APPENDIX F (Part II – Storage)

SITE SPECIFIC TECHNICAL CONDITIONS
CONTENTS

User:	Spalding Energy Expansion Limited
Type of User:	Storage User
Connection Site:	Spalding North 400kV Substation

Contents

General

In addition to the requirements of the Grid Code, the obligations specified in this Appendix F also apply irrespective of whether the Storage User's Plant and Apparatus operates in such a mode as to import or export power from the System.

Electrical Standards

These appendices contain references to the Relevant Transmission Licensee's Relevant Electrical Standards (RES) throughout. The Storage User shall ensure that all Storage User's equipment contained within the Relevant Transmission Licensee's busbar protection zone at the Storage User/National Transmission Connection Point (see Grid Code ECC 6.2.1.2) complies with the RES. The Storage User can access these standards from The Company's website at: -

https://www.nationalgrideso.com/uk/electricity/codes/grid-code/electrical-standards-documents-including-specifications-electronic

The RES are updated periodically. If the RES are updated in the period between issuing the Connection Offer and the Storage User completing the connection to the National Transmission System, then The Company will seek agreement with the Storage User to use the updated RES as the standard for plant and apparatus at the Connection Point.

APPENDIX F1

SITE SPECIFIC TECHNICAL CONDITIONS
AGREED BALANCING SERVICES

User:	Spalding Energy Expansion Limited
Type of User:	Storage User
Connection Site:	Spalding North 400kV Substation

Agreed Balancing Services

The Connection and Use of System Code (CUSC) and the Grid Code detail The Company's requirements for provision of Mandatory Ancillary Services (CUSC Clause 1.3.3, Section 4 and Schedule 2 - Exhibit 4 and Grid Code ECC.8).

The Storage User may wish to consider, prior to the construction phase of its project, whether it intends to negotiate the provision of additional Balancing Services (Agreed Ancillary Services) in order that it can install the necessary hardware to allow monitoring of such services.

Details of the types of Balancing Service and methods of securing them are contained in The Company's Procurement Guidelines and Balancing Principles.

General

The Company may wish to approach the Storage User to establish a valid bilateral payment arrangement for the establishment of a Commercial Transmission System to Generator Operational Intertripping Scheme in the future. This approach would be made at such time that The Company has established certainty in the local generation background.

The Storage User shall co-operate with The Company in installing/enhancing/amending these facilities and will not unreasonably withhold its agreement to any such proposals should The Company require this at a later date.

Any changes to this Appendix F1 and/or to The Company's and/or Storage User's obligations shall be subject to the provisions of Paragraph 2.9.3 of the CUSC which states that if either party wishes to modify, alter or change the site specific technical conditions it shall be deemed to be a Modification for the purposes of the CUSC unless CUSC 4.2B.3 (Agreed Ancillary Services) applies. CUSC 4.2B.3 states that if both parties have failed to reach agreement within a reasonable period then The Company is entitled to initiate the procedure for resolution as an "Other Dispute." This does not apply in the case of Max Generation or System to Generator Operational Intertripping.

APPENDIX F2

SITE SPECIFIC TECHNICAL CONDITIONS
DEROGATED PLANT

User:	Spalding Energy Expansion Limited
Type of User:	Storage User
Connection Site:	Spalding North 400kV Substation

Derogated Plant

Not applicable.

APPENDIX F3

SITE SPECIFIC TECHNICAL CONDITIONS
SPECIAL AUTOMATIC FACILITIES

User:	Spalding Energy Expansion Limited
Type of User:	Storage User
Connection Site:	Spalding North 400kV Substation

Special Automatic Facilities

1. Transmission System to Generating Unit Intertripping Schemes

General
None identified at this time. However, the Storage User shall co-operate with The Company and the Relevant Transmission Licensee in installing/enhancing/amending these facilities, should The Company or the Relevant Transmission Licensee require this at a later date, and will not unreasonably withhold its agreement to any such proposals.

For the avoidance of doubt, except where CUSC 4.2A.6 applies, any such changes of this Appendix F3 and/or to The Company's and/or the Storage User's obligations in respect therefore shall be subject to the provisions of Paragraph 2.9.3 of the CUSC.

2. Special Automated Facilities
(ECC.6.2.2.7)

Requirement	
Disconnection from the Transmission System with or without Storage User Demand	Not applicable
Transmission System to Demand Intertripping Scheme	Not applicable
Transmission System to Directly Connected Customers Intertripping Schemes	Not applicable
Restricted Entry Capacity	Not applicable

3. Other Facilities
(ECC.6.2.2.7)

Requirement	
Automatic Open/Closure Schemes	Not applicable
System Splitting/Islanding Schemes	Not applicable

4. Synchronising & Voltage Selection
(ECC.6.2.2.9)

The Storage User will be required to interface with the National Electricity Transmission System substation synchronising system in accordance with the TS.3.24.60_RES. In circumstances where the Storage User does not synchronise at the Grid Entry Point the Storage User is required to participate in the Relevant Transmission Licensee's voltage selection scheme.

5. Site Specific Requirements – Commercial Intertripping Fast/Deload Scheme
Not applicable.

Appendix F3 - Schedule 1

Site Specific Technical Conditions – Circuits to be selected for Operational Intertripping.

Selection	System Maintenance Condition	Trip Condition	Overload Condition
1.	Not Applicable	Not Applicable	Not Applicable
2.			
3.			
4.			
5.			
6.			

APPENDIX F4

SITE SPECIFIC TECHNICAL CONDITIONS
RELAY SETTINGS & PROTECTION

User:	Spalding Energy Expansion Limited
Type of User:	Storage User
Connection Site:	Spalding North 400kV Substation

Relay Settings & Protection

1. Relay Settings
(ECC.6.2.2.5, ECC.6.2.2.6)

The Storage User shall complete the attached blank protection schedule pro-forma (Schedule 1 of this Appendix). The Storage User shall submit the protection coordination report and settings on its plant for agreement with The Company and the Relevant Transmission Licensee. This shall include details of the following:

a. Circuit diagrams of both ac connections and tripping for the purposes of interpreting the schedule.

b. Protection co-ordination report confirming compliance with the applicable clauses of the Grid Code Connection Conditions. The report shall also show how co-ordination with the Transmission Owner's existing system backup protection is achieved including proposed back-up protection grading curves.

c. Details of the Protection Dependability Index per protected zone. (ECC 6.2.2.2.2 d)

Not less than 3 months before the Commissioning Programme Commencement Date for the agreed works, the Storage User shall have agreed the protection settings on the Storage User's equipment with The Company and the Relevant Transmission Licensee. The Company and the Relevant Transmission Licensee shall then finalise the protection settings on the Transmission System equipment, complete the protection schedule with supporting details where necessary, and supply it to the Storage User.

Any subsequent alterations to the protection settings (whether by the Storage User or The Company or the Relevant Transmission Licensee) shall be agreed between The Company, the Relevant Transmission Licensee and the Storage User in accordance with the Grid Code (ECC.6.2.2.5 and ECC.6.2.2.6).

No Storage User equipment shall be energised until the protection settings have been finalised. The Storage User shall agree with The Company and the Relevant Transmission Licensee, and carry out a combined commissioning programme for the protection systems, and generally, to a minimum standard as specified in the Relevant Transmission Licensee's Transmission Procedure (TP) 106 which is available from the Relevant Transmission Licensee's Extranet. Access to the Relevant Transmission Licensee's Extranet can be requested via email to:- transmission.documentcontrol@nationalgrid.com.

2. Electricity Storage Module Protection Arrangements
(ECC 6.2.2.2)

The fault clearance time (from fault inception to circuit breaker arc extinction) for faults on all the Storage User's equipment directly connected to the Transmission System shall meet the following minimum requirement(s): -

400kV within 80ms

For faults on transformers the clearance time is specified for the HV side (e.g. for a fault on a 400/33kV interconnecting transformer the maximum clearance time is 80ms). Where intertripping is required to open circuit breakers, the overall fault clearance time shall not be extended by more than 60ms (total 140ms in this example) to allow such intertripping to operate.

In addition, the Storage User shall consider provision of the facility to enable (through local intervention) a dedicated setting group within the IED(s) of their circuit protection(s) to enable a reverse looking distance element that can cover for the Storage User circuit's infeed to a busbar fault during short periods of loss/unavailability of the busbar protection system. This feature is in line with wider Transmission System contingency planning. The settings shall be discussed and agreed with the Relevant Transmission Licensee during detailed design and delivery.

Appendix F4 - Schedule 1

PROTECTION AND INTERTRIPPING DETAILS AT THE RELEVANT TRANSMISSION LICENSEE / STORAGE USER INTERFACE

SITE NAME:

CIRCUIT NAME*:
* where a feeder exists between two sites, a separate schedule will be required for each end.

CIRCUIT BREAKER TO BE OPERATED	PROTECTION					SPECIFIED CLEARANCE TIME (See F4 Item 2)	MOST PROBABLE CLEARANCE TIME					FAULT SETTING		RELAY SETTINGS PLUS COMPONENT VALUES	CT RATIO
	PROTECTED ZONE	FUNCTION	MAKE	TYPE/ RATING	DEPENDABILITY INDEX		PROT^{N}	TRIP RELAY	CB	INTER TRIP	TOTAL	PHASE-PHASE	PHASE-EARTH		

Storage User Representative Name: Date: Signature:

The Relevant Transmission Licensee's Representative: Name: Date: Signature:

APPENDIX F5

SITE SPECIFIC TECHNICAL CONDITIONS
OTHER TECHNICAL REQUIREMENTS

User:	Spalding Energy Expansion Limited
Type of User:	Storage User
Connection Site:	Spalding North 400kV Substation

Other Technical Requirements

The Storage User can gain access to the technical specifications from the Relevant Transmission Licensee's Extranet website. Access to the Relevant Transmission Licensee's Extranet website can be requested via email to:- transmission.documentcontrol@nationalgrid.com.

	Criteria	**Grid Code Ref – User to comply with:**	**Obligations**
1.	Protection of interconnecting connections	ECC 6.2.2.3.1	Defined as connections between current transformers on the Storage User's circuit side of the circuit breaker to the Grid Entry Point at the busbar clamps on the busbar side of the busbar selector disconnectors. The Relevant Transmission Licensee: Shall design the protection scheme for the Interconnection Connections at the site once the Construction Programme has commenced. The Storage User: Shall install auxiliary components on its circuits which are compatible with the Relevant Transmission Licensee's to provide required dependability and setting for the protection. Shall provide two current transformers type PX-B cores in each of the Storage User's bays in accordance with TS 3.02.04_RES exclusively for use by the Relevant Transmission Licensee for the protection of the Interconnecting Connections. This will ensure compatibility with the Relevant Transmission Licensee's interconnecting connections protection system.

			All protection equipment capable of tripping the interconnecting circuit breaker shall comply with ECC.6.2.2.2.2 of the Grid Code.
2.	Circuit Breaker Fail Protection	ECC.6.2.2.3.2	The Storage User: To install circuit breaker fail protection equipment on all Storage User circuit breakers that interface directly with the National Electricity Transmission System. The Storage User shall provide Circuit breaker fail back trip facilities to integrate with the Relevant Transmission Licensee's back tripping scheme. Alarms and Indications associated with the Circuit Breaker Fail Scheme must be provided to The Company and the Relevant Transmission Licensee to indicate operation of circuit breaker fail protection. In the event that the Circuit Breaker Fail is an integral function of the Relevant Transmission Licensee's busbar protection scheme, the Storage User shall provide CT signals, plant status and initiation contacts from their bay(s) to the Relevant Transmission Licensee. The Storage User shall accept tripping commands from the Relevant Transmission Licensee's Busbar Protection/Circuit Breaker Fail scheme to the Storage User's circuit breaker trip systems. All provisions are to be in accordance with TS 3.24.39_RES.
3.	Fault Disconnection Facilities		The Storage User: To make provision for tripping of the Storage User/transmission transformer circuit breakers by the Transmission protection systems.
4.	Reactive capability	ECC.6.3.2	The Storage User: Required to meet the applicable requirements of ECC.6.3.2 of the Grid Code. With all plant in service, each Type C or Type D Electricity Storage Module shall be required to be capable of full Leading Power factor from 100% to 20% of Rated MW output.
5.	Frequency Response	ECC.6.3.7	The Storage User: In respect of each of its Type A, Type B, Type C and Type D Power Generating Modules (which includes Type A, Type B, Type C and Type D Electricity Storage Modules) shall be required to satisfy the applicable requirements of ECC.6.3.7.1. In addition, the Storage User in respect of each of its Type C or Type D Power Generating Modules (which includes Type C or Type D Electricity Storage Modules) shall also be required to satisfy the applicable requirements of ECC.6.3.7.2 and ECC.6.3.7.3.
6.	Black Start Capability	ECC.6.3.5	The Storage User: May wish to notify The Company of their ability to provide a Black Start facility and the cost of the service. The Company will then consider whether it wishes to contract with the Storage User for the provision of a Black Start service. Where a Storage User provides a Black Start facility to The Company, they will be required to ensure that

			each Electricity Storage Module satisfies the requirements of ECC.6.3.5.1 – ECC.6.3.5.5 of the Grid Code in addition to those of a Black Start Contract.
7.	Quick Resynchronisation Capability	ECC.6.3.5.6	The Storage User: Storage Users are not permitted to automatically re-synchronise to the System unless instructed to do so by The Company in accordance with BC2.5.2. Notwithstanding this, Type C and Type D Electricity Storage Modules shall be capable of satisfying the requirements of ECC.6.3.5.6. The requirements for Houseload Operation including the minimum operating time, shall be agreed between The Company and the Storage User in the detailed design phase which shall be dependent upon the prime mover technology.
8.	Fault Ride Through	ECC.6.3.15	The Storage User: To meet the requirement of ECC.6.3.15.
9.	Trading Point Electronic Data Transfer (EDT), Control Points, Control Telephony and Control Point Electronic Dispatch and Logging (EDL)	ECC.6.5.8(a) CC.7.9 OC.7 BC.2 ECC.6.5.2 to ECC.6.5.5 E CC.6.5.8, ECC.6.5.9 and BC.1.4.1 ECC.6.5.8(b)	The Storage User: To fulfil the obligations defined in Schedule 1 of this Appendix.
10.	Control Point	ECC.7.9	The Storage User: As required under BC2.9 of the Grid Code, the Storage User will be required to respond to Emergency Instructions, some examples of which are described in BC.2.9.1. In order to fulfil these requirements, it is envisaged that the Storage User has the ability to de-energise all their electrical equipment by ensuring it can open circuit breakers remotely and safely from their Control Point without delay and, where applicable, has the ability to open/close its busbar disconnectors at the Grid Entry Point remotely and safely from their Control Point without delay. For the avoidance of doubt, this functionality is generally required to enable timely restoration of the Transmission System and prevent delays to the return to service of the Storage User's Plant and Apparatus following receipt of such an instruction.
11.	Operational Metering	ECC.6.5.6	The Storage User: To fulfil the obligations defined in Schedule 2 of this Appendix. The operational metering requirements are detailed in TS.3.24.100 (Operational Data Transmission).

12.	Fault Recording and Dynamic System Monitoring	ECC.6.6.1	The Storage User: Is required to fulfil the obligations defined in Schedule 3 of this Appendix in respect of all Type C and Type D Electricity Storage Modules. Any additional requirements or signals necessary for dynamic system monitoring or fault recording shall be agreed between The Company and the Storage User in the detailed design phase.
13.	Frequency Response monitoring	ECC.6.6.2	The Storage User: To install Frequency Response Monitoring equipment and allow remote access of the data by The Company. The Frequency Response Monitoring requirements are detailed in TS 3.24.95_RES (Frequency Response (Ancillary Services) Monitoring). In the unlikely event that The Company requires any additional signals to be monitored over and above those specified in TS.3.24.95_RES, these will be discussed and agreed between The Company and the Storage User in the detailed design phase. In the event that any part of the Storage User's equipment fails (including the communications routes) up to the Relevant Transmission Licensee's interface, then the Storage User shall be required to repair the equipment within 5 days of the fault unless otherwise agreed.
14.	Voltage Unbalance	ECC6.1.5 (b) ECC6.1.6	The Storage User: To provide Voltage Unbalance Assessment information as specified in PC.4.4.1, PC.4.4.2, PC.4.5, PC.A.4.7 and DRC.6.1.5 Schedule 5, of the Grid Code. The Relevant Transmission Licensee: To carry out voltage unbalance assessment in accordance with ECC.6.1.5(b) and ECC.6.1.6. Following the assessment, the Relevant Transmission Licensee (in coordination with The Company) will (where applicable) specify to the Storage User (by written notice), the negative phase sequence current limits to which the Storage User will comply.
15.	Electromagnetic Transients, Voltage Fluctuations and Transformer Energisation	ECC.6.1.7(a) ECC.6.1.7(b)	The Storage User: To minimise the probability and severity of electromagnetic voltage transients or transformer inrush at the Grid Entry Point which may occur when the Storage User's Plant and Apparatus, or any material subsystem is connected to or disconnected from the National Electricity Transmission System. The Storage User shall provide The Company (for onward transmission to the Relevant Transmission Licensee) with details of such measures and an assessment of the predicted probability and severity of such transients or transformer inrush. In the event that The Company (upon advice from the Relevant Transmission Licensee) needs to undertake transient overvoltage assessments or voltage assessment studies, the Storage User will be required to provide the data required under PC.A.6.2.1 or PC.A.6.5 of the Grid Code. The fault levels that should be used for the Electromagnetic Transient studies are described in Table 1 below, in the section headed 'Short Circuit Levels'.

<table>
<tr>
<td>16.</td>
<td>Short Circuit Levels</td>
<td></td>
<td>The Storage User:
The Storage User must continue to operate satisfactorily and keep fundamental frequency over-voltages to within the limit specified under ‘AC System Voltage Variations,’ using minimum fault levels as described in the Table 1 below:
<table>
<tr><th>SQSS Condition</th><th>3-phase Sub-Transient (kA)</th><th>1-phase sub-transient (kA)</th><th>Purpose
(It is recommended the relevant fault levels are used for the following purposes)</th></tr>
<tr><td>Minimum fault level</td><td>TBC</td><td>TBC</td><td>1- Protection settings with additional appropriate safety margins.
2- Electromagnetic transient study in relation to ECC.6.1.7(a) and (b) and TOV (TGN 288).
3- Any study in relation to unbalance.</td></tr>
<tr><td>Post fault minimum fault level</td><td>TBC</td><td>TBC</td><td>1- Fault ride through
2- Transient active and reactive power exchange studies
3- For SSTI and control interaction studies the part of network around the point-of-interest is usually modelled. Post fault minimum fault level, which represent a N-1-D condition on a summer minimum scenario should be included in the study cases.</td></tr>
</table>
Table 1
Please note, to allow for any uncertainty concerning factors that could influence the minimum fault level to be mitigated, such as network changes, system topology and performance as well as generation despatch, the values in Table 1 will be provided in the detailed design stage as defined in PC.A.8.</td>
</tr>
<tr>
<td>17.</td>
<td>AC System Voltage Variations</td>
<td>ECC.6.1.4</td>
<td>The Storage User:
In addition to withstanding the requirements of ECC.6.1.4 of the Grid Code, the Storage User’s plant and apparatus shall also be capable of withstanding typical fundamental frequency temporary overvoltages that may occur on the onshore transmission system and should not produce, by means of their equipment switching or otherwise, TOVs exceeding the limits stated in the TGN (E)288 – Issue 1 – May 2016 which is available from the Relevant Transmission Licensee upon request.

For clarification please reference the following document:
TGN(E) 288 – Issue 1 – May 2016
https://www.nationalgrid.com/sites/default/files/documents/TGN%28E%29_288_0.pdf</td>
</tr>
<tr>
<td>18.</td>
<td>Paralleling</td>
<td></td>
<td>The Storage User:</td>
</tr>
</table>

			To ensure there is no paralleling of the National Electricity Transmission System through the Storage User's System.
19.	Safety and Operational Interlocking		<u>The Storage User:</u> Electrical and mechanical interlocking to be provided by the Storage User in accordance with TS.3.01.01_RES.
20.	Earthing Facility		<u>The Relevant Transmission Licensee:</u> To provide two points within its substation(s) to facilitate any bonding with the Storage User's site if required. All earth mats on the Storage User site(s) and the Relevant Transmission Licensee's site(s) where these are adjacent may be bonded together. The Relevant Transmission Licensee's site earth mats can be bonded to the Storage User's site earth mat. <u>The Storage User:</u> To carry out an earthing survey of their sites prior to construction of the Storage User's Plant and Apparatus. The earthing system is to be designed to withstand a short circuit current of 63kA for 1 second at 400kV substations. The Storage User shall ensure that its Plant and Apparatus is designed and installed such that the rise of earth potential (ROEP) at Spalding North 400kV substation conforms to the touch, step and transfer voltage limits which are defined in ENA TS 41 – 24. Where intertripping (second main protection) is required to open circuit breakers, the overall fault clearance time shall not be more than 140 ms at 400kV substations. The Storage User's earthing system design review shall take the Relevant Transmission Licensee's earthing system design into account and the Storage User shall collaborate with the Relevant Transmission Licensee to ensure that compliance has been demonstrated at the Grid Entry Point which also mitigates 3rd party impact as required. The earthing system at Spalding North 400kV substation shall be designed to comply with ESQCR 2002 and BS EN50522.
21.	Compliance Testing		<u>The Storage User:</u> To demonstrate compliance with the requirements of the Grid Code.
22.	Settlement Metering	ECC.6.2.2.3.5	<u>The Storage User</u>: To provide CTs/VTs that comply with the relevant metering Code of Practice required for Settlement. To provide the Settlement Meters and register compliant items of Metering Equipment for Settlement purposes. All of the above to be completed prior to energisation and in accordance with the Balancing and Settlement Code (BSC).
23.	Model Requirements and Dynamic	ECC.6.1.9	<u>The Storage User:</u> Is required to satisfy the requirements of PC.A.6.1.3 and ECC.6.3.17.1.5 and assist The Company to ensure compliance with ECC.6.1.9, ECC.6.1.10.

	performance and Interactions	ECC.6.1.10 ECC.6.3.17.1.5 PC.A.6.1.3	Please note the following: <u>Power Factory RMS model(s):</u> This includes model(s) and any associated set up script(s) that form part of the model delivery to The Company and should be compliant with PC.A.5. Any set up scripts should be compatible with the Powerfactory network used by The Company. Also, the RMS model should not require the use of integration time steps less than 10ms due to the time to run a set of simulations on a large network with a large number of models and should not include DLL codes. <u>Power Factory version:</u> Model(s) to be delivered in a version of Powerfactory to be agreed with The Company. After the PF model is provided, the model validation report which compares results against simulation results of PF model and FAT results should be submitted. <u>EMT Model:</u> The Storage User is required to provide an EMT model. After the EMT model is provided, the equipment model validation report which compares results against simulation result of EMT model and equipment FAT results should be submitted. Specification for the model (including time step) should be agreed in advance between The Company in consultation with the Relevant Transmission Licensee and the Storage User. Dynamic Performance Study (DPS) results may be required to demonstrate that the expected steady state and dynamic performance of the Storage User's Plant and Apparatus has been met. To ensure its converters (including controllers) within the System do not cause negatively or lightly damped resonances or interactions on the NETS, adequate damping control facilities to be installed if there is a risk of the following phenomena: • Sub-synchronous oscillations due to interactions between the Storage User's Plant and Apparatus and the NETS. For clarity, sub-synchronous torsional oscillation with other User's Plant and Apparatus shall be included in the study. • Control interaction due to interactions between the Storage User's Plant and Apparatus, network and/or any plant directly or indirectly connected to the NETS. For clarity, Control Interaction with the network and other User's Plant and Apparatus shall be studied in the sub-synchronous and super-synchronous frequency ranges where the Storage User's Plant and Apparatus is identified to be responsive.

			To provide data and results to The Company in consultation with the Relevant Transmission Licensee including full EMT and RMS models (models to be provided 3 years prior to connection, ideally to be included in tender documents) and updated version of the model to be provided after commissioning. Specification for the models to be agreed with The Company and the Relevant Transmission Licensee of all the Storage User's plant to enable the following studies: • Transient Analysis studies – electromechanical and electromagnetic. • Frequency Domain studies – including eigenvalue analysis and damping torque assessments for all the Storage User's equipment. Detailed requirements in relation to the above studies can be agreed with The Company and the Relevant Transmission Licensee at a time convenient to the Storage User. The results of these studies must be provided to The Company and the Relevant Transmission Licensee by the date defined in the Appendix J of the Construction Agreement. The Storage User shall provide The Company with any relevant information required in the above assessments. <u>Additional Note</u> Both The Company and the Storage User endeavour to revise and update as applicable the contents of this clause before the Completion Date Stage 2, unless otherwise agreed, in accordance with the Grid Code applicable at the time. <u>The Company</u> To outline the detailed requirements and the extent of the studies to be performed, and the criteria to demonstrate compliance with (depending on the static and dynamic models of onshore transmission network) other relevant Users before the Completion Date Stage 2. The results of these studies must be provided to The Company and the Relevant Transmission Licensee by the date defined in the Appendix J of the Construction Agreement.
24.	Voltage Control Performance Requirements	ECC.6.3.8.4 and ECC.A.7	<u>The Storage User:</u> To install a continuously acting automatic control system to provide control of the voltage at the Grid Entry Point as detailed in ECC.6.3.8.4 of the Grid Code. The performance requirements of this control system are detailed in Appendix E7 of the Grid Code Connection Conditions. To declare to The Company, the ability of each Non-Synchronous Electricity Storage Module to contribute to voltage control below 20% of Rated MW output. As a minimum and as specified in ECC.6.3.8(a)(iii) of the Grid Code, if voltage control is not being provided below 20% of Rated MW output, the Storage User shall ensure that the control system of each Non-Synchronous Electricity Storage Module shall be designed to ensure a smooth transition between the shaded area and the non-shaded area in Figure ECC.6.3.2.4(c) of the Grid Code.

			For the avoidance of doubt each Electricity Storage Module control system is not required to be fitted with Reactive Power Control or Power Factor Control. If such facilities have been installed within the voltage control system they should be disabled.
25.	Power Oscillation Damping	BC.2.11.2	<u>The Storage User:</u> There is no requirement for the voltage control system to be fitted with a Power System Stabiliser (PSS). However, if the Storage User chooses to install a PSS within the Non-Synchronous Electricity Storage Module voltage control system, its settings and performance shall be agreed with The Company and the Relevant Transmission Licensee, and commissioned in accordance with BC.2.11.2 of the Grid Code.
26.	Power Quality Monitoring		<u>The Storage User:</u> To provide three phase voltage transducers of suitable accuracy which are appropriately sited at the Point of Common Coupling to enable continuous power quality voltage monitoring whether or not the Non-Synchronous Electricity Storage Module is energised. Examples of suitable voltage transducers are detailed in TS 3.02.05_RES “Voltage Transformers” (with particular reference to Section 1.3) or, alternatively, in TS 3.02.12_RES “Voltage Dividers”. To provide three phase current transducers of suitable accuracy on the Storage User’s feeders at the Relevant Transmission Licensee’s Spalding North 400kV substation at the Grid Entry Point to enable continuous power quality current monitoring. The current transducers on the Storage User’s feeders shall be sited such that the monitored currents include any contribution from reactive power compensation and / or harmonic mitigation equipment. The transducer is required to meet TS 3.02.04_RES (Current Transformers for Protection and General Use). A current transducer is suitable for power quality monitoring if it is also compliant with IEC 61869-1 and IEC 61869-2. The Storage User to provide the output signal of these voltage and current transducers to the Relevant Transmission Licensee. <u>The Relevant Transmission Licensee:</u> To install permanent, Class A power quality monitors as defined in IEC 61000-4-30 at the Grid Entry Point in order to check compliance against the specified limits. To undertake a four week period (unless otherwise agreed) of continuous power quality voltage measurements using the above facilities immediately prior to the energisation of the Storage User’s feeders to establish a baseline for compliance with the Grid Code. Continuous power quality monitoring shall then be performed during and after commissioning.

27.	Harmonic Performance	ECC.6.1.5	<u>The Relevant Transmission Licensee:</u> The Company (upon advice from the Relevant Transmission Licensee) shall specify to the Storage User, the harmonic voltage distortion or harmonic current emission limits (as appropriate), in conjunction with harmonic impedance loci and background levels. The specification of the above limits shall be prepared in accordance with procedures specified in Engineering Recommendation (ER) G5/5. The harmonic limits and loci for this connection shall be provided in Schedule 4 of this Appendix F5 by the date specified in Appendix J of the Construction Agreement unless otherwise agreed between The Company, the Relevant Transmission Licensee and the Storage User. <u>The Storage User:</u> The Storage User shall comply with the limits specified by The Company (in collaboration with the Relevant Transmission Licensee). The Storage User shall undertake Harmonic voltage distortion assessments in accordance with Grid Code Conditions ECC.6.1.5(a). Any inter-harmonic component produced by the Storage User's equipment shall be determined in accordance with relevant sections in ER G5/5. If the predicted level of inter-harmonic distortion is below 0.1%, no further assessment is required. If the inter-harmonic distortion is above 0.1%, the Storage User shall inform The Company, The Company will then (in consultation with the Relevant Transmission Licensee) specify inter-harmonic distortion limits to the Storage User. The timeframe for provision of inter-harmonic distortion limits shall be agreed between The Company, the Relevant Transmission Licensee and the Storage User. The Storage User will provide The Company (for onward transmission to the Relevant Transmission Licensee) with Harmonic Assessment information (as specified in PC.4.4.2, PC.4.5, PC.A.5.4.3.4, DRC.6.1.1 Schedule 1 and DRC.6.1.5 Schedule 5 of the Grid Code) and also, in accordance with ER G5/5, submit a report to confirm compliance with limits specified (including inter-harmonic distortion) by the date specified in Appendix J of the Construction Agreement.
28.	Switching Groups	PC.A.3.2.2(k) PC.A.3.2.4 OC2.4.2.1(f)	<u>The Storage User</u>: To notify The Company of any change to the number, type or configuration of Non-Synchronous Electricity Storage Units within each Non-Synchronous Electricity Storage Module. To ensure that each Non-Synchronous Electricity Storage Module is capable of meeting the full requirements of the Grid Code and this Bilateral Agreement (including but not limited to matters of quality of supply requirements, fault infeed and reactive capability) irrespective of the connection configuration of each Non-Synchronous Electricity Storage Unit within each Non-Synchronous Electricity Storage Module.
29.	Additional data for new types of Power	PC.A.7	<u>The Storage User:</u> Should be aware that The Company may reasonably require additional data to correctly represent the performance of the Storage User's Plant and Apparatus where the present data submissions would prove insufficient for the purpose of producing meaningful studies.

	Stations and configurations		
30.	Low Frequency Demand Disconnection	OC.6.6	The Storage User: Is required to make arrangements (specified in OC.6.6) that will enable automatic low frequency demand disconnection to limit the consequences of a major loss of generation or an event which leaves part of the system with a generation deficit. This would only apply when the Storage User's Plant and Apparatus is operating in a mode analogous to demand. To discuss and agree (as applicable) the arrangements and settings with The Company in the detailed design phase which shall be at least 18 months before the Completion Date Stage 2 unless otherwise agreed.
31.	Fast Fault Current Injection		The Storage User: Is required to satisfy the requirements of ECC.6.3.16. In addition, the Storage User shall inform The Company of their control strategy for satisfying the requirements of ECC.6.3.16 including the use of Blocking where it is employed in the Storage User's control system design.
32.	Flicker		The Storage User To follow EREC P28-Issue 2 and provide a report to show that their flicker impact is below 0.5. If the Storage User's emissions are greater than 0.5, then The Company (upon advice from the Relevant Transmission Licensee) shall issue appropriate limits in accordance with Stage 3 assessment procedure within EREC P28-Issue 2.

Appendix F5 - Schedule 1

Site Specific Technical Conditions - Communications Plant. (ECC.6.5)

Description	Location	Source	Provided By	Comments
Control Telephone ECC.6.5.2 to ECC.6.5.5, ECC.6.5.8, ECC.6.5.9 and BC.1.4.1	Control Point	The Transmission Substation Exchange.	The Storage User to provide and install wiring from the Storage User's Control Point to The Company substation exchange, and install free issue handset. The Relevant Transmission Licensee to provide communications path to the Storage User's Control Point site (Great Britain only) in conjunction with the Storage User. The Relevant Transmission Licensee to provide Green handset only.	Control Telephony provides secure point to point telephony for routine Control Calls, priority Control Calls and emergency Control Calls. If the Storage User intends to have a nominated Trading Point/Control Point outside of GB, The Company will provide the communication routes and Control Telephony facilities to the Storage User's Control Point but will charge the Storage User for the overseas element of this work including any ongoing regular maintenance. Any subsequent relocation of Control Point will be charged to the Storage User by The Company.
Trading Point Data Transfer (EDT) (ECC.6.5.8(a) and BC.1.4.1)	Trading Point	The Company Substation Exchange	Storage User to provide and install EDT terminal The Storage User shall provide communications path to the EDT terminal in conjunction with The Company in order to submit the data required by the Grid Code.	The Company to include site in instructor database and commission. Facility provided via Control Telephone and/or Facsimile machine. The Storage User will provide the communications path for the EDT terminal from the Storage User's Trading Point and can elect to send this to two locations (Warwick or Wokingham). The Company will provide the necessary connection and interfacing equipment at its Data Centres. If the Storage User intends to have a nominated Trading Point outside Great Britain, the responsibilities, functionality, dependability, security, procurement, configuration, delivery points, protocol and repair times of the communication links to be agreed with The Company 6 months prior to the Completion Date Stage 2.
Data Entry Terminals (Electronic Despatch & Logging (EDL)) (ECC.6.5.8(b))	Control Point	Public Telephone Operator	Storage User to provide and install EDL terminal approved by The Company which will permit submission and acceptance of Grid Code data between the Storage User's Control Point and The Company continuously. The Company to provide communications path to the EDL terminal (Great Britain only) in conjunction with the Storage User.	The Company will only provide the communications path to the EDL terminal where the Storage User's Control Point is located in Great Britain. If the Storage User intends to have a nominated Trading Point/Control Point outside of GB, The Company will provide the communication routes and Control Point Electronic Dispatch and Logging facilities to the Storage User's Control Point but will charge the Storage User for the overseas element of this work including any ongoing regular maintenance.

				Any subsequent relocation of Control Point will be charged to the Storage User by The Company.
Facsimile Machine (ECC.6.5.9)	Trading Point and Control Point	Public Telephone Operator.	Storage User to provide and install facsimile machine and wiring to PTO.	

NB: The specifications for Control Telephony, EDT and EDL are defined in the Annex to the General Conditions of the Grid Code which is available on The Company's website. Please see reference to Electrical Standards hyperlinks page at the end of this Appendix.

Appendix F5 - Schedule 2

Site Specific Technical Conditions - Operational Metering Requirements in respect of The Company and the Relevant Transmission Licensee. (ECC.6.5.6)

Description	Units	Type	Provided by	Notes
MW and MVAr for each Balancing Mechanism Unit and Station Supplies derived from Boundary Point Settlement Metering System.	MW MVAr	Signals to have a 1Hz update rate or better and provide input to the Ancillary Services Monitoring equipment	Storage User.	The Storage User is required to install a Remote Terminal Unit (RTU) and supply the signals defined in this schedule. The Company will install the communications channels to Spalding North 400kV substation in order to interface with the Storage User's Operational Metering signals. The functional performance, availability, accuracy, dependability, security, delivery point, protocol and repair times of the equipment generating and supplying the signals (i.e. the meters and communication links) shall be agreed with The Company and the Relevant Transmission Licensee at least 12 months before the Completion Date Stage 2. In the event that any part of the Storage User's Operational Metering equipment, including the communications links to the Relevant Transmission Licensee's Spalding North 400kV substation fails, then the Storage User will be required to repair such equipment within 5 working days of notification of the fault unless otherwise agreed. In the worst case, the Storage User may be required to reduce its Maximum Export Limit (MEL) or Maximum Import Limit (MIL) as required by The Company. The Storage User to provide Single Line Diagram showing location of CT/VT equipment and nomenclature of HV Apparatus. The Company will use this information to notify the Storage User of which HV circuit breaker and disconnector positions (i.e. status indications) are required. The nomenclature of Storage User's equipment should be in accordance with OC11 of the Grid Code. The signals may be presented at a marshalling kiosk located either within the host TO's substation as agreed between the Relevant Transmission Licensee, and the Storage User during the detailed design phase.
Voltage for each Storage User bay connection to the Relevant Transmission Licensee's Spalding North 400kV substation derived from single phase VT (usually a CVT).	kV	Signals to have a 1Hz update rate or better.	Storage User. Note the Storage User shall also make this signal available at its own Control Point for responding to Voltage Control Instructions from The Company.	
Frequency	Hz	Signals to have a 1Hz update rate or better and provide input to the Ancillary Services Monitoring equipment.	Storage User.	
Status of Storage User circuit(s) HV and LV circuit breaker(s) and disconnector(s), as agreed with The Company.	Open/ Closed Indication	Double point off dedicated auxiliary contacts (1 n/o and 1 n/c).	Storage User.	
Each Storage User transformer Tap Position Indication (TPI)	TPI	Tap Position Indication	Storage User.	
System Availability	MWhrs	Signals to have a 1 second update rate or better.	Storage User	Availability of a storage system to export or import from the system-measured in MW of export and the length of available time. For example, 100% System Availability for a 50MWhr Storage project means it could deliver 50MW for 1 hour or 1MW for 50 hours. The characteristics of the storage system will need to be discussed and agreed with The Company in the detailed design stage but The Company would expect a signal identifying the MW output and the length of time those MW would be available.
State of Charge	%	Signals to have a 1 second update rate or better.	Storage User	Percentage of maximum storage capability
Additional signals as may reasonably be required by The Company.		Various to be agreed with The Company.	Storage User	If required will be discussed and agreed with The Company in the detailed design stage.

Note: The term ‘Boundary Point Metering System’ is defined in the Balancing and Settlement Code. In the event that any part of the Storage User’s Operational Metering equipment, including the communications links to Spalding North 400kV substation fails, then the Storage User will be required to repair such equipment within 5 working days of notification of the fault from The Company or the Relevant Transmission Licensee unless otherwise agreed. The Storage User shall also provide facilities to allow The Company and the Relevant Transmission Licensee to monitor the health of the Operational Metering equipment up to the Grid Entry Point. NB: The specifications for Control Telephony, EDT and EDL are defined in the Annex to the General Conditions of the Grid Code which is available on The Company’s website. Please see reference to Electrical Standards hyperlinks page at the end of this Appendix.

Appendix F5 - Schedule 3

Site Specific Technical Conditions – Dynamic System Monitoring and Fault Recording. (ECC.6.6.1)

The Storage User is required to provide the dynamic system monitoring facilities in respect of each Type C and Type D Power Generating Module (which includes each Type C and Type D Electricity Storage Module) and provide communication facilities allowing remote access of data to The Company.

Description	Type	Provided by	Notes
3 phase voltage and current at Spalding North 400kV substation.	AC Waveforms	Storage User	The functionality, performance, availability, accuracy, dependability, security, configuration, delivery point, protocol and repair times of the equipment generating and supplying the signals (i.e. the inputs, monitors and communication links) shall be agreed with The Company/the Relevant Transmission Licensee at least 12 months before the Completion Date Stage 2.
Dynamic System Monitoring and remote communications and interfacing on Storage User Circuits at the Relevant Transmission Licensee's Spalding North 400kV substation.	Monitors	Storage User	Connection to enable data to be retrieved from Dynamic System Monitoring equipment. Connection to The Company with connection, monitoring and security arrangements to be agreed with The Company/the Relevant Transmission Licensee at least 12 months before the Completion Date Stage 2.
	Communications Channels	Storage User to provide signals and interface at the Relevant Transmission Licensee's Spalding North 400kV substation.	

In the event that any part of the Storage User's equipment fails to deliver the information required at Spalding North 400kV substation (including the communications routes) then the Storage User shall be required to repair the equipment within 5 working days of notification of the fault from The Company unless otherwise agreed. The Storage User shall also provide facilities to allow The Company to monitor the health of the Dynamic System Monitoring equipment up to the Grid Entry Point.

Note:- The specification and performance requirements for Dynamic System Monitoring are detailed in Technical Specification TS 3.24.70-RES (Dynamic System Monitoring (DSM)).

In addition, the Storage User is also required to install Fault Recording equipment in accordance with the requirements specified in TS.3.24.71_RES.

Appendix F5 - Schedule 4
Site Specific Technical Conditions – Harmonic Performance (ECC.6.1.5(a))

The Storage User shall ensure that any apparatus in their plant is designed and constructed to limit the contribution of injected harmonic currents and/or voltage such that the incremental harmonic voltage distortion at the Spalding North 400kV substation conforms to the limits specified in Table 1 below.

The Storage User shall ensure that any apparatus in their plant is designed and constructed such that the total harmonic voltage distortion (due to harmonic components emitted by the Storage User's apparatus together with background distortion as modified by the Storage User's apparatus) at the Spalding North 400kV substation conform to the limits specified in Table 1 below.
Table 1 also provides the levels of background harmonic voltage distortion at the Connection Site prior to the connection of the Storage User.

Table 1: Background, Incremental and Total Harmonic Voltage Distortion Limit at Spalding North 400kV substation

Harmonic Order 'h'	Background Voltage Distortion at 400kV (% of fundamental)	Incremental Voltage Distortion Limits at 400kV (% of fundamental)	Total Harmonic Distortion Limits at 400kV (% of fundamental)
2	To be determined	To be determined	To be determined
3	To be determined	To be determined	To be determined
.	To be determined	To be determined	To be determined
h	To be determined	To be determined	To be determined

The Storage User shall conform to the Total Harmonic Distortion (THD) level, at the Grid Entry Point as given in Table 2 below.

Table 2: Total Harmonic Distortion Limits

Harmonic order	THD
≥ 2	TBC

The limits specified in Tables 1 & 2 shall apply for all possible conditions and operation of the Storage User's system. They shall apply for system impedance envelopes at the Spalding North 400kV busbar connection point up to 5kHz (100th harmonic) that are shown below. All impedances within and on the periphery of

the envelopes represent the system impedance seen from the Spalding North 400kV busbar. The impedance envelopes are sectionalised for different harmonic ranges as illustrated below.

NB: Graphs will be provided once limits have been determined

USEFUL LINKS

The Grid Code:

https://www.nationalgrideso.com/codes/grid-code

Electrical Standards:

https://www.nationalgrideso.com/codes/grid-code/electrical-standards-documents-including-specifications-electronic-data

Extranet (ID and password required, email transmission.documentcontrol@nationalgrid.com to request access):

https://extranet.nationalgrid.com/

Connection Policies and Guidance:

https://www.nationalgrideso.com/connections/registers-reports-and-guidance

Procurement Guidelines and Balancing Principles:

https://www.nationalgrideso.com/balancing-services/c16-statements-and-consultations