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Voltage 2026

Technical Requirements and Specification

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Version Control

Version number	Date	Notes
V1	06/10/2023	Initial version published at EOI. Please note this document may be updated at ITT stage following market feedback and/or learnings in-between EOI and ITT stages of the Voltage 2026 tender process.
V2	19/12/2023	Updated version published at ITT. Please note the following updates have been made: - Model provision requirements updated in Section 3.7. - Minimal size of solution updated in Section 3.3.
V3	26/01/2024	Technical Specification has been updated to reflect the increase in requirement in the North region. Previously the requirement was –200Mvar being sought from April 2026. The requirement is now –200Mvar from April 2026 and an additional –200MVar from April 2027.
V4	29/02/2024	Section 3.2 updated to provide better clarity on the utilisation profile.
V5	19/03/2024	Section 3.6 Control and Indication Facilities item 3.2 updated to clarify Voltage Control Mode Setpoints.

Introduction

This document presents the technical requirements and specification which solutions will need under the Voltage 2026 Network Services Procurement Tender.

This document is made up of the following parts:

- Part 1 – Regions of Need and Reactive Power Requirements
- Part 2 – Acceptable Sites within Regions of Need
- Part 3 – Specifications
- Part 4 – Definitions

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Part 1 – Regions of Need and Reactive Power Requirements

Voltage 2026 tender defines two regions of need, namely: London and North England. The reason for defining regions of need, rather than one large region with many reference points, is due to the need for this tender to procure reactive power absorption capability (RPAC), which is highly locational in nature, with effectiveness dropping sharply as the electrical distance from the reference site increases. Moreover, a high amount of reactive power connected to one substation to get the desired compensation at the reference point could deteriorate the voltage profile in the former. Figure 1 indicates the approximate locations of the regions of need. The specific locations that compose London and North England regions referenced in this document are detailed in Part 2.

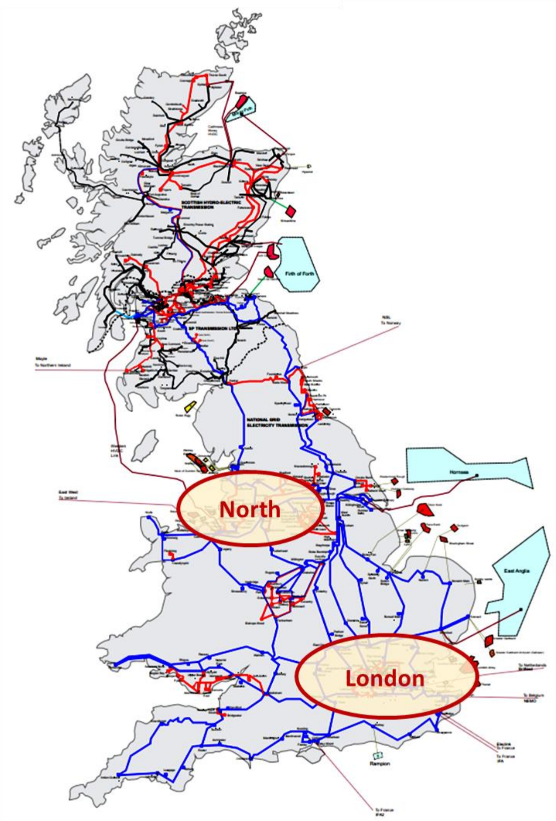

Figure 1. Regions of need

For each region of need, a reactive power requirement has been identified, which is associated to a reference point as presented in Table 1. The reference points have been chosen based on the network topology, considering both pre- and post-fault analysis, and aiming at sites with better connectivity with other locations. For solutions connected to other substations, an effectiveness factor should be considered as explained in the next section.

Table 1 – Reactive power requirement

Region	Requirement	Reference point
London	**-200 Mvar from April 2026**	Tilbury 400 kV
North England	**-200Mvar from April 2026**	Eggborough 400kV
	-200Mvar from April 2027	

Part 2 – Acceptable Sites within Regions of Need

The analysis conducted by ESO has identified several locations inside the regions of need that are suitable for solutions within the Voltage 2026 tender. ESO is not accepting any submissions for the Voltage 2026 tender that would connect at sites that fall outside of ESO's defined regions of need. Please refer to the 'Voltage 2026 Connections Approach' document for full details on tender rules relating to the connection requirements for this tender.

Table 2 and Table 3 present the acceptable sites for London and North England, respectively, and also show the corresponding effectiveness factors, which have been computed against the reference point. The reference point is the most effective location to connect reactive power compensation for voltage control purposes in each region. The effectiveness factors have been calculated based on a defined network topology and reflect the voltage sensitivity when reactive power compensation is connected at different locations. The sensitivities are extracted from nodal equations used in the load flow formulation[1].

To allow sufficient range of connection sites, a threshold of 40% has been applied when defining the acceptable sites in both regions. For the avoidance of doubt, the maximum size of solutions will be subject to assessment by the relevant TO as part of the connection application process. Please refer to Section 3.4 for additional details. Please refer to the 'Voltage 2026 Connections Approach' document for full details on tender rules relating to the connection requirements for this tender.

For some locations indicated in Table 2 and Table 3, the last column specifies the associated node. This specification is required depending on the substation arrangement which may cause different effectiveness factors at different busbars/electrical nodes.

In order to illustrate the use of the effectiveness factors, we take Barking 400 kV and 275 kV as examples. According to Table 2, these locations have the following effectiveness factors:

- Barking 400 kV: 80%
- Barking 275 kV: 64%

These figures indicate that, to meet the full requirement of London region (200 Mvar at Tilbury 400 kV), solutions at those locations would require the following capacity:

- Barking 400kV: 200 Mvar ÷ 80% = 250 Mvar → 100% of the total requirement
- Barking 275kV: 200 Mvar ÷ 64% = 313 Mvar → 100% of the total requirement

If smaller solutions are considered at those locations, e.g., 70 Mvar, the correspondent contribution at the reference point would be:

- Barking 400kV: 70 Mvar × 80% = 56 Mvar → 28% of the total requirement
- Barking 275kV: 70 Mvar × 64% = 45 Mvar → 23% of the total requirement

The diagrams in Figure 2 and Figure 3 indicate the acceptable locations in London and North England regions, respectively.

[1] *In the load flow formulation, the Jacobian matrix is composed by partial derivatives of active and reactive powers with respect to voltage magnitude and phase angle. This matrix is then used to obtain the voltage sensitivities to the reactive power at each busbar. Sensitivities are normalized using the values of the reference point.*

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Table 2 – Acceptable sites and effectiveness factors: London

Region	Location	Effectiveness Factor [%]	Specific node
London	Tilbury 400kV*	100	
	Coryton South 400kV	94	
	Rayleigh 400kV	87	
	West Thurrock 400kV	86	Connection nodes to Littlebrook 400kV
	Kingsnorth 400kV	85	
	Tilbury 275kV	84	
	Singlewell 400kV	83	
	Rowdown 400kV	83	Connection node to Littlebrook-Kemsley 400kV (Circuit 2)
	Northfleet East 400kV	83	
	Littlebrook 400kV	82	
	West Thurrock 400kV	82	Connection nodes to Barking 400kV
	Barking 400kV	80	
	Warley 275kV	79	
	Rowdown 400kV	78	Connection node to Littlebrook-Kemsley 400kV (Circuit 1)
	Grain 400kV	77	
	Medway 400kV	77	
	Bulls Lodge 400kV	75	
	West Ham 400kV	74	Double busbar
	Kemsley 400kV	73	
	Hackney 400KV	70	
	Hurst 275kV	69	
	Highbury 400kV	68	
	Pudding Mill 400kV	68	
	City Road 400kV	67	
	St.Johns Wood 400kV	66	
	Kensal Green 400kV	65	
	Wimbledon 400kV	65	
	New Cross 275kV	64	
	Barking 275kV	64	
	Elstree 400kV	63	Main and reserve busbars
	Redbridge 275kV	62	
	Tottenham 275kV	61	
	Waltham Cross 275kV	58	
	Elstree 275kV	58	
	Beddington 275kV	57	
	North Hyde 275kV	57	Connection nodes to SGTs 2 and 3
	Watford South 275kV	57	
	Iver 275kV	57	Reserve Busbar 2
	Willesden 275kV	51	
	Chessington 275kV	51	
	Waltham Cross 400kV	51	Connection node to Rye House-Pelham 400kV
	Ealing 275kV	50	
	Rye House 400kV	50	
	Elstree 400kV	49	Connection node to Sudon 400kV (Circuit 1)
	Laleham 275kV	47	
	West Weybridge 275kV	45	
	North Hyde 275kV	45	Connection node to SGT 1
	Iver 275kV	45	Double busbar (except reserve Bus 2) and node to Laleham 275kV
	Iver 400kV	40	

**Reference point*

Table 3 – Acceptable sites and effectiveness factors: North of England

Region	Location	Effectiveness Factor [%]	Specific node
North England	Eggborough 400kV*	100	
	Ferrybridge 400kV	98	
	Monk Fryston 400kV	95	
	Knaresborough 275KV	90	
	Poppleton 275kV	89	
	Monk Fryston 275kV	89	
	Ferrybridge 275kV	89	
	Thorpe Marsh 400kV	87	Mesh corner
	Skelton Grange 275kV	87	
	Drax 400kV	84	
	Thorpe Marsh 275kV	81	
	Stocksbridge 400kV	81	
	Rochdale 400kV	81	
	Kirkstall 275kV	80	
	Brinsworth 400kV	80	
	Bradford West 275kV	78	
	Elland 275kV	77	
	Thorpe Marsh 400kV	76	Double busbar
	West Melton 275kV	74	
	Aldwarke 275kV	74	
	Neepsend 275kV	73	
	Sheffield City 275kV	73	
	Pitsmoor 275kV	73	
	Wincobank 275kV	73	
	Jordanthorpe 275kV	73	
	Templeborough 275kV	73	
	Tinsley Park 275kV	72	
	Brinsworth 275kV	72	
	Thurcroft 275kV	72	
	Stalybridge 400kV	70	
	Chesterfield 275kV	69	
	Thornton 400kV	67	
	Bradford West 400kV	66	
	Stalybridge 275kV	62	
	Osbaldwick 400kV	62	
	Rochdale 275kV	62	
	High Marnham 275kV	62	
	Padiham 400kV	58	
	Kearsley 275kV	56	
	Bredbury 275kV	54	
	Macclesfield 275kV	53	
	South Manchester 275kV	50	
	Macclesfield 400kV	49	
	Carrington 275kV	48	
	Kearsley 400kV	48	
	Carrington 400kV	41	
	Daines 400kV	41	

**Reference point*

V3 Clarification: Please note the substations and effectiveness values presented in Table 3 should be applied for the both the -200Mvar requirement from 2026 and the -200Mvar requirement from 2027.

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Tables 2 and 3 list out the electrical nodes that fall within our regions of need for this tender. Please refer to the 'Voltage 2026 Connections Approach' document for more information on the connections criteria for this tender.

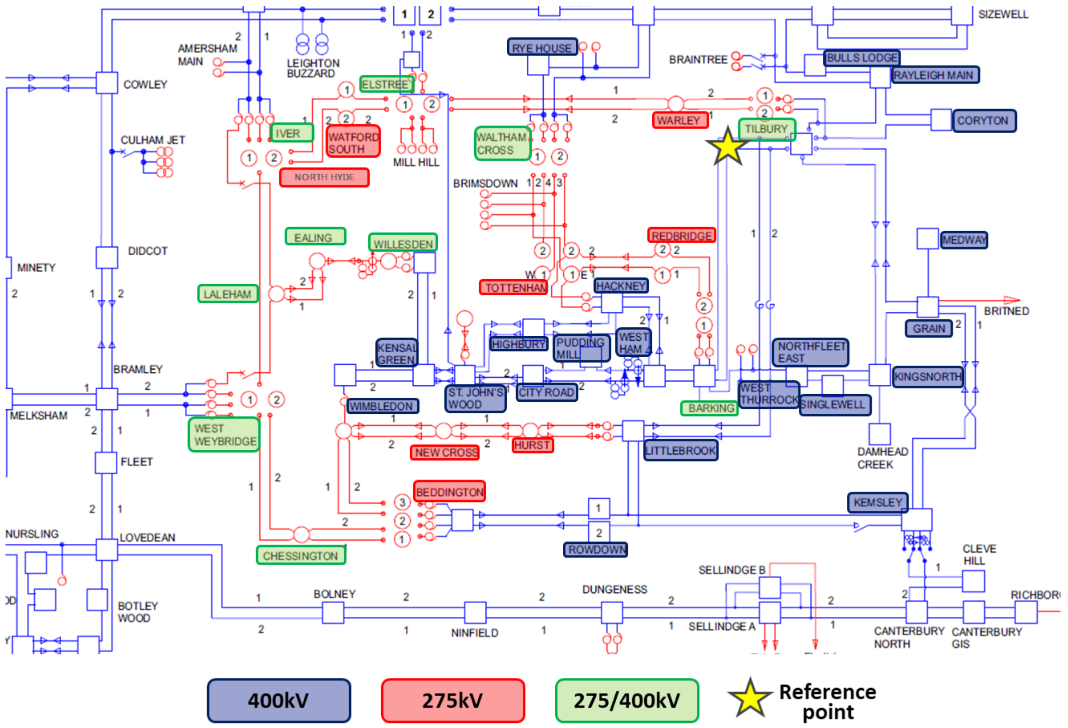

Figure 2. Acceptable locations in London

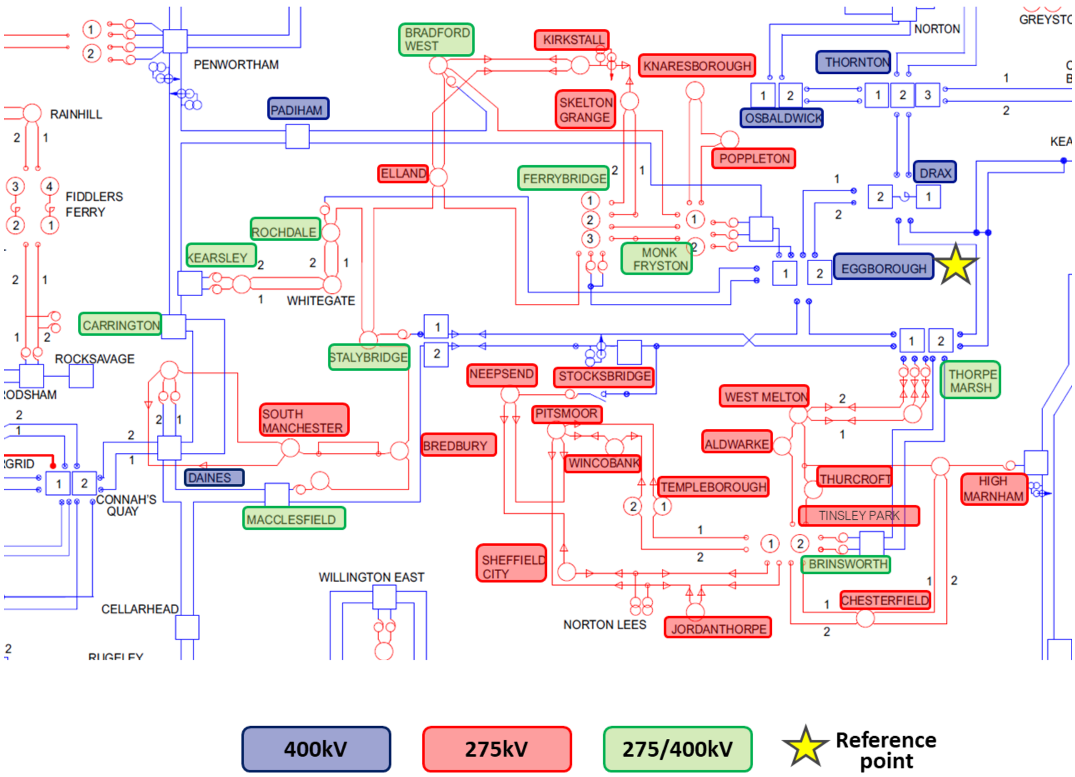

Figure 3. Acceptable locations in North England

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Part 3 – Specifications

3.1 Location

All providers must be within the regions of need and locations described in Part 2.

3.2 Availability and Utilisation Profile

V4 Clarification: *This section has been updated in V4.*

This tender is seeking 90% availability. There is no defined utilisation requirement (or payment for utilisation) however for transparency we have provided an indicative utilisation profile. Please note there is no contractual utilisation cap. While the usage of each solution will depend on the system conditions, it is expected this will primarily be overnight and during weekends, but solutions could still be instructed at other times when they are available.

Table 4 below provides an indicative utilisation level per year per solution.

Table 4 – Indicative utilisation per year per solution

Utilisation	Settlement Periods (SP)
Indicative utilisation	11,000

Table 4 is indicative only and provided in good faith, ESO make no guarantee that actual usage will align to Table 4 of this technical specification. ESO reserves the right to utilise assets in every settlement period for which it is available. Please note that for dynamic assets, the reactive power output may vary according to ESO instructions. Please refer to Section 3.4 and 3.6 for more details.

3.3 Sizing and Number of Solutions

In order to participate in the Voltage 2026 tender, each individual solution should observe sizing limits as detailed in Table 5. The maximum values indicated in Table 5 correspond to the usual figures that can be switched by a single circuit breaker without violating voltage step change limits at different voltage levels. However, there might be viable solutions greater than these maximum values. For avoidance of doubt, technical assessments will be carried out by the relevant TO as part of the connection application process to verify whether solutions are compliant with voltage step change limits.

Table 5 – Sizing limits

Limit	Connection	Total reactive power absorption
Minimum	New*	15 Mvar
	Existing	15 Mvar
Maximum	400 kV	200 Mvar
	275 kV	100 Mvar

**Any asset not on the TEC register as at 6th October 2023*

A solution can be composed by smaller units with individual switching capability, which may be beneficial for compliance with voltage step change limits.

There is a cap on the number of solutions submitted per Tenderer. Please refer to the 'Voltage 2026 Instructions to Tenderers – ITT' document for more information. For avoidance of doubt, any change in the asset, MW value, Mvar value, site, topology, voltage level or connection type counts as a different solution.

3.4 Reactive Power Capability

Unless otherwise stated, the reactive power capability should refer to the Grid Entry Point (GEP). The Grid Entry Point is defined as the point where the solution will directly connect to the transmission system, i.e., one of the acceptable connection points inside the regions of need. Any equipment between the solution and the GEP that may impact the solution's performance must be considered when informing the reactive power capability. That equipment may include transformers, cables, circuits, etc.

Voltage 2026 is seeking technologies that provide reactive power absorption services, based on a technology agnostic specification. Therefore, solutions based on static or dynamic assets can be proposed yet observing all technical and connections criteria. In addition, dynamic assets may employ zero-MW or non-zero-MW solutions.

For each proposed solution within tender submissions, the Tenderers should declare the reactive power range at the GEP for both Mvar absorption and injection conditions[2], i.e.:

- **Absorption capability** – Lead Mvar at GEP (-ve), for voltage at the GEP equal to 1.0 pu.
- **Injection capability** – Lag Mvar at GEP (+ve), for voltage at the GEP equal to 1.0 pu.

For the purpose of the Voltage 2026 tender, all solutions will be assessed based on the declared absorption capability at the GEP (absolute value). More information about the assessment methodology will be published at ITT.

For avoidance of doubt, for non-zero MW solutions, the declared Mvar range must be accessible independently from its MW output. See the Eligibility Criteria within the 'Voltage 2026 Instructions to Tenderers' document for more information.

The proposed solution must be compliant with all applicable Grid Code sections, observing but not limited to:

- The reactive power capability of Power Generating Modules, including Grid Forming Plant, should be in accordance with the applicable sections of ECC.6.3.2.
- Grid Forming Plant for which there are no explicit reactive power provisions in the Grid Code, e.g., those that do not export MW, should meet the requirement as defined in Figure 4 and Figure 5 for GBGF-S and GBGF-I, respectively.
- Any excitation and voltage control systems must be in accordance with the applicable sections of the Grid Code (e.g., ECC.6.3.8) and as specified in their Bilateral Connection Agreement. For the avoidance of doubt, Grid Forming Plant not explicitly catered for in ECC.6.3.8 should meet the requirements of ECC.6.3.8.3 and ECC.6.3.8.4.
- Tenderers are required to consider and account for transient and temporary voltage issues for any installation at all sites considering the obligations to be placed on connectees through the Bilateral Connection Agreement (BCA). All requirements regarding AC System Voltage Variations, covering TOV (Grid Code ECC.6.1.4, and TGN(E) 288 requirements) and Electromagnetic Transients, Voltage Fluctuations and Transformer Energisation, covering inrush (Grid Code ECC.6.1.7) must be met. Standard BCA templates can be found on the ESO website at: https://www.nationalgrideso.com/document/33976/download. TGN(E) 288 can be found at the following location: https://www.nationalgrid.com/sites/default/files/documents/TGN%28E%29_288_0.pdf.
- Any proposed solution based on technologies not covered by the Grid Code must have the requirements agreed with the ESO.

[2] *Lead (Mvar absorption) and lag (Mvar injection) terminology adopted here considers a MW generator perspective.*

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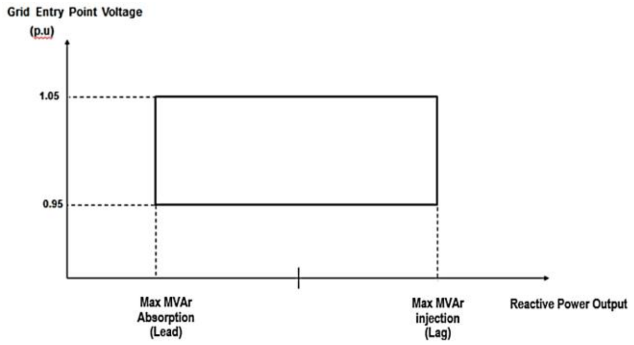

Figure 4. Reactive Capability requirement for GBGF-S Plants not specified in the Grid Code

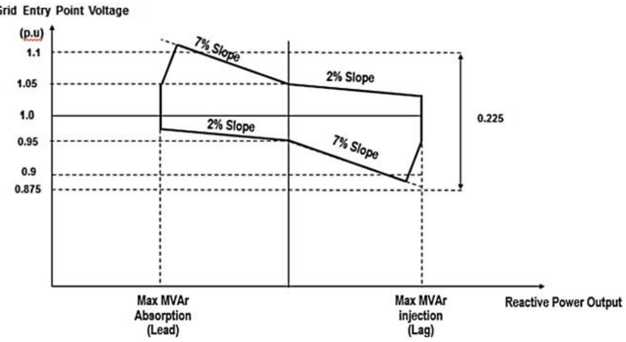

Figure 5. Reactive Capability requirement for GBGF-I Plants not specified in the Grid Code

Any solutions with dynamic reactive support capability, e.g., Grid Forming Plants and SVCs, must be able to operate in either Voltage Control Mode or Constant Reactive Power Control Mode:

- In Voltage Control Mode, the reactive current shall be directly proportional to the deviation of the system voltage from the preselected setpoint and inversely proportional to the slope setting.
- In Constant Reactive Power Mode, the control system responds to keep a target reactive power injected or absorbed at the GEP equals the preselected Mvar setpoint. The solution must still respond rapidly to sudden changes in system voltage, its output returning steadily to the target value over a definable subsequent period.
- The solution must be able to switch between Voltage Control Mode and Constant Reactive Power Mode on instruction from the ESO within an agreed time scale of no longer than 30 minutes.
- The solution must be able to change the preselected voltage and Mvar setpoints on instruction from the ESO within an agreed time scale of no longer than 30 minutes.

3.5 Dispatch

1. There must be a single point of dispatch.
2. Providers to be dispatched via EDL/EDT or signals over a VPN via IEC104 server connection.
3. Providers must acknowledge receipt of instruction within 2 minutes.
4. The minimum notice period required to deliver the contracted reactive power service must not exceed 30 minutes.
5. Providers must have capability of receiving and responding to instructions 24/7 for the duration of the contract period.
6. Providers must inform ESO of planned outages/periods of unavailability.

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3.6 Control and Indication Facilities

1. Where applicable, the transformer tap position shall be provided for by the provider at the ESO operational metering system control and data acquisition (SCADA) outstation interface, as specified in the provider's Bilateral Connection Agreement.
2. Where applicable, the following facilities for voltage/reactive power control to the ESO instructions shall be provided by the provider at a manned control point:
   2.1. Start-up of the solution.
   2.2. Target voltage setting for Voltage Control Mode (resolution 1kV).
   2.3. Target Mvar setting for Constant Reactive Power Control Mode (resolution 1Mvar).
   2.4. Control mode selection, i.e., Voltage Control Mode or Constant Reactive Power Control Mode.
   2.5. Slope setting (range 2% to 7%, resolution 0.5%.)
3. The following additional facilities for voltage/reactive power control shall be provided by the provider. The provider shall use all reasonable endeavours to adjust any of the following specified quantities on the ESO instruction within 24 hours' notice. Adjustments including 3.1 and 3.2 shall not be made unless instructed by the ESO.
   3.1. Change the time for switching between Voltage Control Mode and Constant Reactive Power Control Mode. The value shall be within the range 5 minutes to 30 minutes, with a resolution of 5 minutes.
   3.2. When operating in Voltage Control Mode, the control system shall be capable of operating to a Setpoint Voltage between 95% and 105% with a resolution of 0.25%.
4. Providers must provide, at the point of connection, operational and settlement metering for real time visibility and service settlement purposes.

3.7 Model Provision

1. Solutions without dynamic reactive power capability must, prior to commissioning, submit a Root Mean Square - RMS model with all relevant electrical parameters, including saturation characteristics when applicable.
2. Solutions with dynamic reactive power capability must, prior to commissioning, submit a dynamic (Root Mean Square - RMS) model and an Electromagnetic Transient (EMT) model in accordance with Grid Code PC.A.5.3 or PC.A.5.4 as appropriate.
   2.1. The ESO may accept an open RMS model (i.e., transfer functions visible with no encryption on any block diagrams, equations or macros and not contain DLL code or requiring set up script to function) produced in DIgSILENT PowerFactory in a software version that is agreeable between the ESO and the provider.
   2.2. The EMT model must be submitted in a software that is agreeable between the ESO and the provider 3 months before the Scheduled Commercial Operations date. Any model submitted should be in line with PC.A.9.4 and PC.A.9.6.
   2.3. Solutions with Grid Forming Capability must submit models in compliance with PC.A.5.8 when applicable.
   2.4. The provider must submit a Performance Chart in accordance with Grid Code OC2.4.2.1.
3. All models must be accepted by the ESO.
4. All models should be expected to be shared with the relevant TO.

For more information around Model Provision please see Guidance Notes for Electro-Magnetic Transient (EMT) Models.

3.8 Compliance Requirements

1. Compliance testing requirements should be discussed with the ESO and will be determined based on the solution technology.
2. For Grid Forming Plant Owners, the Operational Notification Process contained in ECP.5 to ECP.7 shall apply in relation to the type of Plant to which the Grid Forming Capability is provided in order for the solution to become operational.

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Part 4 – Definitions

Term	Definition
ESO	National Grid Electricity System Operator Ltd
Reactive Power	The product of voltage and current and the sine of the phase angle between them measured in units of voltamperes reactive.
Solution	Any one asset or group of assets connected through one connection point/bay being proposed as a solution to the Voltage 2026 requirement.
Provider	Used to refer to whichever company is successful and contracted for provision of the reactive power service when referring to their obligations within the technical specification or the contract.
Static Asset	An asset which delivers the Reactive Power Service by absorbing an approximately constant level of reactive power level during normal operation.
Dynamic Asset	An asset which delivers the Reactive Power Service according to its control mode, which can be Constant Reactive Power Control Mode or Constant Voltage Control Mode.
Grid Entry Point	The point at which the solution connects to the transmission system (275kV or above).
Zero-MW Solution	A solution which can provide reactive power, without the capability of injecting or absorbing active power in steady-state condition, excluding any intrinsic operational losses, e.g., reactors, synchronous compensators, SVCs, and STATCOMs.
Non-Zero-MW Solution	A solution which can provide reactive power, with the capability of injecting or absorbing active power in steady-state condition beyond any intrinsic operational losses, e.g., generators, batteries, and wind farms.
GB Grid Forming Inverter or GBGF-I Plant	Any Power Park Module, HVDC System, DC Converter, OTSDUW Plant and Apparatus, Non-Synchronous Electricity Storage Module, Dynamic Reactive Compensation Equipment or any Plant and Apparatus (including a smart load) which is connected or partly connected to the Total System via an Electronic Power Converter which has a Grid Forming Capability.
GB Grid Forming Synchronous Plant or GBGF-S Plant	A Synchronous Power Generating Module, Synchronous Electricity Storage Module or Synchronous Generating Unit with a Grid Forming Capability.

Dynamic Reactive Power Capability	Capability of injecting or absorbing Reactive Power in a controlled manner which could be performed by diverse technologies, including but not limited to Synchronous Compensators, SVCs, STATCOMs, or Batteries.
Constant Reactive Power Control Mode	The control system responds to keep a target reactive power injected or absorbed at the GEP equals the preselected Mvar setpoint.
Voltage Control Mode	The unit reactive current shall be directly proportional to the deviation of the system voltage from the preselected setpoint and inversely proportional to the slope setting.
Setpoint	Preselect voltage or Mvar target value as instructed by the ESO.
Slope	The slope setting is equivalent to the percentage voltage change, based on nominal, that results in a change in reactive power from zero to the maximum absorption or injection.