ESO

Electricity System Restoration (ESR) Competitive Procurement Event – Wind Tender 2022

Appendix 1 - Technical Requirements and Assessment Criteria

Executive summary

Each potential Electricity System Restoration (ESR) Service Provider will have a different impact on Great Britain (GB)'s restoration, depending on individual characteristics and network location. Detailed in this document are the required capabilities needed from ESR wind service providers, along with information about how these will be valued and how the tender will be assessed.

For this tender, wind service providers will be treated as primary restoration service providers, providing full-service requirements.

What's inside?

1. Technical requirements – These are the minimum requirements that a provider will need to be able to meet. Note that a provider doesn't need to have all of these at the time of tendering, but during the feasibility and tender process they should ensure their tendered solution details how the provider intends to meet these.
2. Assessment criteria – The overall assessment will be weighted 50:50 (Commercial: Technical), this is because providers that meet the minimum criteria will provide an acceptable level of service, but we will still value technical capability that contributes to a faster restoration.
3. Type of services to procure - A potential primary restoration service provider must be able to provide all of the minimum technical requirements listed
4. Availability – This section covers at a high level how availability for intermittent generation will be monitored.

1. Technical requirements

The primary restoration service provider must be able to meet the technical requirements at one point of connection.

Requirement	Minimum	Definition	Rationale
Time to Connect	≤ 2hours	Time taken to start-up the Restoration Station from shutdown without the use of external power supplies, and to energise part of the NETS, within two hours of receiving an instruction from the Electricity System Operator (ESO) or its delegate.	As per the Grid Code requirement (OC9.4.5.1)[1].
Service Availability	≥ 80%	The ability to deliver the contracted Restoration Service over 80% of a year. *Notes:* *It is the responsibility of the Provider to demonstrate its service availability. By submitting a tender, the provider*	Primary Restoration Service Providers are expected to have a high restoration service availability so that they can be relied upon in the instance of a Total or Partial shutdown, which could happen at any time.

[1] https://www.nationalgrid.com/sites/default/files/documents/8589935287-OC9%20Contingency%20Planning.pdf

Requirement	Minimum	Definition	Rationale
		commits to ensuring availability at least 80% of each year of the service. *In regard to service availability calculations, we will provide more information ab*out this during the next stages of the tender.	
Voltage Regulation	Existent	Ability to create a voltage source and remain connected within acceptable limits during energisation/block loading (±10%).	During events such as load pick-ups, Primary RSPs will need to maintain voltage (within limits) when creating, maintaining, and expanding a power island following instructions from the ESO.
Frequency Regulation	Existent	Ability to manage frequency level when block loading (47.5Hz – 52Hz).	During a restoration event, a Primary RSP will need to maintain frequency within limits when creating, maintaining, and expanding a power island following instructions from the ESO.
Resilience of Supply, Restoration Service	≥ 10hours	When instructed, the minimum time the RSP will deliver the contracted service.	To support restoration of the NETS.
Resilience of Supply, Restoration Auxiliary Unit(s)	≥ 72hours	Run continuously at the output required to support / deliver the contracted restoration Service	The ESO or it's delegate would not instruct all Primary RSPs at the same time therefore this is to allow for Primary RSPs to remain ready and instruct able anytime within the resilience period.
Block Loading Size	≥ 10MW	Capability to accept instantaneous loading of demand blocks.	The restoration approach for GB going forward will be a combination of top-down approach and bottom-up approach. The Primary RSP must be able to match the DNO's ability to segregate and switch the Distribution Network remotely.
Reactive Capability	≥ 50MVAr Leading	Ability to energise part of the NETS, managing Voltage with Leading or lagging capability whilst active power is zero.	Primary RSPs must be able to re-energise parts of the National Electricity Transmission System (NETS), with no load. The higher the reactive capability of a provider, the more quickly access to demand can be achieved.
Sequential Restoration attempts	≥ 3	Ability to perform at least three sequential start-ups.	To allow for possible tripping of the NETS during the re-instatement period, or trips during the Primary RSP's own starting sequence.

Requirement	Minimum	Definition	Rationale
Short-circuit level (SCL) (following the start of a system disturbance)	For t ≤ 80ms: $I \geq \frac{240\ [\text{MVA}]}{\sqrt{3} \cdot U}$ [kA] For t> 80ms: $I \geq \frac{100\ [\text{MVA}]}{\sqrt{3} \cdot U}$ [kA] U ≡ connection voltage [kV]	Injection of reactive current during a disturbance.	The higher the SCL, the quicker Power Islands are developed. This requirement can be demonstrated from Fault Ride Through test evidence, or in the case of a synchronous generator, Grid Code DRC schedule1 modelling data being provided as an alternative.
Inertia Value	≥400 MVA.s	Stored energy available in the RSP for immediate release in response to changes in power levels and thereby helping to maintain frequency and voltage on the power island within acceptable bounds. (This can be real, physical inertia as in a rotating machine, or virtual inertia as in converter-connected resources with suitable control).	If more Inertia is provided, larger active power imbalances may be managed across re-energisation, enabling larger demand blocks and generation that is not synchronous to be restored earlier than would otherwise be possible.

2. Type of services to procure

A potential primary restoration service provider must be able to provide all of the minimum technical requirements listed above under the relevant section. They may achieve this through adaptations proposed in the Feasibility Study. It will be entirely at the discretion of the ESO to confirm whether a provider not meeting all of the requirements will be eligible to participate

3. Assessment Criteria

We are proposing to assess the tender submissions in line with the assessment criteria outlined below. The technical elements have a range of sub-criteria that make up each element, and the rationale for these is also explained.

Commercial assessment will be based on cost per Settlement Period, based on 87648 SPs (based on a 5-year contract including one leap year), however, at tender submission, a full breakdown of all submitted costs will be required, and the ESO will reserve the right to employ a third party to verify and challenge the costs associated with designs.

Technical 50%	Minimum requirements	Pass/Fail
	Connection to Network	8%
	Time to Connect	5%
	Service Availability	10%
	Power Output	25%
	Block Loading Size	10%
	Resilience of Supply	20%

	Contribution to System Stability	12%
	Contribution to Restoration Time	10%
Commercial 50%	Total costs £/Settlement Period (87,648 SPs)	100%

3.1 Requirements

3.1.1 Connection to Network

The restoration under the current Restoration Strategy for GB follows a top-down approach: re-energisation of the NETS followed by restoration of demand. The point at, and way in, which a potential contracted provider is connected has an impact on the speed of restoration.

Transmission connected providers are able to progress with the energisation of the NETS without having to energise (part) of a Distribution Network first. This also simplifies the initial stages of restoration and allows for all of the reactive capability of those providers to be used in the expansion of the NETS.

Where a contracted Restoration Service Provider has more than one connection onto the Network, that increases the likelihood of availability of that specific Service Provider under a full or partial National Power Outage event.

Resilience is also affected by geographical locations, and diversification of technologies.

		Score (%)
Connection to the Network (8%)	Transmission Connected	2
	Distribution Connected	0
	Multiple connections to the Network	3
	Single connection to the Network	0
	Other contracted Service Provider(s) in the same Substation (if NO)	3

3.1.2 Time to Connect

Contracted providers with the ability to self-start will have different challenges to Start-Up and will be able to contribute to Restoration at different stages.

			Score (%)
Time to Connect (5%)	Phase 1	0h < t ≤ 2h	5
	Phase 2	2h < t ≤ 24h	2
	Phase 3	24h < t ≤ 72h	1

3.1.3 Service Availability

Contracted Restoration Service Providers are expected to have a high restoration service availability so that they can be relied upon in the instance of a Total or Partial shutdown, which could happen at any time.

		Score (%)
Service Availability (10%)	80% ≤ SA <85%	2
	85% ≤ SA <90%	6
	SA ≥ 90%	10

3.1.4 Power Output

A higher active and reactive capability will support a faster restoration.

Reactive Capability (10%) (MVAr > 0, MW = 0)	MVAr	Score (%)
	50 ≤ RC < 100	2
	100 ≤ RC < 150	6
	RC ≥ 150	10

Active Capability (15%)	MW	Score (%)
	P ≤ 100	2
	100 < P ≤ 200	6
	200 < P ≤ 350	10
	P > 350	15

3.1.5 Block Loading

Blocks of bigger size will require less switching and will contribute to speed up Restoration.

		Score (%)
Block Loading Size (10%)	10 ≤ BLS <15	2
	15 ≤ BLS <20	6
	BLS ≥ 20	10

3.1.6 Resilience of Supply

After a shutdown the ESO will work to restore demand as quickly as possible. Returning to a normal system operation will not resume for a while after the event, so the ability of contracted Restoration Service Providers to contribute to different stages of Restoration will be valued.

Restoration Service at Contracted Output	Time (hours)	Score (%)
	10 ≤ t < 24	2
	24 ≤ t < 72	6

	72 ≤ t < 120	10
	t ≥ 120	15

Electricity System Restoration Auxiliary Unit(s)	Time (hours)	Score (%)
	72 ≤ t < 120	2
	t >=120	5

3.1.7 Contribution to System Stability

Throughout restoration and particularly during block loading, contracted Restoration Service Providers will need to manage and be able to withstand larger frequency deviations than normal within their power island (47.5Hz – 52Hz). Providers that can contribute to inertia of the power island will reduce the risk of trips/restarts. Also, throughout restoration, the higher the Short-Circuit Level the more robustly voltage and voltage angle movement will be contained across larger network and load energisation, allowing a power island to be developed faster.

3.1.7.1 Short-Circuit Level

t≤80ms following the start of a system disturbance

kA	Score (%)
$I \geq \frac{240\ [MVA]}{\sqrt{3} \cdot U}$	2
$I \geq \frac{360\ [MVA]}{\sqrt{3} \cdot U}$	3
$I \geq \frac{480\ [MVA]}{\sqrt{3} \cdot U}$	4

>80ms following the start of a system disturbance

kA	Score (%)
$I \geq \frac{100\ [MVA]}{\sqrt{3} \cdot U}$	1
$I \geq \frac{150\ [MVA]}{\sqrt{3} \cdot U}$	2
$I \geq \frac{200\ [MVA]}{\sqrt{3} \cdot U}$	3

U≡ connection voltage [kV]

3.1.7.2 Contribution to Inertia

Inertia	MVA.s	Score (%)

	400 ≤ Inertia < 800	1
	800 ≤ Inertia < 1200	3
	Inertia ≥ 1200	5

The inertial response must be provided from a Grid Forming Plant for frequency changes in both directions. Inertia shall be defined as in the following equation:

$$\textbf{Inertia (MWs)} = \frac{\Delta P \times f_0}{2 \times RoCoF}$$

Where:

- ∆P is the Active Inertia Power of the Grid Forming Plant for a frequency event of 1Hz/s (MW).

  For frequency ramps events, ∆P must be calculated using the following formula:
  ∆P = [Average MW provided by the plant at Grid Entry Point across all recorded samples over the frequency ramp period] – [Initial MW provided by the plant prior to the event].

- RoCoF is the Rate of Change of Frequency (RoCoF) in Hz/s.
- f_0 is the pre-fault System Frequency (Hz).

The above equation gives acceptable inertia calculation accuracy for both synchronous machines and Grid Forming Converters (GFC) for a 1Hz/s RoCoF events lasting for 1 sec.

In order to determine the minimum inertia for a GFC it is required to apply in time domain simulation 8 events (table below and network configuration below) and calculate the inertia for each of the events. The simulation time step should not exceed 1ms. The frequency events must be modelled as a change in the grid source frequency. The minimum inertia from these 8 events is “minimum guaranteed inertia”. Step 3 and Step 4 can be bypassed as the importing scenario is not applicable in this tender process.

Step	Initial Conditions	Simulated Event
1	Pre-event voltage at the Grid Entry Point equal to 1p.u. If applicable, plant operating at maximum active power export (generation). Plant operating at maximum reactive power export (i.e. lagging mode or reactive power injection).	Simulate frequency event to drop from 50Hz to 49Hz with RoCoF of 1Hz/s.
2	Pre-event voltage at the Grid Entry Point equal to 1p.u. If applicable, plant operating at maximum active power export (generation). Plant operating at maximum reactive power import (i.e. leading mode or reactive power absorption)	Simulate frequency event to drop from 50Hz to 49Hz with RoCoF of 1Hz/s.
3	Pre-event voltage at the Grid Entry Point equal to 1p.u. If applicable, plant operating at maximum active power import (demand). Plant operating at maximum reactive	Simulate frequency event to increase from 50Hz to 51Hz with RoCoF of 1Hz/s.

	power export (i.e. lagging mode or reactive power injection)	
4	Pre-event voltage at the Grid Entry Point equal to 1p.u. If applicable, plant operating at maximum active power import (demand). Plant operating at maximum reactive power import (i.e. leading mode or reactive power absorption)	Simulate frequency event to increase from 50Hz to 51Hz with RoCoF of 1Hz/s.
5	Pre-event voltage at the Grid Entry Point equal to 1p.u. Plant operating at zero active power output. Plant operating at maximum reactive power export (i.e. lagging mode or reactive power injection)	Simulate frequency event to drop from 50Hz to 49Hz with RoCoF of 1Hz/s.
6	Pre-event voltage at the Grid Entry Point equal to 1p.u. Plant operating at zero active power output. Plant operating at maximum reactive power import (i.e. leading mode or reactive power absorption)	Simulate frequency event to drop from 50Hz to 49Hz with RoCoF of 1Hz/s.
7	Pre-event voltage at the Grid Entry Point equal to 1p.u. Plant operating at zero active power output. Plant operating at maximum reactive power export (i.e. lagging mode or reactive power injection)	Simulate frequency event to increase from 50Hz to 51Hz with RoCoF of 1Hz/s.
8	Pre-event voltage at the Grid Entry Point equal to 1p.u. Plant operating at zero active power output. Plant operating at maximum reactive power import (i.e. leading mode or reactive power absorption)	Simulate frequency event to increase from 50Hz to 51Hz with RoCoF of 1Hz/s.

3.1.8 Contribution to Restoration Time

The ESO's plan, as defined under the current Strategy, is to achieve an average Restoration Time across the year of 24 hours to restore 60% of national demand. To assess that Restoration Time a model has been developed by the ESO (validated by BEIS and Ofgem) and is the tool used to monitor Restoration performance.

Each Service Provider, depending on their offering, will make a different impact on the Restoration Times. The provider that makes the highest reduction in the restoration time will score 10% all others will be scored proportionally.

4. Availability

Availability of the service will be assessed from historical data and/or design documentation. Providers are expected to demonstrate that they will be able to comply with the declared availability. They are expected to agree a wind output forecast algorithm, and this shall be considered as an integral part of the Operational Metering requirements.

Note that the algorithm will be shared when it is ready. At a high level, we will expect that:

1. Power curves will have been supplied for each turbine type and wind direction.
2. Local variations in the observed wind speed and direction data may exist between the two (or more) meteorological masts / nacelle anemometers (e.g., due to wake effects). To account for this in a relatively simple and standardised manner, the maximum measured wind speed across the two (or more) meteorological masts / nacelle anemometers will be adopted as the 'observed' wind speed. For wind direction, an average across the two (or more) meteorological masts / nacelle anemometers will be taken as representative of the farm area.
3. For each timestamp, the total power output of the farm will be calculated as follows:

- For each turbine type, the Power Curve associated with the measured/forecasted wind direction will be selected.
- This Power Curve will be used to convert the wind speed to MW power output, interpolating linearly between the values in the power curve table.
- The power output per turbine will be multiplied by the number of available turbines of that type.
- The power output for all turbine types will be summed to determine the total power output of the wind farm.

Further guidance with more detail will be issued separately.

Next Steps

Please read all sections within this document, if you have any questions about any of the information provided please submit them using Appendix 2 – Query Form to manpreet.patel@nationalgrideso.com and CC roopkamal.phull@nationalgrideso.com marked 'Tender Query'.

The ITT part 2 stage closes on the **1 December 2023**. All submissions should be emailed to manpreet.patel@nationalgrideso.com and CC roopkamal.phull@nationalgrideso.com before the deadline at 2300hrs.

Failure to do so will result in a non-compliant submission.