Procedure for First Time Charging of BESS

Procedure for First Time Charging of Battery Energy Storage System(BESS)

BESS shall consist of:

i) A power conversion system (PCS)

ii) An energy storage

iii) Battery Management System (BMS)

Basic components of BESS as follows:

i) Batteries as its underlying storage technology to be connected to an electrical network

ii) Bidirectional inverter is the main device that converts power between the AC line voltage and the DC battery terminals, and allows for power to flow both ways to charge and discharge the battery

iii) Other components of a BESS may include an isolation transformer, protection devices (e.g. circuit breakers), cooling systems, and a high-level control system to coordinate the operation of all components in the system

Documents and data to be submitted for integration of BESS:

1. The applicant shall furnish the undertaking to comply with CEA Technical Standards for connectivity to the Grid Regulations. The following information also need to be provided alongwith the application:

S.No.	Description	Details to be furnished
A	**Battery**	
1	Make/Manufacturer	
2	Type / Chemistry	
3	Design capacity of battery in terms of KWh	
4	Self-Discharge rate	
5	DoD	
6	Life cycle of battery	
7	Round trip efficiency	
8	Dimensions and weight of battery	
9	Test certificate available for battery cell/module (IEC Standards	
10	Number of series & parallel connected cells and modules	
11	Power/energy rating cells and modules	
12	BESS favorable operating temperature	

B	**Power Conditioning Unit**	
1	Make/manufacturer	
2	Type of charge controller(DC-DC converter)	
3	Inverter- power rating & efficiency	
4	Inverter minimum response time	
5	Test certificate available (IEC Standards)	
C	**Measurement and control Devices**	
1	Sensors	
2	Sensitivity Type/Make	
3	Accuracy/Precision	

Battery Static Parameters:

Details	**Technical requirement**
AC ratings	
Total rated output power to load @ nominal voltage (charge) MW to (discharge) MW	
Apparent power @ nominal voltage	
No of units	
Rate output power of each unit	
Real and reactive power control accuracy(%)	
Voltage range	
Type of output	
Frequency (Nominal Frequency and the tolerance band)	
VAR production (full MVAR production at rated Voltage)	
Harmonics (as per CEA standards)	
DC input ratings	
Voltage range	
Ripple voltage	
Ripple current (% of full current peak to Peak)	
Environmental ratings	
Operating temperature	
Humidity	
Functions/Features	
Power flow operation (, Support four - quadrant control)	Yes / NO

Real power control (Positive and negative)	Yes / NO
Reactive power control (capacitiveand inductive)	Yes / NO
Combination of real and reactive power control(priority real power)	Yes / NO
Load following (renewable smoothing)	Yes / NO
Low-voltage ride through	Yes / NO
Synchro-check function	Yes / NO
Operation modes	
Black start (external command)	Yes / NO
Commanded power (external command)	Yes / NO
Commanded VAR (external command)	Yes / NO
Frequency regulation	Yes / NO
Frequency response (Automatic)	Yes / NO
Islanding	Yes / NO
Renewable smoothing (if applicable , automatic)	Yes / NO
Scheduled power (preconfigured time/date of work power profiles	Yes / NO
Voltage regulation	Yes / NO
Response time of PCS to the command received (Milli seconds)	
Communications	
Communications with LDC (main /standby)	Yes / NO
Battery technologies	
Battery technologies supported(Ex Li-Ion etc ..)	
Battery Cycle life	> 4,000 at 20-80% SOC
Voltage Regulation (%)	
Reactive Power Regulation (Var flow level Range +/- example +/- 5%))	
Frequency Regulation (+/_ cycle /second)	
Capacity (Ah)	
Power factor	
Battery temperature (average/extreme)	
Overload capability (%) and Switching frequency(in kHz) State of Charge (SOC)	
Protection system	
Under/over voltage (DC and AC)	
Under/over frequency	
Over current protection	
Ground fault protection	
Over heat protection	

Surge protection (DC and AC)	
Automatic AC & DC open circuit when fault detection	

2. Following parameters need to be telemetered at RLDC/NLDC:

i. Operating Mode:
   a. Grid connected/ Standalone mode
   b. Automatic/ Manual mode
   c. Charge/discharge

ii. Measurements (Voltage, Current, P, Q, Status of Charging, charge/discharge rate freq., energy export/import)

iii. Events and alarms Breaker position/operation

iv. BESS Start Inhibit Status

v. Ambient Temperature

vi. Parameters of PCS such as active power, reactive power, power factor, operating DC voltage etc.

vii. Number of battery inverters in operation and Number of battery inverters available in BESS

viii. Full pack energy: Estimated maximum energy capacity of the batteries

ix. Energy remaining: Estimated energy remaining of the batteries

x. Available maximum capacity: State of energy available in batteries

xi. Possible charge and discharge power

xii. Local MW set point

xiii. Reference set points for voltage, power factor and reactive power control

xiv. Local limit for charge and discharge

xv. Charge and discharge ramp up and ramp down rates

xvi. MW reference (AGC)

xvii. AGC availability status

xviii. Control mode: AGC/Local

xix. Indication of frequency control status

xx. Indication of control modes; voltage, power factor, reactive power

xxi. State of Charge (SOC) (Mwh)

xxii. Maximum State of Charge (Mwh)

3. Test Certificates:

The applicant shall furnish the following test certificates prior to trial run:

i. Verification of sensors, metering and alarms
ii. Verification of all control functions including automatic, local and remote control
iii. Verification of the performance criteria
iv. Demonstration of all the intended applications
v. Demonstration of grid interface protection & control system
vi. Verification of power quality parameters

4. 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. Power Conversion System Operation conditions:

i. 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 CEA regulation.

ii. 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.

iii. Black start capability

iv. The PCS shall have the ability to perform four-quadrant control.

v. The PCS shall be able to perform load following (for PV smoothing) Voltage shall be maintained at +/- 5% nominal under normal operating conditions and +/- 10% under emergency conditions.

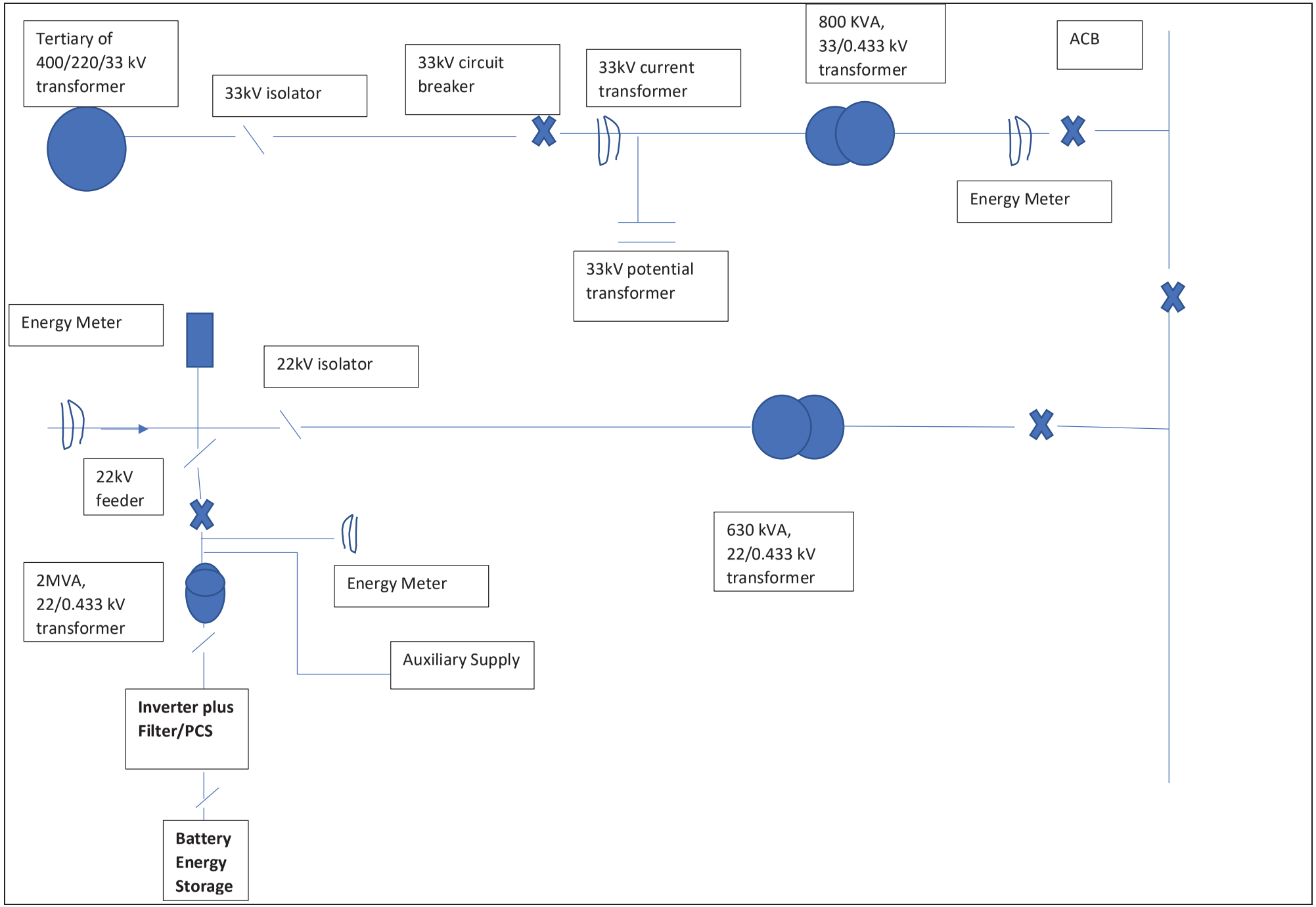
vi. The PCS shall have the synchro-check function to allow parallel operation with the grid, diesel and PV generators.

vii. PCS shall be able to operate in the following four modes of operation:

a. 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.

b. 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.
c. 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.
d. 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.

5. A sample connectivity of the BESS connected with the system is given below. BESS system is shown to be inter-connected with grid at secondary terminal of distribution transformer i.e. three-phase four-wire, 433 Volts (L-L) at point of common coupling (PCC).


Tertiary of 400/220/33 kV transformer
33kV isolator
33kV circuit breaker
33kV current transformer
800 KVA, 33/0.433 kV transformer
ACB
Energy Meter
33kV potential transformer
Energy Meter
22kV isolator
22kV feeder
630 kVA, 22/0.433 kV transformer
2MVA, 22/0.433 kV transformer
Energy Meter
Auxiliary Supply
Inverter plus Filter/PCS
Battery Energy Storage

Category	Parameter Description	Data
Electrical Control model : BESS		
Generic Electrical Control model for Utility Scale BESS: (REECCU1)	Vdip (pu), low voltage threshold to activate reactive current injection logic	
	Vup (pu), Voltage above which reactive current injection logic is activated	
	Trv (s), Voltage filter time constant	
	dbd1 (pu), Voltage error dead band lower threshold (≤0)	
	dbd2 (pu), Voltage error dead band upper threshold (≥0)	
	Kqv (pu), Reactive current injection gain during over and undervoltage conditions	
	Iqh1 (pu), Upper limit on reactive current injection Iqinj	
	Iql1 (pu), Lower limit on reactive current injection Iqinj	
	Vref0 (pu), User defined reference (if 0, model initializes it to initial terminal voltage)	
	Tp (s), Filter time constant for electrical power	
	QMax (pu), limit for reactive power regulator	
	QMin (pu) limit for reactive power regulator	
	VMAX (pu), Max. limit for voltage control	
	VMIN (pu), Min. limit for voltage control	
	Kqp (pu), Reactive power regulator proportional gain	
	Kqi (pu), Reactive power regulator integral gain	
	Kvp (pu), Voltage regulator proportional gain	
	Kvi (pu), Voltage regulator integral gain	
	Tiq (s), Time constant on delay s4	
	dPmax (pu/s) (>0) Power reference max. ramp rate	
	dPmin (pu/s) (<0) Power reference min. ramp rate	
	PMAX (pu), Max. power limit	
	PMIN (pu), Min. power limit	
	Imax (pu), Maximum limit on total converter current	
	Tpord (s), Power filter time constant	
	Vq and Iq curve (Reactive Power V-I pair in p.u.) : 4 points	
	Vp and Ip curve (Active Power V-I pair in p.u.) : 4 points	
	T, battery discharge time (s) (<0)	
	SOCini (pu), Initial state of charge	
	SOCmax (pu), Maximum allowable state of charge	
	SOCmin (pu), Minimum allowable state of charge	

Note: SOCini represents the initial state of charge on the battery and is a user entered value. This is entered in pu; with 1 pu meaning that the batter is fully charged and 0 means the battery is completely discharged