Distributed ReStart

Energy restoration for tomorrow

Functional Requirements for Procurement & Compliance

In partnership with:

tnei

SP ENERGY NETWORKS

nationalgridESO

Contents

Abstract

The Distributed ReStart project (formerly known as Black Start from DER) is a partnership between National Grid Electricity System Operator (ESO), SP Energy Networks (SPEN) and TNEI that has been awarded £10.3m of Network Innovation Competition (NIC) funding.

The project is exploring how distributed energy resources (DER) can be used to restore power in the highly unlikely event of a total or Partial Shutdown of the National Electricity Transmission System. Past and current approaches rely on large power stations but as the UK moves to cleaner, greener and more decentralised energy, new options must be developed. The enormous growth in DER presents an opportunity to develop a radically different approach to system restoration. Greater diversity in Black Start provision will improve resilience and increase competition leading to reductions in both cost and carbon emissions. However, there are significant technical, organisational and commercial challenges to address.

The project will tackle these challenges in a three-year programme (Jan 2019–Mar 2022) that aims to develop and demonstrate new approaches and develop a new route to market if deemed feasible and cost effective. Case studies on the SP Distribution (SPD) and SP Manweb (SPM) networks will be used to explore options then design and test solutions through a combination of detailed off-line analysis; stakeholder engagement and industry consultation; desktop exercises; and real-life trials of the re-energisation process.

Project description

The project is made up of five workstreams. The Project Direction and Knowledge Dissemination workstreams cover the effective management of the project and sharing of learning. The other three workstreams cover the wide range of issues to enable Black Start services from DER:

- The Procurement & Compliance (P&C) workstream will address the best way to deliver the concept for customers. It will explore the options and trade-offs between competitive procurement solutions and mandated elements. It uses a strategic process to develop fit for purpose commercial solutions that are open and transparent, stakeholder endorsed, and designed end-to-end with the commercial objectives of the project and workstream in mind. It will feed into business as usual activities to make changes as necessary in codes and regulations.
- The Organisational Systems & Telecoms (OST) workstream is considering the DER-based restoration process in terms of the different roles, responsibilities and relationships needed across the industry to implement at scale. It will specify the requirements for information systems and telecommunications, recognising the need for resilience and the challenges of coordinating Black Start across a large number of parties. Proposed processes and working methods will be tested later in the project in desktop exercises involving a range of stakeholders.
- The Power Engineering & Trials (PET) workstream is concerned with assessing the capability of GB distribution networks and installed DER to deliver an effective restoration service. It will identify the technical requirements that should apply on an enduring basis. This will be done through detailed analysis of the case studies and progression through multiple stages of review and testing to achieve demonstration of the Black Start from DER concept in 'live trials' on SPEN networks. Initial activities have focused on reviewing technical aspects of DER-based restoration in a number of case study locations that will support detailed analysis and testing within the project. Each case study is built around an 'anchor' resource with 'grid forming' capability, i.e. the ability to establish an independent voltage source and then energise parts of the network and other resources. Then, it is intended that other types of DER, including batteries if available, join and help grow the power island, contributing to voltage and frequency control. The ultimate goal is to establish a power island with sufficient capability to re-energise parts of the transmission network and thereby accelerate wider system restoration.

Keep up to date and find all other project reports at:
https://www.nationalgrideso.com/innovation/projects/distributed-restart

Executive summary

This report is the first deliverable from the Procurement and Compliance (P&C) workstream. It describes the existing procurement and commercial approach and sets out the strategy for determining what the future commercial models might look like. It also includes a summary of gaps and blockers to relevant codes and licence conditions that will need to be addressed to enable any new Black Start services.

Our focus throughout has been to propose a strategy development process that will provide a mechanism and rigour for the required commercial solutions, once all of the inputs we need are available. Reviewing the information available already, including the current procurement and commercial processes for Black Start services, as well as the outputs from the PET workstream, and the OST workstream, provides some insight, but this needs to be refined through challenge and review from our industry colleagues. The paper uses commercial tools to help us better understand these factors, and how they might need to change in a future Black Start service from DER, and uses a strategic process that should achieve fit for purpose commercial solutions that are designed end-to-end with the commercial objectives of the project and workstream in mind.

The report is structured in the following sections:

Procurement

This section reviews the current procurement practices, and draws insight to be taken forward for consideration in the development of a future Black Start service from DER.

The fundamental principles of Black Start procurement are identified in section 2 of this report. These are:

- a clear and transparent requirement;
- enabling competition, where appropriate; and,
- reducing and removing barriers to entry to enable broader participation.

It is critical to the project that these continue to be the guiding principles for any future procurement design and are fully considered from a commercial and a technical perspective across all workstreams. To this end, a review of the existing procurement methodology is provided to act as a basis for the new procurement design, and draws insights to be taken forward in the development of a future Black Start service from DER.

Key findings from this section include:

- The project should create technical requirements which are functional and transparent.
- There is an opportunity to improve value for the end consumer through transparency in the procurement process, consideration of options which improve liquidity and splitting technical requirements where possible.
- There is an opportunity to maximise service provider participation and take advantage of demand elasticity by procuring over a range of timeframes and closer to real-time, and designing a more streamlined end-to-end contractual process.

Commercial design

This section reviews the commercial structure for the existing service, considering key areas of risk, and how these are balanced, which is used to draw insight for consideration in the development of a future Black Start service from DER.

Section 3 provides a thorough review of the route to market for a new Black Start provider and the commercial implications at each stage. It reviews the commercial structure for the existing service, considering key areas of risk, and how these are balanced, which is used to draw insight for consideration in the development of a future Black Start service from DER.

Key findings from this section are:

- There is a need to review the feasibility process to reflect the larger number of providers expected to deliver a service, and that a study may need to cover a group of DER rather than a single provider.
- A new service should continue to protect consumers against the costs of non-delivery, late delivery and lack of capability/availability, potentially leveraging commercial mechanisms to achieve this, but should also focus on leading measures and preventative structures that encourage strong availability performance, and prevent unavailability where possible.
- The project should consider opportunities for self-assessment whilst still ensuring service minimum standards are met.

- Consideration should be given to the assurance processes which enable national and regional standards. This will become particularly important if the obligations for assurance or procurement are shared across multiple entities.
- The project should continue to prioritise cost transparency.
- The project should consider how integrated systems could support achievement of overall project objectives, including more accurate operational monitoring, more accurate data for preventative performance monitoring, and data accessibility to enable provider self-servicing.

Strategy

This section uses project outcomes and wider economic theory to propose a strategic process for developing the procurement approach and commercial design, which will be iterated and refined through industry engagement. This section considers both procurement and commercial design in a combined approach.

Section 4 uses project outcomes and wider economic theory to propose a commercial design aligned to the proposed workstream objectives:

- increased competition
- reduced barriers to entry
- increased transparency
- financial value for the end consumer
- accelerated restoration times
- functional route to market for new service.

The strategy section is principally intended as an industry thought piece which will be iterated and refined through engagement across the design stages but incorporates current known inputs from power engineering and organisational systems and telecommunication proposals, in addition to wider input from economic theory.

The key findings include:

- There is a need for the project to investigate options for funding wider infrastructure requirements of a new service, including changes to network assets, control systems and resilient operational telecommunications, to balance capital costs, market liquidity and competition.
- The project should view systems holistically, considering integration and interaction between control systems and procurement platforms to maximise liquidity and competition and promote provider self-servicing.
- The need to consider the impact on liquidity and competition when looking at automatic control options, the entity (or entities) responsible for procurement and assurance, the size of a distribution network restoration zone, and the number of DERs considered for a single plan.
- Where possible, technical requirements should be split into component parts and the timeframes over which these are procured varied.
- A requirement to balance wider infrastructure capital investment and the improved liquidity and competition which results from lower barriers to entry.

Developing options

To consider the options for procuring a future service, we have outlined a number of 'scenarios' which illustrate various points along the spectrum of procurement options, and used worked examples to explore elements of these further. An effective solution will be developed through stakeholder engagement and iterating the strategy development process. This section considers both procurement and commercial design in a combined approach.

The key considerations are:

- The future approach should consider the characteristics of the requirement, and how these can be best met through market mechanisms.
- Most of the outlined options could be adapted to suit the future requirement, once this is refined.
- Iterations of the strategy process will support the development of effective and efficient commercial processes, that are fit for purpose, and built with the commercial objectives of the project in mind.

Codes and licence conditions

System restoration requirements and procedures are embedded across a number of industry codes, policies and standards. A review of these has been carried out to highlight what changes may be required to accommodate Black Start restoration from DER.

The codes, policies and standards that have been reviewed are:

- Grid Code, in particular sections OC5 and OC9.
- Distribution Code, in particular sections DOC9 and DPC7.4.
- Security and Quality of Supply Standard (SQSS), in particular sections 5 and 6.
- Electricity Safety, Quality and Continuity Regulations (ESQCR), in particular regulation 8.
- ER G99, in particular clauses 9–14.
- ER P28, P29 and G5.
- Connection and Use of System Code (CUSC), in particular sections 4, 6, 14 and Schedule 2 Exhibit 1.
- Distribution Connection and Use of System Agreement (DCUSA).
- Balancing & Settlement Code (BSC), in particular Schedule G.
- System Operator Transmission Owner Code (STC), in particular procedure STCP6.1.
- Telecommunications and Cyber Security (from various codes), in particular ER G59, G99, G91, EU Network Code Emergency and Restoration, UK Network and Information Security (NIS) Regulations.

The key findings of the code review include:

- The Grid Code review did not highlight any significant barriers to the implementation of a novel approach to Black Start and restoration. Many of the points raised relate to terminology and the inclusion of key players in specific clauses relating to roles and responsibilities, particularly in OC5, OC9 and BC2.9.
- There is no issue with the STC or the STCP06-1 in principle, however, their applicability should be considered in a Distributed ReStart future. Largely, these documents could either be adapted to include all relevant participants (DNO, DSO, etc), or a distribution equivalent document could be created.
- The main area of focus on the Distribution Code review was DOC9, relating to Black Start and synchronising islands. There are two options available to ensure the code is suitable for a distribution-led restoration: either there is more detail provided in the appropriate clauses within DOC9 (and others), or there is adequate signposting to the requirements set out in the Grid Code.
- The SQSS does not specifically refer to Black Start or system restoration and it is not immediately evident whether it is required. Guidelines for such an event could be handled in the SQSS, with minimum technical requirements for a power island being outlined.
- The earthing policy within the ESQCR could pose a risk in a distribution power island. With the current regulations, it is possible that during a system restoration from DER, a power island with a voltage below 132kV may be unearthed. This is a key concern highlighted as part of this review.
- A number of potential issues were noted in the review of EREC G99. Several clauses relating to island operation, protection, frequency response and fault ride through may be subject to change, or derogations provided for a Black Start and restoration scenario.
- No major challenges were found in the review of P28, P29 and G5, with only minor alterations or potential relaxation of certain conditions during a restoration scenario likely to be required.
- Changes in the CUSC and DCUSA are likely to be similar through both documents. The main changes required are understood to be around the procurement mechanisms, e.g. Black Start capability could become a mandatory ancillary service, and around how cost and revenue of providing a Black Start service would be treated.
- It is likely that changes in the BSC would be made in a number of sections to reflect the greater involvement and role of DERs and the distribution network operator during restoration.
- From a Telecoms and Cyber Security perspective, there are no major challenges to overcome or changes to be implemented, although it is recommended that the Grid Code and ER91 include clearer requirements for telecoms resilience of Black Start DERs in the event of power outages.

This report ends with our findings and conclusions, including setting out our next steps in line with the final report for this workstream.

Conclusions

This section considers outcomes and conclusions from a whole workstream perspective.

Within the report, we have reviewed a number of inputs to the strategic process, including outputs of the PET and OST workstreams, current processes and methodologies, current and forecast Black Start spend positions, and have used commercial analysis tools to help us understand the current structures. This enables us to consider what we know about what a future Black Start service from DER might look like, and draw insights regarding what we might need to change to deliver a successful and appropriate commercial solution.

The strategic process that has been proposed here presents a rigorous and defensible mechanism for developing a fit for purpose solution, that will be underpinned by engagement and endorsed by stakeholders.

The review of relevant codes has been undertaken to highlight key areas for consideration with the GB network codes in relation to Black Start and system restoration. This has highlighted where amendments may need to be made to enable a future Black Start service from DER, but has not uncovered any areas that we feel would be insurmountable.

Next steps

This section outlines the next steps for the Procurement and Compliance workstream.

As we enter the design stage of the project, there will be two main streams of activity. For the procurement and commercial design, the next steps revolve around iterating the strategy process through detailed stakeholder input, challenge and review, in order to further develop a potential commercial solution. The codes activity stream will consider required changes in more detail, understand the interdependencies, and develop an implementation plan.

Distributed ReStart

Report on functional requirements for Procurement and Compliance

1. Introduction

This report proposes a strategic process for developing commercial structures and procurement mechanisms for a future Black Start service, by reviewing existing arrangements and wider project outcomes, and using these to draw insights that will inform the development of a stakeholder endorsed end-to-end process.

1.1 Background

At present, Electricity System Operator (ESO) is obliged under the Grid Code (OC9) to maintain the capability to restore the network from a total or Partial Shutdown. The procedure to perform this recovery is known as Black Start, and ESO procures this capability under Special Condition 4G to support this procedure through Black Start and/or restoration contracts.

The network conditions under a shutdown scenario and the early stages of a restoration are complex and challenging and require a wide span of technical capability to manage this. ESO currently employs a top-down skeletal restoration strategy, where a number of contracted Black Start providers re-energise parts of the transmission system, enable the start-up of non-contracted secondary generation and the restoration of demand. The current technical requirements, which are aligned to the top-down restoration approach, are published on the ESO website and provide the basis on which the current commercial design of the service and procurement mechanism have been established. See link below.

https://www.nationalgrideso.com/balancing-services/system-security-services/black-start?technical-requirements

Historically, the types of provider who have been able to meet all of the technical requirements for restoration services have been large, conventional generators. The key to providing a Black Start service is the ability to start-up without external supplies (power taken directly from transmission/distribution networks). However, as the obligation to provide Black Start capability lies with the ESO, there is a limited case for generators to install this capability in their designs for the plant, so most assets in GB are built without this. Installing this capability for a large thermal generator can typically require auxiliary generators in the region of 5–25 MW to be installed (depending on the characteristics of the main units), along with retrofitting of control and instrumentation systems to ensure the ability of the plant to control and regulate a power island. These changes contribute a large proportion of the costs of delivering a Black Start service and are central to the commercial framework and procurement mechanism for the service today. In addition, they require a lengthy and complex process from concept to implementation; to assess the feasibility of the proposals, provide assurance to ESO of the capability, and to contract can take (end-to-end) up to four years in some cases. Although significant changes have been implemented to broaden participation and reduce barriers to entry, such as introducing competitive procurement events, the process for achieving restoration was developed on the basis of a top-down restoration strategy, which is more easily delivered by certain types of providers.

As a number of the stations that historically have had Black Start capability (and may have had it built into the design for the stations) are now coming to the end of their expected life, we are approaching a period where a larger scale of investment is required to replace this Black Start capability. Given the rate at which the energy landscape is evolving, it is prudent to ensure that where investment is necessary to ensure capability, Black Start should be futureproofed as far as possible. This should take into account that the number of large thermal generators connected to the transmission system at present is likely to decrease. This is likely to require adjustments to the Black Start Strategy and Procurement Methodology (BSSPM) in order to deliver new commercial frameworks and procurement mechanisms to access Black Start services from DER utilising a bottom-up approach as well as the current top-down approach.

The aim of this report is to consider the process through which Distributed ReStart could develop a strategy to ascertain the most effective procurement approach and commercial design for Black Start services from DER. Given the dependence of this activity on outputs of the PET and OST workstreams, this report seeks to identify the questions that must be answered and the considerations that will have to be taken into account to develop the approach. The report proposes a strategic process that will support the development of appropriate commercial mechanisms and includes as inputs the information available at present which forms the first iteration of the process. This will serve as a thought piece to drive stakeholder engagement throughout 2020. The purpose of this is to challenge, review and collect information to inform the second milestone report [1]. Several examples of hypothetical procurement 'options' are featured purely to illustrate a spectrum of possible solutions. These are to be used to provoke the thoughts of industry during the design phase two of the project. The range of levers that can be used in the development of the commercial design of the service will also be discussed.

It is likely that some changes are required within the GB codes and policies that underpin how the electricity network is planned and operated, and place requirements on the users that connect to it. These codes have been written, and adapted over time, based on the principle that large, conventional generators are the Black Start service providers.

As DER becomes able to participate, it will be important to adapt the rules and requirements to enable access to these smaller providers. Greater participation is also anticipated from distribution network and System Operators (DNO/DSO) and so their inclusion in the relevant codes will be essential, alongside appropriate guidelines on how all parties should communicate and share data.

The components of the first Procurement and Compliance (P&C) workstream deliverable will be to:

- report on procurement options and the criteria for determining the preferred option
- report on commercial design of the service (e.g. term, obligations, delivery and payment etc.) with consideration of the learnings from the OST and PET workstreams
- report on gaps and blockers in relevant codes and licence conditions that will need to be addressed to enable new Black Start services.

1.2 Method

At this stage of the project, the objective of this report is to propose a strategic process as a vehicle for reaching the most effective solution, as opposed to trying to predict which solutions might be effective before all of the inputs are finalised. This format will provide the structure and basis for stakeholder engagement in the next year of reporting and will be refined through an iterative process as more information becomes available.

As such, this paper will look at hypothetical scenarios rather than potential options, so as not to bias the strategy development process. As the approach to procurement and the commercial design of the service are so closely related, they will be covered using a combined approach, with a number of report sections being common to both elements. For these parts of the report, each section ends with an 'insights' summary, where key considerations for the future service are highlighted.

The third component of the report covers gaps and blockers in relevant codes and licence conditions that will need to be addressed to enable proposed new Black Start services.

1.3 Assumptions/scope

- Organisational models have been investigated through the OST workstream. At this stage, most procurement approaches are adaptable to suit any of the organisational models proposed in the OST workstream report. Once further assessment is completed to see which of these are more likely, the P&C workstream will consider these more closely.
- Once the technical requirements for a Black Start service from DER have been mapped out from the PET and OST workstreams, a procurement process and commercial design of the service can be effectively developed and will be based on the following assumptions:
  - A Black Start service from DER is likely to include a greater number of smaller providers than at present.
  - Any new DER-based service will, in the short-term at least, have to fit into the existing national strategy for system restoration including the use of Local Joint Restoration Plans (LJRPs).
  - Coordination of this new service is therefore likely to be more complex, potentially involving more parties.
  - Processes that currently rely on manual interventions will need reconsidering due to additional complexities; simplification, reduction of steps in data flows, and the role of automation should be considered throughout.

1.4 Approach to engagement

The project aims to incorporate the views of wider industry at every opportunity, bringing in the diverse expertise found across the electricity market. Distributed ReStart continues to reach out to a broad stakeholder base and is actively seeking ways to engage with a range of parties. This is done through regular project email updates, a stakeholder advisory panel, industry advisory groups, and multiple industry events detailed in table 1.

Additionally, a number of stakeholders were consulted specifically regarding the code review work to discuss and validate the assessment. This was conducted largely by phone and included stakeholders from ESO, ENA, DNOs and DER providers.

Table 1.1

Table of stakeholder events

Event	Value unlocked
Utility Week Live **21–22 May 2019**	Engagement with broad industry stakeholders, established relationships which have directly impacted on project outputs.
CIGRE – Denmark **4–6 June 2019**	International level working and best practice sharing.
Distributed ReStart webinar **9 August**	Knowledge share with over 100 interested parties reaching a broad audience allowing international engagement.
Power Responsive **26 June 2019**	Engagement with demand side response stakeholders.
Networks Round Table **11 September 2019**	Specific Black Start industry experts invited from TOs and DNOs who provided significant input into procurement and code considerations. The outputs of this session can be viewed here: **https://www.nationalgrideso.com/document/153861/download.**
Stakeholder Advisory Panel **18 September 2019**	First meeting made up with representatives from across the industry. The outputs of this session can be viewed here: **https://www.nationalgrideso.com/document/153856/download.**
Customer Connection Seminar **1 October 2019**	Engagement with stakeholders seeking new electricity system connections.
Electricity Ops Forum **23 October 2019**	Engagement with current NGESO customers with a specific focus on commercial performance of balancing services.
LCNI Conference **30–31 October 2019**	Project engagement with audience with a specific interest in lower carbon innovation projects.

This paper will underpin the engagement for phase two of the Distributed ReStart project for the P&C workstream, as we engage with our industry colleagues to iterate the strategy development process, refine the inputs and develop initiatives to meet the objectives.

2. Procurement

This section reviews current procurement practices, and draws insight to be taken forward for consideration in the development of a future Black Start service from DER.

2.1 Introduction to procurement strategy

The purpose of a procurement exercise is to enable access to goods or services in an economic and efficient way that maximises value. Typically, the focus of procurement exercises is to improve profitability by reducing costs, or to maximise output. In this application specifically, both of these apply, where ESO have a responsibility to ensure that all spend decisions that are made represent good value to the end consumer. To this end, the P&C workstream uses procurement and category strategy tools to develop a tailored solution that maximises benefit to the end consumer. As the PET workstream continues to investigate engineering design solutions and specifications, for phase two, P&C will propose a strategy development process which will be refined and iterated to identify all of the necessary inputs to the strategy, and begin to draw insight from the inputs that are already available. This paper will serve to provoke thoughts from stakeholders and to inform the engagement plan for phase two, enabling delivery of the next paper "Contract terms and regulatory arrangements".

This section will review current arrangements with the aim of understanding the basis for the current structure to help us identify insights and considerations to take forward in the development of a future Black Start service from DER. Each section refers to part of the current process and will be followed by an 'insights' section which highlights key learnings to take forward.

2.2 Current procurement methodology and recovery of costs

As part of Special Condition 4G of its licence, National Grid Electricity System Operator Limited (ESO) produces a Black Start strategy (BSS) along with a Black Start procurement methodology (BSPM). The (BSS) identifies how the restoration time expectation is used to identify an appropriate level of Black Startcapability to meet system restoration requirements. Once the capability requirement is known, this can then be procured, using the methodologies and principles described in the BSPM.

The BSPM documents the approach to determining value to current and future consumers, and the trade-off between economic and efficient service provision and the contribution to restoration time that a service will deliver. Our principles for procuring Black Start services are:

- a clear and transparent requirement
- enabling competition, where appropriate
- reducing and removing barriers to entry to enable broader participation.

An ex-post assessment at the end of each relevant year is conducted by an independent auditor and the Authority to determine if the spend decisions made by the ESO in that year are deemed to be in line with the BSS and BSPM. This assessment determines whether ESO is able to recover the Black Start costs.

2.2.1 Spend – cost components

The BSPM provides full details of each of the cost components, which can be summarised as follows:

Black Start availability – to cover costs for providers to maintain the availability of capability on site for the duration of the contract term.

Black Start capital investment – to cover costs for either installing capability or works required to maintain capability – typically an auxiliary generator.

Black Start Testing – to reimburse the provider for costs to prove the capability of service providers.

Black Start feasibility studies – to cover the costs for a provider to understand what is required to deliver a Black Start service, including identifying if any capital investment is required.

Black Start warming – to cover costs associated with bringing existing Black Start providers' units to a warm state so they can be Black Start available when their position in the wholesale market means they would not otherwise be running.

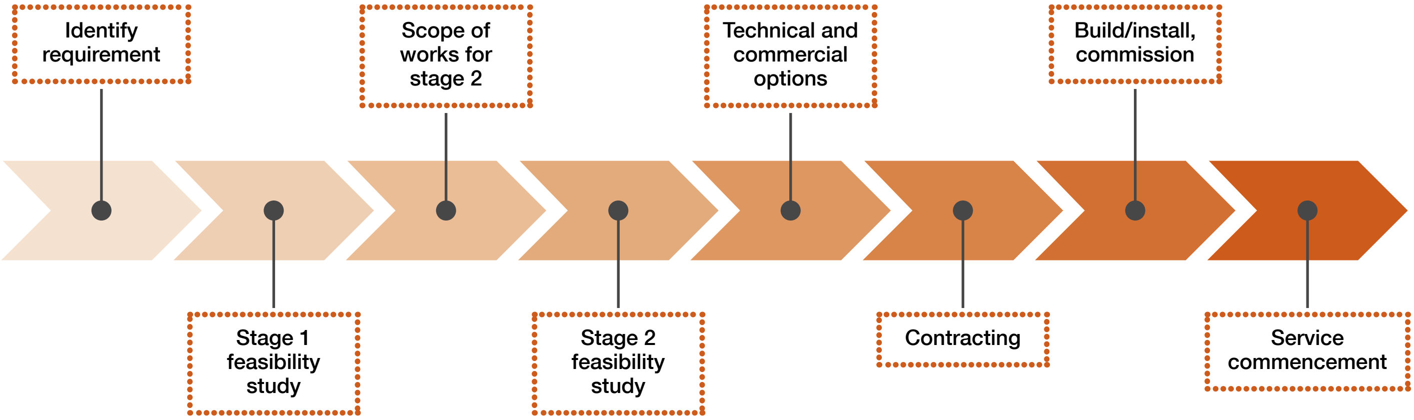
2.2.2 Contracting process

The contracting process at present recognises that generators are not, typically, specified or built to have self-start capability and so some costs must be incurred to add this.

ESO has developed the first competitive procurement process of its kind for Black Start services, trialling the approach in an area covering the South West and Midlands Black Start zones. This is based on functional technical requirements and a transparent, open process which has dramatically increased participation. Whilst this delivers a step change in transparency and competition, it largely follows the original principles of the contracting process to assess feasibility and capability. The success so far of this approach has led to the release of a second competitive procurement event in a region covering the Scotland, North West and North East Black Start zones. More information on the Black Start zones can be found in Appendix 11.5.

Figure 2.1

Contracting process for existing Black Start services



2.3 Identify requirement

ESO regularly assesses availability of capability, both across the contracted fleet as well as looking further ahead at the pipeline of potential new providers in each Black Start zone. To develop a requirement and understand the most appropriate way to procure against it [2], ESO will assess the following (taken from the BSPM):

- What are the characteristics of the current Black Start contracts? How able are they to meet the technical requirements? What are the contract expiry dates?
- Who are the parties who could contribute to meeting this requirement? How many are there? Are they suitably independent or do they share a parent company? Is there a liquid pool of providers? What is our best view of the life expectancy of current providers using Future Energy Scenarios (FES)?
- Is there resilience through diversification of technology/ fuel types?
- When does the requirement start? How long would it take for the identified parties to complete the feasibility assessment process and be able to prepare a commercial offer? Could other parties also complete this process in this timeframe? Is introducing competition in the best interests of the end consumer, considering whether additional capital investment would be required?

Once a requirement for procurement of a service or services has been identified, ESO must engage with the identified potential new providers. Historically, this has tended to have been done bilaterally, however, wherever possible now, ESO will publish requirements on the Black Start website and communicate to industry through the agreed distribution channels.

Insights

- Ensure technical requirements are functional and transparent.
- Consider ways to allow a proportion of the requirement to be assessed closer to real-time, to increase accuracy and create flexibility in volumes to be procured, and to maximise participation. This may include developing a hedging strategy.

2.4 Feasibility assessment process

The stage 1 feasibility assessment process (F1) [3] requires a potential Black Start service provider to assess the capability of its main generating units and associated plant to provide the Black Start service, together with some preliminary work to consider possible solutions. It allows the venture to terminate at an early stage should the main plant be deemed inappropriate for provision of a Black Start service. The objective is to give enough information and confidence that the plant can meet the technical requirements and that a decision can be taken about moving to a full design stage.

If the outcome of F1 is a decision to progress, then ESO will instruct the tenderer to proceed to scoping a stage 2 feasibility study assessment process (F2) [3]. Prior to commencement of a F2 study and associated F2 report, a scope of works for delivering the report (including costs and programme) must be delivered to and approved by NGESO.

The aim of F2 is to provide a comprehensive and robust technical and commercial evaluation of the proposed service to enable progression to a contractual negotiation or tender.

The outcomes of F1 and F2 are dedicated reports (F1 report, F2 report). Both reports should be prepared using dedicated templates, which will be provided when NGESO requests Expressions of Interest. Each report should provide sufficient confidence in the capability of the service provider to support a decision to continue with the feasibility process.

With the recent implementation of the competitive procurement events, a standard contracting timeline has been introduced. At present, we would expect that all providers who satisfactorily demonstrate capability at each stage would be invited to proceed to the next stage, though ESO reserves the right to shortlist if required.

The current feasibility assessment process means that requirements have to be outlined and the contracting process started 1–2 years ahead of the service commencement date.

The full outlines for each study are available on the NGESO website [3].

Insights

- Consider ways that the lead time on procurement can be reduced and brought closer to service commencement. This would allow greater flexibility and accuracy when assessing the requirement.
- Consider ways to streamline the requirements of the feasibility assessment process, and how to enable providers to self-assess where possible.

2.5 Value assessment

The current approach for value assessment is defined in the published BSPM, approved by the Authority (ofgem) in July 2019. The BSPM will determine value to current and future consumers, how each Black Start service contracted will provide that value and how this is assessed cumulatively. It also outlines our approach to assessing the trade-off between an economic and efficient level of service provision for consumers and the restoration timeframe that such provision will deliver.

Once an offer has been received for a Black Start service, either through a market mechanism (tender) or a bilateral negotiation, ESO shall then assess the cost of that service against the value it contributes to the regional and GB restoration time.

The existing methods (as taken from the BSPM) for assessing value are:

Market pricing – Where the ESO has determined there is sufficient liquidity to competitively procure, the costs of the service will be determined by the market. ESO will seek to allow potential providers to make clarifications and refinements to these costs where necessary to ensure the best overall solution.

Cost Plus – This approach is used for new services that require significant capital investment; to cover the costs of the investment, plus variable costs for the service. Based on the available information, analysis is undertaken to evaluate the cost to provide the service. ESO will use our own models to provide estimates of costs and fair returns on investment to provide an indicative service cost. This will guide our negotiations as to a fair price for the service. Alternative costs (see below) will also be considered for new build or retrofits.

Alternative costs – This approach is the primary assessment approach for existing Black Start providers, although it can be used for new providers or retrofits, and is based on using real and forecast alternative costs to calculate Black Start service costs. The technical capability of the provider, as well as the contribution to the restoration, will be taken into consideration alongside existing service providers' prevailing costs and future operating costs in the determination of value.

Insights

- One set of assessment criteria, or one value assessment methodology, may not be fit for all purposes. Once further confirmation is available on how technical requirements might be split, and how lots or bands of a service might be structured, develop transparent assessment methodologies should be developed that are appropriate for all scenarios. There may be elements where there is less liquidity, and alternative methods to market-led pricing may be most appropriate for ensuring value to the end consumer.
- The project should consider the balance between restoration timeframes and cost to end consumers, ensuring that expected restoration timeframes are met in an economic and efficient way.

2.6 Testing

Black Start Testing is used to prove the capability of service providers. Traditionally, the cost reimbursement arrangement is agreed between the provider and ESO at the time of the test, based on the provisions in their Black Start service contract. In the current competitive procurement events for Black Start, we are trialling including the testing costs in the Black Start availability fee to equally compare the total cost of the service and provide more transparency.

For existing providers, we have developed a standard template for cost reimbursement that reflects lost opportunity in accordance with published market prices and we will continue to work together with the provider to test the unit at the most economic and efficient time.

Further detail is provided in section 3.4.4.

2.7 Availability and performance monitoring

Once contracted, providers will be paid an availability fee to cover their costs for maintaining the availability of capability on site for the duration of the contract term – typically resource, maintenance and a revenue for providing the service.

If a provider declares themselves unavailable during the contract term, they will not be paid until such time they redeclare their availability status and an Annual Assessment will also be carried out to determine whether they have met their agreed annual availability. Typically, we expect availability to be 90 per cent or greater, to cover outages. If, during the Annual Assessment, the ESO determines that the availability is below this agreed level, the provider will pay a shortfall payment back to the ESO.

Further detail on this is provided in section 3.4.6.

2.8 Requirements for change

All aspects of the current process are based around a top-down skeletal restoration strategy, which at present favours a smaller number of larger providers, coordinated by ESO to restore demand through re-energisation of the transmission network. Subject to the project successfully demonstrating the concept and proving value to the end consumer, implementing a service whereby DER can contribute to restoration will require a review of the end-to-end process. We expect there to be a transitional period, where any future Black Start services from DER will be operated in coordination with a top-down national strategy.

We assume that the ESO will continue to play a leading role for identifying the need for new Black Start services, taking account of the national position, expected changes in availability and estimated restoration timescales. As part of this, we assume that the ESO will lead on the assurance that sufficient services are contracted to satisfy whatever is specified in future Black Start standards. For example, should the proposed Black Start standard currently being assessed by BEIS be approved for implementation, alignment with the required volumes would be needed. Thus, in the transitional period at least, we assume that the ESO will determine when there is a need that a DER-based service might satisfy.

A detailed explanation of the necessary innovations are described in Appendix 11.3 – Appendix H of the final bid submission. Following review of the current process, a number of additional insights have been drawn which should be taken forward for consideration as the methodology for a future service is developed.

3. Commercial design

This section reviews the commercial structure for the existing service, considering key areas of risk, and how these are balanced, which is used to draw insight for consideration in the development of a future Black Start service from DER.

3.1 Introduction to commercial service design

The purpose of the design of a commercial service and accompanying contractual frameworks and structures is essentially to manage commercial risk. Commercial services and their contracts should be set up in a way which provides a framework for commercial and operational risk management, to agree the terms of engagement, formalise remuneration, and minimise the likelihood and/or impact of damages or losses to an involved party. In this case, one of the key objectives of the commercial design is to ensure that the service represents good value for the end consumer, by formalising the level of service agreed, and setting out the consequences in any event of default.

As a potential future service is likely to be delivered through a larger number of smaller service providers and involved parties, the challenges of setting out each set of responsibilities becomes more complex, particularly in a scenario where components of a service are delivered by different parties and assimilated. It is therefore of even greater importance to manage the impacts of identified risks, to ensure the end consumer is receiving what is agreed.

This section will review current arrangements with the aim of understanding the basis for the current structure to help us identify insights and considerations to take forward in the development of a future Black Start service from DER. Each section refers to part of the current commercial design, and will be followed by an 'insights' section which highlights key learnings to take forward.

The key areas of risk within term are encompassed at present by clause 4 of the Commercial Services Agreement (CSA). This section considers the following elements, and should be read throughout in conjunction with the current standard terms for the service [4].

3.2 Design of service

At present, it is the ESO's responsibility, reflected in the Black Start Procurement Methodology, to contract with providers of Black Start services to ensure that the National Electricity Transmission System (NETS) can be restored in the event of a total or Partial Shutdown.

To do this, ESO uses a CSA [4], within which an optional clause 4 sets out the terms of the Black Start service and plays a large role in setting risk levels and mitigations. There are, however, a number of pre-contract steps which also contribute to this. For the purposes of this report, considerations will be organised into 'pre-contract', and 'within term', with a number of subsequent chapters set out when reviewing considerations 'within term'.

- Pre-contract.
- Within term.
- Construction/installation.
- Black Start capability.
  - Agreed level of service and contractual obligations
  - Self-declaration of presence and absence.
- Testing.
- Availability and performance monitoring.
- Settlement.
- Events of Default (EODs) and termination.

The report presents a summary of the current status of each of these, which will be key themes for consideration in the design of a new service. Each represents a key area of operational and commercial risk and will be followed by a discussion regarding the balance of risk between the party responsible for contracting (currently ESO) and the provider, and how this balance ultimately protects the end consumer. In this context, we will also consider the requirement for change and highlight 'insights' which will be taken forward for consideration.

Figure 3.1

Balance of risk in commercial design

Process	Pre-contract			Within term				
	F1	F2	Contract award	Develop capability	Service commencement	Payment	Testing	Performance monitoring and EODS
Provider	Delivers at own cost informed decision	Protected from costs if study determines not capable		Late commissioning reduces revenue		Availability payments	Test cost	Revenue lost in case of default on obligations
ESO	Enables informed decision	Funds F2 Quality risk reduced Enables informed decision		Capital contribution during build		Firm service ESO meets obligations	Test cost	Assurance on meeting obligations
End Consumer	Provider commitment	Greater assurance of capability		Benefits from lower total cost		Firm service in place	Assurance of quality	Protected from non-delivery by EODS

3.3 Pre-contract

The assessment of a provider's suitability for Black Start takes the form of a phased, two stage feasibility process, the aim of which is to provide assurance at each stage that the provider does have or will have the Black Start capability by the service commencement date.

The stage 1 feasibility study requires a potential provider to assess the capability of its main generating units or equipment to provide the Black Start service, together with some preliminary work to consider possible solutions for auxiliary power sources and construction timescales. It allows the process to terminate at an early stage should the main plant be deemed inappropriate for provision of a Black Start service. The objective is to give enough information and confidence that the plant can meet the technical requirements and that a decision can be taken about moving to a full design. The stage 1 report is a lighter touch report, usually up to around 20 pages long, and is done at the cost of the provider.

If the outcome of stage 1 is a decision to progress to a full design stage, then the ESO will instruct the tenderer to proceed to scoping a stage 2 feasibility study. The aim of stage 2 is to provide a comprehensive and robust technical and commercial evaluation of the proposed service to enable progression to a contractual discussion or tender. It will detail the commercial offer of the Black Start service (fees, etc.) and include confirmation of technical capability detail, how the Black Start service will be delivered, an implementation strategy and network modelling where necessary to ensure the Black Start Service will not cause any impact or damage to third party plant or equipment (where the service is provided in an alternative operating mode). ESO will contribute to reasonable costs incurred in undertaking a stage 2 feasibility study, subject to agreeing the scope of works and contractualising the agreement beforehand.

During this process, ESO minimises operational risk by accepting a low level of commercial risk – contributing financially to cover the reasonable (and agreed) costs of the stage 2 feasibility study in order to assure that the resulting service will be effective and will deliver as intended. This approach means that the provider is not at cost risk to demonstrate the capability, and subsequently, any risk of 'short cuts' to minimise financial exposure is reduced. This reduces commercial risk over the longer-term too, meaning 'no surprises' later in the process, and therefore ensuring good value for the end consumer.

At present, a provider cannot progress to making a commercial offer or to delivering a service without ESO confirmation that the required standards have been sufficiently demonstrated in the study. Using this approach means that a consistent quality standard is applied and enforced. This will need to be considered if the party responsible for procurement changes, and particularly if there is a change to more than one party holding the responsibility.

The two-staged approach to feasibility studies that is currently employed can take a long time to deliver. Considering the tendered approach that is currently utilised, the timeline allowed between commencing a Stage 1 study and submitting an offer is 12 months for the South West and Midlands zones, and 11 months on the accelerated timeline for the Northern zone tender (with assessment time on top), both of which have been streamlined as far as reasonably possible under the current strategy. The long timelines that are required to meet the study specifications mean that all parties take a risk in engaging whilst the energy landscape is evolving at such a fast pace.

At present, the ESO may contribute up to £150k to the cost of a stage 2 feasibility study with an agreed scope of works. Making this contribution removes a barrier to market entry and enables competition later in the process. This approach is appropriate for the procurement methodology employed under the current restoration strategy, however, should there be a transition through the Distributed ReStart project to a larger number of smaller providers, this may no longer be a cost-effective solution. Depending on the outcome of the project and any subsequent changes to the restoration strategy, the feasibility approach is likely to require adaptations.

Insights

- Consider redeveloping the feasibility assessment process to enable further self-assessment, to reduce the costs where there could be a greater number of smaller providers.
- Consider ways to reduce the lead time of assuring capability so that all parties can make informed decisions closer to service commencement dates.
- Consider how consistent quality standards would be ensured should there be more than one party responsible for procurement.
- Consider whether this approach is effective if a DNO needs to complete feasibility studies on behalf of a group of DER.

3.4 Within term

The key areas of risk within term are encompassed at present by clause 4 of the CSA.

This section considers the following elements, and should be read throughout in conjunction with the current standard terms for the service which can be found on the ESO website [4].

- Construction.
- Black Start capability.
  - Agreed level of service and contractual obligations
  - Self-declaration of presence and absence.
- Testing.
- Availability and performance monitoring.
- Settlement.
- EODs and termination.

3.4.1 Construction

Where new plant or changes to existing plant is/are deemed necessary solely to deliver a Black Start service, the provider would reasonably expect to recover those costs through revenue from the contract. At present, ESO offers to make a capital contribution to cover these costs as a separate payment from the availability payment for two primary reasons:

- reimbursing providers for project costs as they are invoiced by their suppliers can remove the need for any associated costs of project financing, reducing the overall cost of the project for end consumers.
- separating the capital costs from the availability fee allows ESO to scrutinise and challenge the proposed costs with greater transparency to ensure value for the end consumer. Capital is recoverable on an open book basis once ESO has received satisfactory evidence that the costs were incurred and incurred reasonably.

By offering to make capital contribution payments ahead of service commencement, ESO accepts a level of risk to maximise value for the end consumer. The key considerations in relation to this are covered in:

- clause 4.4 – Works
- clause 4.6 – Payment
- Annexure A
- Schedule E.

Clause 4.4 and Annexure A of clause 4 of the CSA detail the process for commissioning of the works and proving the Black Start capability through the commissioning assessment. The provider must use reasonable endeavours to meet the target commencement date, as failure to do so may result in the ESO having to take alternate actions to ensure sufficient Black Start availability across the fleet. To mitigate this risk, a milestone schedule (Annexure A) is agreed at the time of contracting, which enables the buyer to monitor progress of the works programme in line with paragraph 2, and liquidated damages are outlined, so that the end consumer is not exposed to the cost of any alternate actions that must be taken to ensure availability.

As a last resort, should the provider fail three successive commissioning assessments, the ESO has the right to terminate the provisions of clause 4, in which instance any capital contribution payment that had been made would be repayable under clause 4.5.3, and Schedule E, Section 2, Part III (the Works Contribution Refund Payment), to ensure that the end consumer is not exposed to costs for a service that wasn't delivered. To provide further certainty, clause 4.6 outlines further payment provisions, including security, and validation of invoices. Security is required under clause 4.6.4 to ensure that, at any point in the contract, there is certainty that the provider is capable of making the Works Contribution Refund Payment. Clause 4.6.3.4 provides further detail relating to validation of invoices for capital contribution payments too, again, to validate that costs being claimed for have been incurred and incurred reasonably, to protect the end consumer.

Insights

- The end consumer cannot be liable to cover costs of a non-delivered service. If a Black Start service from DER still requires capital contributions of any kind, the contract must provide protection for end consumers against risk of non-delivery.
- Likewise, if alterations to assets are required, ensure the structures are in place to encourage delivery on time and balance risk appropriately if not on time.
- Consider whether it will still be viable to make capital contributions for a greater number of smaller providers, particularly if there is a functioning marketplace with a greater ability to switch providers/higher level of redundancy.
- Consider ways to ensure transparency of costs until there is a functioning marketplace with truly market-led pricing.

3.4.2 Black Start capability

Agreed level of service

Taken from the Grid Code [5], Black Start capability is defined as:

> An ability in respect of a Black Start Station, for at least one of its Gensets to Start-Up from Shutdown and to energise a part of the System and be Synchronised to the System upon instruction from The Company, within two hours, without an external electrical power supply.

For the purposes of contracting for Black Start or restoration services, the CSA defines it as:

> An ability in respect of Black Start Plant to Start-Up from Shutdown and to energise a part of the System upon instruction from the Company, within two hours, without an external electrical energy supply and including the obligations of the BS Service Provider contained in sub-clause 4.8.4 in addition to and without prejudice to the BS Service Provider's obligations under the Grid Code with regard to Black Starts;

It is the responsibility of the ESO under its licence condition 4G [6] to contract for Black Start services, with providers who have Black Start capability. The ESO defines the capabilities and characteristics that are necessary to provide Black Start capability (under the current restoration strategy) in the published technical requirements, which can be found in Appendix 11.1 – technical requirements, a summary table is available in table 2.

Table 2

Current procurement assessment criteria

	Minimum requirements	Pass/Fail
Technical 30%	Connection to Network	10%
	Power Output	35%
	Resilience of Supply	30%
	Contribution to System Stability	15%
	Contribution to Restoration Time	10%
Commercial 70%	Total costs £/Settlement Period (87,648 SPs)	100%

These technical requirements set the bar for service entry and are used in conjunction with a set of assessment criteria that allow for consideration of relative technical value to be taken into account in a tender submission or service offer. The assessment criteria used at present (under the current restoration strategy) are available below, with further detail in Appendix 11.2 – Assessment Criteria.

Clause 4.8 of the CSA [4] describes the capabilities that the provider must maintain. In addition, when a potential service provider makes an offer or tender submission for the service, their specific parameters or characteristics on which their offer is based on is contractualised in Part 3 of Schedule E – Black Start capability, Section 1 – Data. This section will include both their responses against the technical requirements as well as their responses which are assessed and scored using the assessment criteria.

As the costs for the Black Start service are passed through to the end consumer, it is of the utmost importance that service providers are held to account for delivering against their service offer. As incremental changes are introduced to the procurement process, the contract is updated to ensure it remains effective. It is anticipated that this will be necessary for a Black Start service from DER. A new contract structure or evolution of the current structure will be developed in conjunction with agreeing an operational format for a future service with OST and PET.

Self-declaration of presence or absence of Black Start capability

At present, it is the responsibility of the provider under clause 4.9 of the CSA to make notifications to the ESO to declare the absence and return of the Black Start capability. Currently, notification is to ESO Electricity National Control Room (ENCC) and is done as soon as possible once the provider becomes aware of the absence of Black Start capability. The ENCC uses this notification to monitor availability to ensure sufficient coverage across the Black Start fleet and then notifies the Settlement team to use for payment purposes (to be covered further later under section 3.4.6)

Insights

- There is an operational risk of reliance on self-declaration. Consider ways to objectively monitor key Black Start capability systems through a performance dashboard and smarter systems for live monitoring that can be shared in real-time with ENCC.

3.4.3 Testing

There are a variety of testing provisions available under clause 4.20 of the standard contract terms. At a minimum, the Black Start capability of a provider is physically tested at commissioning and then in accordance with OC5.7.2 of the Grid Code [7] (a Capability Assessment), with the option to also complete a Remote Synchronisation Test and Deadline Charge test in addition not more than once every two calendar years (4.20.1.3 and 4.20.1.4), which meets the codified requirement.

A typical Capability Assessment for most providers is likely to involve a witnessed, timed test, where external power supplies are removed and the provider must demonstrate that they can perform their start-up process and re-energise up to the point of connection so that they can be ready to export active power within two hours. For most Black Start providers, physical tests have the potential to be disruptive to normal operations, by forcing them to deviate from their planned commercial position during the test period. For this reason, at present, ESO will keep the provider whole during a Capability Assessment. There are a number of ways that testing costs can be minimised, for example, when scheduling, assessing market conditions to minimise impact on wholesale participation, and aligning testing dates with scheduled return from outages. For services procured going forward through a competitive procurement event, the provider will be expected to include testing costs (with a breakdown provided) within their availability fee. The purpose of this is to holistically assess the total cost of a contract ahead of contract award. As the total cost (including cost of testing) is used as part of the tender submission process, this should incentivise providers to minimise the costs as far as possible or risk being out of the 'merit stack' of returned tenders.

ESO is also able to carry out Reproving Assessments following the provider's notification of return to service following the absence of Black Start capability to verify the restoration of Black Start capability (4.20.1.5) should there be reason to do so.

In any circumstance, failure of a Black Start Test will result in cessation of availability payments until or unless a subsequent test is passed. This protects end consumers from paying for availability of a non-functional service.

3.4.4 Assurance

In addition to physical tests, NGESO has a responsibility for Black Start assurance including monitoring of the number of contracted providers, the suitability of the LJRPs, the overall suitability of the national restoration plan and the capability of NGESO to deliver these plans. Furthermore, NGESO has an obligation to maintain internal system resilience and organisational capability including the testing of control centre power resilience and testing internal systems (FATE, IEMS, SCADA, Optel, details provided in the OST viability paper). [8]

Insights

- As the Black Start tests are a Grid Code requirement, it is fair to keep providers whole, however, the project should consider ways to minimise these costs, particularly in a scenario where there are a larger number of providers, and particularly considering regulatory changes that may alter the testing frequency.
- Ensure the testing programme for the new service is fit for purpose and appropriately assesses the provider against whatever the definition of the Black Start capability is.
- Ensure that there are appropriate provisions for failure of a test.
- Capability assessments are witnessed at present, consider whether this is viable from a resourcing perspective if there is a much larger number of providers. Consider the role of automation and ways to increase assurance through real-time monitoring and self-certification/certification through an independent engineer and reduce manually witnessed tests (particularly if further consideration is given to breaking a 'full service' down into components delivered by different parties).
- A DER-based service may require demand customers to be involved in testing if a transmission system energisation capability is to be demonstrated. This poses questions over possible compensation for interruption of supplies, or whether sufficient testing can be done without impact on other customers.

3.4.5 Settlement – availability and performance monitoring

Providers are paid an availability fee, an agreed price per settlement period (£/SP) for the time that they are available. Network shutdowns have a low likelihood and are unpredictable, so providers are expected to have high levels of availability, at least 90 per cent is expected. At the time of tender submission, providers are expected to submit their expected availability for the duration of the contract. Providers are paid monthly, based on their declarations of availability, and for each 12-month period of the contract, an Annual Assessment of Black Start capability is conducted. Where a provider's annual availability falls below the agreed level in Annexure C, the Annual Availability Shortfall Payment is applied in accordance with Schedule E, Section 2, Part II, which can include a Works Contribution Refund Payment in the case that a capital contribution has been made. This is to ensure that the ESO and ultimately the end consumer is not 'overcharged', where an asset has essentially been paid for but is not delivering the agreed service at the agreed level. This balances the commercial risk, where the ESO has paid for an asset which will belong to the provider, to incentivise the provider to ensure the asset is available, reducing any operational risk regarding level of and availability of capability in the event of a shutdown on the network.

The detailed formulae are available in Schedule E, Section 2 of the CSA, which can be accessed here [4].

The assessment involves a semi-manual process. For the required numbers of 'conventional' Black Start providers using the proxy measure of three per zone to meet ESO's agreed service level for restoration, this is appropriate. It may be necessary, however, to consider whether this is possible in a scenario where there is a greater number of smaller providers, particularly if each of them are delivering different elements of a service.

Insights

- Consider ways to ensure end consumer spend is protected where capital contributions are required 'up front' and ensure reasonable balance of risk.
- Ensure operational risk is mitigated to an acceptable level, and consider ways to further reduce the commercial risk without affecting it.
- Consider the role of automation and whether smarter systems can support removing manual elements of the current process to ensure all processes are viable from a resourcing perspective, and are fit for purpose in a new service design.

3.4.6 Events of default (EODs) and termination

There are a number of listed contractual defaults, which have consequences for the provider if they are made. Annexure B of the contract [4] details the characteristics of the default and the consequences.

In all of these instances, the resulting penalty relates to either a repayment amount considering the availability fee and/or capital contribution, or termination grounds. Both of these act as a contractual penalty, but are based on lagging measures (enforced after the fact). In reality, and taking a pragmatic approach, whilst the contractual grounds are there and would be used if necessary, at present it would not be preferable to the ESO to terminate a contract with a provider that has capability, without an appropriate alternative – this could mean needing to make additional capital investment, which considering the whole picture would not be the most valuable option to the end consumer. While these should encourage the provider to deliver as contracted, leading measures (preventative) may be overall of more benefit operationally to the party responsible for procurement/coordination, and of greater economic value to the end consumer.

Insights

- Can key performance indicators (KPIs) be developed that include leading measures to monitor performance ahead of EODs?
- Consider whether an appropriate incentive mechanism could be developed to encourage enhanced performance if this is of benefit.
- Consider that value is gained if EODs are prevented, but ensure that measures are in place to protect the end consumer from paying for a service that doesn't deliver.

3.4.7 Summary

The contract terms are designed to minimise operational risk for the ESO, whose responsibility it is to ensure a Black Start of the network is possible in the event of a shutdown, and commercial risk for the end consumer who ultimately pays for the service. This is done by balancing an appropriate level of risk and reward for providers, with an acceptable level of risk for the ESO on behalf of consumers.

3.5 Requirements for change

The current design of the service is reflective of and appropriate for meeting and delivering the current restoration strategy, including the manual nature of processes, and a cost structure that suits a smaller number of providers. While any proposals for service design from an engineering perspective are unclear at such an early stage of the project, what we can reasonably assume at this stage is that there are likely to be a greater number of smaller providers, and greater complexities in terms of coordination of a future service, which will likely filter down into contract management.

4. Strategy development

This section uses project outcomes and wider economic theory to propose a strategic process for developing the procurement approach and commercial design, which will be iterated and refined through industry engagement. This section considers both procurement and commercial design in a combined approach.

4.1 Introduction

The focus of this report is on what considerations must be made to begin the process of developing an appropriate solution once confirmations are made in the wider project. The report will include research and analysis to further understand the supply characteristics, and a strategic approach to developing initiatives which meet the objectives. These will support us to steer a decision on which approach or combination of approaches will deliver the best value for end consumers.

Using a standardised approach to strategy development (see figure 3) will highlight key areas to focus on in procurement events, by conducting analysis in a number of areas to develop an in-depth understanding of the spend area. We can apply a number of tools, and refine them as more information on the viability and feasibility of engineering and organisational options is confirmed in the design and refine stages of the project. We propose the following key stages for developing a new strategy in a formalised and logical way, which will be iterated and refined as more confirmations are made over the course of the project. Engagement with stakeholders will be key at every stage to provide challenge and review, feedback and ultimately to steer an appropriate course of action. Not all of these stages will be complete in the first iteration.

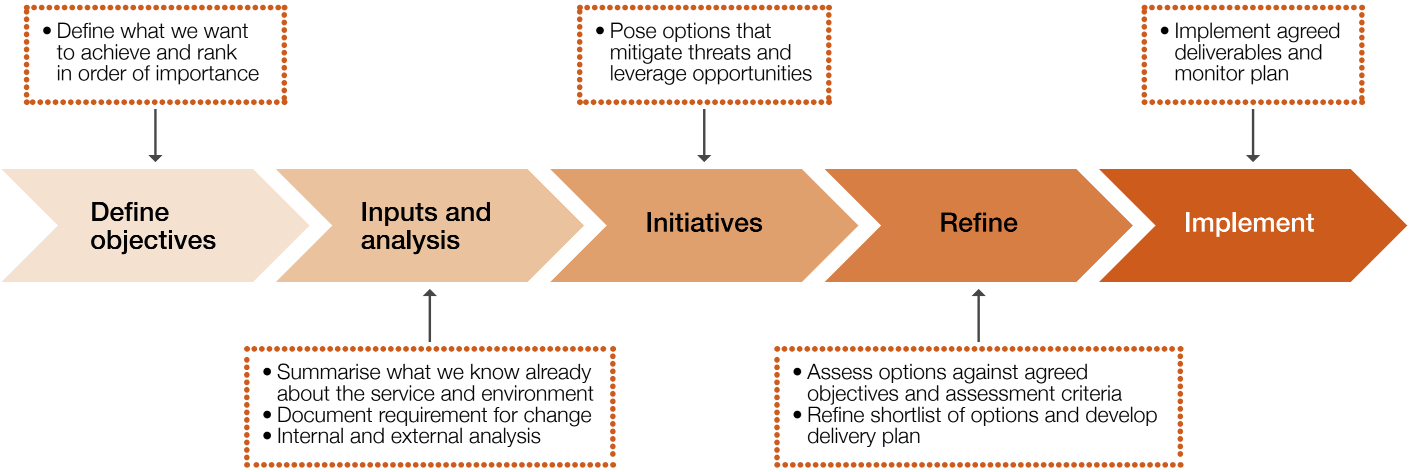
4.2 Objectives

The first step of a strategic process is to define the objective. The broader objective of the Distributed ReStart project is to trial the concept of a Black Start service delivered from DER. The P&C workstream is developing the commercial structure and procurement mechanism that enable the delivery of a Black Start service from DER. Typically, objectives for procurement mechanisms are primarily to reduce cost or increase value. Both of these are likely to be applicable, but considering the regulated position of the ESO, and that the service/market currently doesn't exist, there are likely to be additional aims to consider. At present, we expect that objectives for the procurement approach to access these services, and the associated commercial structure, could include:

- increased competition
- reduced barriers to entry
- increased transparency
- financial value for the end consumer
- accelerated restoration times
- functional route to market for new service.

These proposed objectives are for review, feedback and refinement by stakeholders to support us to appropriately define and agree what we aim to achieve through the procurement approach. The next steps would be to consider ranking these in order of importance, as there are likely to be decisions that arise where trade-offs may need to be made.

Figure 4.1
Flow chart of strategic process



4.3 Inputs

The purpose of this section is to outline what inputs will be needed for the strategy development process in order for the proposed solution at the end of the project to be well informed and considered. Where possible, and where the information is already available, or is available to a certain extent, this will be included. We strongly encourage stakeholder feedback to further develop and broaden these inputs as required to inform the strategy development process. One of the key inputs for the procurement design will be the engineering, organisational and telecommunications outputs.

Sections 4.3.1 and 4.3.2 discuss the initial findings and high-level commercial implications but these will be refined through the design stages.

4.3.1 Power engineering and trials

The commercial design for Distributed ReStart will have a large interdependency with the power engineering requirements and capabilities identified in both the initial viability paper and the ongoing design process. This will require continual iteration between engineering solutions and procurement considerations to ensure that the final solution is technically capable, but also introduces broad and open participation which will in turn develop competition though liquidity.

Pertinent findings to date that impact upon the procurement process are detailed below and will form the basis for the commercial design stage.

Multiple DERs involved in a single plan

The power engineering analysis has identified that no single DER provider will be suitable to provide a full transmission restoration capability equivalent to existing Black Start providers. It is proposed that Distributed ReStart will use co-location of multiple DERs to operate as a collective virtual Black Start provider. This would be a change in the means of procuring and contracting for services as a single restoration plan should be capable of incorporating multiple electrically local providers. Furthermore, the capital investment requirements for Black Start may be split across multiple DERs and may be significantly different for DERs included within the same restoration area.

Component technical requirements

It is not envisaged that a single provider will be the only DER involved in a distribution-led restoration plan. Therefore, there is opportunity for aggregation of technical capabilities. This already exists as an option for the traditional Black Start service and ongoing work from the power engineering design will refine these into a similar set of requirements.

A large advantage of this approach is the potential to procure component technical requirements over different timeframes enabling greater flexibility in the commercial approach and changing system conditions.

Network change requirements

It is anticipated that investment will be needed to enable the distribution network to facilitate a Distributed ReStart plan. Consideration will need to be given to the most effective balance between improving market liquidity, by preventing network blockers to DER participants, and enabling capital-intensive works on network which may never have an associated Distributed ReStart plan.

Specifically, it is expected that they will require:

- a new 33kV earth reference at the DER connection point as a minimum safety requirement
- changes to protection settings at multiple voltage levels (this may require modern relays to be installed which can have a second group of settings applied automatically)
- investment in distribution substation resilience to ensure that all control/protection equipment is still functioning when required to be energised after a Black Start
- voltage transformers and power system synchronising relays to be installed at points in the network which will be defined for synchronising. These may be at transmission voltages or distribution voltages depending on outcomes from further power engineering work.

Interdependencies

It is critical to P&C for PET to deliver:

- disseminated understanding of what is viable from an engineering perspective
- functional specification for technical requirements, potentially divided into bands/levels
- disseminated understanding of functional requirements for testing, as well as for pre-qualification (pre-contract assurance).

Insights

The PET outputs deliver opportunities for splitting service requirement capabilities across multiple parties, this may reduce construction costs compared with the auxiliaries needed to make a large power station self-starting but may include investment in voltage and frequency control.

Additionally, requirements for the involvement and cooperation of multiple electrically local DERs has potential to restrict market liquidity. The procurement design in conjunction with PET should consider means of preventing this.

- Stage 1 feasibility study now requires the involvement of multiple providers. This raises the question: who should pay for the initial feasibility study?
- Stage 2 feasibility study will require holistic assessment of all parties involved in the plan rather than a single provider and will require network capability assessment.
- Testing will need to change but this is dependent upon live trial results from later project stages.
- Construction may include remedial works to bring a distribution network to the required standards to facilitate a restoration plan.
- Availability of a restoration plan may depend on availability of a single provider. If this provider is unavailable, how will this impact on compensation for other DERs incorporated within the plan?
- The feasibility process will be largely dependent on the technical requirements for the service, however, at this stage we can assume that if we are able to revisit and refine this to reduce the time and cost, it will reduce barriers to entering relevant markets, and will allow for procurement over much shorter timescales.
- Likewise, if it is possible to split the technical capabilities into component parts of a full service, this could reduce the requirement for construction, and reduce these timescales too. This would also support the development of a procurement approach over much shorter timescales, or to develop ‘bespoke’ timescales for each market.
- Procuring over shorter timescales would enable flexibility and agility in the approach, allowing the organisation responsible for procurement to adjust the requirement (‘volume’ procurement), based on more accurate and closer to ‘real-time’ requirements.

4.3.2 Organisational systems and telecommunications

Iteration between organisational systems and telecommunications design and procurement design is essential for project delivery. The specification for systems requirements could enable options for monitoring availability and performance, and potentially tendering or auctioning. Furthermore, highly functional systems may allow for procurement solutions and commercial designs for services that reduce resourcing requirements, enabling greater market participation. However, onerous requirements on the number of DERs per restoration plan or on automation requirements could affect liquidity. This inherent reciprocal dependency between market access and optimised delivery will be considered in project design proposals.

Some key outcomes of the OST viability paper which impact on the commercial design are detailed below:

Distributed restoration zone

The OST report defines a power island within the distribution network used for the purpose of Black Start as a distributed restoration zone (DRZ). When considered with the PET outputs, it leads to a concept of a virtual Black Start provider, potentially delivering a service equivalent to existing transmission level providers. The size of this zone, the requirements per zone and the method of instruction and control have potential to impact on competitive pressures and thus the commercial approach which is most suitable.

Service controller

Options for controlling a DRZ are considered in the OST paper, including DNO control and NGESO control. Further analysis is required on all options and close working between the workstreams will be used to fully identify the implications of each operational model. The results of this analysis may have significant implications on any Black Start procurement platform, particularly if there are multiple parties responsible for ensuring regional provision.

Furthermore, liquidity could be impacted if multiple parties are responsible for procurement; the service components are delivered by different parties; and the service is procured in regions, rather than in a national pool.

Automation and systems

The OST workstream is considering a full spectrum of automation capabilities ranging from no new automation to a fully automatic system for dispatch and control of the Distributed ReStart service. At this stage, we anticipate that some level of automation may be beneficial in developing the procurement design, and P&C will work closely with the OST workstream to ensure that the implications for procurement, are fully considered.

A number of commercial options could be ruled out based on requirements for control room, procurement and assurance resourcing. Consideration will be given to where automation allows for more effective technical capability but also where it affects market access and liquidity.

Automation also has a possible impact on the construction costs and may reduce flexibility on contract length.

Operational telecommunications resilience

Existing Black Start providers have resilient operational telecoms provided directly through a dedicated fibre-optic network. DERs are currently connected through various technology types and are not subject to the current Black Start resilience requirements. Operational telecommunications for DER will therefore form part of the construction requirements, and the mechanism for recovering this cost will have to be considered.

Furthermore, dependent upon the entity responsible for providing resilient telecommunications, there may be an impact on liquidity and competition.

Insights

- The trade-off between systems and resourcing manual processes, reducing process risk, and enabling closer to real-time contracting decisions is highly dependent on what systems functionality and capability is available – it is likely that a number of commercial options could be ruled out based on requirements if they had to be delivered manually.
- Consideration will be given to where automation allows for more effective technical capability but also where it affects market access and liquidity.
- Liquidity could be impacted if multiple parties are responsible for procurement; the service components are delivered by different parties; and the service is procured in regions rather than in a national pool.
- Zones for Distributed ReStart may be significantly smaller than those for the existing Black Start service if based around automation. This has potential to affect competitive pressures.
- Multiple parties being responsible for procurement of the Black Start from DER service could have impacts on liquidity and procurement platforms which can be used.
- Automation has the potential to increase capital costs which in turn could make shorter contracts less effective.
- Resilient telecommunications are not provided to DERs. Therefore, construction costs will need to include this additional investment requirement.

4.3.3 Historical costs

The nature of the Distributed ReStart project means that there isn't historical spend specifically reflecting services from DER. However, table 4.1 below shows a summary of the publicly available spend data for the two years covered by the current cost recovery regime.

Table 4.1
Historical costs

	2017/18	2018/19
Availability payments	£35,392,352.16	£38,503,951.95
Capital investment	£1,528,771.40	£2,906,146.96
Feasibility studies	£724,490.17	£1,171,913.18
Testing	£193,702.38	£658,905.78
Warming	£19,903,961.88	£5,710,374.98
Total	£57,743,277.99	£48,951,292.85

ESO has shared the following reflections/insights in relation to these:

- Increase in assurance activities.
- Increase in feasibility studies, reflecting the move to reduce barriers to entry and increase competition.
- Warming reduced following introduction of new strategy but reflects the load factors of current providers.

We can draw the following insight from this to inform our future strategy, and will request feedback and input from stakeholders in developing solutions to the considerations below:

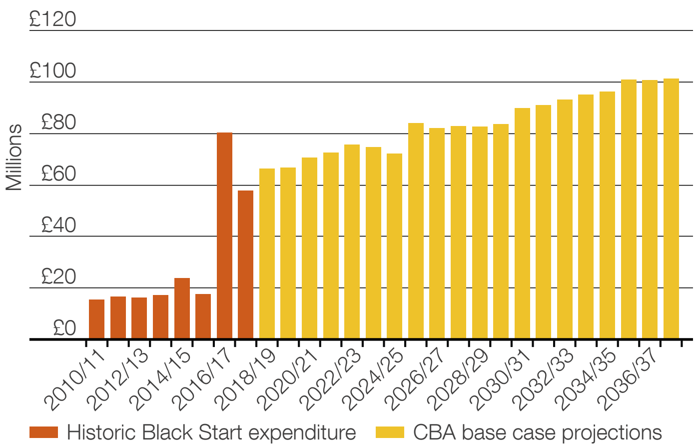
- Consider ways to reduce feasibility costs as the number of parties increases.
- Consider Future Energy Scenarios [9] and the expected load factors/merit positions of the range of DER, and more widely what factors will affect the availability of different technology types.
- Consider ways to access the various required capabilities, without requiring all of them from all providers.

4.3.4 Forecast costs

Our project team explored the costs and benefits of including distributed energy resources in restoration as part of the NIC funding bid we submitted to Ofgem in 2018, identifying a total cumulative benefit of £115.1m by 2050. Our cost benefit analysis (CBA) model considered the different mix of generation that would be used in restoration with and without the Distributed ReStart project and selected the lowest cost combination of providers in each year. It assumed that other sources of innovation would be available to support restoration, such as offshore wind, and that distributed restoration would become an option eventually with funding (in the mid-2030s).

The figure below compares historical Black Start spend through BSUoS to the future costs considered within the CBA. This is reproduced from our 2018 NIC funding submission.

Figure 4.2
Historic BSUoS Black Start expenditure and base case projections from our 2018 CBA

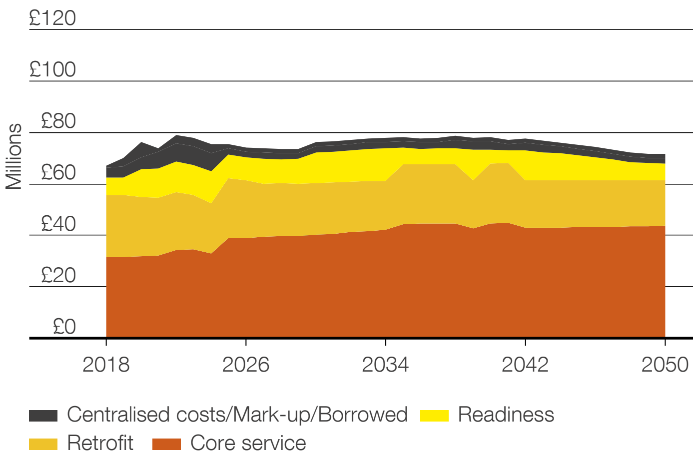


This suggests that, without taking action, costs would continue to be high in the future due to (i) the need to continue to retrofit equipment onto existing large transmission-connected Black Start providers, so they can provide the service, (ii) the need to ensure thermal plant readiness by dispatching it in the energy market, and (iii) the "mark-up" of service costs due to there being comparatively less competition for the service in the market. The figure also shows costs for (i) "borrowed" restoration capability, where generators in one zone are assumed to have to contribute to restoration in a neighbouring zone, (ii) the "centralised" cost of the service e.g. for systems and personnel, and (iii) the core service cost for providers, based on historical costs which exclude these other elements.

These costs reduce significantly when distributed energy resources are available as part of the solution. This reduction is primarily driven by the reduced need to make readiness payments to thermal plant – in the scenario we considered, these plants were running very infrequently by the late 2020s and early 2030s which meant re-dispatching them was very expensive. There is also a reduction in the cost associated with the mark-up of the service above costs – this is due to lower market concentration, enabled by introducing new participants into the market. However, the costs associated with retrofitting equipment are slightly higher with Distributed ReStart – these retrofit costs are necessary to install additional equipment on the distribution network to ensure it is restoration ready, such as neutral earthing transformers.

Figure 4.3 shows the breakdown of costs after adding distributed energy resources to restoration.

Figure 4.3
Historic BSUoS Black Start expenditure and base case projections from our 2018 CBA



These projections were prepared as part of the business case for the 2018 funding bid to Ofgem, using information from the 2017 FES scenario Slow Progression, which we considered would provide a conservative view of the benefit associated with the method. We will be updating our cost benefit analysis of the benefits of Distributed ReStart through the course of the project.

Insights

- We expect that over the short term, at least, a service from DER will need to operate in conjunction with the current provision – to ensure operational coverage and value for money where capital is already sunk into current services.
- The project should consider ways to ensure the timelines for any BAU procurement tie in to timelines proposed for a service from DER to avoid duplication/inefficiency.
- It is expected that there will be costs involved in the transitional period and to 'upskill' DER to the right capability; the proposals from this project for the commercial design and procurement mechanism should include cost reduction/value maximisation as key objectives.

Market forces

Further insight can be drawn by categorising the environmental factors into market forces, using, for example, a Porter's Five Forces model, see figure 4.4 below, which assesses the competitive nature of a market by considering the threats of new entrants and substitutes, and the power dynamics between suppliers and buyers. Some of the factors we think we need to consider are as follows (in the context of the current Black Start market), though we encourage input from our stakeholders to further inform our thoughts.

4.3.5 Porter's Five Forces – current market

Figure 4.4
Porter's five forces – current market

Threat of new entrants

- Limited capacity for new entrants due to:
  - bundled complex technical requirements.
  - cost and difficulty of feasibility assessments.
  - capital investment required to meet capability requirements.
- Strong position held by current players due to all of the above, prior investment, experience with process, pricing and contracts.
- Low threat of new entrants to current providers.

Buyer power

- Only buyer due to regulated ESO position and special licence conditions.
- Terms and conditions are standardised and public to enable potential providers to make an informed decision regarding whether to participate.
- Historically, a relatively small number of providers reduces the buyer power, this is changing under the more recently introduced procurement methodology and commencement of competitive procurement events.

Competitive rivalry

- At present, there are significant barriers to entering the market, creating a strong position for current providers to defend, which limits competitive rivalry.

Supplier power

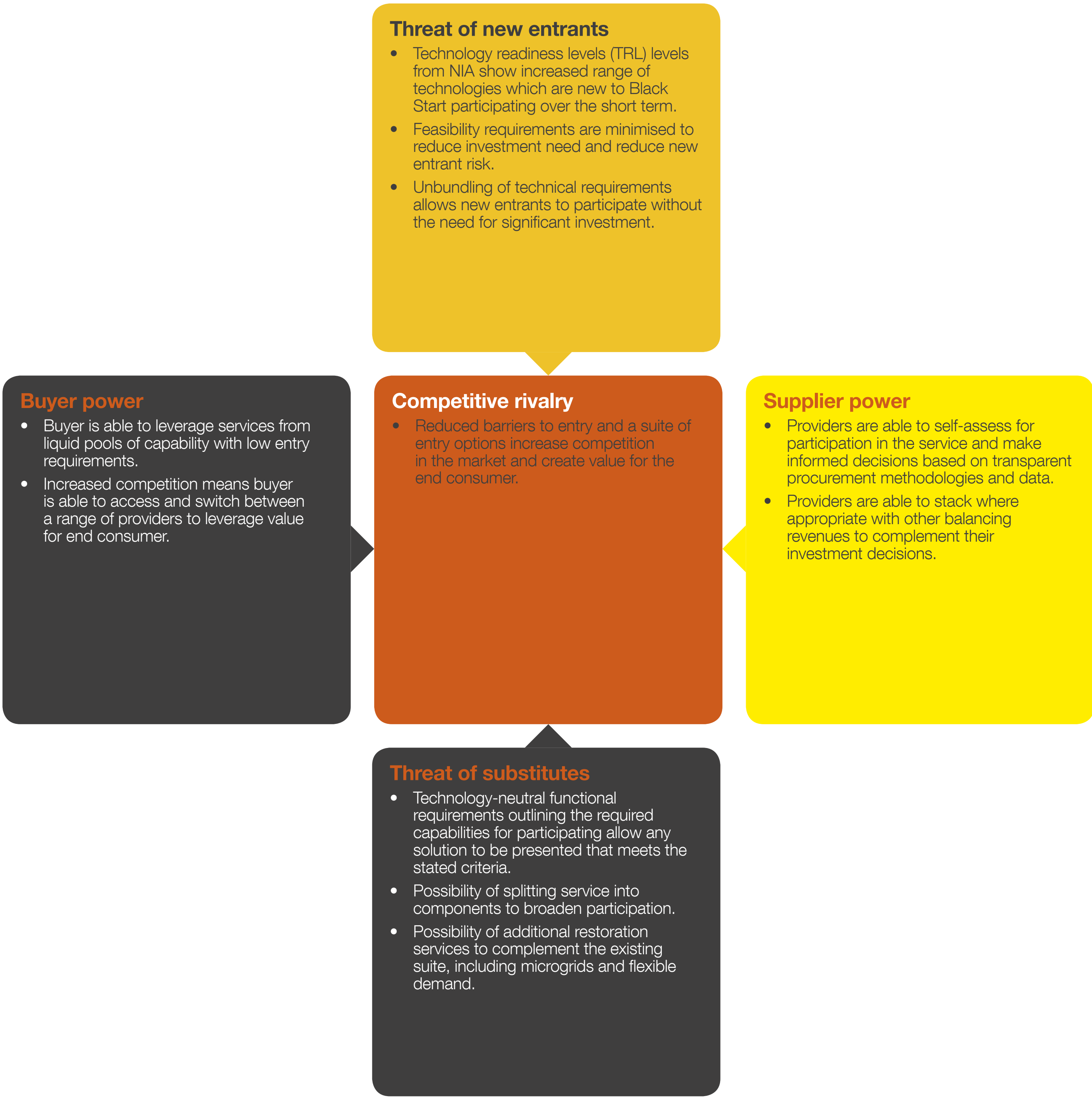
- ESO is obligated to buy under Special Condition 4G of the Electricity Transmission Licence.
- Other revenue opportunities/stacking of other balancing services is possible, however Black Start is seen as a new market opportunity and can provide additional revenue making the service 'attractive'.

Threat of substitutes

- Limited possibility for substitution due to service boundaries set by ESO and regulatory mechanisms (Grid Code).
- Recent increase following introduction of Trip to House Load (TTHL) services, combined services, fast start only services and interconnector services.
- Substitution can only be enabled by party responsible for procurement of services.

4.3.6 Porter's Five Forces – desired state

Figure 4.5
Porter's 5 forces – desired state



Insights

Considering the delta between the current state and the desired state, we can draw the following insights:

- Consider ways to reduce feasibility requirements; for example, developing ways for providers to self-assess and self-certify (the PET and OST workstreams will consider this further and aim to produce the specifications against which potential providers might self-assess).
- Consider ways to reduce the need for capital investment to lower provider risk at point of entry; for example, by splitting service into components so that they can participate with capability they already have – the more scarce capability will attract a higher market value.
- Consider what other restoration services could be added to the existing suite.
- Consider what regulatory changes are required to enable this.
- Ensure technical requirements are functional and technology neutral.

These insights can be used later in the process to inform the development of value strategies against a number of value levers.

4.3.7 Barriers to entry

One of the expected objectives for a new Black Start service from DER is reducing barriers to entry. Here, we consider some of the factors that can currently impede entrance to the Black Start market. We can draw insights from these factors to use later in the strategy development process.

- Capital costs.
- Technical requirements.
- Contract durations and provider switching.
- Pricing and competitive advantages.
- Other cost advantages.
- Demand elasticity.
- Compliance – Licences, permissions, permits and consents, compliance, testing risks and overheads.
- Lack of transparency in requirements, procurement and service delivery, which reflects the nature of Black Start as a critical component of national infrastructure and emergency planning.

At present, the technical requirements for participating in a Black Start service reflect the top-down restoration strategy, where demand is restored through re-energisation of the transmission network. In practice, this means that high capability levels are required in a number of areas and, as a whole package, many providers cannot achieve all of them without investing in the plant or developing a joint venture with another party. As they stand at present, the technical requirements (though they reflect the system needs) are prohibitive to many potential new providers of a Black Start service.

The level of capital investment often required in order to meet the current technical requirements may also be prohibitive, as many providers would be unlikely to accept the risk of not being able to recover these costs should they not be able to secure a contract. At present, we would expect that most potential service providers would need to secure a contract ahead of investing in the plant, which could have a negative effect on liquidity and the ability of the 'procuring party' to switch providers once contracts have been awarded.

In addition, once providers have secured a contract and invested in their plant, they gain a commercial advantage over new entrants, where new providers may be more expensive due to the need to invest, which compounds the reducing effect on new providers and on the ability to switch providers. There are other cost advantages in this situation that may also apply; for example, prior experience of the contracting process which may reduce tendering costs or costs involved with producing feasibility reports, modelling or intellectual property that supports in-project development, or price point guidance.

Time advantages may also exist for current service providers, where they have already met all of the compliance requirements, such as an approved feasibility study, or where construction is required, the necessary permits and consents are in place and the assets are built.

This allows current providers to respond to contract requirements at shorter notice, where the time it takes for a new or potential provider to progress through the feasibility/construction and installation/assurance phases may rule them out. Included within this is the likelihood that other compliance activities will also be necessary to allow a project to go ahead, including, for example, planning permission, environmental consents and permits. There are also costs associated with these activities that providers may not wish to commit to prior to confirmation of a contract being secured.

At present, the information published on pricing is not specific enough to enable providers to understand the revenue opportunity and to make an informed decision about whether they wish to participate in a service based on known costs and benefits. This is likely to be a prohibitive factor for new entrants who still need to develop an investment case, whereas established providers may have a broader knowledge of likely revenue.

At present the ability for intermittent generation to participate is limited without the use of storage. A lengthy contracting process, partnered with long contract durations often agreed ahead of time, means that for intermittent generators to participate in a service, the MW volumes for example must be limited to whatever can be guaranteed at any point in time, which could typically be equivalent to a storage unit, which minimises the revenue opportunity and essentially reduces the attractiveness of the service. There is also limited ability to take into account seasonal (and other) demand elasticity, where, for example, national demand is typically lower over summer, and in theory a lower contracted volume of national capability would still meet restoration timescales at a reduced cost to the end consumer.

Insights

- The project should consider ways to unbundle or reduce the technical requirements in order to access provision from parties who may otherwise be unable to participate.
- Consider ways to reduce the need for capital investment in order to enable switching between providers, increase liquidity ahead of contract award, reduce risk of market entry for providers.
- Consider ways to remove competitive advantage for ‘experienced’ or current Black Start providers, including knowledge and experience.
- Consider ways to improve transparency in relation to service revenues to enable providers to make informed decisions.
- Consider ways to include procurement closer to real-time, so that intermittent generation can accurately forecast output and participate effectively.
- Consider ways to take advantage of seasonal demand elasticity.

4.3.8 PESTLE analysis

PESTLE is a tool used to analyse the macro-environment and identify factors that could present risks or opportunities to achieving the objectives (section 4.2). Considering the possibility of a Black Start service from DER, the following have been identified by the ESO as factors that will have to be assessed, considered in conjunction with stakeholders, and where necessary mitigated or leveraged.

Table 4.2
PESTLE analysis summary

	To be reviewed and mitigated as threat or leveraged as opportunity
Political	• Brexit – accessing services via interconnectors • Brexit – codes and regulations • General election and nationalisation • Regulatory responsibility for coordination and procurement of Black Start
Economic	• Regulatory regime for cost recovery • Interest rates and costs of construction • Ease of entry to market • Ease of revenue stacking/business case • Liquidity of market and contestability • Supplier and buyer leverage • Investment required for providers to develop capability • Lead times for providers to develop capability • Resourcing requirement for all parties • Lead time on procurement (time ahead of active service) • Availability of credit/cost of financing • Internal project competition for potential service providers • Ability to hedge
Social	• Value of Lost Load • Restoration timescales and impact • Regulatory Black Start standard • Assessment of ‘economic and efficient’
Technological	• Technology Readiness Levels (TRL) of ‘new for Black Start’ technologies [10] • Innate abilities of ‘new for Black Start’ technologies and alignment with the technical requirements • Liquidity of each Black Start capability • Engineering viability of potential solutions • Viability of systems for procurement, performance monitoring, dispatch and settlement • Obsolescence of current and future technologies • Accuracy of forecasting to access intermittent generation • Other innovation projects/technological advancements within industry
Legal	• Codes and regulatory environment • Contractual design and reward/penalty system • Energy and reconciliation
Environmental	• Emissions legislation • 2025 ESO zero carbon ambition • Mitigation of climate risks (e.g. increased carbon taxing) • Impact on ambient conditions • Ability to access intermittent generation/renewables

The next steps to further our understanding of these areas is to ascertain whether these factors represent opportunities, threats (or potentially both), for which we will request input from stakeholders. Once these have been initially categorised, we will be able to develop strategies to mitigate the threats and leverage the opportunities as we further develop and refine the options for a procurement approach.

We expect these factors and any others presented during stakeholder engagement to support generation of ideas and in the next stages of the process initiatives.

4.3.9 Inputs – route to market

At present, there are essentially two routes to market, both of which are only accessible to providers who meet the full set of technical requirements, which as previously discussed are linked to the top-down restoration strategy.

If a potential provider meets the technical requirements, they can approach ESO and offer to develop a feasibility study to assess their contribution to a restoration, after which, assuming the study is successful, they can present an offer to the ESO which will be assessed in line with the Black Start Procurement Methodology. The second route follows the same process, but a potential provider is is invited by the ESO through a published competitive procurement event.

There are currently a number of providers who could potentially make a contribution to a restoration, but do not have a route to market to offer their services. To broaden participation, ESO has established 'combined services', where multiple parties who could not meet the technical requirements on their own, collaborate with 'partners' to present a full service between them to the ESO. If licences and regulated funding permitted it, this could include a DNO that contracts with DER in a given area to create a service with a capability, at the transmission-distribution interface point, that satisfies the existing technical requirements.

Insights

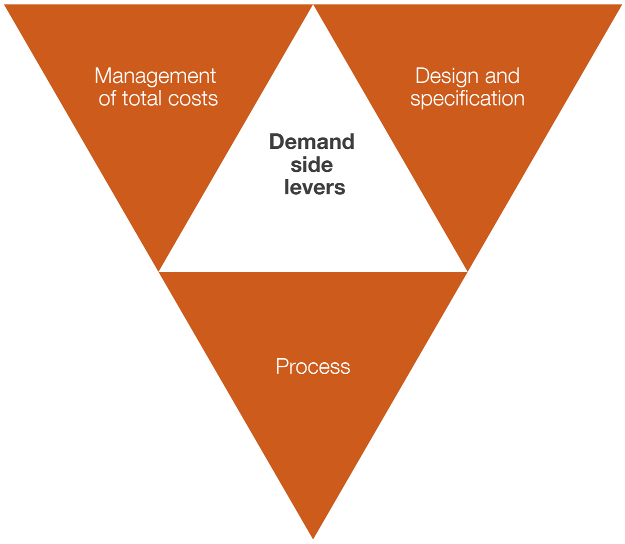
- Consider how the restoration strategy can be adapted in conjunction with the PET and OST workstreams.
- Consider the viability of a system that could assimilate component elements of what we currently know as a full service, so that parties with certain elements can offer these services to support a restoration.
- Consider the technical requirements from a functional perspective to identify current and future parties that may wish to participate and ensure that the routes developed are technology neutral.
- Consider that there may need to be multiple levels or entry points to a market to ensure access to all.
- Consider in conjunction with the OST workstream what the organisational structure of industry is likely to be in a restoration scenario.

4.4 Initiatives

The next stage of the strategy development process is to develop initiatives that aim to provide solutions to the considerations raised through the insights drawn from each of the tools used in the analysis section. At this stage of the process, and particularly considering the ground-breaking nature of the Distributed ReStart project, it is important to think in an unconstrained manner, and not rule out any idea presented.

Value levers, as shown in figure 4.5, can be used to provoke thoughts and develop these initiatives. As the project progresses, and the inputs are reviewed, developed and added to through stakeholder engagement, we expect to develop these further and in more detail. For now, using the insight drawn in the previous stage, and based only on what we know now, the following could be suggested:

Figure 4.5
Demand side levers



4.4.1 Demand side

Process: These are levers in the contracting process that could impact the delivery of the objectives, for example:

- forecasting
  - improving forecasting to more accurately reflect the requirement/required volumes
- compliance/assurance management
  - process evolution to provider-led assurance/self-certification
- enablement
  - smart, integrated systems that allow providers to self-service their contracts, 'bids' or tender submissions
  - access to data to allow providers to self-assess cost/benefit of providing.

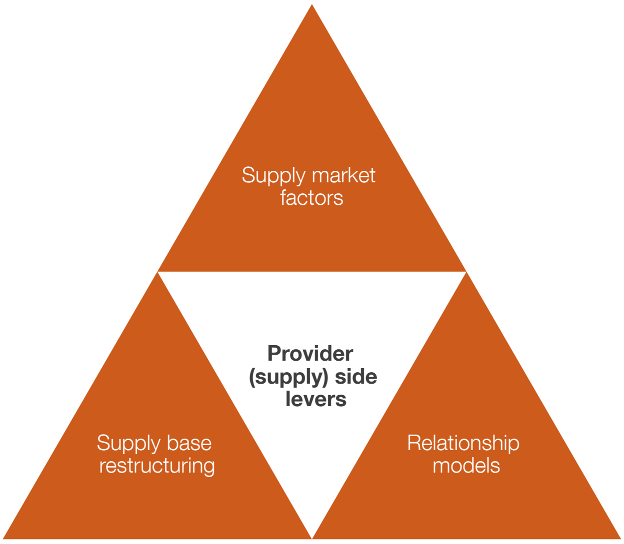
Design and specification: These are levers associated with the service design and specifications/technical requirements for the service that impact the delivery of the objectives, for example:

- harmonise specifications
  - ensure compatibility of technical requirements across any variants or components of the service
- functional specifications
  - ensure technical requirements are functional and based on an objective capability to remove 'assumed' barriers to entry.
- product substitution
  - are any of the components of a service more expensive, are there viable (functional) substitutes?
- de-proliferation
  - balance alternate services with competition levels, standardise where possible.

Total costs: These are levers based on a holistic view of the entire service/contract and all associated costs, for example:

- cost-bundling/unbundling
  - are total costs of service considered in value assessment, for example, testing and assurance?
  - can the elements/components of a service be unbundled to remove barriers to entry?
- demand management
  - can a hedging strategy be employed?

Figure 4.6
Provider side levers



4.4.2 Provider/Supply side

Supply base restructuring: These are levers that relate to the structure of the base of providers who may want to participate in a future service, for example:

- supply base expansion
  - remove barriers to entry to encourage participation of new entrants to the market
- supply base capability
  - assess the innate capability of the providers to deliver the technical requirements, and understand whether the components of a service can be aligned to reduce need for investment.

Supply market factors: These are levers that consider the whole supply market, for example:

- volume leverage
  - committing firm or baseline volumes to longer-term contracts
- consortium buying
  - can primary capital investment items be procured centrally?
- eAuction
  - drive competition on volumes above baseline requirement.

Relationship models: These are levers that consider changes to relationship models as a means to impact delivery of the objectives, for example:

- strategic partnerships
  - consider partnership approach for delivery of key strategic items where capital investment is highest
- product development
  - consider joint-development approach or consultation with industry so specifications are efficiently aligned with capability and fit for purpose
- performance incentives and EODs
  - consider how EODs and incentives (such as a pain-gain share) could be employed to drive performance within contract or within build and installation period.

4.4.3 Insights to initiatives

The primary timeline for developing initiatives to address these items will be in the next stage of the project, as we collect further insight and data on the inputs from stakeholders, however, at this stage, potential strategies could include:

- Develop commercial structure that allows participation in multiple timeframes, for example, day ahead for 24 hour contracts, month ahead (for example) for quarterly contracts, and quarter to year ahead of time for one year contract periods. This would allow the party responsible for procurement to hedge the requirement, at the same time as enabling intermittent generation to participate, thereby broadening participation and competition.
- Develop categories or components of a service by assessing market liquidity of each characteristic or capability. Use this to consider whether mandating certain characteristics could be in the best interests of the end consumer.
- Refine technical requirements into functional elements that can be split into components or 'lots', that allow parties to participate based on their existing capabilities, to minimise the investment needed to meet a wide range of bundled technical requirements. A smart system would likely be required to assimilate these components to meet closer to real time restoration timescales in line with minimum service levels, or a restoration standard following the introduction of one (see table 4.3 below for illustration).
- Systems integration to allow provider interface, which would interact with 'trading platform' style system, feeding in contract data to enable monitoring and dispatch.
- Develop methodology for procuring closer to real time to take advantage of seasonal and other demand elasticity.
- Develop a pre-qualification process and system interface where providers are able to self-serve and self-certify their capability to minimise resource bottlenecks for the party responsible for procurement.
- Develop transparent requirements to empower potential providers to make informed decisions about participating. Consider whether if there are enough smaller providers the requirements for not identifying them can be relaxed.
- Develop and be transparent regarding the full suite of restoration services to increase ability for buyer to 'substitute' and increase competitive rivalry.
- Develop, if possible, leading performance measures to prevent EODs, which is more valuable to the end consumer than enforcing penalties ex-post. Consider whether an appropriate incentive mechanism could be developed in this context.
- Design the end-to-end process to be lean and provider-led.
- Develop a value assessment model that considers the total costs of the service, and consider strategic ways to reduce the high spend areas.

Table 4.3
Example of procurement by lots. Please note this is an example and may not be reflective of the final design solution.

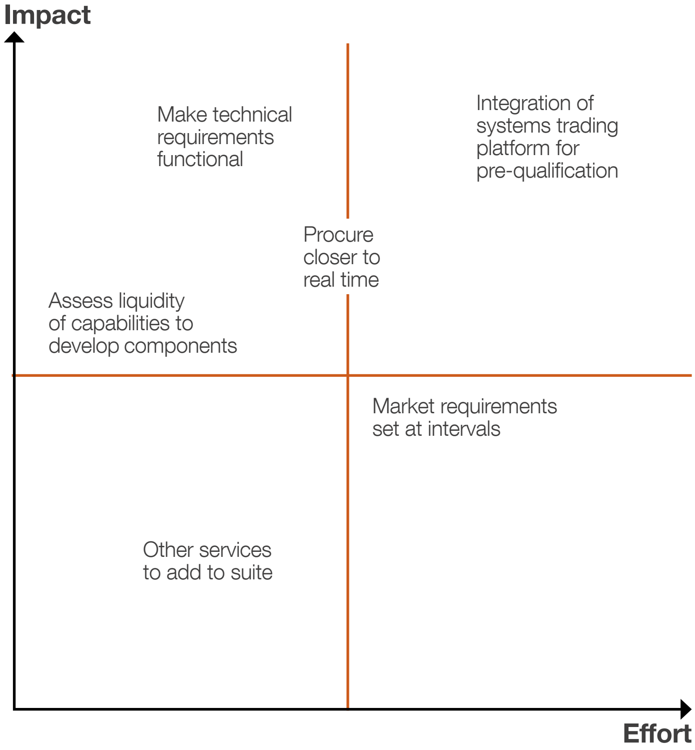
	Contracting durations and timeframes		
Lots	**1 year contract, procured quarter ahead**	**1 month contract, procured month ahead**	**24 hour contract, procured day ahead**
Lot 1	40%	30%	30%
Lot 2	Longer lots may provide the baseline service requirements	More capability may be procured to reflect seasonal demand changes	Shorter timeframe blocks may be used to enable non-dispatchable generation to participate
Lot 3			

4.5 Refine

The next stage is to take all of the suggested initiatives and assess them for impact and effort, which allows them to be arranged into a matrix. Initiatives in the top left quadrant have the highest impact and are easiest to implement so should be prioritised and tackled first.

In the next phase of the project, the P&C workstream will engage with industry to seek challenge and review on the information provided, and to gather wider perspective and insight to develop initiatives that meet the commercial objectives. As this happens, we can continue to assess each of these options, and prioritise accordingly. Based on what we know at present, we can surmise the following placement of our known initiatives into the impact/effort matrix in figure 4.7.

Figure 4.7
Impact to effort matrix



On completion of this, items in the top left quadrant should be prioritised, followed by those in the top right and bottom left. These priority initiatives should be taken forward to be developed in more detail, potentially into a number of options if more than one seems to be viable. A worked example taking on board the priority initiatives that have been generated so far will be presented in section 5 for reference. The detailed proposal or proposals should be presented back to our stakeholders to endorse.

4.6 Implement

Following satisfactory engagement with stakeholders and having received endorsement regarding the developed proposal or proposals, the project will develop an implementation plan which will detail how the proposals should be integrated and translated into holistic Black Start plans and procurement.

As the intention of the project is to be in a position to commence a procurement process as soon as reasonably practicable (and economic and efficient) to do so, consideration must be given early on to timing procurement for the existing Black Start service to align with the project.

This is in progress already, and through close interaction with the BAU Black Start service leads has been considered in the recently released 'Northern' competitive procurement event which covers a region including the North West, North East and Scotland Black Start zones.

An example of what this may look like is included in figure 4.8. This is, of course, subject to the requirement for capability. If there is no change in requirement, there may be no requirement to procure ahead of the end of the contract duration agreed for the two ongoing competitive procurement events. This timeline is illustrative and is subject to change if necessary.

Figure 4.8
Potential timeline for Distributed ReStart to be incorporated into the existing Black Start service (subject to change).

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	Ongoing
NIC	Phase 1; Phase 2	Phase 3	Implementation and procurement process		Future services commence					
SC, NE, NW – BAU	Current services endure, tender open		Tendered service duration							
SC, NE, NW – Future			Implementation and procurement process			Future services commence				
Mids, SW – BAU	Current services endure, tender open		Tendered service duration, procurement process for post contract opens							
Mids, SW – Future			Implementation and procurement process		Future services commence					
SE – BAU	Current services endure									
SE – Future			Implementation and procurement process		Future services commence					

Certainty of timing: High Medium Low

5. Developing options

To consider the options for procuring a future service, we have outlined a number of 'scenarios' which illustrate various points along the spectrum of procurement options, and have used worked examples to explore elements of these further. An effective solution will be developed through stakeholder engagement and iterating the strategy development process.

This section considers both procurement and commercial design in a combined approach.

For the purposes of this report, the options discussed below are purely illustrative to highlight a range of the many possible solutions that could be employed as a result of the strategy development.

It is possible that there may be a requirement for more than one solution, to access a wider range of participants or to access different types of services. An example of this could be 'bands' of a service, where some providers can energise further up the distribution and transmission networks, and depending on the market liquidity of the providers with these capabilities, different procurement methods may be appropriate.

This commercial design element in particular is especially difficult to speculate on, because the key areas of risk cannot be effectively identified until the structure of the functionality of the service has been developed.

This section will consider a number of scenarios and a worked example of how a route to market could work, as well as highlighting some of the variables and risk and opportunity levers as noted in section 3 – Intro to commercial design.

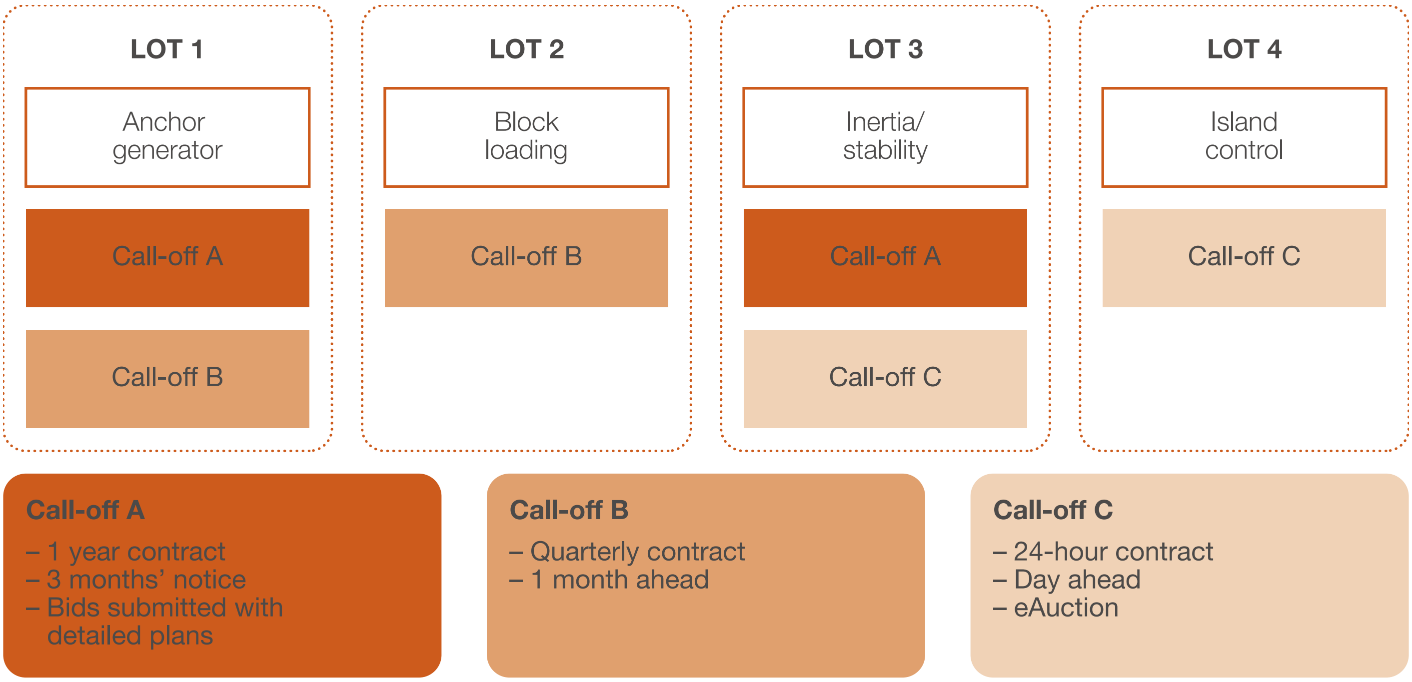
Typically, the following approaches are most appropriate for use in scenarios where the requirement is broadly aligned with their accompanying descriptions/characteristics. If the benefits of an approach are appealing, the requirement could be refined to be appropriate.

Table 5.1
Table of routes to market

eAuction	Frameworks	Open tender/Request for proposal (RFP)	Bilateral/Single source	Mandated
May also require a framework agreement. Requires an online platform where providers can bid against a requirement. Generally allows greater flexibility and suits shorter-term requirements/closer to real time procurement.	High level requirements are set and 'zero-value' contracts are agreed with more parties than are required. Closer to real time, mini-tenders can be used to 'call off' these contracts based on pre-agreed terms bound by the frameworks.	Requirements are set and published, providers submit a tender against an agreed timeline. New contracts are awarded each time. Generally useful for more complex requirements with solutions that take longer to develop.	Agreeing contracts independently with providers to access specific partnership/portfolio benefits. Typically useful in situations where liquidity is low, or where significant innovation is required to solve a challenge.	A solution where certain capabilities are required as a condition of connecting to the network.

Considering the complex and challenging scope of the Distributed ReStart project, it is likely that a combined bespoke solution would be required. Based on the initiatives and proposed strategies that have been developed using the insights drawn through the inputs and analysis, an example of a potential solution is detailed below.

Figure 5.1
Illustration of a potential market solution (details for illustrative purposes only)



A framework model is developed that sets out heads of terms, agreed characteristics and scope of service, and includes several 'lots', and multiple call-off procedures. Any provider can sign up to a framework agreement at any time, providing they meet the pre-qualification criteria to do so, and can register their capability to provide one or more of the service components that have been developed. At this point, there is no commitment of supply.

This enables the party responsible for procurement to access pools of capability (components set and defined by the buyer), to operate more flexibly depending on the requirement, and would allow for hedging of volumes by procuring in different timescales and using call-off methods appropriate to the requirement.

For example only:
Lot 1: forward contracts of a one year duration are available, where providers deliver the full set of characteristics and are 'rewarded' with firm, fixed-term contracts over a longer period. These may require proposals to be submitted and assessed manually, or may be adapted to allow auction style submissions. The buying party may agree that 40 per cent of the requirement for the period in question will be procured this way ahead of time.

Lot 2: eAuctions are run daily to procure against the remaining requirement for the period, this allows participation from intermittent generators too. The flexibility allows for a broader range of participation, and for the buyer to leverage demand elasticity, but increases the uncertainty for the buyer in the short-term ahead of the period of requirement. The data processing requirement is greatly increased, but the competitive tension is greatly increased too.

A number of lots could be combined with a number of call-off procedures for flexibility in options. figure 5.4 is demonstrative only; lots and corresponding call-off procedures would be determined based on balance of risk and benefit.

5.1 Risks and opportunities of associated processes

Considering some of the key stages of the process, and the associated risks and opportunities in the commercial design, the next section will aim to highlight how these could vary depending on what functional structure is implemented.

5.2 Worked example: feasibility assessment

Figure 5.2 shows a spectrum of possibilities for how the feasibility assessment process could be adapted, depending on what is suitable and appropriate for the approach.

At one end of this spectrum, the focus is on self-service and self-certification, where functional specifications are provided, and a provider can self-certify, or certify through an independent engineer that the requirements are met in order to participate in a tender. This approach would typically be lower cost to all involved, require less resource for the party responsible for procurement, but could potentially limit market-led innovation and limits control for the party whose ultimate responsibility it is to maintain the capability.

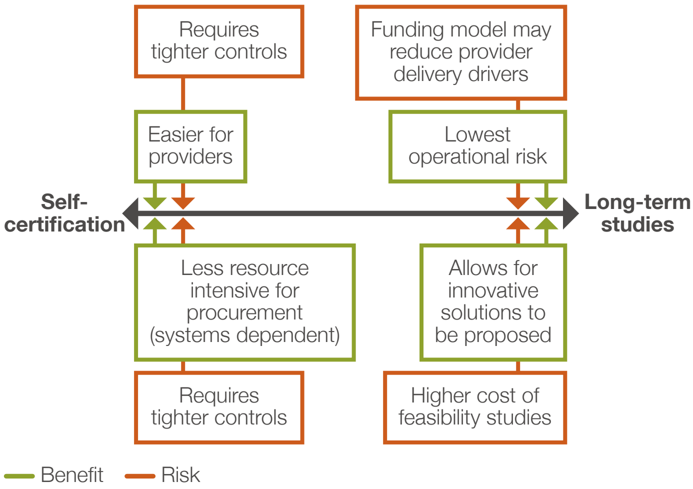
At the other end of this spectrum is an approach similar to what is employed at present, where in depth, bespoke studies are required to be produced by a potential provider and signed off by ESO before a provider can participate. Where these studies are paid for by another party, the incentive to innovate/maximise efficiencies could be reduced, but there is a high level of control and therefore confidence from the party responsible for procurement that the needs will be met.

If, for example, through further study over the course of the project, we determine that the component parts of a current service could be broken up and procured separately, it may be that each of these elements could have their own standards for pre-contract assurance, which sets an appropriate level of risk and opportunity for each party, for example (and for illustrative purposes only):

- Network considerations – perhaps the installation of microgrid controllers to ensure suitable network considerations could require more detailed studies and would tend to the right-hand side of the spectrum.
- Anchor generation – could potentially be proven by the statement of an independent engineer.
- Block-load capability – could potentially be proven by submission of generator capability curves and an accompanying statement from the equipment manufacturer.
- Frequency management – could be assessed in conjunction with the pre-qualification process for other balancing services to minimise rework.

While these hypothetical examples are illustrative only, the takeaway is that risk and opportunity for all parties can be balanced in a sensible way so that an appropriate level of assurance is set. This should be done in a coordinated way, bespoke to the functional solution that is proposed.

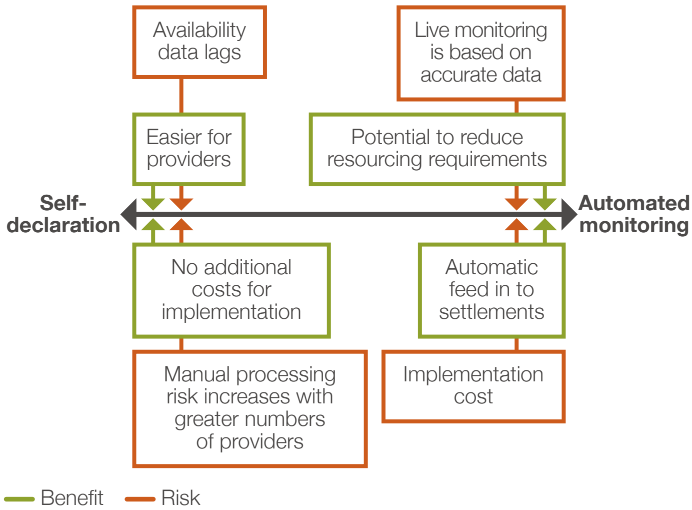
Figure 5.2
Considerations for feasibility assessment



5.3 Worked example: performance monitoring

Figure 5.3 shows a spectrum highlighting the extremes for operational and performance monitoring.

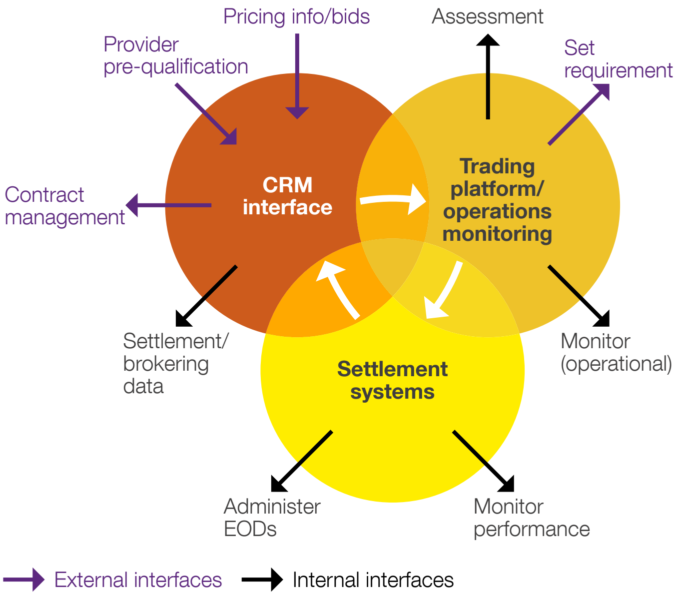
Figure 5.3
Considerations for operational and performance monitoring



The risks here are that operational monitoring relies on self-declarations from providers of the service, and there could be a lag between the actual point of unavailability and the declaration of unavailability. While the manual processing has been suitable so far, in a scenario where there are a greater number of providers, these risks are magnified.

At the other side of the spectrum is a world where smart systems monitor the key characteristics of Black Start capabilities, and feed into a dashboard system which can automatically notify the ENCC (or designated responsible party), when plant becomes unavailable. These systems are interlinked with the dispatch platform, settlements systems and Customer Relationship Management (CRM) system, so settlement for the service is automatically adjusted, taking into account real time data. This creates more accurate operational and contract management data, and makes settlement and EOD adjustment simpler, however, there is likely to be an implementation cost associated which may outweigh the benefits. There is, however, likely to be a middle ground that sets an acceptable level of cost and benefit. Figure 5.4 shows the anticipated functionality requirements for system integration in a future service.

Figure 5.4
Functionality of integrated future system



5.4 Assessment criteria

The assessment criteria discussed here are in relation to the method by which we will determine how appropriate a proposed solution is, and how well it meets the commercial objectives once these are agreed. For absolute clarity, these are not intended for assessing 'tenders' in an enduring solution.

The assessment criteria for determining how appropriate a proposed commercial solution is should be based on the objectives as discussed in section 4.1, which as yet have not been confirmed. Once consensus is reached on the objectives, through industry engagement in the next phase of the project, the methodology for assessing the solution can also be agreed. However, the aim of the strategic approach proposed in this report would support development of a tailored, fit-for-purpose solution with these objectives in mind throughout the end-to-end process, reducing the reliance on assessment of suitability at the end. At present, the success criteria for any solution to be implemented could include the following items, though as with the wider content of this report, we would anticipate challenge and review from industry peers to endorse them, and to develop the scoring mechanisms and weightings should we choose to use these.

Through industry engagement in the next year of the project, it will be important to understand what is most important to stakeholders in terms of determining the route to market for a service. This information will confirm which criteria should be used and will guide the setting of weightings for each.

5.5 Summary

It is crucial to consider and balance the risks and opportunities through the commercial design and procurement approach. This would be most effective once further confirmation of the engineering viability of different solutions has been completed and the functional structure of a future service has been outlined. A number of the types of solutions that would make the greatest commercial impact are likely to be heavily reliant on the introduction of smart, integrated systems to make them feasible. For example, as follows:

Table 5.2
An example assessment criteria

Criteria	Sub-criteria	Weighting/Value	Scoring
How well the solution meets project objectives	Reduce carbon emissions	To be developed through industry engagement	To be developed through industry engagement
	Reduce cost to end consumers		
	Accelerate restoration timescales		
How well the solution meets commercial objectives	Increased competition		
	Reduced barriers to entry		
	Increased transparency		
	Financial value for the end consumer		
	Functional route to market for new service		
Ease of engagement for service providers	Access to market information/details of requirement to inform participation		
	Level of self-service – self assessment and certification, ability to submit/adjust position		
	Access to options for participating, e.g. contract durations, procurement lead times		
Ease of delivery for party responsible for procurement/contracting	Engineering viability		
	Organisational viability		
	Systems viability		
	Contract management/personnel/resourcing requirements		
	Risk appetite – operational		
	Risk appetite – commercial		

6. Horizon scan – commercial

The aim of this section is to identify upcoming issues that have the potential to impact the commercial aspects of a future Black Start service from DER.

6.1 Restoration standard

The proposed Black Start Standard has been under review with the Department for Business, Energy & Industrial Strategy (BEI and is awaiting review by the Secretary of State.

The likely impact, assuming the standard is approved for implementation, is that a greater level of capability could be procured, and greater accuracy of operational monitoring and associated data will be needed for assurance.

6.2 Innovation projects

Network innovation projects of relevance to the commercial design for the Distributed ReStart service are detailed below, this does not provide a full or extensive list of all projects ongoing which may impact upon the project but outlines some wider industry activities which will provide supporting analysis for procurement requirements or commercial design.

NIA: Network islanding investigation
- Led by Western Power Distribution.
- Examines localised approaches to balancing the network; principally investigating at commercial opportunities, including a review of islanding overseas.

NIC: Power potential
- Led by National Grid ESO in partnership with UK Power Networks (UKPN).
- Aims to create a new reactive power market for distributed energy resources.

NIC: Electricity flexibility and forecasting system
- Led by Western Power Distribution.
- This project is to explore in detail the additional functionality required as a DSO.

NIA: Testing coordinated DSO-ESO procurement and dispatch
- Led by National Grid ESO.
- The project will trial one simple route to multiple flexibility markets via one platform.

NIA: demonstration of virtual synchronous machine control of a battery system
- Led by National Grid ESO.
- The project will deliver technical demonstration of the virtual synchronous machine functional specification.

NIA: Residential response
- Led by National Grid ESO.
- The project will develop new approaches for testing, monitoring and managing portfolios of residential-scale assets for participation in ESO balancing services.

NIA: Short-term inertia forecast
- Led by National Grid ESO.
- This innovation project involves, for the first time, investigation of the feasibility of a data-driven approach to provide multi-time resolution inertia forecasts with high accuracy.

NIA: Frequency response auction trial
- Led by National Grid ESO.
- This project will enable understanding of the impact of closer-to-real-time procurement.

NIA: Virtual stat-com
- Led by Western Power Distribution.
- This project will implement an algorithm in power system analysis software, which controls and coordinates the power factor of existing generators in order to increase network capacity.

NIA: A holistic intelligent control system for flexible technologies
- Led by Scottish Power Energy Networks.
- This project will investigate the potential use of a holistic intelligent control system for the power network.

NIA: Customer-led distribution system
- Led by Northern Power Grid.
- The project will identify and demonstrate the most appropriate market design and industry structure for distributed energy markets and distribution network management and the roles of DSOs within this.

NIA: Micro resilience
- Led by Northern Power Grid.
- The project will assess the technical viability and comparative economics (including non-financial benefits) of smart technology enabled resilience.

NIA: The planning data exchange system between network licencees to enable a smarter grid
- Led by Scottish Power Energy Networks.
- This project will deliver a software interface list, and communication specifications, including a roadmap to implementation.

6.3 The DSO transition

Of key importance across all workstreams is the role of a future DSO because finding synergies with wider network and organisational changes will deliver the greatest value to the consumer. Distributed ReStart will align its outputs with the ENA Open Networks project to achieve this. Focus will be given to the flexibility services; whole electricity system planning and T-D data exchange, and DSO transition workstreams due to the potential impact on an optimised commercial design.

6.4 Updates to Black Start strategy & procurement methodology

The current cost recovery regime for Black Start services is an ex-post assessment of whether spend incurred in each relevant year is determined to be in line with the agreed Black Start Strategy and Black Start Procurement Methodology. Respectively, these documents set out the restoration strategy, and the associated commercial mechanisms and principles that are used to contract against it.

Updates will either need to be made to these documents, or to the regime, to accommodate a new or amended Black Start service from DER. The programme for making updates to these is to submit the amendments to the regulator for review no later than 12 months following the date on which the previously approved methodologies started, after which the Authority has three months to review and come to an approval decision. Updates can, however, be made more often as required.

This timeline will have to be considered, as updates or a new regime will have to be implemented ahead of any spend decisions being made under a new service.

Distributed ReStart

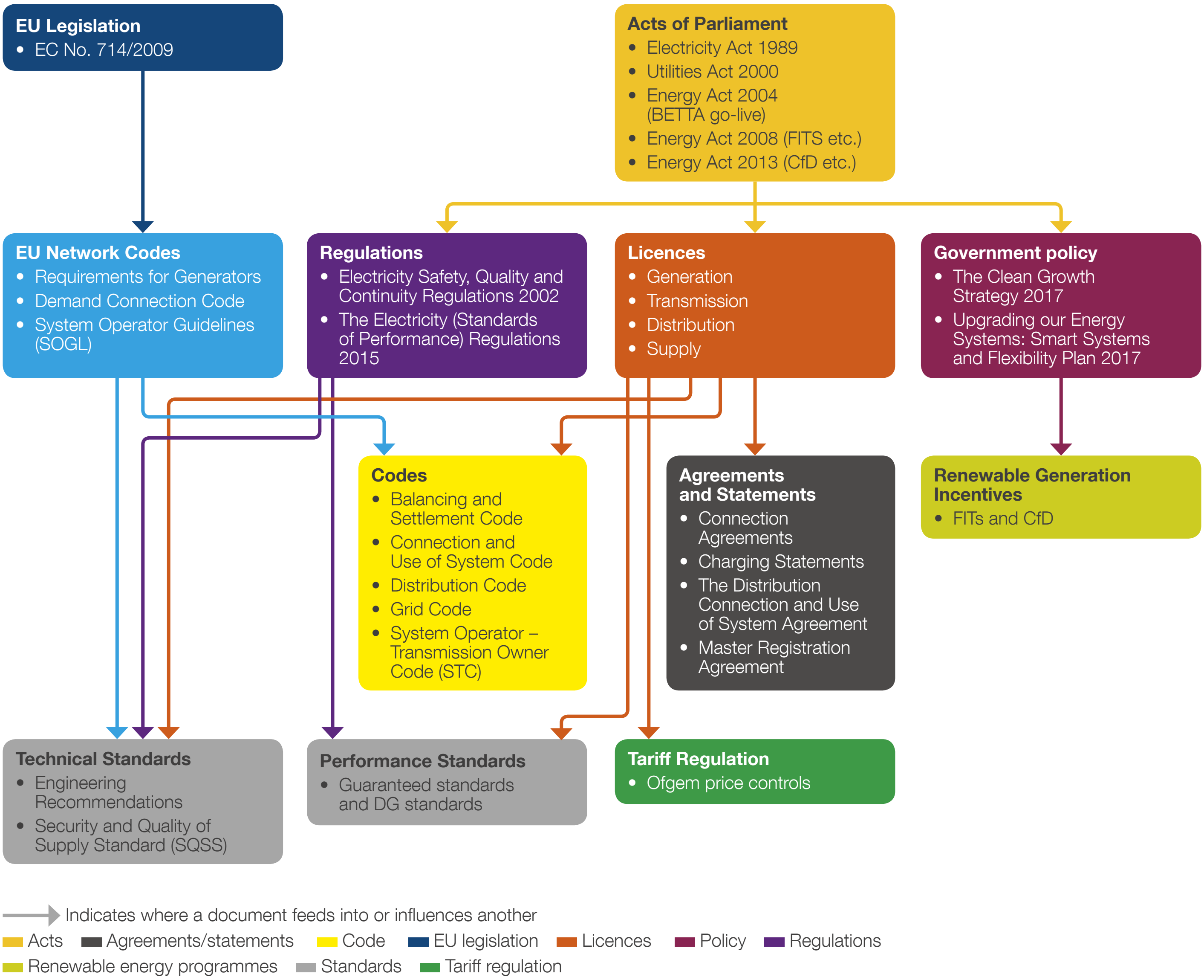
Codes

7. Review of codes

Network operation is governed by a range of policies, regulations, codes and standards.

These different policies, regulations, codes and standards are all linked and interact in different ways, as shown in figure 7.1.

Figure 7.1
Interaction and hierarchy of network policies, regulations, codes and standards [Source: ENA Distributed Generation Connection Guide, 2019]



The Third Energy Package of EU Network Codes has seen eight codes come into force as UK law. There are three Grid Connection Codes, three Market Guideline Codes, and two System Operation Codes [16]:

- GC: Requirements for Generators (RfG)
- GC: High Voltage Direct Current (HVDC)
- GC: Demand Connection Code (DCC)
- MG: Capacity Allowance and Congestion Management (CACM)
- MG: Forward Capacity Allocation (FCA)
- MG: Electricity Balancing Guideline (EBGL)
- SO: System Operation Guideline (SOGL)
- SO: Emergency and Restoration (NCER)

The standards and requirements within these EU Network Codes filters down into the GB-specific documents e.g. Grid Code. System restoration requirements and procedures are embedded across a number of these codes and standards, and so any proposed changes in the restoration procedures of a network must be reflected in each of these documents in turn.

Code and Policy Interdependencies

It can be seen from figure 0-1 that there are significant interactions and interdependencies of the regulations, codes, policies, standards, etc that govern the GB electrical system. This review, as stated, does not cover all of these documents and instead has covered those understood to be most relevant when considering a Distributed ReStart.

There are extensive interdependencies between several of the documents. For example:

- The Grid Code outlines the requirements for connection and development of the National Electricity Transmission System (NETS) and it is a requirement of the CUSC that all new connections comply with the Grid Code.
- The ESQCR outlines regulations for minimum security and safety measures to be taken by all network operators and users, including generators.

It is important therefore, that any changes made in respect of new Black Start service provision are streamlined appropriately across all relevant documentation. This review exercise is an early step in identifying the significant coordination effort that will be required to ensure all documents, and indeed participants, are accounted for and adequately informed on their responsibilities.

The following sections detail the key findings in the code review exercise.

Stakeholder Engagement

A number of key stakeholders were consulted as part of this review and horizon scanning exercise. National Grid ESO, the Energy Networks Association (ENA), several DNOs and generators were consulted and provided assurance across a wide perspective on the code review. The stakeholders provided important contributions, both in validating the outcomes and in identifying potential gaps and areas of interest or concern.

7.1 Review of current codes

As part of the Procurement & Compliance workstream of the Distributed ReStart project, a review of the relevant network codes and policies will highlight what changes will likely be required to accommodate system restoration provision from renewable and Distributed Energy Resources (DERs). A number of codes and policies have been reviewed at this stage to highlight the most relevant considerations:

- Grid Code
- System Operator Transmission Owner Code (STC)
- Distribution Code
- Security and Quality of Supply Standard (SQSS)
- Electricity Safety, Quality and Continuity Regulations (ESQCR)
- Engineering Recommendations – G99, P2, P28, P29 and G5
- Connection and Use of System Code (CUSC)
- Distribution Connection and Use of System Agreement (DCUSA)
- Balancing & Settlement Code (BSC)
- Telecoms & Cyber Security (from various codes)

This review is not exhaustive and aims to draw attention to some fundamental requirements and considerations related to Black Start and system restoration as the energy landscape evolves. Recognising that there is a lot of ongoing activity in the industry that could also impact how these codes develop, a horizon scanning exercise has also been undertaken to map out important effects and key changes.

Grid Code (Issue 5, Revision 38)

The Grid Code [17] is the technical code for connection and development of the NETS. It sets out the compliance requirements and conditions that connected parties must meet to ensure the safe and reliable operation of the NETS. Compliance with the Grid Code is set out as a requirement within the CUSC. The Grid Code Review Panel maintains the Grid Code. There is open governance which means that any party can propose a Grid Code modification for the Panel to consider. Any changes are subject to industry consultation and approval by the Office of Gas and Electricity Markets (OFGEM).

Legacy Black Start and system restoration arrangements have considered a top-down approach with transmission-connected generators providing this service. As such, the Grid Code is one of the key documents that will have to adapt to account for future arrangements in this area i.e. a Distributed ReStart.

A key step to achieving this could be around the definition of a Black Start Station. At present, the term Black Start Station is understood to mean a single plant or site in England and Wales with a Bilateral Agreement (**OC9.4.5**). Restoration is achieved through Local Joint Restoration Plans (LJRP) in which a Black Start Station provides the initial energisation (**OC9.4.5.2**).

OC9.4.5.2	For each **Black Start Station**, a **Local Joint Restoration Plan** will be produced jointly by **The Company**, the relevant **Generator** and **Network Operator** in accordance with the provisions of OC9.4.7.12. The **Local Joint Restoration Plan** will detail the agreed method and procedure by which a **Genset** at a **Black Start Station** (possibly with other **Gensets** at that **Black Start Station**) will energise part of the **Total System** and meet complementary local **Demand** so as to form a **power island**.

In Scotland however, the term can mean a group of plants or sites in an area, and the LJRPs reflect this (**OC9.4.5.3**).

OC9.4.5.3	In respect of **Scottish Transmission Systems**, a **Local Joint Restoration Plan** may cover more than one **Black Start Station** and may be produced with and include obligations on **Relevant Scottish Transmission Licencees**, **Generators** responsible for **Gensets** not at a **Black Start Station** and other **Users**.

The latter also refers to Scottish transmission licencees and Generators having responsibilities in an LJRP; Distribution Licencees will likely have to be included in future. Operational instructions for LJRPs are detailed in clause **OC9.4.7.6** of the Grid Code.

In future, the term of a Black Start Station should be reviewed to ensure the most appropriate definition is outlined. For example, it could cover multiple generators in an area (such as happens on Scottish networks), or simply encompass any generator with Black Start capability, inclusive of DER, which would facilitate the creation of power islands on lower voltage networks. Additionally, the existing LJRPs used for Scotland could form the template to set out the requirements for distribution power islands.

Presently, a Large Embedded Generator (i.e. connected to a distribution network) has different threshold levels across the three transmission licence areas: 100MW for National Grid Electricity Transmission (NGET); 30MW for Scottish Power Transmission (SPT) and 10MW for Scottish Hydro Electricity Transmission (SHE-T). National Grid ESO (NGESO) is the System Operator across all three licence areas. It is generating sites of these sizes which are subject to Bilateral Agreements and, as such, may be considered as Black Start Stations. Changes to these threshold values, or caveats around Black Start provision, will be required to include smaller capacity providers in several relevant Grid Code sections. An example of this is:

- **PC.A.5.7** which states that data (related to Black Start) is to be provided only by Large Power Stations. This would have to be modified to include all Black Start-capable generation.

PC.A.5.7	Black Start Related Information Data identified under this section PC.A.5.7 must be submitted as required under PC.A.1.2. This information may also be requested by **The Company** during a **Black Start** and should be provided by **Generators** where reasonably possible. **Generators** in this section PC.A.5.7 means **Generators** only in respect of their **Large Power Stations**.

In clause **OC5.7** regarding Black Start Testing, self-starting and grid-forming services are considered. Further restoration support services are not explicitly included. Additionally, instances whereby more than one plant or site combine to provide a service e.g. wind farm with battery energy storage plus a remote thermal plant, are not considered. Nor is the provision of partial Black Start services by a single (or multiple) sites, as could be the case in future with, for example, a battery energy storage site providing only frequency support to a power island.

Clause **OC5.8** outlines procedures applying to embedded medium power stations and embedded DC/HVDC converter stations not subject to a Bilateral Agreement. The clause states that DNOs are responsible for any testing as well as communications with the ESO. There is potentially an opportunity here to allow DNOs to set the requirements here in respect of Black Start Testing e.g. permit larger frequency variations.

The requirements for contingency planning are set out in OC9, with three key subsections: Black Start (**OC9.4**); Re-synchronisation of de-synchronised islands (**OC9.5**); and Joint System Incident Procedure (including Civil Emergencies) (**OC9.6**). The sections in **OC9.4** specifically outline, in detail, the procedures for all users of the transmission system in the event of a partial or Total Shutdown, outlining Black Start and operation of LJRPs, and sets out the plan for interconnecting power islands. Changes to these sections will depend on how a future restoration procedure looks but it is likely large sections could be applied, while ensuring new restoration participants (generators, DNO, DSO, etc.) are accounted for.

Some examples include:

- **OC9.4.6** allows SPT or SHE-T to declare a Black Start situation. A similar permission could be established for DNO/DSOs.

OC9.4.6	In respect of **Scottish Transmission Systems**, in exceptional circumstances, as specified in the **Local Joint Restoration Plan**, **SPT** or **SHETL**, may invoke such **Local Joint Restoration Plan** for its own **Transmission System** and **Scottish Offshore Transmission Systems** connected to it and operate within its provisions.

- **OC9.4.7.7** states the ESO is responsible for re-synchronising islanded networks, with further details also provided in **OC9.5**. There could be an option to delegate this to a DSO in future, under the appropriate circumstances.

OC9.4.7.7	**The Company** will instruct the relevant **Users** so as to interconnect **power islands** to achieve larger sub-systems, and subsequently the interconnection of these sub-systems to form an integrated system. This should eventually achieve the re-establishment of the **Total System** or that part of the **Total System** subject to the **Partial Shutdown**, as the case may be. The interconnection of **power islands** and sub-systems will utilise the provisions of all or part of OC9.5 (**Re-Synchronisation of De-synchronised Islands**) and in such a situation such provisions will be part of the **Black Start**.

Related to this is clause **OC9.2.4** which sets out the objective of **OC9** and the role Scottish Transmission Systems and Scottish transmission licencees have in the various procedures.

OC9.2.4	To describe the role that in respect of **Transmission Systems**, **Relevant Transmission Licencees** may have in the restoration processes as detailed in the relevant **OC9 De-Synchronised Island Procedures** and **Local Joint Restoration Plans**.

This particular clause will likely have to be extended to include a description of the role for DSOs (in England and Wales, as well as in Scotland).

Another key section in the Grid Code is **BC2.9**, Emergency Circumstances, which is referred to extensively in **OC9**. The section details circumstances whereby emergency actions are required and what these actions can consist of. Communication between the ESO and DER will likely have to be defined here. It should be noted that legacy DER may not have the required “Control Point” noted in **BC2.9.1.3**, and would have to install the necessary communications equipment to enable their Black Start capability.

BC2.9.1.3	In the case of **BM Units** and **Generating Units** in **Great Britain**, **Emergency Instructions** will be issued by **The Company** direct to the **User** at the **Control Point** for the **BM Unit** or **Generating Unit** and may require an action or response which is outside its **Other Relevant Data**, **QPNs**, or **Export** and **Import Limits** submitted under **BC1**, or revised under **BC1** or **BC2**, or **Dynamic Parameters** submitted or revised under **BC2**.

Summary of potential changes in Grid Code

Clause/Section	Potential changes
OC9.4.5, OC9.4.5.2. OC9.4.5.3, OC9.4.7.6	Inclusion of Distribution Licencees and other relevant parties in LJRPs.
PC.A.5.7	Inclusion of all Black Start-capable generation
OC5.7	Inclusion of additional restoration support services, and provision of services from multiple sites.
OC5.8	Allow for DNOs to set requirements for Black Start Testing.
OC9	Ensure permissions for all restoration participants are accounted for throughout clauses.
OC9.2.4	Description of the role of DSOs.
BC2.9	Define communications requirements between ESO and DER.

System Operator Transmission Owner Code (STC) (1 August 2019)

The System Operator Transmission Owner Code (STC) [18] defines the relationship between the transmission system owners and the System Operator. In GB, the Transmission Owners (TO) are National Grid Electricity Transmission (NGET), SPT and SHE-T and the System Operator is NGESO. **Section C, Part 3** of the STC details:

1.1.1; 1.1.2; 1.1.3	This Section C, Part Three deals with: 1.1.1 the Testing of each Transmission Owner's Transmission System and arrangements between the Parties to facilitate the testing and commissioning of User Equipment; 1.1.2 Transmission Owners entering into Interface Agreements with Users in relation to Connection Sites and New Connection Sites; and 1.1.3 other operational matters including Event Reporting and Joint Investigations, Black Start, and the De-energisation of User Equipment.

Operational matters relating to Black Start (**1.1.3** above) are outlined in **Section 5** of **Section C, Part 3**.

5.1.1	Notwithstanding that a Transmission Owner is not a party to the CUSC and is not thereby required to comply with the Grid Code, a Transmission Owner shall comply with sections OC9.4 and OC9.5 of the Grid Code (as amended from time to time) and any Local Joint Restoration Plan and OC9 De-Synchronised Island Procedure agreed with the Transmission Owner pursuant to those sections.
5.1.2	NGESO shall comply with, and shall procure that a User shall comply with sections OC9.4 and OC9.5 of the Grid Code and any Local Joint Restoration Plan or OC9 De-Synchronised Island Procedure agreed pursuant to OC9.4 or OC9.5 where and to the extent that such section applies to NGESO and the User.

It can be noted that the STC does not currently refer to any DER or liaison with DNOs during a Black Start, instead outlining coordination between TOs and NGESO. This may need to extend to include NGESO coordination with DNOs, between TOs and DNOs, etc. Alternatively, a similar code may need to be established to account for DNO and DSO collaboration, and this would also likely require some coordination with TOs and/or NGESO.

Within the STC are the STC Procedures which set out roles and responsibilities of different parties under different circumstances. STCP 06–1 pertains to Black Start.

STCP 06–1 Issue 006 Black Start (Issue 006, April 2019)

The STCP 06–1 document [19] details planning and procedures required by NGESO and the TOs to manage the Black Start and restoration effort on the GB power system.

NGESO is responsible for establishing the overall Black Start for the transmission system as stated in Section **3.1.1**, which includes Black Start Stations and other power stations which are part of an LJRP.

3.1.1	NGESO shall establish the overall Black Start for the TOs' Transmission Systems. This shall require Black Start Stations and other Power Stations to be party to Local Joint Restoration Plans. Where an offshore network connects within an onshore network covered by a Local Joint Restoration Plan (LJRP) the offshore TO shall not be a party to the Local Joint Restoration Plan and the offshore TO network will not be connected to the onshore TO network until the LJRP has been terminated as outlined in sections 3.4.11, 3.4.12 or 3.4.14 and NGESO have taken control of co-ordination of the interconnection of both systems.

As described in the Grid Code review previously, NGESO has overall responsibility to declare a Black Start, but there are several clauses which give permissions to the Scottish TOs. It may be required to account for giving permissions to DNO/DSOs, either within the Grid Code or the Distribution Code.

Section **3.2.1** describes LJRPs and, similar to the Grid Code description of the same, there is no mention of DNO/DSO participation currently included in this process. The description would need to be updated alongside any corresponding changes in the Grid Code. Section **3.2.2** provides guidance on the creation of a new LJRP while Section **3.2.3** outlines the procedure for changes to an existing LJRP; these should also be updated to include all relevant parties (DNO, DSO, Black Start capable-DER) in line with changes in other code documents to reflect wider participation.

Section **3.4.5** of the STCP 06–1 provides information on the operation of power islands, specifically that they should operate under the following conditions:

- The frequency on the Transmission System shall be nominally 50Hz and shall be controlled within the limits 49.5–50.5Hz;
- The voltage on the Transmission System shall normally remain within –/+5 per cent of nominal. The minimum voltage is –10 per cent and the maximum is +10 per cent of nominal. Voltages of +10 per cent and –5 per cent should not prevail for more than 15 minutes.

There are also guidelines on responsibilities for the duration of the power island (Sections **3.4.6–3.4.10**), and interconnection of multiple power islands (**3.4.11**). As before, DNO/DSOs are not included in these clauses and so they should be updated to reflect any future changes in the creation and operation of a power island. Or, as suggested before, if there is a distribution-specific STC created for DNO/DSO interactions, limits for power islands created at distribution level will need to be considered and agreed.

Summary of potential changes in STC and STCP 06–1

Clause/Section	Potential changes
STC 5.1.1, STC 5.1.2	Extend to include coordination of ESO with DNOs, TOs with DNOs etc. Provision of separate STC for distribution networks to account for DNO and DSO collaboration. This would also likely require coordination with TOs and ESO.
STCP 06–1 section 3.1.1	Account for permissions of DNO/DSOs to declare a Black Start.
STCP 06–1 section 3.1.2	Account for DNO/DSO participation in LJRPs.
STCP 06–1 sections 3.2.2, 3.2.3	Inclusion of all relevant participants in the creation of and changes to LJRPs.
STCP 06–1 sections 3.4.5–3.4.11	Inclusion of DNO/DSO responsibilities for the creation and management of power islands.

Distribution Code (Issue 42, September 2019)

Licenced distribution network operators (DNO) are required to maintain and adhere to the Distribution Code [20], which sets out the technical requirements and conditions for the connection to, and operation of, their distribution networks. The Distribution Code is the distribution network equivalent of the Grid Code. Currently, all UK DNOs work under the same version of the code, and it is maintained by the Distribution Code Review Panel, with modifications requiring approval by OFGEM.

The Distribution Code outlines contingency planning procedures (**DOC9**), covering Black Start (**DOC9.4**), re-synchronising Islands (**DOC9.5**), Joint System Incident Procedure (**DOC9.6**) and Civil Emergencies (**DOC9.7**). All of these are also covered in the Grid Code (**OC9**) in more detail, as described in the previous section. In the event that system restoration services are to be provided from DER, the above sections of the Distribution Code will have to provide more detail around these procedures, or at least clearly signpost to the Grid Code requirements (making sure to specify what clauses apply to what service providers).

Of those conditions that are provided in these sections of the Distribution Code, the following are of interest:

- For Black Start, **DOC9.1.1** and **DOC9.4.1.4** refer to the Grid Code and the requirements of NGESO. No specific Black Start requirements are set out for distribution networks.

DOC9.1.1	**Black Start** This **Distribution Operating Code** DOC9 covers the requirements for the implementation of **Black Start** recovery procedures following a **Total Shutdown** or **Partial Shutdown** of the **Total System** as recognised by **NGESO**. The **Black Start** procedure provides for the recovery of the **Total System** in the shortest possible time taking into account **Power Station** capabilities and the operational constraints of the **Total System**, in accordance with the **Grid Code** and the requirements of **NGESO**.
DOC9.4.1.4	For each **Black Start Station** plans will be put in place, in accordance with the **Grid Code**, which in the event of a **Partial Shutdown** or **Total Shutdown**, will provide for the establishment of a **power island**. These plans are known as Local Joint Restoration Plans produced jointly by **NGESO** the **DNO** and **Generators** and may include **Embedded Generators**. **DNOs** will be party to these Plans irrespective of whether the **Black Start Station** is **Embedded**.

All Power Generating Modules (PGM) are required to trip off (Loss of Mains protection, Under/Over Voltage protection) when the grid is lost as per **DPC7.4.3**. On the other hand, **DPC7.4.7** allows the DNO to operate isolated networks. In order to achieve that, **DPC7.4.3** (protection) may have to be changed such that Loss of Mains and other protection preventing islanded operation are only permitted when sanctioned by the relevant DNO or NGESO.

- **DOC9.4.1.1** and **DOC9.4.1.2** note that deviation from technical requirements and market suspension may be necessary during a shutdown.

DOC9.4.1.1	During a **Total Shutdown** or **Partial Shutdown** and during the subsequent recovery the Security Standards set out in, or deriving authority pursuant to, the **Transmission Licence** and the **Distribution Licence** may not apply and the **Total System** may be operated outside normal voltage and **Frequency** standards.
DOC9.4.1.2	In a **Total Shutdown** or **Partial Shutdown**, it may be necessary for **NGESO** to issue Emergency Instructions and it may be necessary to depart from the normal **Balancing Mechanism** operation in issuing Bid-Offer Acceptances.

This protects the ESO from difficulties in maintaining these requirements through an emergency situation. It could impede transparency however e.g. a clear rule set for operation, yet it is recognised in **DOC9.4.3.2** that a flexible approach to Black Start is required and it would be extremely difficult to enforce any definite rules during such an event.

DOC9.4.3.2	The complexities and uncertainties of recovery from a **Total Shutdown** or **Partial Shutdown** require that **Black Start** is sufficiently flexible in order to accommodate the full range of **Power Generating Module** and **Total System** characteristics and operational possibilities and this precludes the setting out of concise chronological sequences. The overall strategy will in general include the overlapping phases of establishment of isolated groups of **Power Generating Facilities** together with complementary local **Demand** termed **"power islands"**, step by step integration of these groups into larger sub-systems and eventually re-establishment of a complete **Total System**.

- In clause **DOC9.4.1.5**, the LJRP for Scotland is outlined, noting one "may include more than one Black Start Station". This will likely have to be extended to all of GB, and also include obligations on Distribution Licencees (as well as the existing transmission licencee and Generators with responsibilities). This is mirrored by changes to the corresponding Grid Code clause (**OC9.4.5.3**).

DOC9.4.1.5	In Scotland a Local Joint Restoration Plan may include more than one **Black Start Station** and may be produced with and include obligations on the relevant **Transmission Licence, Generators** responsible for **Power Generating Modules** not at a **Black Start Station** and other **Users**.

- According to **DOC9.4.3.4**, the procedure for a Black Start will be specified by a transmission licencee, yet it gives authority to DNOs to issue instructions which might appear to conflict with the overall Black Start strategy.

DOC9.4.3.4	The procedure for a **Black Start** shall, therefore, be that specified by the **relevant Transmission Licencee** at the time. **Users** shall abide by the **DNO's** instructions during a **Black Start** situation, even if they conflict with the general overall strategy outlined in DOC9.4.3.2.

- **DOC9.4.3.8** states that the conclusion of a Black Start will be determined by a transmission licencee who shall in turn inform the DNO. This will likely have to be expanded to include a DSO (as well as a transmission licencee) who can determine the conclusion of a Black Start.

DOC9.4.3.8	The conclusion of the **Black Start** situation and the time of the normal operation of the **Total System** will be determined by the relevant **Transmission Licence** who shall inform the **DNO**. The **DNO** will inform Users of the **DNO's Distribution System** which in the **DNO's** opinion need to be informed that the **Black Start** situation no longer exists and that normal operation of the **Total System** has begun.

Isolated distribution network operation and microgrid formation is permitted under emergency conditions within clause **DPC7.4.7 – Frequency Sensitive Relays**.

DPC7.4.7	**Frequency Sensitive Relays**	
	It is conceivable that a part of the **DNO's Distribution System**, to which **Embedded Generators** are connected can, during emergency conditions, become detached from the rest of the **System**. It will be necessary for the **DNO** to decide, dependent on local network conditions, if it is desirable for the **Embedded Generators** to continue to generate onto the islanded **DNO's Distribution System**. If no facilities exist for the subsequent re-synchronisation with the rest of the **DNO's Distribution System** then the **Embedded Generator** will under **DNO** instruction, ensure that the **Power Generating Module** and/or **Embedded Transmission System** is disconnected for re-synchronisation.	

The clause permits the DNO to allow an isolated network to operate, assuming safe operation is possible and suitable facilities exist for the subsequent re-synchronisation e.g. synchronising breaker. Implementation of such equipment could be required for all Black Start-capable embedded generators who would participate in a power island.

In clause **DPC7.4.8**, it is stated that a Power Generating Module with Black Start capability does not have to notify the DNO if NGESO has already been informed under Grid Code requirements. If DSOs are to take more responsibility for some local aspects of Black Start, this clause will have to be amended to reflect this.

DPC7.4.8	Black Start Capability
	The **National Electricity Transmission System** will be equipped with **Black Start Stations** (in accordance with the **Distribution Operating Code DOC 9**). It will be necessary for each **Embedded Generator** to notify the **DNO** if its **Power Generating Module** has a restart capability without connection to an external power supply, unless the **Embedded Generator** shall have previously notified **NGESO** accordingly under the **Grid Code**. Such generation may be registered by **NGESO** as a **Black Start Station**.

Summary of potential changes to Distribution Code

Clause/Section	Potential changes
DOC9	Provide more details for DER; or clear signposting to corresponding Grid Code sections (OC9).
DPC7.4.3	Ensure Loss of Mains and other protection preventing islanded operation are only permitted when sanctioned by the relevant DNO or NGESO.
DOC9.4.1.5	Extended to include all of GB and also include obligations on Distribution Licencees (as well as the existing transmission licencee and Generators with responsibilities).
DOC9.4.3.8	Expanded to include DSO.
DPC7.4.8	Extend to include notification to DSO.

Security & Quality of Supply Standards (SQSS) (Version 2.4, April 2019)

The Security and Quality of Supply Standards (SQSS) [21] set out the criteria and methodologies for planning and operating the National Electricity Transmission System (NETS). They provides a coordinated approach for transmission licencees (onshore and offshore) to adhere to when designing connections to the onshore transmission system, as well as planning upgrades and reinforcements to the NETS. The SQSS provides the minimum operating standards, ensuring equipment is rated appropriately, and sufficient redundancy is available, etc.

Section 5 of the SQSS outlines criteria for operation of the Onshore Transmission System, and within this section are Conditional Further Operational Criteria which are relevant for adverse conditions, such as instability or overloading.

5.7	In the case that neither of the conditions in paragraphs 5.5.1 and 5.5.2 is met, it is acceptable to utilise short-term post fault actions to avoid *unacceptable overloading of primary transmission equipment* which may include a requirement for demand reduction; however, this will not be used as a method of increasing reserve to cover abnormal post fault generation reduction. Where possible these post fault actions shall be notified to the appropriate *Network Operator or Generator*. Normally the provisions of the Grid Code, in respect of Emergency Manual Demand Disconnection and/or, for example through *balancing services*, will be applied. Additional post fault actions beyond the Grid Code provisions may be applied, but only where they have been agreed in advance with the appropriate *Network Operator or Generator*.

Current practice dictates that once a Black Start has been formally declared by ESO to Elexon and the market participants, the SQSS is officially suspended. However, the limits for 'system' frequency quoted in ESQCR still apply (50Hz +/–1 per cent).

There is therefore no specific reference to Black Start or system restoration conditions in **clause 5.7**. System restoration could be handled explicitly within the SQSS in a Distributed ReStart future, with the criteria including the minimum technical requirements in a power island (or other islanded network areas). This would cover acceptable voltage and frequency limits, thermal loading of network components, system stability performance, sub-synchronous oscillations, etc.

Section 6 deals with **Voltage Limits** across planning and operational timescales, but again there is no specific clause for a system restoration scenario since the SQSS is suspended during a Black Start. There are the practical considerations however, whereby every effort is made to keep the voltage within the higher SQSS threshold for voltage to reduce the risk of equipment flashover.

An additional clause could be added here to outline the standards for voltage during a restoration event. The clause would consider acceptable operating voltage limits and voltage step change limits during a system restoration, also accounting for the practicalities mentioned above. The voltage step changes mainly consider the consequence of energisation of network components, network switching events, and block load picking up and would exclude any fault or secured event during a restoration.

Summary of potential changes to SQSS

Clause/Section	Potential changes
Section 5	Set out criteria for system restoration e.g. minimum technical requirements for a power island
Section 6	Clause added to outline acceptable voltage limits during a restoration

Electricity Safety, Quality and Continuity Regulations (ESQR) (2002)

The Electricity Safety, Quality and Continuity Regulations (ESQCR) issued in 2002 (no. 2665) [22] impose requirements regarding the installation and use of electrical networks and equipment owned or operated by generators, distributors (which include, in these regulations, transmitters), and meter operators, and the participation of suppliers in providing electricity to consumers. The regulations contain provisions relating to:

- electrical protection and earthing;
- substations;
- underground cables and associated equipment;
- overhead lines; and
- generation.

While it is not specified, it is expected that these regulations apply for all conditions including Emergency Conditions, such as a Black Start scenario.

This includes, for example, the need to comply with **Regulation 8** which states that "a generator or distributor shall, in respect of any high voltage network which he owns or operates, ensure that the network is connected with earth at, or as near as is reasonably practicable to, the source of voltage". It is foreseen that, with the current earthing practices in the distribution networks, during system restoration from DER, a power island with a voltage below 132kV may be unearthed. In this situation, in order to comply with ESQCR, such a power island will require a new method of earthing.

A section may need to be added or a revision of **Regulation 33** (Exemption from requirements of Regulations) may need to be undertaken to explicitly mention restoration scenarios, although at this stage of the project, such changes are less likely to be needed.

Summary of potential changes relating to ESQCR

Clause/Section	Potential changes
Regulation 8	Revised method of earthing for networks below 132kV to prevent unearthed distribution power islands

Engineering Recommendations

A number of Engineering Recommendations have been reviewed to highlight any specific areas for consideration. **EREC G99** (Issue 1 Amendment 4, June 2019) [23] comes from the Third Energy Package which consists of European Network Codes. The Requirements for Generators (RfG) aims to ensure all generators connected in European Union Member States are subject to the same technical requirements. EREC G99 consists of RfG, G59 and D-Code obligations. Where Grid Code applies in EREC G99, this takes precedence.

EREC G99 contains the requirements for the connection of generation equipment in parallel with public distribution networks, and came into force on 27 April 2019. It provides developers, manufacturers and the DNOs guidance on all aspects of the connection process from standards of functionality to site commissioning, such that customers, manufacturers and generators are aware of the requirements that will be made by the local DNO before the Power Generating Facility will be accepted for connection to the distribution network.

Black Start Station and Black Start Capability are both defined in G99. Future changes surrounding the technical requirements of electricity storage units are likely to occur so the current exemptions may be removed in the near future. The updating of legacy protection settings on older, compliant generators through the **Accelerated Loss of Mains Programme** means most distribution connected generators will be fitted with G99 compliant protection in the near future.

The two British Standards most relevant to current regulations are BS EN 62116 (Islanding prevention) and BS EN 60255 (Relays/Protection). To view the references to ESQCR, EAWR, MHSWR, D-Code and BS 7671 see G99 Part D.3 Main Statutory and Other Obligations – page 382.

Within EREC G99, the sections that will require updating or review are likely to be: Network Connection Design and Operation; Protection; Technical Requirements; Installation, Operation and Control Interface as highlighted in table 7.1 below.

Table 7.1
Sections in ER G99 where updates may be required

G99 clause	Title or relevance
9.6	Island mode
10	Protection
10.1	General
10.2	Co-ordinating with DNO's distribution network's existing protection
10.3	Protection requirements
10.4	Loss of mains (LoM)
11.1, 12.1, 13.1	Power generating module performance and control requirements – general
11.2, 12.2, 13.2	Frequency response
11.2.3, 12.2.3, 13.2.3	Output power with falling frequency
11.2.4, 12.2.4, 13.2.4	Limited frequency sensitive mode – over frequency
13.2.5	Limited frequency sensitive mode – under frequency (LFSM-U)
13.2.6	Frequency sensitive mode – (FSM)
11.3, 12.3, 13.3	Fault ride through and phase voltage unbalance
11.4, 12.4, 13.4	Voltage limits and control
12.5, 13.5	Reactive capability
12.6, 13.6	Fast fault current injection
12.7, 13.9	Operational monitoring
13.7	Black Start capability
13.10	Steady state load inaccuracies
14.5	Synchronising and operational control

In Network Connection Design and Operation, **clause 9.6: Island Mode** could be subject to change as it refers to the conditions when islanded operation is/isn't acceptable. An island is required to remain stable and conform to all statutory obligations, which may not be possible to achieve in the initial stages of a restoration. It also refers to the ESQCR and protection and interface arrangements necessary for islanding (see ESQCR section previously).

Several sections within **clause 10: Protection** may need to be reviewed or changed as these systems are often designed to prevent island operation. The first part is: "The main function of the protection systems and settings described in this document is to prevent the Power Generating Module supporting an islanded section of the distribution network when it would or could pose a hazard to the distribution network or Customers connected to it." This will need to be reviewed since it may be that the Power Generating Modules connected are not serving any customers but instead aiding restoration and may therefore be necessary to be outside the statutory limitations.

The Technical Requirements Sections – **11,12,13** – may need reviewed as the only exemptions are to infrequent short-term parallel operation connected generators and electricity storage. The parameters of Black Start service providers upon initial restoration are likely to deviate and not fully comply with all technical requirements set out in these sections.

Clause 14.5 refers to synchronising two systems/networks and so may affect the allowed switching strategy of the initial restoration.

Engineering Recommendation (EREC) P2 (Issue 7, 2019) [24] is the network code pertaining to Security of Supply. It is a system planning document for use by DNOs to ensure networks are designed with sufficient capacity and redundancy to minimise loss of demand in the event of an outage. EREC P2 is supported by **Engineering Report 130 (EREP130)** (Issue 3, 2019) [25] which provides guidance on the application of EREC P2.

EREC P2 has been updated recently, following an extensive review process, to account for changes in the way that distribution networks are planned, operated and managed. Previous versions of the standard did not account for DER to provide a contribution to system security. EREP 130 has also been updated (as of August 2019). Recognising the need to adapt the standard to accommodate the significant levels of DER connected to distribution networks, Issue 7 of the standard, and Issue 3 of EREP 130, now offer DNOs options to account for the contribution of DER (specified as DG, DSR and Energy Storage (ES)). Section 7 of EREP 130 outlines that it is at the discretion of the DNO to decide whether the contribution from DER "might be sufficient to meet any deficiency in System Security".

A DNO can choose whether to rely on the contribution of the DER under their normal commercial conditions, or extend into another commercial agreement with the DER operators/owners to specify the service they will provide. Section 8 details some of the expectations of a contracted DER operator/owner, including actions, communications and resilience, stability requirements (fault ride through etc), availability and coordination.

There is no explicit reference to Black Start in P2, however it may be the case that these system security contracts could be extended, or provide an option, to include Black Start services.

Engineering Recommendation (EREC) P28 (Issue 2, 2018) "Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom" [26] was published in 2018 (and made applicable in May 2019). It defines planning levels and compatibility levels for the assessment of voltage fluctuations from customer disturbing equipment and fluctuating installations to be connected to transmission systems and distribution networks in the United Kingdom. The document refers to disturbing equipment with the potential for voltage fluctuation, being flicker and/or Rapid Voltage Fluctuation (RVC), to public electricity supply systems. RVCs generally relate to infrequent or very infrequent events that can occur randomly on the system/network or events that need to be separated by time periods, which exceed the minimum intervals stated in this EREC.

The new P28 Issue 2 introduces requirements and planning levels for RVCs, imposing envelope-based limits on the voltage fluctuation. The relevant limits (table 7.4) define an envelope for categories of occurrence, which the maximum root mean square (RMS) RVC is required to fit within. The acceptability of voltage change is now assessed over a time period from the start of the RVC event and not just after 30 ms from the start of the event, as was the case in EREC P28 Issue 1.

The planning limits, which are dependent on the time duration of the dip, vary between +/-3 per cent and +/-6 per cent for frequent events, extend to -10 per cent for infrequent events (e.g. infrequent motor starting, transformer energisation, G59 re-energisation) and to -12 per cent for very infrequent events (e.g. commissioning, maintenance and post fault switching) respectively.

Voltage fluctuations should be assessed under the worst case normal operating condition(s) unless specified otherwise by the system/network operator. Normal operating conditions and worst case normal operating condition are defined in Section 6.1.6 of EREC P28.

Power islands during system restoration are weaker networks (characterised by lower minimum fault level), hence the impact of disturbing equipment and fluctuating installations can be higher than in normal operating conditions for which consumers' equipment and installations have been designed.

According to Section 6.1.6, voltage fluctuations are not expected to conform to planning levels under the following conditions.

a) Temporary/abnormal conditions or whilst steps are taken to maintain/restore supplies to customers, where otherwise supplies would be interrupted.
b) Emergency conditions.

Consequently, voltage fluctuations during Black Start restoration do not need to comply with the EREC P28 planning limits, however the methodology described in EREC P28 to assess the voltage fluctuations can be used as guidance. These voltage fluctuations generated by equipment start-up and shutdown during system restoration in a power island (e.g. motor starting/stopping; energising transformers; switching capacitors/inductors; switching in/out of large electrical loads; tap-changer operation; tripping of load/generation) have to be within the limits of the equipment protection settings to avoid tripping, and within equipment immunity levels. It is recognised that, while system restoration following a system shutdown is considered emergency conditions and is a highly unlikely event, the switching events within the timeframe of the system restorations from DER will be frequent.

Moreover, this EREC P28 only applies to the proposed connection of customer disturbing equipment and fluctuating installations. It is not intended to apply to the connection of equipment or installations operated by licenced distribution network operators or licenced transmission System Operators. Strictly referring to this paragraph, fluctuations which occur during system restoration or in a power island due to energisation of equipment or installations operated by operators e.g. 33/11kV, 132/33kV, 400/132kV transformers, lines/cables, reactive power compensation devices, do not need to comply with EREC P28.

As EREC P28 Issue 2 does not apply to emergency situations (Section 6.1.6), there are no specific gaps that require revision to accommodate new system restoration procedures at this stage. In the event that any new procedures require the addition of new sections to P28, these would likely be strictly relevant to the operation of customer's equipment and installations during Black Start and restoration.

Engineering Recommendation (ER) P29 (Issue 1, 1990) "Planning limits for voltage unbalance in the United Kingdom" [27] was first published in 1990 and provides recommendations and limits for voltage unbalance in public distribution networks operating at 132 kV and below. The scope of EREC P29 applies to the technical evaluation for new loads proposed for connection to the distribution network, which may give rise to voltage unbalance; it does not set generalised network limits.

The document implies, although does not explicitly state, that the scope of EREC P29 only applies to customer installations. It is hoped that this will be clarified in the next revision.

Unbalanced voltage may not be an issue when a long and non-transposed circuit is connected to a large power system, or when a block load with a certain degree of unbalanced demand is supplied from a bulk power system with a large fault current contribution from equivalent sources in the vicinity of the circuit and at the supply point. However, when a long and non-transposed circuit or unbalanced three-phase block load, is re-connected to a small island power system with limited fault contribution from the DER, unbalanced voltages could arise.

EREC P29 does not clearly specify if it applies to abnormal or emergency situations, hence it is assumed that it applies to Black Start situations. Limits (Section 4.3) may need to be relaxed to include Black Start restoration processes, including the formation and operation of power islands. Similarly, Section 4.2 which lists factors to consider when calculating the system impedance may need revision.

Engineering Recommendation G5/4 [28] was first released in 2001 and sets the planning levels for harmonic voltage distortion to be used in the process for the connection of non-linear equipment. These planning levels are set with respect to harmonic voltage distortion compatibility levels. For systems less than 35kV these are set by international standards, and for systems above 35kV, by the comparability levels appropriate to the UK. A process for establishing individual customer emission limits based on these planning levels is described. The planning levels of harmonic voltage distortion should not normally be exceeded when considering the connection of non-linear loads and generating plant to Transmission Systems under the Grid Code, or to distribution networks under the Distribution Code.

The voltage emission phenomena considered in this Engineering Recommendation are:

- continuous harmonic, sub-harmonic and inter-harmonic voltage distortion within the range of 0 to 2500 Hz;
- short bursts of harmonic voltage distortion; and
- voltage notching.

Voltage distortion associated with switching transients is not considered in this Engineering Recommendation.

It is important to note that an update is in progress and will be released in 2020 as G5/5 which will supersede this version. The changes G5/5 will likely propose are relevant for planning and connection conditions and therefore should not pose significant issues for Black Start providers or for the restoration process.

As EREC G5/4 pertains to planning levels for new connections, the document specifies that it is relevant for normal operating conditions. Under a Black Start scenario, which would be classed as Emergency Conditions, this would likely not come into force and the network could operate as deemed necessary to restore power islands, meaning potential exceedance of these stated limits. Therefore, the main section that is relevant is **Section 10: Situations** where planning levels may be exceeded. Special care may need to be taken in these areas where existing harmonic voltage levels are more than planning levels, which is detailed in the conditional connection agreement and lists potential mitigation measures.
A section may need to be added to explicitly mention restoration scenarios and the potential for harmonic voltage levels to exceed planning limits.

Summary of potential changes in Engineering Recommendations

Clause/Section	Potential changes
EREC G99 9.6	Update conditions where island mode operation is acceptable
EREC G99 10	Allow operation outside of statutory limits to account for PGM role in supporting restoration (but not be serving customers)
EREC G99 11,12,13	Relax technical requirements during restoration; or note acceptable deviations
EREC G99 14.5	Account for initial restoration switching
EREC P2/ EREP 130	Account for Black Start services in system service contracts with generators
EREC P28	No specific amendments identified
EREC P29 4.2	Extend list of factors to consider when calculating system impedance
EREC P29 4.3	Limits relaxed to account for restoration scenario
EREC G5 10	Add section to explicitly mention restoration scenarios and the potential for harmonic voltage levels to exceed planning limits

Connection & Use of System Code (CUSC) (Version 1.13, August 2019)

The Connection and Use of System Code (CUSC) [29] is the multi-party contract between NGESO and users of the NETS, which includes Black Start providers (generators and interconnectors) and distribution network operators. The role of the CUSC is required by NGESO's transmission licence. In turn, it requires users to comply with the Grid Code and the Distribution Code.

The CUSC covers topics like the process for connections, standard contracts and payments for certain services, and network charging methodologies. The schedules and exhibits to the CUSC also provide several standard forms and contracts such as the Connection Application form and mandatory services agreements.

The main areas within the CUSC that we have identified for further consideration so far are (i) standardisation of contractual terms and forms related to restoration services, and (ii) treatment of Black Start costs within network charging.

Section 4 of the CUSC is about Balancing Services.

There are several possible changes that could be required in this section, although the exact form of these will depend on the selected option for procurement. **Section 4.1** is concerned with Mandatory Services – this currently includes Obligatory Reactive Power Service and mandatory Frequency Response, with sub topics like utilisation, monitoring, and testing. For frequency response, it also describes the method uses for calculating the level of the payment (also referred to in **Section 4.4** on "Charging Principles").

Services other than mandatory ancillary services, maximum generation[1] and system to generator operational intertripping[2] are covered by **Section 4.2B**. The CUSC states that these other balancing services will be governed as described in the relevant Bilateral Agreement (CUSC **Schedule 2 Exhibit 1**) and governed by a Commercial Services Agreement (not a formal CUSC exhibit). Users can indicate their interested in providing services within the forms that are used for applying for a connection – Figure 7.2 shows the relevant extract from the Connection Application form (which is **Exhibit B** of the CUSC).

Figure 7.2
Connection Application form where users can indicate service provision

4. Please indicate if your plant may be able to provide (or you could consider providing) the following technical capability):-

a.	Generation from Auxiliary Units (Reserve Services)	[ ]
b.	Spinning Generation	[ ]
c.	Fast Start capability	[ ]
d.	Frequency Response above Mandatory requirements	[ ]
e.	Demand Reduction / Management	[ ]
f.	Reactive capability above Mandatory requirements	[ ]
g.	Synchronous Compensation	[ ]
h.	Black Start Capability	[ ]
i.	Emergency Maximum Generation	[ ]
j.	Intertrip	[ ]

Section 4.3 describes the process for making payments for mandatory ancillary services, maximum generation services, and system to generation operational intertripping services. It may be used for other balancing services, subject to the agreement of NGESO and the NETS user. It governs aspects like payment processes and timescales.

Currently, Black Start is treated as an "other" balancing service, which means that it is largely dealt with through a Commercial Services Agreement. NGESO has a proforma template which it uses, but this is not a formal exhibit to the CUSC.

It is likely that the changes to the procurement mechanisms required for Distributed ReStart will change how these services are treated in the CUSC. One option is that the Distributed ReStart capability could essentially become mandatory – this could then be treated in the CUSC as another mandatory ancillary service. Other options may still benefit from greater standardisation – e.g. a set of generic Distributed ReStart service contracts that are defined as Exhibits or Schedules to the CUSC. In the "Framework" worlds described in **Section 5**, both the framework contracts and the mini-tender or eAuction contracts could be standardised in this way.

[1] http://www.chargingfutures.com/media/1348/balancing-services-charges-task-force-final-report.pdf
[2] https://www.ofgem.gov.uk/publications-and-updates/decision-launch-balancing-services-charges-task-force

Section 14 of the CUSC defines the methodologies for calculating use of system charges. This includes Transmission Network Use of System charges, Balancing Services Use of System charges, and Connection charges.

Currently, the allowed revenue from, and associated with, Black Start services for each day is allocated to the half-hourly Balancing System Use of System (BSUoS) charge, based on the relative volume of MWh in each settlement period.

With greater involvement of the DNOs in restoration, it is possible that there could be significant changes in the flows of cost and revenue associated with providing the service. Exactly how this looks will depend on the detailed design of the procurement and contracting arrangements, but some options could potentially require changes to the charging methodologies. For example, it is possible that a significant element of the cost of restoration could be associated with DNOs making changes on their network, as outlined in the first PET report. If the DNOs recovered this cost directly from their customers, then this might mean changes to how they set their network charges (see discussion below on DCUSA). BSUoS would have to be modified to ensure that it only recovered the distribution elements of the restoration costs. On the other hand, if this cost was recovered from the ESO via BSUoS, then there might be opportunities to change the BSUoS methodology to enable this. For example, with potentially different costs being incurred by different DNOs and in different Black Start zones, this could be charged on a more locationally granular basis with higher costs in zones which require more changes to distribution network infrastructure (although this is unlikely to be a priority given a recent decisions not to make BSUoS more cost reflective[3]).

There are likely to be some other changes required in **Section 6** of the CUSC, which covers general matters not covered in detail by other sections. For example, **Section 6.8.3** states that all plant including Black Start generators must comply with **Appendix 2 of Section 6**, which sets out technical requirements for operational metering (with reference to Grid Code **CC.6.5.6**), see table 7.2. These requirements are reproduced below. It is possible that future approaches to restoration could relax or remove these requirements for distributed energy resources that are providing restoration services.

Table 7.2
Technical requirements for operational metering

Description	Type
MW and MVAr for Balancing Mechanism Unit	Unit per pulse
Individual alternator MW and MVAr (applicable to multi-shaft machines)	Unit per pulse
Individual unit transformer MW and MVAr	Unit per pulse
Voltage for generation connection to the transmission substation	Ac waveform
Frequency for each Balancing Mechanism Unit	Ac waveform
All generator circuit(s) LV circuit breaker(s) and disconnector(s)	Status indication
Unit transformer circuit breaker(s)	Status indication
All generator circuit(s) HV circuit breaker(s) and disconnectors(s)	Status indication
Each generator transformer Tap Position Indication (TPI)	Tap position indication

Distribution Connection & Use of System Arrangements (DCUSA) (Version 11.2, June 2019)

The Distribution Connection and Use of System Agreement (DCUSA) [30] is a multi-party contract between distribution network operators, generators and suppliers. The DNOs are required in their licence to maintain the agreement. It covers topics like distribution network charging, connections, metering, and defines the relationships between the distribution network companies and users of the network. It also requires compliance with the Distribution Code.

Based on our review, we have not identified any specific existing references within DCUSA to Black Start or restoration, apart from some generic discussion about planned and unplanned system outages. We anticipate that the sort of changes that might be required in DCUSA would be very similar to those that are required in the CUSC, however, this depends on the overall contracting and procurement framework that is used for restoration services. If the ESO contracts with the DNOs, and they subcontract with their DERs to provide the services, then technical requirements and contractual terms for the services will need to be reflected in the DCUSA. There might also need to be provisions within the charging methodologies for collecting DNO revenue associated with making changes to the network to enable a distributed restoration.

Balancing & Settlement Code (BSC) (Version 18, September 2019)

The Balancing & Settlement Code [31] defines the rules and procedures for balancing the electricity network, and for settlement of consumed units. It is administered by Elexon, which is known as the Balancing and Settlement Code Company (BSCCo). Parties to the BSC include generators, suppliers, traders, interconnectors, the ESO and distribution System Operators.

[3] Options for more cost reflective BSUoS, including locational options, have been considered before. In November 2018, Ofgem set up a task force to consider options to make BSUoS more cost reflective. In May 2019, the task force published its findings that it is not feasible to charge any of the components of BSUoS in a more cost-reflective and forward-looking manner.

Black Start is referenced several times within **Section G**, which is about contingencies, with **Paragraph 3** of this section specifically dealing with Black Start. This paragraph details the rules for market suspension during a total or partial system shutdown. It also describes how compensation claims can be made for participants who are given "Black Start instructions" (as defined within the Grid Code). It is possible that changes would need to be made within **Section G** to reflect any new arrangements introduced through the Distributed ReStart project. For example, if the distributed restoration results in parts of the distribution network running as islands for prolonged periods of time (e.g. several hours) then new arrangements might need to be introduced for how their metering and settlement is treated consistently during those islanded periods.

In general, it is possible that changes might be made to the BSC to reflect the greater involvement and role of DERs and the distribution network operator during restoration, and to potentially reflect the changes in the nature of the service (e.g. within sections on data exchanges and reporting).

Summary of potential changes to CUSC, DCUSA and BSC

Clause/Section	Potential changes
CUSC Section 4.1	Include Black Start services under Mandatory Services
CUSC Section 4.3	Include Black Start services under Mandatory Services
CUSC Section 6	Relax or remove requirements for DER that are providing restoration services
CUSC Section 14	Changes in the methodologies for calculating use of system charges
DCUSA	No specific amendments identified; changes in DCUSA likely to be similar to changes in CUSC
BSC Section G	Reflect new arrangements in rules for market suspension, including greater participation from DER, DNOs and the nature of the service

Telecommunications and Cyber Security

Telecommunication systems and Cyber Security requirements are set out across many of the industry standards, policies and codes. Those relevant to Black Start and system restoration are detailed in the following sections.

Telecommunications
Engineering Recommendations G59 and G99

The four generator categories defined in the GB Grid Code [17] and EREC G59/99 [32], [23] are summarised in table 7.3. EREC G99 applies only to generators connected after 27 April 2019. The vast majority of existing embedded generators were connected according to EREC G59 or EREC G83 [33].

Table 7.3
G59/G99 Grid Code generator types

Type	Connection voltage	Rated capacity
A	<110kV	0.8kW–1 MW
B	<110kV	1 MW–10 MW
C	<110kV	10 MW–50 MW
D	>110kV	≥50 MW

ENA Engineering Recommendations G83/98 [33] specifies the requirements for small-scale embedded or micro generators (up to 16A per phase) connected at 230V/400V e.g. domestic PV systems (< 30m^2 or 18 panels), small wind turbines, Combined Heat and Power (CHP) plant, fuel cells, micro-hydro and battery storage systems. These devices must trip on Loss of Mains power, and can automatically reconnect to the grid if the voltage and frequency is within limits for longer than 20 seconds. No remote control or monitoring of these generators is required.

EREC G59 describes the connection process for generating units equal or less than 50kW (3-phase) or 17kW or less (single phase). The connection process for connecting Type A generators larger than 50kW is slightly different, however, from a control and communications perspective the requirements remain the same. G59/99 generators do not automatically reconnect when the grid is restored, and have to be manually reconnected or remotely instructed via telemetry.

The communications and control requirements for generator (and storage) Type A to D is the following:

Table 7.4
Grid Code remote control and communication requirements for generators

Technical requirements	Type A	Type B	Type C	Type D
Remote control and communications requirements:				
Remote control via SCADA (RTU installed by DNO)			X	X
Remote monitoring of indications and measurements			X	X
Voice communications to generator operator	Some cases	X	X	X
Additional requirements related to Black Start reliant on remote control:				
Automatic disconnection			X	X
Automatic reconnection when grid is restored	X			
Optional Black Start capability			X	X
Ability to automatically reduce power on instruction		X	X	X
Synchronisation only on instruction*				X

* Synchronisation requirements for Type B and C are site specific and as per agreement with the DNO

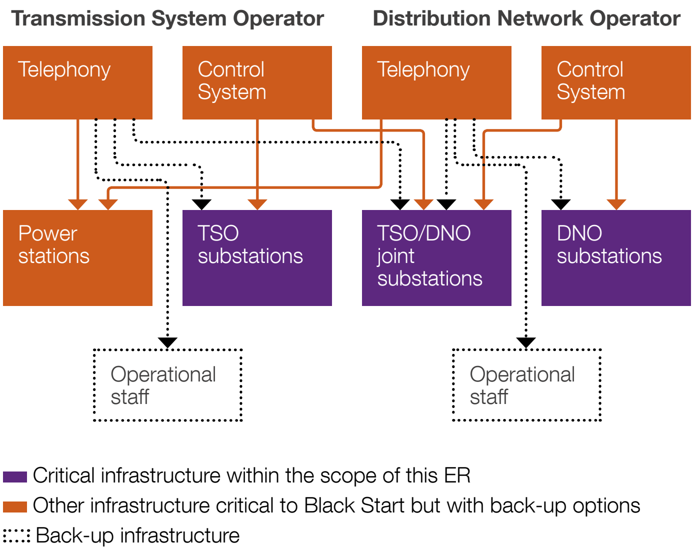
At this stage, there is no common standard for communications between the DNOs and generators, although the protocols most commonly used are DNP3 over IP and IEC61850. The communication protocols are agreed by the TSO/DNOs for each generator.

There are also no common standards for resilience to power loss, and generators seem to determine their own auxiliary standby requirements. In terms of the EU NCER, generators should have power back-up for a minimum of 24 hours.

Engineering recommendation G91 (Issue 1, 2012)

EREC G91 [34] covers the Black Start resilience for substations. It illustrates the core infrastructure for Black Start communications as follows:

Figure 7.3
Core infrastructure for Black Start ER G91



It highlights the importance of having protection, SCADA and communications resilience at core transmission and distribution substations for up to 72 hours following a blackout event.

This means that the following substations should have 72-hour back-up (using batteries or other generation):

- all TSO substations
- all TSO/DNO joint substations
- all DNO substations, except 11kV substations supplying only a single customer.

There are reportedly ~ 6,450 DNO 132kV-33kV substations, and ~ 658,500 11kV/6.6kV substations in the UK grid [35]. While it may be common for the larger substations to have 72-hour power supply resilience, this may not be the case for many of the 11kV substations, considering that only a very small percentage had communications capability in 2011 [35], and therefore the need for long battery standby.

Figure 7.3 also indicates that the SCADA communications between the TSO control centre and the TSO/TSO/DSO joint substations, as well as the SCADA communications between the DNO/DSO control centre and the TSO/DNO joint substations and the DNO substations is critical for Black Start and therefore needs to be resilient as well. Telephony communication between the TSO and DSO control centres and the TSO/DSO substations and TSO/DSO operational staff is depicted as a back-up communications infrastructure.

However, it is important that the resilience of the back-up communications during a Black Start condition is verified, as public telephony services via the mobile networks are known to not be resilient during extended power outages due to limited back-up supplies. Satellite communications are generally considered to be sufficiently resilient as they are not reliant on grid supply, however there is much debate on how effective they would be during a blackout condition.

Grid Code

The Grid Code [17] specifies the following voice communication requirements between TSO and DNO control centres and between control centres and generator control points as follows:

- Control Telephony – via dedicated/private communication system available during normal and emergency conditions – secure point-to-point calls for routine, priority and emergency calls. The system should be resilient to Loss of Mains electricity and should continue operating.
- The telecoms infrastructure and hardware for the telephone system, that is required between the TSO control centre and the DNO control centres and TSO connected generators (Type D) is installed by NGET. The telephones are used for normal control calls as well as emergency control calls during amongst others, Black Start conditions [36].
- System Telephony – alternative telephone/e.g. public telephone system – Telephony for control calls inclusive of emergency control calls [36]. Satellite phones are usually used as a contingency against failure of the Control Telephony system. The Public Switched Telephone Network (PSTN) and the mobile cellular networks are not considered to be reliable or resilient for Black Start.

The requirement is therefore for redundant voice communications, with the "Control Telephony" system constituting the primary communications channel, and the "System Telephony" functioning as the back-up communications system, with the proviso that the back-up communication system needs to be resilient for Black Start purposes.

The communications and back-up supply requirements for generators and Black Start service providers are summarised in table 7.5 and table 7.6. Currently, there is no standard for the resilience of voice communications between DNOs and generators. The current status can therefore be summarised as follows:

Table 7.5
Black Start resilience and redundancy requirements for voice communications

Control centre	TSO substations	TSO/DNO substations	DNO substations	Generator Type			
				A	B	C	D
TSO	Redundant, resilient (≥ 72h) Control Telephony	Redundant, resilient (≥ 72h) Control Telephony	None	Optional		Redundant, resilient (≥24h) Control Telephony	
DNO/DSO	None	Redundant, resilient (≥ 72h) Control Telephony	Control Telephony – resilience and redundancy unspecified				

Table 7.6
Black Start resilience and redundancy requirements for data communications

Control centre	TSO substations	TSO/DNO substations	DNO substations	Generator Type			
				A	B	C	D
TSO	Redundant, resilient (≥ 72h) data comms	Redundant, resilient (≥ 72h) data comms	None		Redundant, resilient (≥24h) data comms if no voice comms		
DNO/DSO	None	Redundant, resilient (≥ 72h) data comms	Redundant, resilient data comms				

EU Network Code on Emergency and Restoration (NCER) – EU Commission Regulation 2017/2196

Chapter 5 of the EU Network Code on Emergency and Restoration (NCER) is based on work by the European Network of Transmission System Operators for Electricity (ENTSO-E) and specifies the requirements for information exchange and communications between TSOs, DSOs, Significant Grid Users (SGUs) and Restoration Service Providers (RSP) during Emergency, Blackout or Restoration states. It also defines the minimum information that the TSO needs to provide to the Electricity Market Operators and the National Regulatory Authority.

SGUs include:

- Type C and D generators (10–50 MW, < 110kV, > 50 MW, > 110kV)
- Type B generators identified as SGUs (1–10 MW, < 110kV)
- transmission connected demand facilities
- transmission connected closed distribution systems
- aggregators or active reserve providers
- HVDC systems.

RSPs are legal entities with a legal or contractual obligation to provide one or more services contributing to the Restoration Plan.

The requirements for the communications systems between these stakeholders are as follows:

Table 7.7
EU Commission NCER communication requirements

Communications	TSO	Neighbour TSO	DSOs	SGUs	RSPs
Interoperable voice communications: redundancy (N-1) with back-up power > 24 hours	X	X	X	X	X
Hotline, identify TSOs incoming call	X	X	X	X	X
Interoperable data only, no voice	X		X	Type B	Type A or B
Interoperable data communication: redundancy with back-up power > 24 hours	X	X	X	Type C or D	X

* Substations that form part of the restoration plan

This means that the NCER requires each DNO, TSO, Significant Grid User (SGU), and each Black Start Restoration Service Provider (RSP) to have a redundant voice and data communication system with a back-up power supply of at least 24 hours. Type B generators, and Type A and B Black Start providers can have data communications to the TSO/DNO only instead of voice communications. However, the data communications shall be redundant and have at least 24-hour back-up supply. Technical specification of these systems is left up to the TSO.

Furthermore, substations that form part of the Black Start restoration are required to be operational for at least 24 hours after loss of primary supply, but no specific requirements are stated for voice and data communications.

Chapter 6 (article 48) specifies that TSOs, DSOs, SGUs and RSPs shall test their communication systems at least every year, while the back-up power supply of the communication systems shall be tested at least every five years. The TSO, in consultation with the other TSOs, shall compile the test plan.

ENTSO-E Network Code on Emergency Restoration (NCER) communication system implementation guideline

The NCER communication system implementation guideline was published in September 2018 by ENTSO-E in response to ACER's (Agency for the Cooperation of Energy Regulators) recommendation on the NCER. It accompanies the NCER, but unlike the NCER itself, it has no legally binding status and is for information only. It makes the following recommendations with respect to telecommunication systems used for emergency restoration services:

- N-1 voice redundancy should be achieved using private, direct, redundant communication links separate from public communication infrastructure with 24-hour back-up power supply. Public communication infrastructure (mobile and landline) should be used as the fall-back communications solution. Satellite communication (Inmarsat or Iridium) should be used as contingency communications if the fall-back solutions are not available, and is the technology of last resort.
- For inter-TSO communications, it is recommended that voice and SCADA are sent via separate networks to avoid simultaneous failures (refer to ENTSO-E ATOM network: All TSO Network for non-real time Operational and Market related data).
- Black Start voice and data communication systems should be available 24/7.
- To achieve 24/7 availability, the following guidelines are provided for equipment redundancy:
  - Active telecommunications network equipment in central control components (e.g. control centres) and the telecommunications backbone infrastructure need to be installed at least twice, i.e. duplicated.
  - Passive network equipment, i.e. physical communication network lines can achieve redundancy through meshed communications, or two separate lines that are geographically separated.
  - Active network equipment must be supplied by mains and back-up power supplies.

Considerations for using satellite communications and public networks. The use of public networks for communications should be avoided due to expected unavailability during system emergencies or blackout.

Implications for Distributed ReStart

From a telecommunication Black Start restoration perspective, Engineering Recommendations G99 and G91 are more stringent than the EU Commission NCER. However, the ENTSO-E implementation guideline for NCER does provide some recommendations that GB should consider. The largest impact for Black Start from DERs and RSPs is the following:

- DERs or RSPs involved with Black Start restoration should have redundant voice and data communication systems between themselves and the TSO. In the case of Type B generators and Type A & B RSPs, only redundant data communications are required as these facilities are often unmanned. Power back-up needs to be at least 24 hours (in the case of EU NCER) and 72 hours in the case of G91.
- All DNO, TSO and joint TSO/DSO substations involved in the restoration process should also have redundant voice and data communications and have back-up power supplies providing power for at least 72 hours.
- Redundant voice and data communications should be provided by private communications, with redundancy in the active as well as passive equipment. Data (SCADA) and voice communications should be transmitted via separate communication networks to improve reliability.
- Public communications should not be relied upon for Black Start, but could be considered a fall-back solution. Satellite services should be considered as a contingency if fall-back systems are not available.

The "Distributed ReStart – Organisations, Systems and Telecommunications Viability Report" identifies the following four automation scenarios or models:

- Model A – ESO is the Distributed ReStart Zone (DRZ) controllers and fully automated instructions are issued.
- Model B – ESO is the Distributed ReStart Zone (DRZ) controllers and only manual instructions are issued.
- Model C – DNOs are the Distributed ReStart Zone (DRZ) controllers and fully automated instructions are issued.
- Model D – DNOs are the Distributed ReStart Zone (DRZ) controllers and only manual instructions are issued.

The different scenarios require different communication links between the parties. The telecommunications infrastructure and communications options proposed as part of the workstream would need to be checked for compliance against the requirements specified in EU Commission Regulation (EU) 2017/2196 [37] and G959/G99 and G91.

Specific issues that need to be considered include:

- separate communication links for SCADA and voice
- redundant private communications, public fall-back options, and satellite for contingency communications.

Summary of potential changes related to telecoms

Clause/Section	Potential changes
EREC G91	Consider requirements for DER resilience to power loss, and auxiliary standby requirements for communication systems.
EREC G99	No changes required.
Grid Code	Include requirements for voice communication resilience between DNOs and DERs.
NCER	Incorporate requirements in planned UK emergency restoration code.

Cyber security

UK Network and Information Security (NIS) Regulations

The NIS [38] is the UK's implementation of Directive (EU) 2016/1148 of the European Parliament and of the Council concerning measures for a high common level of security of network and information systems across the EU.

It applies to all electricity generators, suppliers and distribution and transmission network operators provided that they fall within the definition of an "Operator of Essential Service" (OES). This is covered in Part 3 of the directive. The general thresholds to determine whether such companies will fall within the definition of an OES in Great Britain are as follows (Schedule 2):

- for electricity generators, it is based on having a generating capacity greater or equal to 2 GW, including standalone transmission connected generation and multiple generating units with a cumulative capacity greater or equal to 2 GW;
- for energy distribution and transmission network operators, it is based on the potential to disrupt supply to greater than 250,000 consumers; and
- for energy supply businesses, it is based on the use of smart metering and the potential to disrupt supply to greater than 250,000 consumers.

An OES remains accountable for the protection of any essential service, even if it relies on a third party to provide technology services. Although BEIS and OFGEM will not be enforcing NIS requirements on the supply chain of an OES, there is currently nothing preventing an OES from pushing liability downstream.

As such, Black Start DERs are likely to have contractual obligations imposed upon them following the implementation of the NIS Directive where they enter into contracts with DNOs or NG ESO for Black Start services. This may require such DERs to invest in and confirm certain levels of security, agree to contractual obligations relating to security and incident reporting and generally comply with other requirements of the NIS Directive. These requirements will include the following [39]:

A) Appropriate organisational structures, policies, and processes in place to understand, assess and systematically manage security risks to the network and information systems supporting essential services.

A.1 Governance: The organisation has appropriate management policies and processes in place to govern its approach to the security of network and information systems.

A.2 Risk Management: The organisation takes appropriate steps to identify, assess and understand security risks to network and information systems supporting the delivery of essential services. This includes an overall organisational approach to risk management.

A.3 Asset Management: Everything required to deliver, maintain or support networks and information systems for essential services is determined and understood. This includes data, people and systems, as well as any supporting infrastructure (such as power or cooling).

A.4 Supply Chain: The organisation understands and manages security risks to the network and information systems supporting the delivery of essential services that arise as a result of dependencies on external suppliers. This includes ensuring that appropriate measures are employed where third party services are used.

B) Proportionate security measures in place to protect essential services and systems from cyber attack or system failures.

B.1 Service Protection Policies and Processes: The organisation defines, implements, communicates and enforces appropriate policies and processes that direct its overall approach to securing systems and data that support delivery of essential services.

B.2 Identity & Access Control: The organisation understands, documents and manages access to systems and functions supporting the delivery of essential services. Users (or automated functions) that can access data or services are appropriately verified, authenticated and authorised.

B.3 Data Security: Data stored or transmitted electronically is protected from actions such as unauthorised access, modification, or deletion that may cause disruption to essential services. Such protection extends to the means by which authorised users, devices and systems access critical data necessary for the delivery of essential services. It also covers information that would assist an attacker, such as design details of networks and information systems.

B.4 System Security: Network and information systems and technology critical for the delivery of essential services are protected from cyber-attack. An organisational understanding of risk to essential services informs the use of robust and reliable protective security measures to effectively limit opportunities for attackers to compromise networks and systems.

B.5 Resilient Networks & Systems: The organisation builds resilience against cyber-attack and system failure into the design, implementation, operation and management of systems that support the delivery of essential services.

B.6 Staff Awareness & Training: Staff have appropriate awareness, knowledge and skills to carry out their organisational roles effectively in relation to the security of network and information systems supporting the delivery of essential services.

C) Appropriate capabilities to ensure network and information system security defences remain effective and to detect Cyber Security events affecting, or with the potential to affect, essential services.

C.1 Security Monitoring: The organisation monitors the security status of the networks and systems supporting the delivery of essential services in order to detect potential security problems and to track the ongoing effectiveness of protective security measures.

C.2 Proactive Security Event Discovery: The organisation detects, within networks and information systems, malicious activity affecting, or with the potential to affect, the delivery of essential services even when the activity evades standard signature-based security prevent/detect solutions (or when standard solutions are not deployed).

D) Capabilities to minimise the impacts of a Cyber Security incident on the delivery of essential services including the restoration of those services where necessary.

D.1 Response and Recovery Planning: (i) There are well-defined and tested incident management processes in place, that aim to ensure continuity of essential services in the event of system or service failure; and (ii) Mitigation activities designed to contain or limit the impact of compromise are also in place.

D.2 Lessons Learned: When an incident occurs, steps must be taken to understand its root causes and ensure appropriate remediating action is taken.

ENTSO-E is developing Cyber Security tools and expertise on Cyber Security for the electricity sector, and these developments should be monitored on an ongoing basis, as they may impact NG ESO, which would want to update the Cyber Security agreements with the DNOs and DERs involved in providing Black Start services.

Summary of potential changes related to Cyber Security

Clause/Section	Potential changes
Black Start contracts between ESO/DNOs and DERs	Cyber security requirements from the NIS directive may need to be imposed upon DER Black Start providers.

7.2 Summary of code review

A broad review of a number of key GB network codes and standards has been undertaken to highlight key areas of concern related to Black Start and system restoration as the energy landscape evolves.

The **Grid Code** review did not highlight any significant barriers to the implementation of a novel approach to Black Start and restoration. Many of the points raised relate to terminology and the inclusion of key players in specific clauses relating to roles and responsibilities, particularly in OC5, OC9 and BC2.9. Suitable communications and clarity on how different parties will interact in future will be crucial to the successful execution of a restoration. More parity across the different licence areas (specifically transmission) on the size of generation considered for Black Start will reduce complexity. There is an active Grid Code modification (GC0117) request relating to this which seeks consistency and transparency of access arrangements across GB by the creation of a pan-GB commonality of PGM requirements.

There is no issue with the **STC** or the **STCP06–1** in principle, however, their applicability should be considered in a Distributed ReStart future. Largely, these documents could either be adapted to include all relevant participants (DNO, DSO, etc), or there or a distribtion equivalent document will need to be created. In the case of the latter, communications and clear interactions would again be crucial.

The main area of focus on the **Distribution Code** review was DOC9, relating to Black Start and synchronising islands. There are two options available to ensuring the code is suitable for a distribution-led restoration: either there is more detail provided in the appropriate clauses within DOC9 (and others), or there is adequate signposting to the requirements set out in the Grid Code.

The DPC7.4.7 clause highlights what is required for an isolated network to operate in a DNO area, e.g. a synchronising breaker. Extension or adaptation of this clause, and wider consideration of islanded network operation/ synchronisation, may have to be incorporated further to facilitate generation participation in a power island.

The **SQSS** does not specifically refer to Black Start or system restoration and it is not immediately evident whether it is required. Guidelines for such an event could be handled in the SQSS, with minimum technical requirements for a power island being outlined (frequency, voltage, thermal etc).

The earthing policy within the **ESQCR** could pose a risk in a distribution power island. With the current regulations, it is possible that during a system restoration from DER, a power island with a voltage below 132kV may be unearthed. This is a key concern highlighted as part of this review.

A number of potential issues were noted in the review of **EREC G99**. Several clauses relating to island operation, protection, frequency response and fault ride through may be subject to change, or derogations provided for a Black Start and restoration scenario. There is concern that many of the technical requirements outlined would be unachievable during a restoration event.

Similar to the SQSS, **EREC P2** makes no direct reference to Black Start when outlining the system security requirements. Contributions to system security from DER can be formalised with commercial contracts (if requirements are outside "normal" commercial operation for the DER). It is possible that these contracts could be extended to include Black Start services.

No major challenges were found in the review of **EREC P28, EREC P29** and **EREC G5**, with only minor alterations, or potential relaxation of certain conditions during a restoration scenario likely required.

Regarding the **CUSC** and **DCUSA**, changes are likely to be similar through both documents. The main changes required are understood to be around the procurement mechanisms e.g. Black Start capability could become a mandatory ancillary service. And also, around how cost and revenue of providing a Black Start service would be treated. There are a number of options on how the costs could be recovered, by the DNO or by ESO, and how this could be done fairly.

Similarly, with the **BSC**, it is not thought that there are major challenges to face with changes introduced through Distributed ReStart. In general, it is likely that changes would be made in a number of sections to reflect the greater involvement and role of DERs and the distribution network operator during restoration.

From a **Telecoms and Cyber Security** perspective, there are no major challenges to overcome or changes to be implemented, although it is recommended that the Grid Code and ER91 include clearer requirements for telecoms resilience of Black Start DERs in the event of power outages.

8. Horizon scan – codes

Looking to the future of Distributed ReStart, there are a number of ongoing projects and industry initiatives that could impact how a new Black Start and system restoration scenario is managed.

8.1 EU Network Codes

The ENTSO-E has introduced a Network Code on Emergency and Restoration (NCER), the intention of which is to ensure security and continuity of electricity supply across Europe by creating harmonised standards and procedures to be applied in the emergency and blackout states [40].

NCER sits alongside the System Operation Guideline (SOGL) which sets out harmonised rules on system operation. SOGL sets out five specific system states: normal, alert, emergency (e.g. Partial Shutdown), blackout (e.g. Total Shutdown) and restoration.

The NCER contains the following main sections:

System Defence Plan (SDP): The SDP specifies instructions to be issued by the TSO and measures for which real time coordination is necessary during deteriorating system health. It contains procedures and automatic actions designed to prevent an emergency state occurring or to manage the system when in such a state.

System Restoration Plan (SRP): The SRP consists of the technical and organisational measures necessary to bring the system back to normal operation following a blackout state/event.

Market Interactions: These indicate that the TSO is required to develop a set of rules concerning the market suspension and restoration under certain conditions.

Information Exchange and Communications: This outlines the information that can be gathered and provided and the channels through which this will take place.

Compliance and Review: This outlines the requirements for testing the providers of Black Start capabilities to ensure continuing capability and testing and review of the System Defence and System Restoration Plans.

Terms and Conditions: These consist of the codes and policies the networks must adhere to. In GB, these T&Cs consist of the BSC, Grid Code, STC and the CUSC (as reviewed in the previous section).

The relevant network states in the EU Network Codes are defined as:

Normal state: System operating normally, n and n-1 compliant.

Alert state: System health deteriorating, only n compliant.

Emergency state/Partial Shutdown:
- there is at least one deviation from operational security limits and times
- frequency outside limits for normal and emergency states
- at least one measure of the SDP is activated
- complete loss of all tools and facilities for more than 30 minutes.

Blackout state/Total Shutdown:
- loss of more than 50 per cent load in TSO areas of responsibility
- Total absence of voltage for at least 3 minutes in TSO area of responsibility triggering restoration plans.

Restoration state: Procedures being implemented to return operational parameters back into security limits.

ESO are in the process of developing and agreeing procedures and rules to ensure that the GB codes are aligned and compliant with the NCER.

The following GB parties who do not have a CUSC or interconnector contract with ESO are not within the scope of the EU NCER.
- Embedded generators (medium or small).
- Demand response providers.
- HVDC or DC converter system owners.

Many of the provisions specified in the new plans are already contained in existing GB codes. This review highlights items which are not in the existing codes and which may be perceived to have an impact on Black Start capability. The following sections outline the main code changes which are upcoming/new which have been identified and reviewed.

System Defence Plan

The current proposal for the System Defence Plan (SDP) is Issue 2, issued in August 2019 [41]. The SDP specifies instructions to be issued by the TSO and measures for which real time coordination is necessary during deteriorating system health. The main areas covered by the SDP are:

- system protection schemes; automatic under frequency, automatic low frequency demand disconnection, automatic over frequency and schemes to avoid voltage collapse
- system defence plan procedures; procedures designed to manage frequency deviation, additional demand disconnection, demand restoration, voltage deviation, power flow, assistance for active power flow, National Electricity Transmission System warnings, manual demand disconnection and rota load disconnection
- resilience measures
- assurance and compliance testing
- plan implementation
- plan review.

The requirements of the SDP will be covered by the Grid Code, STC and Distribution Code, however some modifications to these codes may be required to capture the entirety of the SDP. Grid Code modifications (GC) GC127 and GC128 have been raised to capture these with possible further modifications in the future; these are discussed in more detail in a section to follow.

Clauses with implications for Distributed ReStart

System protection

[Item 3.1.5] Energy storage units acting as load must switch to generation during frequencies of 49.5 and 48.8 Hz, a time limit in which units must make this switch will be specified. If the unit cannot switch, it must trip. ESO prefer the tripping option so propose setting the time limit to 1 μs.

Energy storage has been identified as a potential key player in a Distributed ReStart, and so this stringent requirement could hinder participation.

Demand restoration

[Item 4.3.1] Following demand disconnection, DNOs may only reconnect demand on instruction from the ESO in accordance with Grid Code OC6.

More responsibility for reconnection of demand might be required at DNO/DSO level in future.

Manual Demand Disconnection Procedure

[Item 4.8.4] Once netted demand reduction has been applied, each DNO must ensure that their netted demand reduction remains at the instructed level until the ESO instructs otherwise.

It is not clear what deviation/margin is allowed from the instructed level. This may also be a requirement to manage power island demand during a Distributed ReStart.

Assurance and Compliance Testing

[Item 6.2.1] Each generator or HVDC station with a Black Start contract is required to execute a Black Start test at least every three years (GC0125).

[Item 6.2.2] Each generator which owns or operates a generating module capable of delivering quick re-synchronisation must execute a trip to house load test after any change to equipment impacting on its house load operation capability or after two unsuccessful trips in real operation (GC0127/GC0128).

[Item 6.2.6] DNOs and CUSC parties must test their communication systems at least every year (GC0127/GC0128).

[Item 6.2.7] DNOs and CUSC parties must test their back-up power supplies of communication systems at least every year (GC0127/GC0128).

System Restoration Plan

The current proposal for the System Restoration Plan (SRP) is Issue 2, issued in August 2019 [42].

The SRP sets out the technical and organisation measures required to restore the national electricity system in GB back to a normal state following a partial or total shutdown. The objectives of the plan are to resynchronise parts of the system which have become separate, enable communication routes and arrangements for all relevant parties during system restoration, describe the role of all relevant parties in system restoration and to identify the events and processes necessary to enable restoration of the system. These objectives are addressed in the SRP by setting out:

- system restoration plan procedures; re-energisation, re-synchronisation and frequency management
- system restoration to normal state operation; a definition of when system restoration is completed
- system restoration plan implementation
- resilience measures
- plan review.

Clauses with implications for Distributed ReStart

Frequency management procedure
Under current rules, a TSO must be the frequency leader in a restoration. In GB this is ESO, who will instruct the relevant power islands of the target frequency. The exception is in Scotland, where the role has been delegated to another transmission licencee (STCP-006-1).

Changes to the requirement for a TSO to be the frequency leader may be required, perhaps extending this to include DSO.

Where a power generator is the sole generator, it must be able to act in "free governor action" mode. More technical details and requirements would be needed to manage the frequency when there are multiple generators, especially variable DER (wind, solar, etc).

Resilience measures
All critical tools and facilities must remain available for use for at least 24 hours in the case of loss of external power.

Market suspension and communication procedures
ESO have written a letter to Ofgem [43] in which ESO sets out their proposal that the rules for market suspension continue to be held in the Grid Code and Balancing and Settlement Code. The letter further states that the existing market suspension rules set out in the BSC and Grid Code meet and are compliant with the Emergency and Restoration (E&R) requirements.

This letter also sets out the communication procedures during the suspension and restoration of market activities. These primarily involve Elexon and ESO notifying BSC and other relevant parties.

There do not appear to be any new items which would impact a Distributed ReStart.

8.2 Black Start Strategy and Procurement Methodology

The Black Start Strategy and Procurement Methodology [44] published by ESO sets out the strategy and procurement which ESO will use to procure Black Start capability for the national electricity system.

The restoration time expectation is used to determine the level of Black Start capability required to meet the system restoration. The Black Start strategy covers how the level of capability required is determined, while the procurement methodology describes how the identified capability is procured.

ESO states that it has a vision to procure Black Start provision from a wide range of technologies at different voltage levels on the system and it describes in this document how it intends to meet this vision.

Clauses with implications for Distributed ReStart

Technical requirements
There are three main technical requirements; the ability to start up independent of external supplies, the ability to energise part of the network with MVAr export only (i.e. zero MW) and the ability to block load local demand.

Rather than one large provider delivering all three requirements, using "combined services" several providers can work together to meet the Black Start technical requirements together.

The existing strategy tends to focus on initiating the Black Start process, however there should also be consideration of the support services these providers can offer during a restoration. Embedded generation is also still excluded from the latest issue, and so this would have to be revised to enable Distributed ReStart. Inclusion of DER is noted in the medium- and long-term strategies.

8.3 Grid Code modifications

GC0096 – Energy Storage

Under current Grid Code rules, it is not permitted for storage to switch from export to import during times of low frequency, despite its capability to support the system in this scenario. As noted previously, energy storage could play an important role in a Distributed ReStart and so a resolution to this is desirable.

There is a Grid Code modification proposed to change this, GC0096 [45], however there are some complications around setting requirements for storage as different types of storage will respond differently, with batteries able to react faster than other types of storage.

GC0108 – Black Start Testing Requirement

GC0108 [46] was implemented in December 2018. This code modification brought the requirements for Black Start genset testing into line with the NCER requirements. It is now required to carry out a test to demonstrate the Black Start capability of each Black Start genset at least once every three years (previously this was “no more than once a year”).

GC0117 – Improving Transparency and Consistency of Access Arrangements across GB by the Creation of a Pan-GB Commonality of PGM Requirements

GC0117 [47] is proposing more parity on the definitions and requirements of Large Power Stations/Type C generators across England, Wales and Scotland. As described in the previous section, this differs significantly between 10 MW, 30 MW and 100 MW across the transmission licence areas in GB. Bringing this threshold down to, say 10 MW, would streamline the requirements across GB.

Such a change could work in favour of a Distributed ReStart, with more clarity (and parity) on those generators, subject to the requirements of the CUSC, and by extension Black Start. There could be some complications around retro-fitting legacy connections.

GC0125 – Black Start Testing Requirements for Interconnectors

GC0125 [48] is still active, the consultation process having concluded at the end of September 2019. The proposed modification timetable states that the changes would be implemented at the end of December 2019.

This modification introduces HVDC systems, (interconnectors, DC converter stations) as Black Start providers and makes provisions for testing and proof of capability of these systems similar to GC0108.

GC0127 & GC0128 – Requirements resulting from SDP and SRP

Modifications GC0127 [49] and GC0128 [50] have been raised to implement the required Grid Code changes resulting from the SDP and SRP. These changes need to be implemented by the end of December 2019.

The requirements for synchronous power generating modules also apply to synchronous electricity storage modules and the requirements for power park modules apply to non-synchronous electricity storage modules.

There is also a Black Start Standard envisaged for 2020 (as per the extract below from the GC0125 WG).

Black Start Standard – 1 April 2020

“The Workgroup noted that it is currently being proposed by BEIS and Ofgem that there will be a new Black Start Standard (applicable to a number of stakeholders) which could possibly be in place from 1 April 2020. The Workgroup discussed the fact that this may mean further amendments to the requirements on interconnectors, HVDC System Owners and Transmission DC Converter Station Owners in the future and that it was important that they were aware that these may change following the implementation of this modification (should it be approved by the Authority). The Workgroup decided that the best course of action was to note this given the fact that the draft of the proposed Black Start Standard document is not currently in the public domain for them to discuss. It was recognised that Interconnector parties, HVDC System Owners and Transmission DC Converter Station Owners had not been involved in these discussions and a Workgroup member from an Interconnector owner has now contacted relevant people within ESO to ascertain how such parties can get involved.”

8.4 Other initiatives

Aside from the changes going on at the European code level, there are a number of other projects and initiatives ongoing that could potentially impact the way Black Start is planned, procured and executed.

The Clean Energy Package

The Clean energy for all Europeans package (Clean Energy Package, CEP) [51] was prepared to facilitate the delivery of the EU's Paris Agreement [52] commitments. The creation of the EU Energy Union aims to provide a framework to allow consistency of approach across all countries and policy areas through the energy transition, and the CEP is a central part of the EU Energy Union. Within the CEP, there are eight legislative acts which EU countries must enact into national law 1-2 years from mid-2019. The legislation covers energy performance in buildings, renewable energy, energy efficiency, governance, risk preparedness, cooperation of energy regulators, internal market regulation and common rules for the internal market.

One of the main focuses of the CEP is on increased energy security, where the Regulation on Risk-Preparedness in the Electricity Sector (EU) 2019/941 states "(6) This Regulation sets out a common framework of rules on how to prevent, prepare for and manage electricity crises, bringing more transparency in the preparation phase and during an electricity crisis and ensuring that measures are taken in a coordinated and effective manner." Where electricity crises cover extreme weather, malicious attacks (e.g. cyber), fuel shortages etc, any of which could result in a system shutdown.

Regulation 2019/941 also states that "(15) A regional approach to identifying risk scenarios and to developing preventive, preparatory and mitigating measures should bring significant benefits in terms of the effectiveness of those measures and the optimal use of resources."

This suggests that preparing for and managing a Black Start and restoration should remain at the discretion of each Member State and that a suitable approach be applied based on available resources. Nevertheless, there will likely be EU-level regulation and coordination required on some aspects.

Open Networks

The Open Networks project is an ENA-led programme of work that is seeking to transform how networks operate in order to enable a smart, flexible energy system [53]. The transition of DNOs into DSOs is a pivotal requirement for the success of Open Networks, and one of the primary objectives of the project is to support this, through collaboration, knowledge exchange and new approaches.

It is clear that the industry is working collectively towards the DSO transition, and so this will have implications for Black Start and system restoration. In the Review of Codes section, a number of references have been made to DSO and responsibilities they may have to undertake in a restoration event in future. DSOs will have more control over DER, and be capable of managing it actively under normal network conditions, and so the same would be true during a Black Start scenario.

A key area of overlap with Distributed ReStart and Open Networks will be the telecommunications and Cyber Security aspects of network operation and management. Where DSOs expect to have more control over connected DER, there will be a requirement for secure and resilient comms. The same is true for generators that provide Black Start services, and in future there are expected to be a much larger number of such generators. Standards for telecoms and Cyber Security in such an environment will be vital, and there could be an opportunity to streamline the requirements for DER to cover Black Start and restoration, as well as normal operating conditions.

8.5 Next steps

A number of key next steps can be recommended based on the code review and associated horizon scan exercise. These are:

- conduct a more thorough review of interdependencies to understand how changes in a specific code or policy impact clauses or requirements in documents it interacts with
- perform more extensive stakeholder engagement and focus on key areas of concern e.g. earthing requirements in the ESQCR, to develop ideas and potential solutions
- continue to monitor ongoing projects and programmes that could impact future requirements for Distributed ReStart. For example, new telecommunications and Cyber Security standards, being developed under Open Networks, could impact how Black Start participants implement telecommunications and telemetry facilities at their sites
- produce a timeline of known changes to relevant codes and policies e.g. introduction of the Black Start Standard in 2020, to better understand how changes resulting from the Distributed ReStart project might fit into this.

Conclusions and next steps

9. Conclusions

This section considers outcomes and conclusions from a whole workstream perspective.

The first of the principal objectives of this report is to propose a strategy development process, and to include within that process all the inputs and information that we can include at this time, and to use this format to underpin and drive stakeholder engagement for phase two of the project, which will provide a strategic route to developing appropriate commercial solutions.

Within the report, we have reviewed a number of inputs to the strategic process, including outputs of the PET and OST workstreams, current processes and methodologies, current and forecast spend positions, and have used commercial analysis tools to help us understand the current structures. This enables us to consider what we know about what a future Black Start service from DER might look like, and draw insight regarding what we might need to change to deliver a successful and appropriate commercial solution.

While it is our intention to primarily generate initiatives and strategies to develop commercial solutions in phase two, from the work done so far, the following key insights and considerations have been proposed about how a potential future service might be procured:

- Develop a commercial structure that allows participation in multiple timeframes, for example, day ahead for 24 hour contracts, month ahead (for example) for quarterly contracts, and quarter to year ahead of time for one year contract periods. This would allow the party responsible for procurement to hedge the requirement and to take advantage of seasonal and other demand elasticity, at the same time as enabling intermittent generation to participate, thereby broadening participation and competition.
- Refine technical requirements into functional elements that can be split into components or 'lots', that allow parties to participate based on their existing capabilities, to minimise the investment needed to meet a wide range of bundled technical requirements. A smart system would likely be required to assimilate these components to meet closer to real time restoration timescales in line with minimum service levels, or a restoration standard following the introduction of one. See figure 13, for example.
- Systems integration to allow provider interface, which would interact with the 'trading platform' style system, feeding in contract data to enable monitoring and dispatch.
- Develop a pre-qualification process and system interface where providers are able to self-serve and self-certify their capability to minimise resource bottlenecks for the party responsible for procurement.
- Develop transparent requirements to empower potential providers to make informed decisions about participating.
- Develop and be transparent regarding the full suite of restoration services to increase ability for buyer to 'substitute' and increase competitive rivalry.
- Develop, if possible, leading performance measures to prevent EODs, which are more valuable to the end consumer than enforcing penalties ex-post. Consider whether an appropriate incentive mechanism could be developed in this context.
- Design the end-to-end process to be lean and provider-led.
- Develop a value assessment model that considers the total costs of the service, and consider strategic ways to reduce the high spend areas.
- Greater efficiencies can be accrued through one organisation being primarily responsible for coordinating, including being able to carve out markets based on liquidity of capabilities, and the potential to take advantage of a national market for non-regional capabilities. The organisation responsible for procurement should continue to assess the liquidity of each capability, building on the assessment already carried out, taking into account geographical/regional implications, and use this to inform the development of an appropriate approach that delivers value for the end consumer.
- The feasibility process will be largely dependent on the technical requirements for the service, however, at this stage we can assume that if we are able to revisit and refine this to reduce the time and cost, it will reduce barriers to entering relevant markets, and will allow for procurement over much shorter timescales.

These could be refined, for example, into a proposal, where a framework structure provides a number of lots and call-off procedures, providing a balance of assurance ahead of time, and flexibility to take advantage of demand elasticity. This is summarised as a worked example in section 5.

While it is ineffective to speculate on such an early stage of the process, the strategic process that has been proposed here presents a rigorous and defensible mechanism for getting to a fit for purpose solution, that will be underpinned by engagement and endorsed by stakeholders.

The second major objective of the report was to review the relevant codes and licences to identify any elements that could present an obstacle for the implementation of a future Black Start service from DER.

The review of the codes did not highlight any insurmountable barriers. The principal challenges will likely centre around ensuring the correct clauses are adapted appropriately to include the right stakeholders and clarify their required actions and interactions. Interdependencies across the codes must be clearly addressed.

It will also be important to monitor code changes being implemented at EU level, and other ongoing initiatives that could impact how the GB codes evolve.

10. Next steps

This section outlines the next steps for the Procurement and Compliance workstream.

The purpose of this report was two-fold, first, to propose a strategy development process for reaching the most effective solution, inputting into that what we know already, and using the resulting report as the basis for engaging with industry and stakeholders for challenge and review in the next phase of the project, enabling iteration and refinement of the process as more information becomes available. Secondly, to review gaps and blockers in codes and licence conditions to identify potential gaps or blockers to delivering a future Black Start service from DER.

As such, the next steps are:

Lead area	Description	Indicative timeline	Details
Workstream	Engagement plan for Phase 2	Dec 2019	Develop engagement plan detailing how industry colleagues can challenge, input and help to shape the approach.
Project wide	Cross-workstream planning	Dec 2019	All workstreams to reconvene to reiterate dependency planning.
Procurement and commercial, PET	Assess component groupings	Dec 19–Feb 20	In conjunction with PET, assess sensible combinations to form components of a service.
Procurement and commercial	Industry challenge and review of strategy process for procurement and commercial	Dec 19–Apr 20	Ongoing engagement as per plan to iterate and refine all elements of process.
Procurement and commercial	Refine inputs	Dec 19–Apr 20	Use feedback and input from reviews to refine the inputs as part of the strategy development process.
Procurement and commercial	Develop initiatives	Dec 19–Apr 20	Use feedback and input from reviews to develop initiatives and strategies that meet the commercial objectives as part of the strategy development process.
Procurement and commercial	Begin to refine initiatives	Apr–Jun	Use feedback and input from reviews to refine initiatives and strategies into a detailed proposal, or proposals, that meet the commercial objectives as part of the strategy development process.
Procurement and commercial	Propose implementation plan	2 Oct 20	Propose plan for implementation based on known factors at point of phase two report.
Codes	Development of proposals for code changes	Dec 19–Apr 20	Perform targeted stakeholder engagement and focus on the key areas of concern. In parallel, conduct a thorough review of code interdependencies and note interactions. Use this information to propose code change proposals in, and across, the relevant documents and codes.
Codes	Review and refinement with industry	Apr 20–Jun 20	Open industry consultation processes with proposed code changes.
Codes	Begin implementation process for code changes	Jun 20–Dec 20	Submit proposed changes (following industry consultation) to respective Code Review Panels.
Workstream	Iterate horizon scan	Dec 19–Oct 20	
Workstream	Phase two report	2 Oct 20	High-level outline of contract terms and regulatory arrangements.

Assurance accuracy statement

This progress report has been produced in agreement with the entire project hierarchy. The report has been reviewed by all project partners. The report has been approved by the Distributed ReStart, Procurement & Compliance workstream lead and by Peter Chandler the Project Lead. Every effort has been made to ensure all information in the report is true and accurate.

Peter Chandler

Peter Chandler
Distributed ReStart – Project Lead

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12. Appendices

12.1 Appendix 1 – Technical requirements for existing service

Requirement	Minimum	Definition	Rationale
Time to Connect	≤ 2h	Time taken to start-up the BS Plant from shutdown without the use of external power supplies, and to energise part of the Network, within two hours of receiving an instruction from the Electricity System Operator (ESO).	As per the Grid Code requirement (OC9.4.5.1).
Service Availability	≥ 90%	The ability to deliver the contracted BS Service over 90% of a year. Note: It is the responsibility of the Provider to demonstrate its service availability. By submitting a tender, the provider commits to ensuring availability at least 90% of each year of the service.	BS Service Providers are expected to have a high BS service availability so that the ESO we can rely on being able to use them contract in the instance of a Black Start, which could happen at any time.
Voltage Control	Existent	Ability to control voltage level within acceptable limits during energisation/ block loading (±10%).	During a Black Start event, a BS Service Provider will need to maintain voltage (within limits) when creating, maintaining and expanding a power island.
Frequency Control	Existent	Ability to manage frequency level when block loading (47.5Hz–52Hz).	During a Black Start event, a BS Service Provider will need to maintain frequency within limits when creating, maintaining and expanding a power island.
Resilience of Supply, BS Service	≥ 10h	When instructed to BS, the minimum time the Provider will deliver the contracted service.	Long-term restoration.
Resilience of Supply, BS Auxiliary Unit(s)	≥ 72h	Run continuously at the output required to support/deliver the contracted BS Service for a minimum of three days.	Long-term restoration.
Block Loading Size	≥ 20 MW	Capability to accept instantaneous loading of demand blocks.	The restoration approach for GB under the current BS Strategy is a top-down approach. During a Black Start event, the provider must be able to match the DNO's ability to segregate and switch the Distribution Network remotely. , 20 MW blocks will be manageable for DNOs, but still enables an efficient restoration. We have relaxed this requirement from our previous requirements, to allow more providers to participate and to reduce volatility in the power islands. This size will also be sufficient to provide start up supplies to a conventional non-Black Start Station.
Reactive Capability	≥ 100MVAr Leading	Ability to energise part of the network, managing Voltage with Leading or lagging capability whilst active power is zero.	The restoration approach for GB's restoration under the current BS Strategy follows a top-down approach. This means that providers 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 Black Starts	≥ 3	Ability to perform at least three sequential start-ups.	To allow for possible tripping of the Transmission or Distribution Networks during the re-instatement period, or trips during the BS Service Provider's own starting sequence.
Short-circuit level (SCL) (following the start of a system disturbance)	For t ≤ 80ms: $I \geq \frac{240\ [MVA]}{\sqrt{3} \cdot U}\ [kA]$ For t > 80ms: $I \geq \frac{100\ [MVA]}{\sqrt{3} \cdot U}\ [kA]$ *U ≡ connection voltage [kV]*	Injection of reactive current during a disturbance.	The higher the SCL, 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. That this 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	≥800 MVA.s	Stored rotating energy in the system (real or virtual).	More Inertia 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.

12.2 Appendix 2 – Assessment criteria

12.2.1 Connection to network (10 per cent)

The restoration under the current Black Start 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 provider is connected has an impact on the speed and resilience 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 BS Service Provider has more than one connection onto the NETS, that increases the likelihood of availability of that specific BS Service Provider in a under a Black Start event.

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

	Score (%)	Comments
Transmission Connected	3	Consistent with the top-down restoration approach for GB under current BS Strategy.
Distribution Connected	0	
Multiple connections to the Network	2	To value the avoidance of a single point of failure.
Single connection to the Network	0	
Other BS Service Provider(s) in the same Substation	(Y) 0% (N) 3%	Assessed against current provision.
Different Technology within a BS Zone	(Y) 2% (N) 0%	Technology meaning fuel (water, wind, coal, gas, diesel, etc.). Assessed against current provision.

12.2.2 Power output (35 per cent)

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

	MVAr	Score (%)
Reactive Capability (MVAr > 0, MW = 0)	0	
	≥ 100	5
	≥ 150	10
	≥ 200	15

	MW	Score (%)
Active Capability	≤ 100	2
	100 < P ≤ 200	5
	200 < P ≤ 350	10
	350 < P ≤ 500	15
	> 500	20

12.2.3 Resilience of supply (30 per cent)

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 BS Service Providers to contribute to the later stages of restoration will be valued.

	Time (hours)	Score (%)
BS Service at Contracted Power Output (20%)	= 10	2
	10 < P ≤ 72	5
	72 < P ≤ 120	10
	120 < P ≤ 168	15
	> 168	20

	Time (hours)	Score (%)
BS Auxiliary Unit(s) (10%)	72 < t ≤ 120	2
	120 < t ≤ 168	5
	> 168	10

12.2.4. Contribution to system stability (15 per cent)

Throughout restoration, and particularly during block loading, BS 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 Black Start island to be developed faster.

Short-circuit level

t ≤ 80ms following the start of a system disturbance

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

t > 80ms following the start of a system disturbance

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

Contribution to inertia

MVA.s	Score (%)
≥ 800	2
≥ 1200	5
≥ 1600	8

12.2.5. Contribution to restoration time (10 per cent)

The ESO's plan, as defined under the current BS Strategy, is to achieve an average Restoration Time across the year of 24 hours to restore 60 per cent 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 BS performance.

The ESO is considering further developments in the model to accommodate individual contributions from BS Service Providers to zonal restoration times.

12.3 Appendix 3 – Summary of necessary innovations – Appendix H of Black Start from DER final bid submission

Appendix H – Summary of necessary innovations
The table below sets out the innovation required to deliver the method, compared to current BAU activities.

Table H.1
How this NIC project aims to explore a step-change in ESO's Black Start activity

Stage	Current activity	From DERs
Capacity assessment	Black Start requirements are determined based on the ability to meet published restoration times for the GB network. This is then interpreted into the current three stations per each of the six zones to provide some redundancy for failed start-ups and to enable a rapid geographically dispersed restoration along the skeleton network. Simply put, the capacity assessment uses the current restoration method and assesses how many providers are required to meet that timescale. Current technologies are well understood in how their technical parameters contribute to restoration and an assessment can take this into consideration.	Capacity assessment needs an understanding of the suitability of providers to the overall restoration, as well as their relative effectiveness and reliability. This is not something currently known, and the volume required to meet requirements is also an unknown.
	Currently we understand the boundaries of the service as a whole, and are developing a combined service where 'self-start' capability and 'block loading' capability are delivered from two conventional providers separately.	From DER, it is likely that provision will be split into more elements, such as frequency response only, or reactive power only, as well as the traditional self-start and block loading elements. For these, the technical parameters of each element will need to be designed and agreed. In addition, a mechanism for stacking these into a combination that delivers the minimum service level, and can compare the value of these elements separately and in combination, needs to be created to ensure efficient spending.
Initial discussions and	Feasibility studies are undertaken for every new provider. These typically cost hundreds of thousands of pounds. We undertake discussions with new providers of any proven technology on an individual basis, using standardised documents and communications. ESO is required to maintain sufficient Black Start capability to be able to restore the network after a shutdown. Prior to contracting, we need sufficient assurance that the potential provider has BS capability, we do this at the moment through Feasibility Studies. Currently, 'Feasibility Studies' are defined as work undertaken by the licencee and potential New Provider in order to assess their ability to provide Black Start services. At the moment, this involves assessing the provider against a set of known, required capabilities.	DERs, specifically combinations of DERs, are not proven to be able to contribute to a restoration. The project will be determining a whole new set of technical capabilities and requirements that are aligned to this new set of potential providers. Once we understand what technical capabilities will be required from a provider, we will need to formulate a method for efficiently assessing a large number of providers against these new requirements. Currently, we engage bilaterally with a provider and reimburse reasonable costs incurred by them proving their capability. This will not be efficient to continue for large numbers of providers, each delivering a much smaller individual contribution. We will need to develop a new, industry-wide technique for evaluating the combined capability of a network area, and in addition, to define roles and responsibilities in relation to this. As an industry, we will need to find the balance between ensuring the correct level of assurance of capability and the associated cost to manage this. This will be a complex activity, and will need industry input and consensus to develop a solution that will: be widely accepted and fit for purpose; provide the correct level of assurance that Black Start capability is available and that restoration timescales will be met; and will ensure the solution is economic and efficient.

Stage	Current activity	From DERs
Contracting, procurement design, and value assessment	ESO enters into a bilateral contract with the Black Start provider. If there are two or more potential Provider contracts, ESO will manually run a competitive event, but the outcome will still be a bilateral contract.	In the case of a number of DER coordinating to provide the service in a zone, with different assets potentially delivering individual service components (e.g. frequency control or reactive power), a bilateral assessment and contracting methodology will not work. We will also need to explore more efficient procurement methodologies and identify the best option for determining the route to market, tender structure and logistics. We need to design a methodology for determining what will be procured and all of the associated parameters, including: • Procurement timeframes (do certain providers need to invest or build – does this disadvantage them?), • Contract durations and service start proximity to real time – with much greater liquidity could we use frameworks and call off at week ahead or day ahead for short periods? • Framework for determining how much of each component is required, is this fixed or does an increase in one component reduce the need for another? • We need a methodology that will allow us to assess the value of each individual service component, and to assess the commercial offering from each provider. This will be complex and is likely to require a system solution. • Determine how current providers will be assessed against new providers (especially if new providers requirement investment). • Determine whether certain service components are more valuable than others, how much more valuable and whether the value is dependent on other factors. • The appropriate sharing of risk between all the different parties will be complex to apportion and will require a new contractual design, or a new suite of contracts based on the outcome of what the service components are, what will be procured and how it will be valued/assessed. • This NIC project will explore new and innovative commercial arrangements, and develop and test the most appropriate option(s).
Construction	CAPEX required to make the generator Black Start ready is agreed and paid for by ESO before works are undertaken.	For unproven DER technologies, we do not yet understand what generator enhancements or requirements could be needed to ensure Black Start readiness. The same goes for enhancements to the distribution network. This NIC project will assess and test what these need to be in each Case Study. If enhancements are required, we will need a methodology for determining whether this will be funded, and if so, what the parameters are.
	Local Joint Restoration Plan agreed through trilateral conversations will all parties. Routes and restoration are studied and validated before being built into skeleton network restoration plans. Each provider has a direct phone line to the control room which would be used for coordination of activity in a Black Start event.	In the method approach, we will need to develop a whole new approach to Local Restoration Planning, where a complex combination of different DER needs to be coordinated to provide different services to power local islands; and those islands need to grow and integrate with other islands. The role of the DNO needs to be transformed, from facilitating restoration by switching in blocks of demand, to actively coordinating DER and managing multiple power islands. This NIC project will explore different coordination approaches and innovative new tools to bring all of this together. The current infrastructure/equipment for communications in a Black Start event is unlikely to be fit for purpose to accommodate potentially hundreds of DER providers.
	Commissioning, training and testing require resource to complete the tasks, which are completed on a case-by-case basis for each provider.	In the same way, as for feasibility studies, this NIC project needs to examine how we might achieve these labour-intensive activities in a way that is economically feasible for potentially hundreds of new Providers.

Stage	Current activity	From DERs
Availability assessment, performance monitoring and settlement.	Currently, each provider is responsible for making declarations of availability to the control room by fax, and the control room pass these on to Settlements to record and adjust monthly payments accordingly. Settlements make an annual assessment on an individual provider basis, referring to individual contract terms using spreadsheet tools only.	We will need a new methodology for ESO control room to monitor the level of availability/service provision at any time, as individual faxes will not be viable as the number of providers increase. Further, if the DER solution leads to shorter-term contracts/closer to real time procurement/more frequent changing of providers, this will exacerbate the challenge of monitoring and operation. The same applies for performance monitoring for contractual purposes. With the new contractual design, there will need to be a new suite of Events of Default (EODs) and corresponding penalties. It will not be feasible to monitor this using the current spreadsheet system, and by relying on provider declarations. Further, for Settlements to accurately settle this, there will most likely be a requirement for a system upgrade to account for: • increase in number of discrete service components • increase in number of providers • new and varied payment structures (depending on service component) • new and varied EODs (depending on service component)

12.4 Appendix 4 – insights

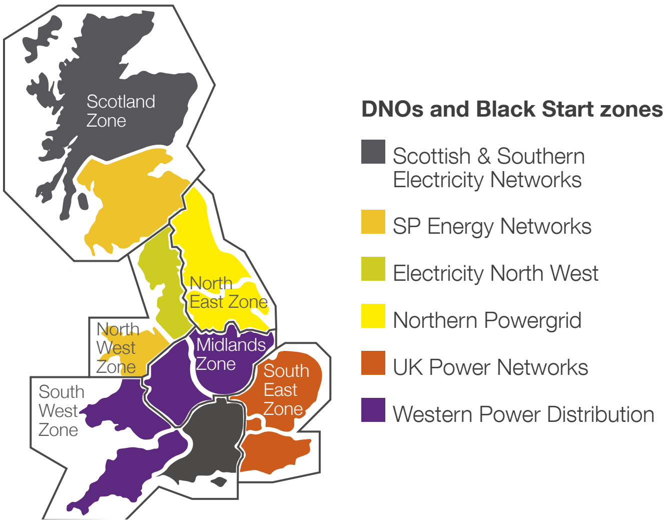
A collated summary of the insights from throughout the report is provided below.

	Insight	Potential impact
Procurement	Technical requirements should be functional and transparent.	Enables greater market access and greater competition.
	Consider ways to allow a proportion of the requirement to be assessed closer to real time.	Increased accuracy and flexibility in volumes to be procured whilst maximising participation. This may include developing a hedging strategy.
	Consider ways that the lead time on procurement can be reduced and brought closer to service commencement.	Greater flexibility and accuracy when assessing the requirement.
	Consider ways to streamline the requirements of the feasibility assessment process, and how to enable providers to self-assess where possible.	Reduces barriers to entry and reduces resourcing requirements for assurance.
	One set of assessment criteria, or one value assessment methodology, may not be fit for all purposes. Once further confirmation is available on how technical requirements might be split, and how lots or bands of a service might be structured, develop transparent assessment methodologies that are appropriate for all.	There may be elements where there is less liquidity, and alternative methods to market-led pricing may be most appropriate for ensuring value to the end consumer.
	The project should consider the balance between restoration timeframes and cost to end-consumers.	This will ensure that expected restoration times are met in an economic and efficient way.
Commercial design	Consider redeveloping the feasibility assessment process to enable further self-assessment.	This will reduce the costs where there could be a greater number of smaller providers and enable providers to more effectively manage their position.
	Consider ways to reduce the lead time of assuring capability.	Enables all parties to make informed decisions closer to service commencement dates.
	Consider how consistent quality standards would be ensured should there be more than one party responsible for procurement.	Assurance of appropriate service provision will be critical nationally even if the contracting/procuring party is different regionally.
	Consider what approach is effective for feasibility study across a group of DER.	Service should have mechanism to enable multiple parties to be assessed holistically where there is interdependence.
	The end consumer cannot be liable to cover costs of a non-delivered service.	If a Black Start service from DER still requires capital contributions of any kind, the contract must provide protection for end consumers against risk of non-delivery.
	If alterations to assets are required, ensure the structures are in place to encourage delivery on time and balance risk appropriately if not on time.	Reduces exposure to the end consumer and the procuring party.
	Consider whether it will still be viable to make capital contributions for a greater number of smaller providers, particularly if there is a functioning marketplace with a greater ability to switch providers/higher level of redundancy.	Potential reduction in total service cost.
	Consider ways to ensure transparency of costs until there is a functioning marketplace with market-led pricing.	Transparency for the end consumer and potential providers.
	Consider ways to objectively monitor key Black Start capability systems through a performance dashboard and smarter systems for live monitoring that can be shared in real time with ENCC.	Greater operational accuracy/reduced operational risk, and more accurate data for settlement.
	The project should consider ways to minimise the costs of Black Start tests, particularly in a scenario where there are a larger number of providers, and particularly considering regulatory changes that may alter the testing frequency.	Reduction in total costs.
	Ensure the testing programme for the new service is fit for purpose, and appropriately assesses the provider against whatever the definition of the Black Start capability is.	Assurance continues to be extremely important.
	Ensure that there are appropriate provisions for failure of a test.	Non-delivery of a contracted service should not carry risk exposure for the consumer.
	Capability assessments are witnessed at present, consider whether this is viable from a resourcing perspective if there is a much larger number of providers. Consider the role of automation and ways to increase assurance through real time monitoring and self-certification/certification through an independent engineer and reduce manually witnessed tests (particularly if further consideration is given to breaking a 'full service' down into components delivered by different parties).	Reduce barriers to entry for consumers and enable delivery of a service without additional dedicated assurance resource.
	A DER-based service may require demand customers to be involved in testing if a transmission system energisation capability is to be demonstrated.	This poses questions over possible compensation for interruption of supplies, or whether sufficient testing can be done without impact on other customers.
	Consider ways to ensure end consumer spend is protected where capital contributions are required 'up front'.	This will ensure there is a reasonable balance of risk.

	Insight	Potential impact
Commercial design	Consider ways to further reduce the commercial risk without affecting it.	Ensure operational risk is mitigated to an acceptable level.
	Consider the role of automation and whether smarter systems can support removing manual elements of the current process.	This will ensure all processes are viable from a resourcing perspective, and are fit for purpose in a new service design.
	Can Key Performance Indicators (KPIs) be developed that include leading measures to monitor performance ahead of EODs.	Effective management of contracted providers, and additional value for the end consumer.
	Consider whether an appropriate incentive mechanism could be developed	This will encourage enhanced performance if this is of benefit.
	Consider that value is gained if EODs are prevented, but ensure that measures are in place to protect the end consumer from paying for a service that doesn't deliver.	End consumer value.
Strategy development	Feasibility studies could require the involvement of multiple providers.	Assurance of capability.
	Stage 2 feasibility will require holistic assessment of all parties involved in the plan rather than a single provider and will require network capability assessment.	Assurance of capability.
	The testing process will need to change.	Dependency to consider from live trial results.
	Construction may include remedial works to bring a distribution network to the required standards to facilitate a restoration plan.	How are networks remunerated for enabling works required for a plan?
	Availability of a restoration plan may depend on availability of a single provider.	If this provider is unavailable, how will this impact upon compensation for other DERs incorporated within the plan?
	Consideration will be given to where automation allows for more effective technical capability but also where it affects market access and liquidity.	It is likely that a number of commercial options could be ruled out based on requirements for control room, procurement and assurance resourcing.
	Zones for Distributed ReStart may be significantly smaller than those for the existing Black Start service if based around automation.	This has potential to affect competitive pressures.
	Multiple parties may be responsible for procurement of the Black Start from DER service.	This could have impacts on liquidity and procurement platforms which can be used.
	Automation has the potential to increase construction/installation costs.	Higher costs could make shorter contracts less effective.
	Resilient telecommunications are not provided to DERs.	Installation costs may include this additional investment requirement, or an alternate strategic approach to this may be required.
	We expect that over the short term at least, a service from DER will need to operate in conjunction with the current provision.	This will ensure operational coverage and to ensure value for money where capital is already sunk in current services. With this in mind, the project should consider ways to ensure the timelines for any BAU procurement tie in to timelines proposed for a service from DER to avoid duplication/inefficiency.
	It is expected that there will be costs involved in the transitional period and to 'upskill' DER to the right capability.	The proposals from this project for the commercial design and procurement mechanism should include cost reduction/value maximisation as key objectives.
	Consider ways to reduce feasibility requirements, for example developing ways for providers to self-assess and self-certify.	The PET and OST worksteams will consider this further and aim to produce the specifications against which potential providers might self-assess.
	The project should consider ways to unbundle or reduce the technical requirements.	This allows access from parties who may otherwise be unable to participate.
	Consider ways to reduce the need for capital investment.	This will enable switching between providers, increase liquidity ahead of contract award and reduce risk of market entry for providers.
	Consider ways to remove competitive advantage for 'experienced' or current Black Start providers, including knowledge and experience.	This will enable greater market access.
	Consider ways to improve transparency in relation to service revenues.	This will enable providers to make informed decisions about participation.
	Consider ways to include procurement closer to real time.	This will allow intermittent generation to participate, and for the party responsible for procurement to more accurately forecast requirement.
	Consider ways to take advantage of seasonal demand elasticity.	This will reduce costs to consumers.
	Consider how the restoration strategy can be adapted.	It will be important to integrate a Black Start from DER service into the existing Black Start Provision.
	Consider the viability of a system that could assimilate component elements of what we currently know as a full service, so that parties with certain elements can offer these services to support a restoration.	Splitting services into component parts will increase availability of the overall restoration service.
	Consider the technical requirements from a functional perspective.	Increased participation.
	Consider that there may need to be multiple levels or entry points to a market.	This will improve market access.
	Align procurement outcomes with organisational structures developed in conjunction with the OST workstream.	This will ensure the contractual terms align with the responsible parties.

12.5 Appendix 5 – Black Start zones

An indication of Black Start zones is given below. Please note the boundaries are flexible and, at present, providers may be able to contribute to different zones depending on their capability and the surrounding network characteristics.



The Black Start zones as they stand are based on the transmissions network and transmission connected providers; the boundaries of these zones are flexible depending on provider capability and network characteristics. The DNO networks have been added in for illustrative purposes, and may not tie in accurately to the existing Black Start zones.