

Technical Design Notes for Grid Connection of Small Renewable Energy/Battery Energy Storage Systems

The following table provides technical information for inverter-based RE/BESS Systems with generation capacity of up to 1MW and non-inverter-based RE/BESS Systems with generation capacity of up to 200kW. Further technical guidelines and information can be found in the latest edition of EMSD’s “Code of Practice for the Electricity (Wiring) Regulations” and “Technical Guidelines on Grid Connection of Renewable Energy Power Systems” (“Technical Guidelines”).

For the requirements of RE/BESS Systems with larger generation capacity, the information can be found in our “Grid Connection Standard of Renewable Energy Systems” or “Grid Connection Standard of Battery Energy Storage Systems”.

Design Requirements and Considerations	Inverter-based Systems (up to 1MW)	Non-Inverter-based Systems (up to 200kW)
The Network nominal voltage is 220/380V, nominal frequency is 50Hz.	✓	✓
The RE/BESS System should be operating normally in the frequency range from 49Hz to 51Hz.	✓	✓
Network auto-switching/reclosing time is from 0.2 to 10 seconds. The RE/BESS System should have an anti-islanding function to cater for the auto-switching/reclosing operation.	✓	✓
After disconnection of the RE/BESS System due to disturbances in the Network, the RE/BESS System should remain disconnected until the Network returns to normal condition continuously for at least 5 minutes.	✓	✓
Total harmonic current distortion of the RE/BESS System should not exceed 5% as measured at the point of the RE/BESS System output.	✓	✓
The RE/BESS System should prevent DC current flowing into the Network, which the DC current injection into the AC Network shall not exceed 0.5% of rated inverter output under normal or abnormal operating conditions.	✓	
The RE/BESS System should have a control function such that its power factor is controllable between 0.9 leading and lagging.		✓
The RE/BESS System should not affect the power factor of our electricity supply to you as recorded at the supply point resulting in deviating from the requirements stipulated in the Supply Rules.	✓	✓

Design Requirements and Considerations	Inverter-based Systems (up to 1MW)	Non-Inverter-based Systems (up to 200kW)
Export power from RE/BESS System to the Network should not less than 0.85 power factor lagging/leading. If power factor correction equipment is used to improve the power factor, the correction equipment shall not cause any excessive voltage disturbance, inrush current, over-voltage, or resonance with other system components.	✓	✓
The overall fault current contributed from both the RE/BESS System and the Network must not exceed the fault current withstanding or breaking capability of any equipment in or connected to the Network under all possible operating conditions. The fault current from the RE/BESS System should not affect the protection system of the Network.	✓	✓
Voltage fluctuation during synchronization operation of the RE/BESS System should be limited to below 3% at the supply point.	✓	✓
After the connection of the RE/BESS System to the Network, the voltage fluctuation at the supply point due to the variation of RE/BESS System's input power shall not exceed 1%.	✓	✓
The level of negative phase sequence voltage at supply point on a three-phase system shall not exceed 1.3% of the positive phase sequence voltage, assuming an initially symmetrical of the Network at this point.	✓	✓
The RE/BESS System should have an adequate earthing system to ensure the safety of personnel and equipment, and the reliable operation of the protection equipment. The RE/BESS System should be properly earthed even when operating in isolation from the Network.	✓	✓
Whenever the generation capacity of the RE/BESS Systems is greater than 200kW, telemetry system should be installed at the terminals of the RE/BESS Systems to record measurements (including active power and reactive power).	✓	Please refer to "Grid Connection Standard of Renewable Energy Systems" or "Grid Connection Standard of Battery Energy Storage Systems"
If the RE/BESS System with generation capacity greater than 200kW is planned for exporting power to the Network, additional telemetry should be installed at the supply points for monitoring of the active power, reactive power, voltage, current and circuit breakers' status.	✓	

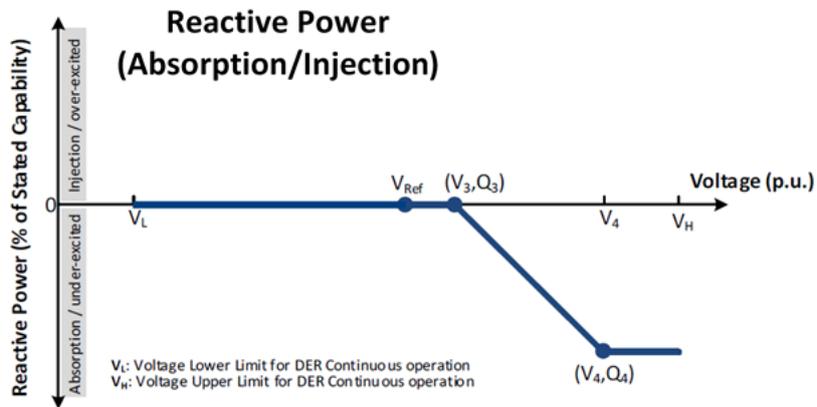
Legend:

✓ Applicable

RE/BESS System Over and Under Voltage Protection Requirement	
Voltage at the Connection Point	Maximum Trip Time (second)
$V > 1.20 \text{ p.u.}$	0.16
$1.10 \text{ p.u.} < V \leq 1.20 \text{ p.u.}$	1
$0.20 \text{ p.u.} \leq V < 0.70 \text{ p.u.}$	2
$V < 0.20 \text{ p.u.}$	0.16

RE/BESS System Voltage Ride Through Capability	
Voltage	Minimum Ride- Through Time (second)
$1.10 \text{ p.u.} < V \leq 1.20 \text{ p.u.}$	1.00
$0.90 \text{ p.u.} \leq V \leq 1.10 \text{ p.u.}$	Infinite
$0.20 \text{ p.u.} \leq V < 0.90 \text{ p.u.}$	$0.625 < \text{Time Slope} \leq 2.00$
$0.00 \text{ p.u.} \leq V < 0.20 \text{ p.u.}$	0.16

RE/BESS System Voltage-Reactive Power (Volt-Var) Control Mode (Reference to IEEE1547)

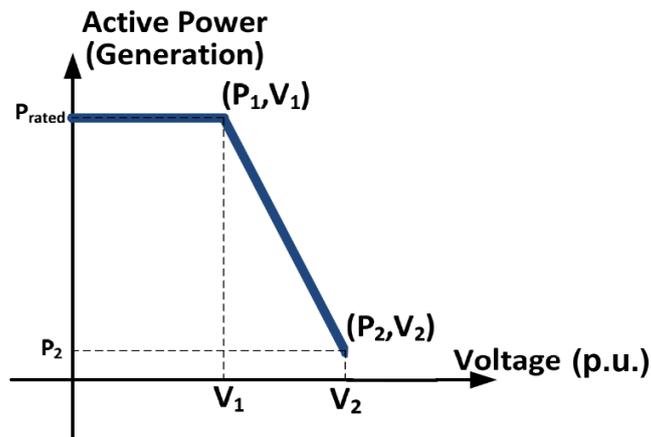


Recommended setting:

$V_3 = 103\%$, $Q_3 = 0\%$ rating of the RE/BESS System

$V_4 = 105\%$, $Q_4 = Q_{max} \geq 43\%$ rating of the RE/BESS System

RE/BESS System Voltage-Active Power (Volt-Watt) Control Mode (Reference to IEEE1547)



Recommended setting:

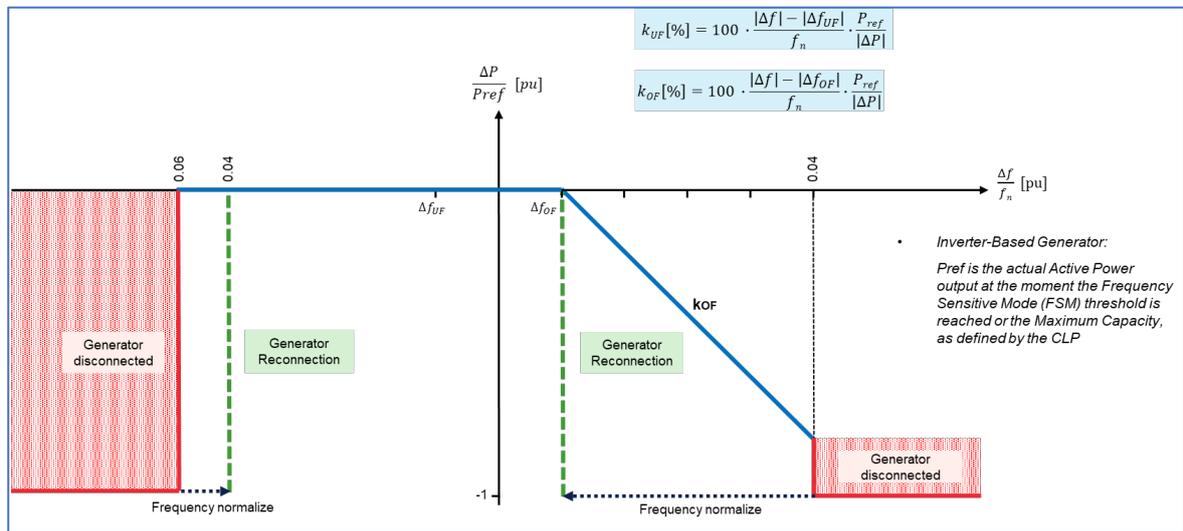
$V_1 = 106\%$, $P_1 = 100\%$ rating of the RE/BESS System

$V_2 = 110\%$, $P_2 = P_{min} \leq 20\%$ rating of the RE/BESS System

RE/BESS System Frequency Operation Range

Frequency range	Duration
47 – 47.5 Hz	Operation for a period of at least 20 seconds
47.5 – 49 Hz	Operation for a period of at least 90 minutes
49 – 51 Hz	Continuous operation required
51 – 51.5 Hz	Operation for a period of at least 90 minutes
51.5 – 52 Hz	Operation for a period of at least 15 minutes

RE/BESS System Frequency Response Requirement



Recommended setting:
 Droop setting: 4%
 Frequency setting: 50.1Hz