Aluminum Oxide (NCA), can be proposed.

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### 5.2 Detailed Technical Specifications

Table 2 Summarizes technical specifications of the battery.

Table 2. Battery technical specifications

| Details | Technical requirement |
|---|---|
| Energy | At least 4 MWh at 15%-90% SOC,<br>at least 1 hour to 4 MW load |
| Type | Li-ion |
| Allowable charging capacity | 1C |
| Allowable discharging capacity | 1C |
| Round-trip AC energy efficiency (excluding auxiliaries of BESS in normal operation) at 33 kV side of BESS for 90% to 15% SOC, 4MW charge/discharge, operation at nominal DC voltage and 100% load condition of PCS | > 85% |
| Cycle life (In some conditions, battery shall be able to operate at 5%-100% SOC) | > 5,500 at 15-90% SOC |

### 5.3 Standard

Battery shall be supplied from a manufacturer with ISO 9001:2015 certification or better. Battery manufacturer shall ensure that any sub-suppliers supplying equipment that will form part of the battery have appropriate levels of quality assurance. The metallic materials for supporting the battery system shall be resistant to corrosion.

### 5.4 Battery Module/Tray

- Battery module shall consist of many battery cells connected in series/parallel.
- Module/tray battery management system (BMS) shall be provided.
- Automatic module balancing shall be provided.
- Module/tray cooling system shall be provided.

### 5.5 Battery Rack

- Battery modules shall be connected in series/parallel in the battery rack so that the nominal voltage of the DC is more than 480V, suitable for PCS DC voltage.
- Rack BMS with battery fuse, DC current measurement devices and contractors shall be provided.
- Electrical connection shall be at rack front side.
- Many racks shall be connected in parallel to total capacity required for this project.

### 5.6 Battery Protection

The following protections shall be provided:

- Over-charge protection
- Over-discharge protection
- Over-temperature protection
- Over-current protection

- Ground-fault detection
- Internal battery fault detection
- Cell balancing

Protective devices should include for DC-side protection:

- Battery fuse for each battery cell and module (preferred)
- DC contactor for each battery rack
- Grounding over current (76G)

### 5.7 Cycle Life

- If the product is sensitive to depth of discharge, the manufacturer must state the limitations and the product should be sized such that the depth of discharge corresponds to the required cycle life.
- For purposes of estimating and demonstrating cycle life, cycles are defined in the same manner as system efficiency.
- For lifetime assessment the supplier should provide a graph that displays the relationship between depth of discharge and the corresponding number of cycles available within the system's life.
- Results of charging and discharging are tested at 1C.

## 6. BATTERY MANAGEMENT SYSTEM (BMS)

### 6.1 General

BMS is used to monitor, protect, maintain safety and optimal operation of each battery cell, module and rack. BMS consist of: Module/tray BEMS, rack BMS and system BMS.

### 6.2 Minimum Functions of Module/Tray BMS

- Metering and monitoring
  - Battery cell voltage (all cells)
  - Battery module voltage
  - Battery cell temperature (at least one or several measured locations in battery module/tray)
  - Battery module current
- Cell balancing
  - Module/tray BMS should balance voltage of cells
- Safety protection
  - Module/tray BMS should protect the battery cells and module/tray from:
    - Over and under voltage
    - Over current
    - Short circuit current
    - Over and under temperature
- Data communication: all metering items and contactor status shall be provided for rack BMS control and monitoring system.

### 6.3 Minimum Functions of Rack BMS

- Metering and monitoring
  - Battery rack voltage
  - Battery rack current
  - Battery rack temperature (one or several locations in battery rack)*
  - Battery SOC of battery modules
- Module/tray balancing
  - Balancing battery modules/trays scheme
- Safety protection
  - Rack BMS should protect the battery rack from:
    - Over and under voltage
    - Over current
    - Short circuit current
    - Over and under temperature
- Data communication: all metering items and contactor status shall be provided for system BMS control and monitoring system.

### 6.4 Minimum Functions of System BMS

- Metering and monitoring
  - Battery system voltage
  - Battery system current
  - Battery rack voltage
  - Battery rack current
  - Battery rack temperature (one or several locations in battery rack)*
  - Battery SOC of each rack and battery system
  - Battery SOH (state of health) of each rack
- Safety protection
  - System BMS should protect the battery system from:
    - Over and under voltage
    - Over current
    - Short circuit current
    - Over and under temperature
- Data communication: all metering items and contactor status shall be provided for PCS control and monitoring system by a standard protocol, e.g., Modbus RTU or Modbus TCP protocol. Data sampling rate should be configured based on process requirement but not more than 2 seconds.
- Preferred functions of system BMS: Controlling individual battery rack
- BMS data communication: All metering items and contactor status shall be provided for PCS control and monitoring system by a standard protocol, e.g., Modbus RTU or Modbus TCP protocol.

## 7. FUNCTIONAL REQUIREMENTS

### 7.1 Voltage Regulation

Voltage deviation should be controlled within +/- 1% for a specified sec sampling rate.

### 7.2 Reactive Power Regulation

The system shall maintain a defined VAR flow level within +/- 5%.

### 7.3 Frequency Regulation

Frequency deviation should be controlled within plus/minus ½ cycle per second.

### 7.4 Round-trip Efficiency

The roundtrip AC-AC energy efficiency, measured at the point of common coupling 33 kV system, shall be provided and exclude parasitic and auxiliary losses under worst case conditions. The calculation is as follows:

$$\eta = \frac{kWh_{out}}{kWh_{in}} \times 100\% = \frac{(rateddischargepower) \times (dischargetime)}{(ratedchargepower) \times (chargetime) + losses} \times 100\%$$

Wherein, the discharge time is from a fully charged to fully discharged system, and charge time is from a fully discharged to fully charged system. If the auxiliary power is provided by a separate connection from the energy storage system, these measured values should be reflected in the losses term in the equation.

### 7.5 Self-Discharge

Supplier shall provide self-discharge characteristics.

### 7.6 Basic Insulation Level

The BESS AC system equipment shall have a Basic Insulation Level in accordance with IEC62109/UL 1741and ANSI C62.41.2-2002 standards.

## 8. ALARMS AND RESETS

### 8.1 Alarms

The BESS shall provide the following alarms.

- Informational Notification—indicates the status of the unit.
- Warning Alarm—indicates a problem with the converter requiring attention (not affecting proper operation).
- Converter Inhibit—indicates a problem with the converter affecting proper operation. The converter will stop operation.
- Trip Offline Alarm—indicates a severe problem with the converter. The system will not operate.
- Isolate Alarm—indicates a problem affecting proper operation of the system. The system will operate with limited functionality.
- Fire detection remote alarm status for main fire alarm control panel, and control and monitoring system.

These alarms shall be reported to MGC and HMI of BESS system.

### 8.2 Resets

Energy storage unit alarms shall be reset by any of the following means.

- Manual Reset—via the reset button located on the control panel, or via a personal computer connected to the control panel Ethernet port.
- Auto Reset—automatically performed until reaching a predetermined reset count.
- Self Reset—automatically performed whenever require.

## 9. INSTALLATION

PCS and Battery need to be located inside building with suitable ventilation/HVAC arrangement to maintain environmental condition for proper operation of these equipment. Proper access and maintenance space shall be maintained inside each room. Battery room shall be equipment with complete and failsafe fire detection/extinguishing system and suitable fire detection shall be provided for inverter room. Each equipment should be properly earthed. Necessary access control, hand held fire extinguishers, first aid kit and safety signages to be provided.

The following items shall be complied.

- A nameplate shall be provided specifying the following:
  - Manufacturer name
  - Connection diagram
  - Unit ratings: Power, energy, voltage, BIL
  - Specimen data: serial number, date of manufacture
- Signage shall indicate Source and Load-Side AC Buses, Neutral Bus, DC Bus, Isolation Contactor, and Module names. Custom signage will be in accordance with specific utility requirements.
- All necessary safety signs and warnings as described in ANSI Z535-2002 shall be included on the unit.
- All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the unit.

## 10. SAFETY

### 10.1 General

- The BESS must be compliant with IEEE 1547 or IEC 62619 or UL 1973 or UL 9540 as appropriate. Systems must be able to protect themselves from internal failures and utility grid disturbances.
- For all BESS equipment, the Supplier shall provide information on specific safety issues related to the equipment, including appropriate responses on how to handle the energy storage system in case of an emergency, such as fires or module ruptures.
- The BESS shall be designed and manufactured with safety and environment as a priority.
- Battery manufacturer shall have an excellent track record over the last 10+ years of safety and environmental performance.
- PCS manufacturer shall have the same model deployed at customers installation for 10+years.
- PEA reserves the right to attend the manufacturer's premises to inspect and carry out audits of the BESS during manufacture and the associated QA documentation. The manufacturer shall assist the client to carry out such inspections and audits and shall rectify and defects found in a timely manner.
- Ventilation of Hydrogen and Methane shall be concerned when design the building.

### 10.2 Fire Mitigation

- Provisions shall be included extinguish internal fires.

# 11. SYSTEM TESTING, DOCUMENTATION, TRAINING COURSE AND WARRANTY

## 11.1 Testing

The following test procedures shall be conducted on the unit prior to shipment. The Testing shall use IEEE 2030.3-2016 as a guidance.

- Battery connection and configuration check
- Circuit boards and subassembly functionality
- Mechanical inspection
- Wiring continuity
- Alarm functionality

The user shall witness the factory acceptance testing at the manufacturer's production facility.

## 11.2 Quality Assurance

- Factory Testing—Prior to shipment, the bidder shall complete a documented test procedure to test all required functions of the BESS and guarantee compliance with the specifications. These are, but not limited to, the followings:
  - The ability to perform PV output smoothing
  - The ability to perform 4-quadrant control
  - The ability to perform black start
  - The ability to deliver zero-voltage ride through
  - The ability to operate in an islanded operation
  - The ability to perform parallel operation with the grid, PV and diesel generator
  - The ability to communicate with MGC via DNP 3.0 over IP or IEC61850
  - The ability to communicate with ADDC via DNP 3.0 over IP or IEC61850

  The user shall witness the factory acceptance testing at the manufacturer's production facility.

- Assemblies and Materials—All materials and parts shall be new, of current manufacture, and shall not have been used in a prior service, except as required during factory testing. The system manufacturer shall conduct inspections on incoming parts, assemblies and final products.

## 11.3 Documentation

The bidder shall provide the following documentation for installing and operating the BESS:

- Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements.
- Operation and Maintenance—This documentation includes a manual for preparing, operating, and maintaining the energy storage unit. This includes equipment wiring connection outlines and written instruction for troubleshooting.
- System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation.

- Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit.
- Recommended spare parts (with list) – If applicable, the instruction book will list the required spare parts to be furnished with the energy storage system. Each spare part shall be interchangeable with, and shall be made of the same material and workmanship as the corresponding part included with the product furnished under these Specifications.
- Special tools - The contractor shall furnish a complete set of any special tools, lifting devices, templates and jigs, which are specifically necessary for installation and/or maintenance of the energy storage system.

Additionally, special tools for PCS configuration and system parameter setting including link cable and software licenses shall be provided.

### 11.4 Approval Drawings

Drawings shall be provided for each energy storage system, which clearly indicate the physical parameters, electrical characteristics, and auxiliary equipment. These drawings shall include, but are not limited to, the following:

11.4.1 Nameplate system drawing to be located on the doors of the container or cabinets.

11.4.2 Outline drawing including the following:

- Assembly of principal component, converter, control cabinet, parts and accessories.
- Power requirements for all control and auxiliary equipment.
- Shipping Center of Gravity – shown on two (2) views
- Installed Center of Gravity – shown on two (2) views
- Centerlines for external conduit and grounding cable connections.
- Projected floor space for container systems if applicable, including air conditioning units mounted on the side.
- Weight of the components and container.
- Kilowatt & Kilowatt-Hour rating.

11.4.3 Control Elementary Wiring Diagrams, with cross references for checking and verifying all of the control circuit and wiring diagrams, along with the terminal designations for termination of field wiring of all equipment.

### 11.5 WARRANTY

Manufacturer warranty shall be provided for the period of at least thirty-six (36) months from the date of commissioning. Please submit price reduction for 12 months warranty. The warranty shall cover all defects of the PCS and the energy storage unit from manufacturing and non-compliance with the contract; and manufacturer shall repair or replace the defect product at their own cost. The certified warranty issued by battery vendors/manufacturers shall be transferred to PEA before the issuance of Final Acceptance Certificate.

## 12. INFORMATION SECURITY

Supplier shall design the BESS to be hardened against willful attack or human negligence as per NISTIR 7628. Supplier shall contract information/cyber security scans and penetration tests by a 3rd party security company.

## 13. FACTORY ACCEPTANCE TEST

Factory acceptance test must be performed to ensure that the BESS meet performance requirements indicated above. Result of factory acceptance test relevant to performance requirements shall be provided to PEA. For more details are in Bidding document.

The contractor shall submit at least I/O lists and FAT procedure before FAT testing at manufacture's site.

## 14. STEP UP TRANSFORMER

STEP UP Transformer shall comply with IEC 60076 or PEA standard.

## 15. EXCEPTIONS TO SPECIFICATIONS

Supplier shall submit a redline/tracked changes documents to any and all exceptions herein this specification and include an explanation for the same. Supplier shall also submit a written signed letter on company letterhead should they elect to not take any exceptions to this specification.

## 16. SPARE PART RECOMMENDATIONS

BESS major equipment: control, protection, metering, local control system, remote control system, protection relay and special tools with recommended spare parts (Breakdown in price schedule of each items).

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