

# Technical recommendation for the purchase of Electrical Energy Storage Systems

## 1 Purpose

The purpose of this document is to set out and describe the technical requirements developed, that enabled the purchase of the various Electrical Energy Storage Systems designed for use on the Northern Powergrid High Voltage (HV) and Low Voltage (LV) power distribution networks that were trialled on the Customer-Led Network Revolution project.

## 2 Scope

This document sets out and describes the technical requirements for 6 complete Electrical Energy Storage (EES) Systems, to be deployed on the distribution networks of Northern Powergrid. The particulars are the 6 systems are:

<b>System Designation</b>	<b>Quantity Required</b>	<b>Nominal Power (kVA)</b>	<b>Nominal Capacity (kWh)</b>	<b>Connection Voltage</b>
EES1	1	2,500	5,000	HV, 6 – 20 kV
EES2	2	100	200	LV, 400V
EES3	3	100	50	LV, 400V

To ensure that this document encompasses complete ESS Systems it will include, but not be limited to, the following:

- The core electrical energy storage medium (eg. a battery bank);
- Controller(s) for the battery management system;
- The associated Power Conversion System (PCS) and controller(s);
- Communications and alarms systems interfacing;
- (any) associated transformer; and
- Associated Balance-of-Plant (BoP).

The combination of the above, shall be deemed to constitute the requisite complete Electrical Energy Storage Systems.

The following Appendices form part of this recommendation document:

- Appendix 1 Technical Particulars
- Appendix 2 Self Certification Conformance Declaration
- Appendix 3 Addendum to Supplier Requirements
- Appendix 4 Pre-commissioning Testing, Routine Inspection and Maintenance Requirements
- Appendix 5 End-of-Life Disposal – Material Schedule
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### **3 Technical Requirements**

This section provides the technical requirements for the Electrical Energy Storage Systems.

The EES systems are required to interface with the existing distribution networks of Northern Powergrid, and the regime of the Grand Unified Scheme (GUS) controller, the system is also required to be implemented as part of a wider project scope. At the local level, the EES will also be required to provide voltage control functionality, via its integral PCS controller.

The EES will initially be deployed to service specific distribution network related applications such as voltage control and thermal support, together with such further applications and functionalities, which may be identified as part of a wider project need.

This document identifies the requirements for a complete Electrical Energy Storage System, applied on the Northern Powergrid distribution networks.

It is acknowledged that the combination and construction of such systems may vary, dependent on the component technologies employed, their individual operational characteristics and the overall system architecture design.

As such, this document provides a degree of latitude in the combination and construction of such Electrical Energy Storage Systems, provided that Northern Powergrid's minimum essential performance and safety requirements are satisfied along with a minimum footprint restriction.

In particular the following should be noted:

- The complete Electrical Energy Storage System may be provided as either a single, self contained enclosure, containing all the essential systems and sub-systems; or
- a distributed system, with a small series of discrete sub-systems electrically connected on-site, to form the complete system; or
- some variation on the above.

### 3.1 Functional Requirements

Parameter	Indicative requirement/comments
Nominal (2 hour) Discharge rating	2.5 MVA (EES1), 100 kVA (EES2), 50 kVA (EES3)
Nominal (2 hour) capacity	5 MWh (EES1), 200 kWh (EES2), 100 kWh (EES3)
Operational capability	Full 4-Quadrant
Rated discharge duration	2 hours
Charge rating	Greater than or equal to 2.5MVA (EES1), 100kVA (EES2), 50kVA (EES3)
Nominal Operating Voltage	6.6kV AC (EES1), 400 VAC (EES2 and EES 3) 3 phase
Operating frequency	50 Hz
Chronological life	Minimum 3 year chronological life, for purpose of CLNR trial, with no replacement of any major component technologies.
Minimum Cycle Life	Five hundred (500) complete charge/discharge cycles
Target Cycle Life	One thousand (1,000) complete charge/discharge cycles
Transient response characteristics	Discharge: From stand-by (idle) to rated output in less than 1 minute (100% per minute); Charge: From stand-by (idle) to full rated charge rating, in less than 3 minutes; Reverse time: (from full power input (charging) to full power output (discharging) in less than 4 minutes and vice-versa.
Acceptable Performance Degradation - Charge/Discharge Ratings	Less than 10%, over required chronological/cycle lifetime
Acceptable Performance Degradation –Energy Storage Capacity	Less than 10%, over required chronological/cycle lifetime
Availability	Greater than or equal to 95% over full 3 year life
External ambient temperature	-20°C to +30°C
External ambient relative humidity	0% to 100%
Elevation	Sea level to 450 meters 1,500 feet amsl
Installation	Outdoor (EES1), Indoor or Outdoor (EES2), Outdoor, via siting in street side cabinets, ie Street Furniture (EES3)
Round trip cycle efficiency at nominal 2 hour rating (defined as kWh AC out/kWh AC in x 100%)	75% or greater
Acceptable Performance Degradation at nominal 2 hour rating –Round trip cycle efficiency	Less than 10%, over required chronological/cycle lifetime

Parameter	Indicative requirement/comments
System mass	To be stated, broken down by principal sub-systems.
System/sub-system height	Less than or equal to 15m (EES1), 3.0m (EES2 and EES3)
Target Footprint <sup>1</sup>	The complete system must be suitable for installation in a site of: Less than or equal to 22m x 11m (EES1) Less than or equal to 6m <sup>2</sup> (EES2 and EES3)
System volume envelope <sup>1</sup>	To be stated, broken down by principal sub-systems.
Voltage control	To be capable of local voltage control to references defined and communicated via DNP 3.0
SCADA	To be capable of communicating with existing SCADA system for device alarms and with Grand Unified Scheme (GUS) control system for device status and control.  DNP3 is the preferred communications protocol.  Hardwired volt free alarm outputs are required to operate with the existing SCADA control system  Other standard protocols with proven reliability in distribution networks will also be considered.
Protection	Connection to the distribution network to comply with the requirements of G59/3

<sup>1</sup> **Note:** The option exists to package the EES3 system in two or more sub-cabinets

### 3.2 Associated Requirements

Parameter	Indicative requirement/comments
Enclosure(s)	<p>To IP54 of BS EN 60529</p> <p>Compliance with Northern Powergrid naming and labelling requirements is required.</p> <p>Sealed enclosures require a permanent method of venting overpressure in the event of system operation or failure.</p> <p>Enclosure must be suitable of incorporating Northern Powergrids existing cable terminations for HV and LV connections</p> <p>Emergency stop functions should not be accessible from the outside of the container body.</p>
Access	<p>Access requirements to the EES and its component sub-systems shall comply with Northern Powergrid locking and security policy.</p> <p>Access to HV terminations and components shall be physically locked, interlocked with supply source circuit breaker, and screened from danger</p>
Noise and vibration	<p>The continuous A-weighted sound pressure level ("noise level") of the EES system, measured at the perimeter of the nearest neighbouring property, in accordance with BS 4142:1997, shall not exceed the background noise level, measured in accordance BS 4142:1997, or 25 dB, whichever is greater.</p> <p>Where the supplier demonstrates the sound generated by the EES system does not meet the criteria specified in Section 8 of BS 4142:1997, entitled "Rating Level", as liable to increase the likelihood of a complaint, the noise level may exceed the background noise level or 25 dB, whichever is greater, by up to 5 dB.</p>

<b>Parameter</b>	<b>Indicative requirement/comments</b>
Seismic	<p>To maintain normal charge/discharge function operation, at seismic disturbances up to and including an intensity of 6 on the European Macroseismic Scale.</p> <p>To shut-down safely, with no damage to EES or adverse impact on power distribution network, at seismic disturbances in excess of intensity 6.</p>
Smoke and fire detection/control	<p>Define smoke and fire detection and control sensors and systems</p> <p>External alert and indication is required to inform where the fire suppression system has been activated and discharged</p>
Fail safe	<p>Any system/sub-system failures to be such as to not unduly degrade future system performance.</p> <p>To reject commands which would unduly degrade future system performance.</p>
Ancillary Services	State requirements (as applicable)
Communications interface	<p>State the communications interface types supported, eg Ethernet, Serial. T.</p> <p>State the communications modules available, eg GPRS</p> <p>To identify and inform the supervisory control system by any means in the event of communications system failure</p>
Data Security	<p>Any access control facilities to restrict control to authorised stations.</p> <p>Any facilities to encrypt the control data payload.</p> <p>Access control mechanisms to restrict on-site electronic access.</p>

### 3.3 Operational Regimes

The EES will be capable of operating in any one of the following states, at any given time:

1. Idle
2. Charging to a level which will allow the EES to operate optimally in its next regime. This state will be entered if the SoC is low and the EES local controller needs to prepare for a regime at a known time (i.e. assessed to be likely on the basis of past regime), this may for example occur at an evening peak when assets being supported are known to be in danger of overheating and thus require thermal support.
3. Discharging to a level which will allow the EES to operate optimally in its next regime. This state will be entered if the SoC is high and the EES local controller needs to prepare for a regime at a known time that will require the EES to absorb energy from the network, such as periods of increased generation at low load times.
4. Maintaining the voltage at the output terminals at a default level set locally, with the option of a default Line Drop Compensation (LDC) setting also set locally. Such voltage control to be provided initially through reactive compensation, within overall power factor limits configurable locally, then (once available reactive compensation exhausted) through real power import/export.
5. Providing thermal and voltage support as defined by the GUS issuing setpoints (i.e. charge/discharge at a given rate between given times). On loss of communications with the GUS, returning to operational as part of an autonomous intelligent substation without further intervention.



### 3.4 Communications Requirements

Description	Direction	Frequency
Local network voltage	Out	Continuous (1 minute frequency) or polled
Local network current	Out	Continuous (1 minute frequency) or polled
Local network phase angle	Out	Continuous (1 minute frequency) or polled
State of Charge (SoC) – reporting to the GUS	Out	Continuous (1 minute frequency) or polled
Current operating regime – reporting to the GUS	Out	On-demand *
Change of regime from the GUS. The EES must be capable of a change to its current operating regime as and when required by the GUS.	In	No set frequency. *
Setpoints – new setpoints/goals for the current operating regime. The EES must be able to accept new voltage reference targets, deadbands and charge/discharge percent targets.	In	No set frequency. *
Alarms – all alarms are to be communicated to the GUS. In addition alarms must be communicated to Northern Powergrid control via open volt free contacts. These are to include: <ul style="list-style-type: none"> <li>Battery/Inverter failure Inability to meet requirements set by the GUS; for example due to insufficient charge</li> <li>Notification of incipient system/sub-system failure(s)</li> </ul>	Out	Immediate upon event (within 1 minute); also accessible via polling.  Anticipated infrequent frequency (< 1 per 24 hours)

\* The frequency requirements of the GUS will be advised in the complementary Site/Project Specific Addendum, to be provided to candidate short-listed suppliers.

## 4 References

### 4.1 External Documentation

The system and/or its component sub-systems described within this document shall comply with the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply. In this respect, the following documents are particularly relevant.

Reference	Title
SI- 2008 No.2164	The Batteries and Accumulators (Placing on the Market) Regulations (for any battery/accumulator based system or systems)
SI- 2009 No.890	The Waste Batteries and Accumulators Regulations (for any battery/accumulator based system or systems)
SI-1994 – No. 3260	The Electrical Equipment (Safety) Regulations 1994
SI-1989 – No. 728	The Low Voltage Electrical Equipment (Safety) Regulations 1989
SI-2006 – No. 3418	The Electromagnetic Compatibility Regulations 2006
SI-2002 – No. 2665	The Electricity Safety, Quality and Continuity Regulations 2002 (Amended 2006, 2009)
IEC 61000-5-1	Electromagnetic compatibility (EMC) – Part 5: Installation and Mitigation Guidelines – Section 1: General Considerations – Basic EMC publication
IEC 61000-5-2	Electromagnetic compatibility (EMC) – Part 5: Installation and Mitigation Guidelines – Section 2: Earthing and Cabling
BS 4142:1997	Method for rating industrial noise affecting mixed residential and industrial areas
BS EN 50272-2:2001	Safety Requirements for Secondary Batteries and Battery Installations – Part 2: Stationary Batteries (covering Lead Acid and Nickel Cadmium batteries, as appropriate)
BS EN 61000-6-2	Electromagnetic Compatibility (EMC) Generic Standards. Immunity for industrial environments
BS EN 61000-3-4	Electromagnetic Compatibility (EMC) Generic Emission Standards. Emission standard for industrial environments
BS 7671	Requirements for Electrical Installations
BS EN 62305-1	Protection Against Lightning. General Principles
BS EN 62305-2	Protection Against Lightning. Risk Management
BS EN 62305-3	Protection Against Lightning. Physical Damage to Structures and Life Hazard
BS EN 62305-4	Protection Against Lightning. Electrical and Electronic Systems Within Structures
BS EN 60529	Degrees of Protection Provided by Enclosures (IP Code)

Reference	Title
Engineering Recommendation G59/2	Recommendations for the Connection of Generating Plant to the Distribution Systems of Licensed Distribution Network Operators
Engineering Recommendation P 28	Planning Limits for Voltage Fluctuations Caused by Industrial, Commercial and Domestic Equipment in the United Kingdom
Engineering Recommendation G5/4-1	Planning Levels for Harmonic Voltage Distortion and the Connection of Non-Linear Equipment to Transmission Systems and Distribution Networks in the United Kingdom
ENA TS 35-1 (for EES1)	Distribution Transformers (From 16kVA – 2000kVA)

Dependent upon the system make-up and architecture, individual sub-systems shall also fully comply with the requirements of the relevant European Commission New Approach Directives, with their associated requirements for CE marking (as appropriate).

Candidate Supplier shall provide with the Tender full technical details of the equipment offered and shall indicate any divergence from these Standards or Specifications.

#### 4.2 Internal Documentation

Reference	Title
(For Northern Powergrid) NPS/003/011	Technical specification for 11 & 20kV Ground Mounted Distribution Transformers
Other DNO's please refer to your current specifications for Transformers required for your PCS output step voltage	

### 4.3 Amendments from Previous Version

Clause	Subject	Amendments
2	EES Capacity and Connection Requirement	Table included to indicate the expected number, connection voltage, nominal capacity and nominal power of each EES system
3.1	Functional Requirements	Included different requirements for EES1, EES2, EES3 as appropriate. Noting the system to which the requirement applied
3.2	Associated Requirements	Included requirement for external alert where the fire suppression system is activated
3.2	Associated Requirements	Included requirement to comply with Northern Powergrid locking policy
3.3	Communication Requirements	Include connection of alarms to Northern Powergrid control via open volt free contacts
3.4	Operational Regimes	Updated to include voltage and thermal support as a response to GUS instructions to charge/discharge real/reactive power and return to local control in the event of communication loss
All		Removed reference to EES1, EES2, EES3 and replaced with EES
All		Updated references from CE Electric to Northern Powergrid
4.1	Electromagnetic Compatibility	BS EN 50081 superseded by BS EN 61000-6-4
4.1	Electromagnetic Compatibility	BS EN 55014 superseded by BS EN 61000-6-2

## 5 Definitions

Term	Definition
amsl	Above mean sea level
BoP	Balance of Plant
CLNR	Customer Led Network Revolution (Northern Powergrid's Low Carbon Network Fund, Tier 2 project)
dB	Unit of sound pressure related to reference pressure of 20 micro-Pascals in air
DNO	Distribution Network Operator
EES	Electrical Energy Storage
GUS	Grand Unified System (overall controller)
HV	High Voltage (network from 6kV to 30kV)
LDC	Line Drop Compensation
LV	Low Voltage (400 V distribution network)
n/a	Not applicable
PCS	Power Conversion System
SoC	State-of-Charge

## Appendix 1: Technical particulars

The template below shall be completed for any one or more EES system offerings provided by the candidate supplier. **Note:** One template to be completed for each and every EES system offering.

<b>Candidate Supplier:</b>	
<b>Unit type and reference:</b>	
<b>Parameter</b>	<b>Supplier specification</b>
Nominal (2 hour) Discharge rating (kVA)	
Nominal (2 hour) storage capacity (kWh)	
Operational capability	
Core storage technology/ies	
Rated discharge duration (hours)	
Charge rating (kVA)	
Nominal Operating Voltage	
Voltage control functionality (local)	
Operating frequency	
Chronological life	
Cycle Life	
Short term discharge ratings (kVA/minutes)	
Transient response characteristics	
Performance Degradation - Charge/Discharge Ratings (over 3 years/500/1,000 cycles)	
Performance Degradation-Energy Storage Capacity (over 3 years/500/1,000 cycles)	
Round trip cycle efficiency at nominal 2 hour rating (defined as kWh AC out/kWh AC in x 100%)	
Performance Degradation – Round trip cycle efficiency (over 3 years/500/1,000 cycles)	
Availability (over 3 years)	
Self discharge characteristics	
Parasitic load(s)	
System mass (disaggregated by major sub-systems, as appropriate)	
System dimensions (disaggregated by major sub-systems, as appropriate)	
System/sub-system height(s)	
Footprint (disaggregated by major sub-systems, as appropriate)	

## Appendix 2 – Self Certification Conformance Declaration

The candidate system offering(s) shall comply with all current versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply.

Candidate Supplier shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

### Conformance declaration codes

N/A = Clause is not applicable/ appropriate to the product

Cs1 = The product conforms fully with the requirements of this clause

Cs2 = The product conforms partially with the requirements of this clause

Cs3 = The product does not conform to the requirements of this clause

Cs4 = The product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

#### Instructions for completion

- When Cs1 code is entered no remark is necessary
- When any other code is entered the reason for non-conformance shall be entered
- Prefix each remark with the relevant 'BS EN' or 'ENATS' as appropriate

#### Note:

**Separate Self Certification Conformance Declaration sheets shall be completed for each System Option/Variant being offered.**

**Manufacturer:**

**Product Reference:**

**Name:**

**Date:**

**Signature:**

<b>Specific requirements within this specification</b>			
Clause/sub- Clause	Requirements	Conformance Code	Remarks
3.1	Compliance with Functional Requirements		
3.2	Compliance with Associated Requirements		
3.3	Compliance with Operational Regimes		
3.4	Compliance with Communications Requirements		
4	Compliance with relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) <b>Note:</b> Candidate Supplier to specifically identify relevant Standards and Codes, as applicable to each System/Variant offering and to state compliance relative to these.		



## **Appendix 3 – Addendum to supplier requirements**

### **Packaging/delivery Information**

Candidate Supplier shall provide details of how the proposed EES system offering(s) will be packaged and delivered to site.

### **Project/site specific requirements**

To be provided in complementary Site Specific Specification, to be provided to short-listed Candidate Suppliers.





## **Appendix 4: Pre-commissioning testing, routine inspection and maintenance requirements**

Candidate Suppliers shall provide details of any recommended pre-commissioning testing or installation requirements.

Additionally, Candidate Suppliers shall also provide information regarding any periodic inspection or maintenance requirements to be undertaken during the lifetime of their product.

## Appendix 5: End-of-Life disposal – Material schedule

The template below shall be completed to identify each discrete sub-system/component utilised in each and every variant of candidate EES system offering(s).

**Note:** One template to be completed for each and every EES system offering.

Sub-system	Disposal/re-cycling routes/options



## Appendix 6: Schedule of components

Item	Description	Price

## Appendix 7: Technical information check list

The following information shall be provided by the Candidate Supplier for technical review by Northern Powergrid. Additional information shall be provided if requested. <b>Requirement</b>	<b>Provided (Y/N)</b>
Appendix 1 – Completed technical schedules	
Appendix 2 – Completed Self Certification Conformance Declaration	
Appendix 4 – Completed Pre-commissioning Testing, Routine Inspection and Maintenance requirements/recommendations	
Appendix 5 – Completed End-of-Life/Material Disposal Schedule	
Appendix 6 – Completed Schedule of Components	
Complete set of data sheets and drawings for each system option/variant offered	
Packaging delivery information	
Summary of operational experience and deployment to date	
Routine inspection and maintenance plan (typical)	