Electricity System Restoration Standard Implementation Consultation

Executive Summary

The Department for Business, Energy and Industrial Strategy (BEIS) released a Policy Statement setting out the need to strengthen the current regulatory framework by introducing a legally binding target for the restoration of electricity supplies in the event of a National Electricity Transmission System (NETS) failure. BEIS' new policy is called the Electricity System Restoration Standard (ESRS).

We are consulting on the services the Electricity System Operator (ESO) should establish and/or procure to comply with the new Electricity System Restoration Standard (ESRS) and the issues each sector of the electricity industry expect to face in providing, or facilitating the provision of, these services. We are seeking responses posed in this consultation by 10 December and welcome responses from all industry stakeholders. These will feed into our industry working groups who will be proposing changes to industry frameworks to support implementation of the ESRS and must come into effect by September 2023 at the latest.

In order to ensure transparency in our consultation, we will publish the responses we receive on our website.

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Context

1. Introduction

A successful path to zero carbon necessitates changes to our existing Electricity System Restoration preparation arrangements. In particular, investments in services, new technologies, frameworks, operational tools and methods will be required to accommodate the transition efficiently.

The Department of Business, Energy and Industrial Strategy (BEIS) released a Policy Statement setting out the need to strengthen the current regulatory framework by introducing a legally binding target for the restoration of electricity supplies in the event of a nationwide electricity failure – a new Electricity System Restoration Standard.

This new Electricity System Restoration Standard (ESRS) requires the ESO to have sufficient capability and arrangements in place to restore 100% of Great Britain's electricity demand within 5 days. This should also be implemented regionally, with an interim target of 60% of regional demand to be restored within 24hrs. The ESO must ensure that everything is in place to comply with this standard by no later than 31st December 2026.

In order to implement the new standard and meet the agreed deadline, the ESO will need to procure additional restoration services from traditional and non-traditional sources.

Considerable work and stakeholder engagement have already been undertaken by Black Start Task Group to understand the potential impact to industry to implement this standard and by the Distributed Restart project to explore how distributed energy resources (DER) such as solar, wind and hydro, could be used to restore power to the transmission network in the unlikely event of a blackout. We have established industry working groups to identify and implement the changes that are required to resolve these issues.

In this consultation, we are seeking additional industry views on the challenges and opportunities each sector of the electricity industry expects to face in providing, or facilitating the provision of, these new services.

2. Current/Previous arrangements – Black Start Strategy & Procurement Methodology

Black Start is the procedure to recover from a Total or Partial National Power Outage (NPO) of the NETS, which has caused an extensive loss of supplies. ESO has a Grid Code obligation to ensure that Restoration Capability is available to enable the NETS to be re-energised in the event of a Total or Partial NPO. Whilst an unlikely event, the consequences of a Total NPO would have significant societal and economic impacts. Therefore, the ESO must demonstrate that the Restoration Capability procured maintains an acceptable level of provision, but at a cost which is economic and efficient.

This Black Start Strategy identifies how the Restoration Time expectation is used to identify an appropriate level of Restoration Capability to meet the system restoration. Once the capability

requirement is known this can then be procured, using the methodologies and principles described in the Procurement Methodology[1].

The Black Start restoration process is complex, and achieving restoration is reliant on the whole electricity sector's ability to participate. Factors that have a significant impact on the speed of restoration include, but are not limited to:

- the number of available Restoration Service Providers (and their MW, MVAr, MVA.s, SCL etc),
- the time for Restoration Service Providers to reconnect and export following a NPO,
- the time for non-Restoration Service Providers to reconnect and export following a NPO,
- network design, network condition and demand availability,
- all network operators' ability to manage several power islands, and
- the resilience and reliability of communications and other critical tools/facilities across all key stakeholders (Providers, ESO, DNOs, TOs, BEIS, Ofgem)

The Grid Code previously stated there was an essential requirement for the NETS to incorporate Restoration Capability, however there was no defined standard. In the absence of a Restoration Standard, identifying an appropriate Restoration Time for GB (with consideration for regional differences and an associated commercial view), required the ESO to set a baseline for restoration against which sufficient Restoration Capability could be sourced and procured.

The ESO has maintained the planning assumption for Restoration Time, in line with historic expectations; this means planning to achieve restoration of 60% of national demand within 24 hours, provided the procurement of this capability can be demonstrated to be economic. Whilst there will inevitably be regional variations to this Restoration Time, the aim has been to create a broadly consistent rate of restoration, reflecting the regional nature of civil contingency planning.

The current GB Restoration Approach aims to create a skeletal version of the NETS – called the skeleton network. This Restoration Approach uses a number of self-starting service providers to restore local demand, to energise the network following a pre-agreed Local Joint Restoration Plan (LJRP) and create a small power island. Power Islands are developed in line with LJRPs which are agreed alongside a Restoration service contract and set out the activities and steps that the Restoration Service Providers, relevant TO, DNO and ESO will carry out during a NPO event.

It is a contractual obligation for the Restoration Service Provider to have an agreed LJRP in place when the Restoration service goes live. The number of LJRPs that each TO and DNO area can carry out at any one time is continually reviewed for changes in Restoration Service Providers and LJRPs. During a NPO event, not all contracted providers may be able to provide restoration and a spread of LJRPs across TO and DNO areas is therefore a consideration for resource management during an event. Examples shown in figures 1-4 below.

[1] https://www.nationalgrideso.com/document/191636/download

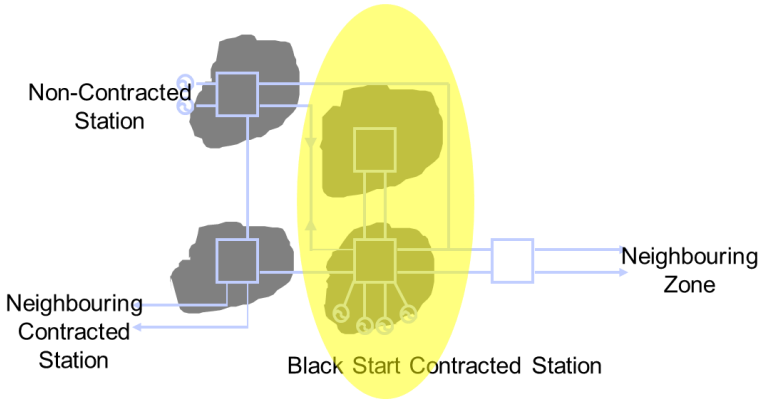


Figure 1: System Restoration Stage 1 (0-2hrs): System is dead, Transmission equipment in uncertain condition, Restoration Service Providers readying, restoration strategy developed

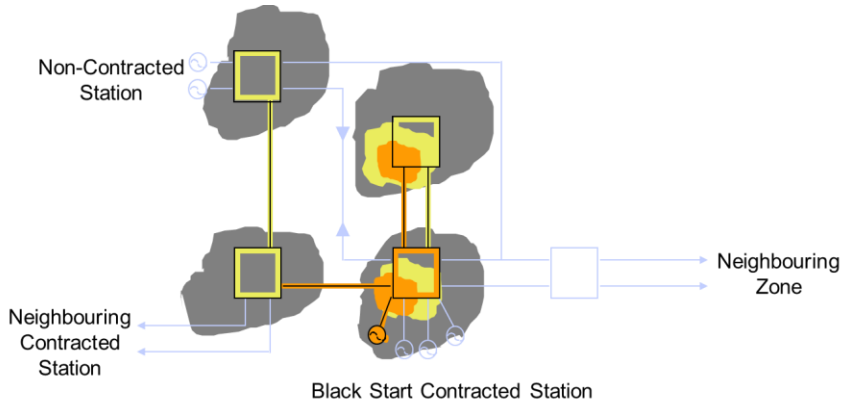


Figure 2: System Restoration Stage 2: Block loads applied, island expanded to include non-contracted stations

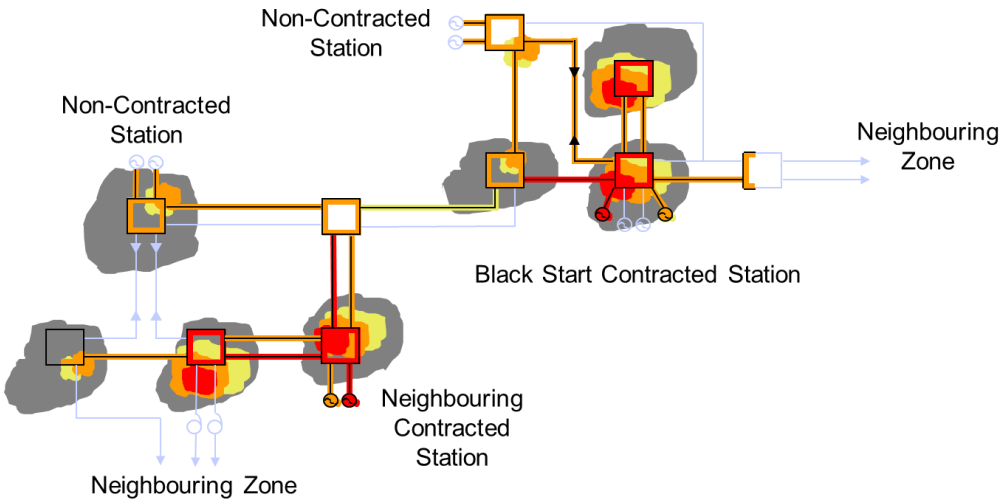


Figure 3: System Restoration Stage 3: Power Islands synchronised

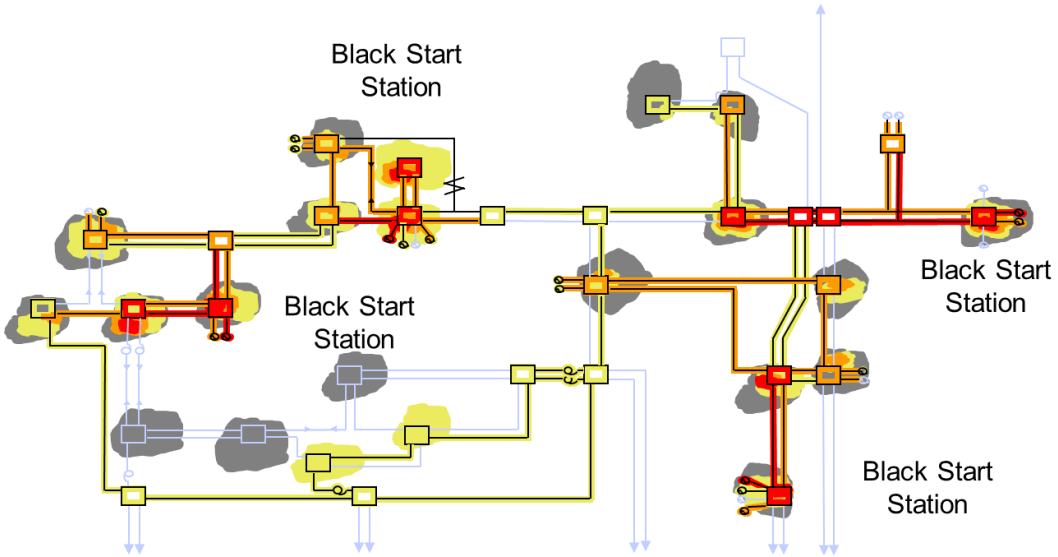


Figure 4: System Restoration Stage 4: Energise whole transmission system

The changing nature of the generation mix within GB has led to rising operational costs for current conventional Restoration Service Providers. Alternative approaches to restoration techniques, and restoration provider technologies are being actively considered and developed through the Distributed Re-Start project, which we expect will lead to an evolution in System Restoration Approach and technical requirements.

3. Changes for ESRS Implementation

The ESRS requires the ESO to have sufficient capability and arrangements in place to restore 60% of regional demand within 24hrs and 100% of Great Britain's electricity demand within 5 days. Whilst our current approach plans to achieve restoration of 60% of national demand within 24 hours, there are regional variations and time taken for full system restoration is based on a probabilistic assessment of shutdown scenarios, reflecting the range of severity of events, to determine likely timescales for differing stages of restoration.

In order to implement the new ESRS, the ESO has identified seven areas that need development and we are seeking views from industry on. These are:

- Technologies and locational diversity
- Future networks
- Markets and funding mechanisms
- Regulatory frameworks
- Assurance
- Communication Infrastructure
- Modelling and Restoration Tool

Technologies and locational diversity

Our Black Start tenders have been developed to encourage participation from a wider technology range of providers and increase competition. To meet the ESRS we will need a wider range of technologies across the different regions of GB to provide restoration service. Having these different technologies providing restoration services across all regions could contribute to faster restoration times and deliver an enduring supply of demand (2-5 days after a blackout event).

To enable system restoration, we will need:

- Restoration Service providers (Phase 1): These should have capability to self-start (no external supply) within 2hours of a NPO. The ESO expect to contract a minimum of 3 technology types from potential providers within each Restoration region.

- Other Restoration Service providers: These will have the capability to self-start and should be available to connect to/energise the network at various timescales (Phase 2,3,4 are 2h – 24hrs; 24hr – 72hrs; 72hrs – 120hrs respectively). The ESO expect to contract a minimum of 3 technology types per restoration phase.

- Secondary Restoration Service Providers: These will not have the capability to self-start and have no contractual framework in place specifically for Restoration. However, any upgrades needed to meet the minimum requirements defined under 'Assurance Activities' should be cost-neutral.

Commercial Service Providers	**Restart Time**
Phase 1 ESR Service Provider	Within 2hrs
Phase 2 ESR Service Provider	2-24hrs
Phase 3 ESR Service Provider	24-72hrs
Phase 4 ESR Service Provider	72-120hrs
Non-Commercial Service Providers	
Secondary ESR Service Provider	Up to 120hrs

Q1. Are there any technical barriers that currently prevent you from providing a restoration service? If so, what changes are needed to our technical requirements to ensure the ESO continues to provide a level playing field for the provision of restoration services?

Future Networks

Greater level of renewable energy is connecting across GB and electricity networks are developing to accommodate these changes in the generation mix. These networks will need to adapt further to meet the requirements of the ESRS.

Additional providers will need to be contracted to provide restoration services and the networks they connect to will need to ensure that they can meet the technical requirements to enable them to provide that service in a black-out event.

For DNOs this may include (but is not limited to):

- The ability to segregate its network to allow block loads up to 2MW (to align with Distributed Re-Start)
- The ability to block load every 3 minutes
- The ability to change protection and control settings as required
- The ability to reconnect another DER within 4hrs within Distribution Restoration Zone
- The ability to reconnect with another Distribution Restoration Zone within 8hrs
- The ability to provide slow balancing to support block loading and enable maximum demand to be restored while retaining sufficient resources in reserve to respond to generation/balance mismatches.
- The ability to initiate fast control of available resources to balance the system (frequency and voltage) and minimise the stress on the phase 1 generator
- Have in place the required infrastructure, regardless of route chosen for restoration, to remain available for a minimum of 72hrs (e.g. substation diesel generators)
- Ability to synchronize power islands in, at least:

    - (E&W) 70% of 132kV Substations
    - (Scotland) 50% of 33kV substations

For Onshore TOs this may include (but is not limited to):

- No Load Gain between adjacent substations not exceeding 50MVAr.
- The ability to deliver reactive compensation in steps of up to 60MVAr.
- The ability to change protection and control settings as required.
- Have in place the required infrastructure, regardless of route chosen for restoration, to remain available for a minimum of 72hrs (e.g. substation diesel generators).

Further requirements will be defined in the Future Networks working group.

Distribution Network Operators may also have a larger role in the management of frequency within Restoration Regions. This has been trialled by Distributed Restart Project and learnings from this project will form part of the inputs to the working groups.

Q2. What further changes to your network will be needed to enable rapid and accurate restoration of services and ensure robust levels of local power resilience?

Q3. Could automation be used to speed up restoration? If so, where and how could automation be used?

Markets and funding mechanisms

Procurement

Procurement of black start (restoration) services is defined in the Black Start Strategy and Procurement Methodology[2] which will be replaced by the new Restoration Assurance Framework which will be published in April 2022.

The principles of this procurement methodology are:

- A clear and transparent requirement.
- Enabling competition, where appropriate.
- Reducing and removing barriers to entry to enable broader participation.

In order to meet the requirements of the ESRS we want to encourage a diverse mix of technologies and locations to provide restoration services. We also need to ensure that costs are optimised and the services are procured efficiently which is best done by procuring these services using competitive markets.

Distributed Restart have designed a procurement approach which includes DER contracts as well as DNO asset funding. Following project stakeholder approvals this new method will be included in the project milestone report in December 2021 and shared with the relevant working groups for inclusion in their recommendations, where relevant.

Q4. Do you see any commercial barriers to entry that may prevent a fair and competitive market for a restoration service across Transmission and Distribution connected technologies? If so, what changes are needed to ensure the ESO provides a level playing field for the provision of restoration services?

Q5. We currently use pay-as-bid, do you think that pay-as-bid is an appropriate pricing method for Restoration services? If not, what mechanism do you think better meets the objectives?

[2] https://www.nationalgrideso.com/document/191636/download

Funding

The current approach for procurement of restoration services for the ESO is through a cost pass-through and recovered through BSUoS. We expect to continue with this approach for implementing ESRS.

Q6. Do you think cost pass-through and BSUoS recovery is the correct approach for Restoration Services?

Q7. How might we best incentivise providers to design capability as part of their connection?

The ESO believes that efficient costs for transmission and distribution network changes in direct support of ESRS should be recouped through their respective price controls and that network companies should have (or add) appropriate terms in their licence to enable recovery of costs associated with implementation of the ESRS.

Q8. Do you agree that network costs associated with implementation of ESRS should be recovered through price controls? If not, what funding mechanism do you favour?

Regulatory Frameworks

The ESO are implementing changes to relevant codes to align with requirements of the Network Code on Emergency & Restoration (NCER) and to meet the recommendations from our Distributed Restart project.

We anticipate that further changes to codes will be identified and proposed to implement the ESRS. The ESO intends to have all code modifications in place by September 2023 at the latest to allow required changes to be implemented by December 2026. However, stakeholders have indicated that this may not be early enough to allow all anticipated changes to be made to meet the ESRS.

Q9. Do you have any early views on which codes and/or licence obligations will need to be changed to allow implementation of the ESRS?

Q10. When must code changes be in place to allow you to deliver the potential changes required to implement the ESRS by December 2026?

Assurance

The ESO will need to produce and consult on an ESR Assurance Framework. This Framework will need to demonstrate that the ESO has a credible plan for monitoring its compliance with the ESRS at all times. Regular testing is already performed for existing Restoration Service Providers including restoration capability tests, voice system tests, control system resilience tests, cyber security tests, auxiliary power sources test and power Island synchronisers tests.

However, in order to meet the requirements of the ESR Assurance Framework, there is an increased need for a baseline level of testing and exercising of restoration capabilities, across the power sector.

Q11. How could industry provide visibility of its capability to meet the ESRS?

Q12. How often would the industry provide visibility of its capability to meet the ESRS?

Q13. Are there any additional tests that needs to be considered for assurance of restoration capabilities?

Communication Infrastructure

Effective and efficient communication is key to enabling the restoration of the electricity network following a blackout event. We will need end-to-end operational telecommunication between all parties involved in system restoration to be available whilst supplies are restored (up to 5 days). This will enable exchange of data, supervisory control, provide situational awareness and voice communication between restoration participants.

The Distributed Restart project has identified several changes to systems, tools and data that need to be made to enable restoration from distributed energy resources including functional specification for resilient and cyber secure telecoms. The findings from this project will form some of the inputs for the Communications industry working groups.

Q14. How can we continue to deliver a secure and resilient communication infrastructure across the industry?

Modelling & Restoration Tool

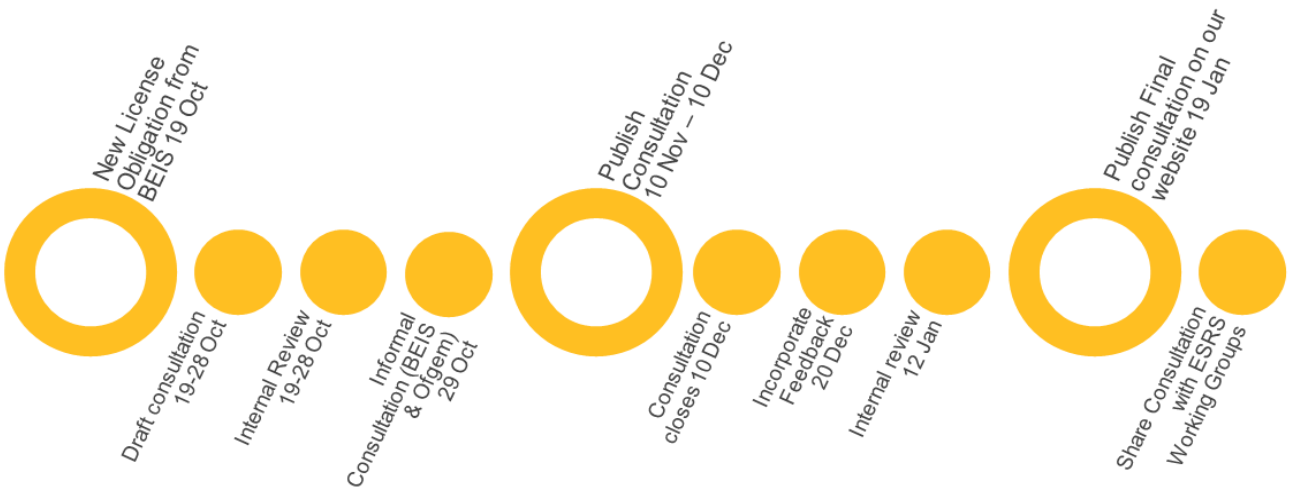
The ESO will require the ability to model the restoration capability to provide the appropriate level of confidence to industry parties that the outcomes of the model are a fair representation of the restoration times in GB.

We currently use a probabilistic tool which was developed by the ESO on behalf of wider industry owing to our central role and access to relevant sensitive information. The results have been determined through Monte-Carlo simulation techniques to explore the range of possible outcomes for a set of central circumstances.

Q15. Do you have a view on the adoption of a deterministic model over a probabilistic model?

Q16. If we were to have a blank sheet of paper and were designing a system that can be restored within 24hours, what would it look like?

4. Consultation Timeline



5. General Feedback

Please provide you general views on implementation

Q17. What other issues do you think you will face in implementing the ESRS?

Q18. Do you have any general feedback on ESRS implementation?

Q19. Do you have any comments about the overall process of this consultation?