Distributed ReStart

Energy restoration for tomorrow

Project Progress Report

December 2020
Redacted version

In partnership with:

tnei

SP ENERGY NETWORKS

nationalgridESO

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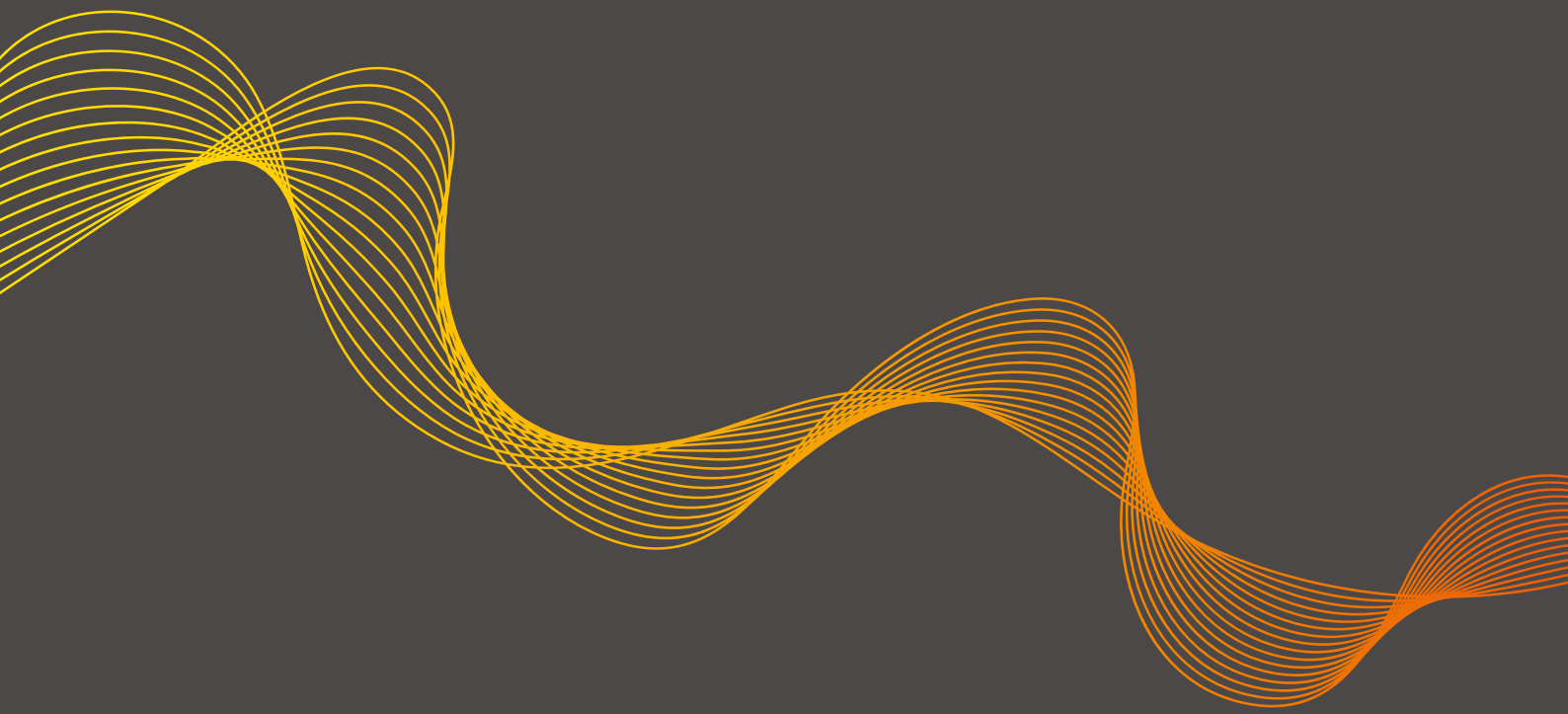

Project Overview

The Distributed ReStart project is a partnership between National Grid Electricity System Operator (ESO), SP Energy Networks (SPEN) and TNEI (a specialist energy consultancy) that has been awarded £10.3 million 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 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 is tackling these challenges in a three-year programme (January 2019–April 2022) that aims to develop and demonstrate new approaches, with the possibility to commence procurement activities for an initial Black Start service from DER from mid-2022 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 and Dissemination workstreams cover the effective management of the project and ensure stakeholders are considered and communicated with throughout all project deliverables. The other three workstreams cover the wide range of issues to enable Black Start services from DER:

- The **Organisational, Systems and Telecommunications (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 is developing requirements for information systems and telecommunications, recognising the need for resilience and cyber security, and the challenges of coordinating Black Start across a large number of parties. Proposed processes and working methods are being created, building on the models illustrated in the 'Viability Report' produced in November 2019.
- The **Power Engineering and 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. It will be tested through demonstration of the Black Start from DER concept in 'live trials' on SPEN networks.
- The **Procurement and 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 in mind. It will feed into business as usual activities to make changes as necessary in codes and regulations.

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nationalgrideso.com/innovation/projects/distributed-restart

Executive Summary

This report provides a 6-monthly progress review for the Distributed ReStart Network Innovation Competition project. Through this, it is demonstrated that Distributed ReStart is currently on schedule, on benefit and under budget.

Project Direction

The project has delivered its design stage outcomes on time and under budget. This has been achieved through an effective cycle of control processes with appropriate financial management and key quality controls in place. Planning is ongoing for the refine stage as the project begins live trials, desktop exercises and Test procurement events to prove the designs work in practice. This will allow the project to demonstrate feasibility of all aspects of Black Start from DER in this final project stage. As a result of effective project management, the program of works has been expanded to deliver a Distribution Restoration Zone Controller (DRZ-C) and a third live trial in addition to the original scope of the project. This has already produced a functional design specification for a DRZ-C but is being progressed through to demonstration with hardware-in-the-loop testing of a prototype in the next project phase. Our third live trial will test the grid forming capabilities of a battery energy storage system (BESS) in the context of a bottom-up restoration. This enables us to meet stakeholder feedback and build on recent innovations from the Dersalloch wind farm trial and the BESS Black Start test in Bordesholm.

Power Engineering and Trials

The Power Engineering and Trials (PET) workstream has produced two design stage reports (issued in July and December 2020) providing an assessment of the power engineering aspects of Black Start from DER. The first report is focused on outputs from power systems studies and the capability of grid forming converter technologies, while the second report focuses on the initial development of an automation system, DRZ-C, to overcome the technical and human resource limitations associated with Black Start from DER.

The workstream has also undertaken an initial live network trial in October 2020. This demonstrated the energising of 50km of 132kV overhead line, and two associated grid transformers, from an 11kV connected hydro generator.

Organisational, Systems and Telecommunications

The Organisational, Systems and Telecommunications (OST) workstream has delivered two design stage reports (issued in October and December 2020). From these, the workstream has developed the functional requirements for operational telecommunications, provided design specifications for the systems required to facilitate Distributed ReStart and designed the process for stabilising a power island and integrating it into the wider restoration process. The outcomes of these designs are a communications specification taking into account technical requirements, general requirements, bandwidth requirements, supported protocols and cyber security considerations. These are developed with the proposed central organisational model in mind. The central organisational model splits responsibilities for the process between National Grid ESO and DNOs, enabling DNOs to manage an individual island restoration procedure but National Grid ESO to remain as a strategic national and regional coordinator of the overall restoration. These models and specifications will be refined during 2021 through desktop exercises, simulation and further stakeholder engagement.

Procurement and Compliance

The Procurement and Compliance (P&C) workstream has developed three procurement approaches and recommended an approach (approach two) based on open tenders for the essential ‘anchor’ generator and a flexible framework approach for the ‘top-up’ services to be taken forward for further development (please see the P&C October 2020 report for more information). A more detailed codes review has taken place, including mapping interdependencies between the relevant industry codes’ clauses and sections.

The next steps involve organising and running a test procurement event and contract drafting, both subject to dependencies, as well as continuing to craft the specific code modifications required for Distributed ReStart. The workstream delivered the P&C design stage report in October 2020 and is on track to move into the refine stage in 2021.

Knowledge and Dissemination

The learnings from this project will be of immense value to the industry, both locally and internationally, as energy systems continue to decarbonise and decentralise. Knowledge and Dissemination plays a key role in sharing these learnings. Over the last year, the project has hosted a virtual conference with a total reach of over 1200 people through a combination of on-demand and live viewing, effectively demonstrating our commitment to widely disseminate learnings. Furthermore, the project has been a speaker at 11 external industry events and engaged individually with many key stakeholders across all workstreams. Effective stakeholder engagement is not only crucial for sharing key findings and challenges, but also for incorporating valuable feedback into the project.

Project Governance

This project meets all governance requirements in line with the *Electricity Network Innovation Competition Governance* document.

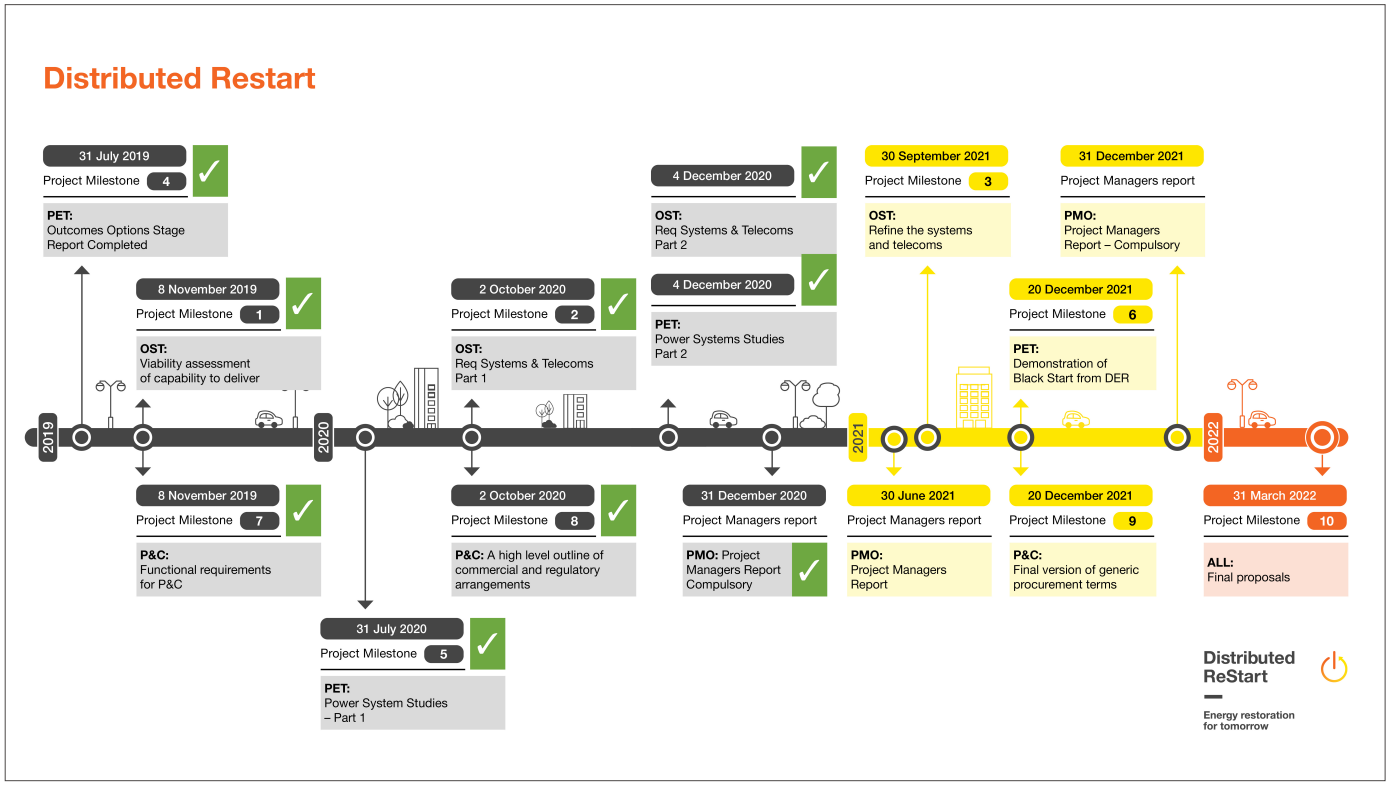
The project confirms:

- no intellectual property has been generated to date which has not been publicly shared
- all data is either publicly available on our webpages or available on request to our mailbox: ReStart@nationalgrideso.com
- there are no material changes to project plans or outcomes from the bid submission stage
- every effort has been made to ensure the contents of this report are accurate.

Gavin Brown

Gavin Brown
Distributed ReStart Steering Committee Chair

Project Timeline



1. Project Direction

Project delivery is highly dependent upon ensuring alignment between all workstreams, maintaining a clear direction, and a project management office to hold the team to account. The Project Direction workstream delivers against these goals.

1.1 Key Controls

The Project Direction workstream has established and maintained a consistent approach to project management through a cycle of project controls, including:

- monthly cost reporting from all partner companies contained in a centrally available system and detailed as far as possible against workstreams, cost categories and companies
- monthly finance surgeries to analyse costs incurred, verify their category allocation and review forecast costs
- monthly steering committee updates to senior leadership from all partner companies to scrutinise performance and action escalations
- weekly whole project calls to address actions, update risks, update and mitigate any COVID-19 risks and promote awareness of whole project outputs
- fortnightly design architect calls with senior engineers to ensure alignment of all workstreams
- legal review of significant contracts to ensure value is being provided to the consumer through our significant works.

This is considered sufficient control to enable delivery and manage spend, progress, risks and issues.

1.2 Key Challenges

Contracting for live trials inclusive of NDAs, participation agreements, long lead item agreements and consultancy agreements has caused delays as compared with baseline plans. This compounded with long lead items required for trials means that they are not due to complete within this financial year. However, a trial at the Galloway case study has been conducted creating significant project findings and the Chapelcross case study is in an advanced contracting state enabling procurement of required auxiliary equipment.

1.3 Plan and Progress

The project has successfully delivered against the full design stage bid document milestones. In addition to the mandatory project deliverable milestones, supplementary requirements documents have been published, containing additional information linked to design stage outcomes and including outputs of the Distribution Restoration Zone Control (DRZ-C) System design. This includes a telecommunications and systems requirements document alongside a power engineering requirements document.

The project has also started a tender for build and test of a prototype DRZ-C. Although not in the original project scope, we will deliver this important cross-workstream activity within existing budget and timescale, and demonstrate a capability that our work has identified as being essential to effective restoration capability from DERs.

1.4 Financial Performance

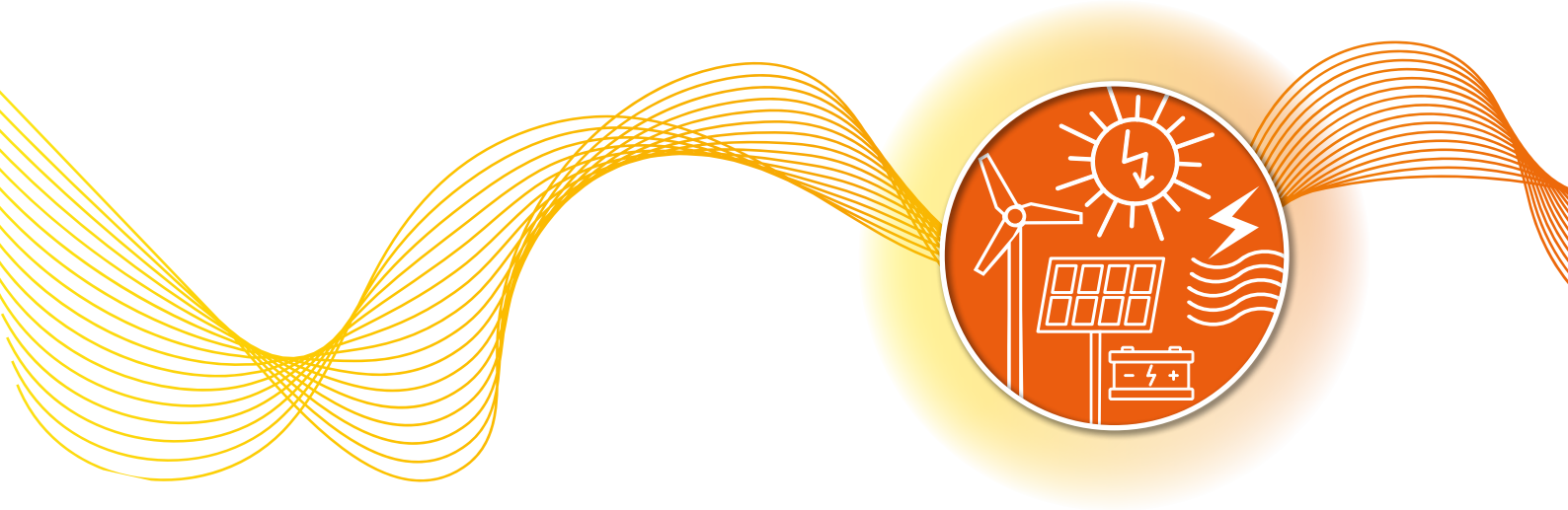
The overall project remains under budget while meeting all stage gate requirements. Budget outperformance is currently met through a leaner resourcing structure and effective utilisation of external resources. Furthermore, extensive stakeholder engagement has opened project opportunities for low or no cost delivery of some required inputs.

Underspend to date has enabled development of DRZ-C concept(s) and further cyber security analysis but will continue to be closely monitored to demonstrate project value. Since the last project progress report in June 2020 the decision has been made to utilise project underspend from the design stage to progress this system into a build stage, inclusive of developing full cyber security requirements and hardware-in-the-loop testing.

Overall project costs are strongly linked to live trials. These costs have been forecast for both short- and long-term live trials at three locations compared with the bid document commitment to test at two locations. The cost risk is managed through a two-phase approach of testing using short- and long-term trials.

1.5 Quality Assurance

The project has established a stakeholder advisory panel consisting of independent experts from across the electricity industry to scrutinise the outputs of the project. This provides independent quality assurance and raises points for investigation in later outputs. Furthermore, webinars, email promotional campaigns, a virtual project conference and presentation at external industry events has enabled public commentary on outputs. A full record of this engagement is available on our webpages: nationalgrideso.com/innovation/projects/distributed-restart



2. Power Engineering and Trials

The technical capability to deliver Black Start using DER is assessed through the Power Engineering and Trials workstream. The outcomes are detailed technical specifications supported by live trials.

2.1 Workstream Summary

The Power Engineering and Trials workstream has completed the development phase of the project, with the final output of this stage being a second report providing an assessment of the power engineering aspects of Black Start from DER. The workstream has also undertaken an initial network live trial in October 2020, energising the 132kV network, and associated grid transformers, from a 11kV connected hydro generator.

The workstream has delivered part 2 of an *Assessment of power engineering aspects of Black Start from DER* in December 2020, and has completed the first live trial at the Galloway case study in October 2020.

The workstream has met its development phase delivery requirements.

The *Assessment of power engineering aspects of Black Start from DER – Part 2* report (December 2020) primarily focuses on the initial development of an automation system (DRZ-C) to overcome the technical and human resource limitations associated with Black Start from DER. In addition, the functional requirements for an anchor generator have been developed, an assessment undertaken on the potential for GB roll out of a Black Start from DER service, and the proposed testing requirements of this service are presented. System study work covering the areas of network protection and system energisation is also considered. This builds on the extensive power systems studies, grid forming converter analysis and automation requirements discussed in the complimentary *Assessment of Power Engineering Aspects of Black Start from DER – Part 1* report (published in July 2020).

The workstream is now in the demonstration phase of the project. As such, the main focus in 2021 will be to take the technical learning to date, enhance this in specific areas as required, and put the technical learning into practice where possible in simulation and live network environments. As such the following is planned for 2021:

- continuation and development of live trials (first trial completed October 2020)
- factory development and testing of a DRZ-C
- hardware-in-the-loop (HIL) testing of DRZ-C prototype on the National HVDC Centre Real Time Digital Simulator (RTDS)
- HIL testing of a grid forming converter at the Power Networks Demonstration Centre (PNDC).

2.2 Key Workstream Findings

The following key findings relate to the *Assessment of Power Engineering Aspects of Black Start from DER – Part 2.*

2.2.1 DRZ-C

It is believed that the DRZ-C functional designs undertaken by technology companies demonstrate that the required control and coordination functionality is credible.

2.2.2 Functional Requirements – Anchor Generator

Functional requirements for DER to provide the services of an anchor generator (used initially to be self-starting and energise the network) have been developed. These will be further refined based on stakeholder engagement and as the technical requirements of a Distribution Restoration Zone (DRZ) are developed.

2.2.3 GB Rollout

An estimation of the potential for concept roll out of Black Start from DER across the DNOs in GB has been undertaken using information published within the November 2019 long term development statement (LTDS). There is a total of 6GW of anchor generation, 4.8GW connected at 33kV. In addition, 12GW (79%) of all additional DER (wind, solar, batteries) is connected at 33kV. There are 283 potential DRZ sites with an anchor generator connected at 33kV.

2.2.4 System Studies

Protection

In order to ensure operation of fuse protections on the 11kV and 415V networks, a minimum fault level (at the 33kV terminals of a primary 33/11kV transformer) of 30MVA is required for 11kV overhead line feeders up to 30km in length, and 16MVA for 20km.

Energisations

System studies show that energisation of a grid transformer (e.g. 132/33kV) from a 33kV anchor generator is feasible, and also the simultaneous energisation of a 33kV grid network (including multiple primary transformers).

2.3 Live Trials

2.3.1 Galloway Initial Trial

The first network live trial, on the Galloway case study network, was undertaken in October 2020. The goal was to prove the island mode operation of a 11kV hydro generator and develop a restoration strategy to energise the associated 132kV network.

The initial tests were to close Grid 1 11kV circuit breaker at Glenlee to energise a 132/11kV transformer, approximately 50km of 132kV overhead line, and a 132/33kV transformer simultaneously from a 15MVA hydro generator. The initial tests were unsuccessful with the generator voltage at 11kV and also reduced to 8.25kV (0.75pu). The generators high voltage protection operated to disconnect the generator with high voltage detected at its 11kV busbars due to harmonic voltages produced by the transformer inrush currents.

After subsequent energisation tests on a sectionalised network, the complete network was energised simultaneously utilising a Point on Wave (PoW) switching relay, which acts to time the closing of the energising circuit breaker to minimise the transformer inrush currents. The trial proved the requirement, and effectiveness, of a PoW relay for situations where harmonic induced over voltages may be an issue (typically where a transformer and overhead line are energised simultaneously).

2.3.2 Trial Requirements

The project bid document states that “we will deliver at least two live trials within the project, which will be developed from the case studies we use for detailed assessment and development of solutions across all workstreams”. It is our intention to energise a section of un-energised transmission system within the trials, as a minimum on the 132kV network in Scotland.

It is anticipated that further live trials will be undertaken on the Galloway case study network in 2021, ideally incorporating a wider network area and multiple DER. In addition, preliminary works are being undertaken at present to facilitate future live trials on another case study network (Chapelcross), with a third trial site also being investigated to ensure the tests cover a broad range of networks and DER types. It follows that the PET workstream is currently on track to exceed the bid document trial requirements.

2.4 Workstream Delivery

The Power Engineering and Trials workstream has delivered two reports in July and December 2020 which meet the design stage criteria outlined in table 1.

Delivery Criteria	Status	Action
Detailed assessment of the power engineering aspects of Black Start from DER	Published in 'System studies part 1' report and 'System studies part 2' report	To be tested through live trials where required.
Examples of Power Engineering through case studies including firm live trial proposals	Published in 'System studies part 1' report and 'System studies part 2' report	Extensive evaluation of the restoration process completed across multiple case studies. Part 1 report chapters 3–7. Part 2 report chapter 5.
Support of conclusions through power system studies	Published in 'System studies part 1' report	Extensive power systems studies completed across multiple case studies. Part 1 report chapters 3–7.
Enable Steering Group and DERs to make informed live trial decisions	Ongoing development and costing of trials	Stage 1 trial delivered at the Glenlee case study, preparatory works being contracted at the Chapelcross case study.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Table 1: Power Engineering and Trials design stage successful delivery criteria

2.5 Workstream Technical Challenges

A summary of the biggest challenges expected to be resolved through the design stage of the PET workstream is given in table 2.

Challenge	Current Supporting Activities
Validate the functional specification of the DRZ-C.	Tender issued to build a prototype DRZ-C and test in hardware-in-the-loop real time simulation.
Understand the limitations associated with connecting converter-connected resources (e.g wind, solar and batteries) onto a weak network.	Strathclyde University commissioned to undertake further studies looking at stability issues and penetration levels of converter connected DER in a distribution island.
Understand the part which grid forming converter technology may play in a DRZ.	Hardware-in-the-loop testing of a grid forming converter planned at the Power Networks Demonstration Centre (PNDC) to investigate to what extent a grid forming converter can provide the services of an anchor generator.

Table 2: Key PET workstream challenges and mitigating actions

2.6 Workstream Plan

Activities	Target Date
Contract issued for DRZ-C prototype build and testing	February 2021
Strathclyde University – additional studies on converter dominated islands	March 2021
HiL testing of DRZ-C prototype at The National HVDC Centre	October 2021
PNDC – HiL testing of a grid forming converter	Ongoing

Table 3: Workstream delivery plan for PET

3. Organisational, Systems and Telecommunications

Delivering the restoration process will be dependent upon the capabilities of the organisations involved, their teams, processes, systems and secure operational telecommunications. These areas are being developed through the Organisational, Systems and Telecommunications workstream.

3.1 Workstream Summary

The Organisational, Systems and Telecommunications workstream (OST) is currently in the refine phase of the project. The next output being a refine stage report *Final Organisational, Systems and Telecommunications Design*, reviewing any changes required from the design stage proposals across organisational structures, systems and operational telecommunications. This report is due to be published in September 2021. Two design stage reports have been published in October 2020 and December 2020, representing timely delivery against the original stage gates.

The workstream has met its development phase delivery requirements.

The next stage of the project will focus on proof of concept through use of desktop exercises, further development of the automated platform, including an integration plan and consultation on the functional requirements for operational telecommunications. This will allow the project to demonstrate capability to conduct a Black Start using DERs with tested processes and system integration proposals, alongside costed options for delivery of the required communications channels and protocols.

3.2 Key Workstream Findings

3.2.1 Organisational Models

A process design, inclusive of estimations for the required personnel and identification of automation opportunities has been delivered in the Design Stage I report (published in October 2020). This recommends proceeding with a 'Central Model.' Under this organisational framework, DNOs and National Grid ESO share responsibility for the overall restoration process. National Grid ESO remains responsible for overall national and regional restoration, while DNOs coordinate locally within the bounds of the predefined Distribution Restoration Zone (DRZ) as depicted in figure 1. This is shown to leverage efficiencies of local control and national coordination. To achieve an effective and efficient restoration, this relies on automation within a Distribution Restoration Zone Control (DRZ-C). This output is the result of a wide-ranging consultation process on the control options provided at the feasibility stage and will be further developed through desktop exercises.

3.2.2 Operational Telecommunications

A functional specification for operational telecommunications has been delivered through the Design Stage II report (published in December 2020), inclusive of cost case studies, infrastructure requirements and protocol requirements for voice and automation.

The functional specification includes technical requirements, general requirements, bandwidth requirements, supported protocols and cyber security considerations. It also includes an evaluation of technology suitability to meet these requirements.

The cost case studies include an evaluation across 11 DNO licence areas and National Grid ESO for implementation of voice and data communications. The cost case studies show a significant variance between DNO areas in costs for provision due to the differences in terrain, existing infrastructure and rural/urban location of DERs.

3.2.3 Operational Systems

An overview of the DRZ-C is included in the Design Stage I report and shows the indicative architecture and requirements. These will be further developed through hardware-in-the-loop testing of a prototype controller. Outputs of the front-end engineering design have been incorporated into the functional requirements presented in the Design Stage II report. In addition, a detailed cyber security review has been conducted and non-sensitive components have been published in the Design Stage I and Design Stage II reports. This includes a review of the BEIS cyber security guidance for DERs published in September 2020. Finally, a review of DER connection interfaces and comparison against DRZ-C requirements is presented in the Design Stage II report, finding significant parallels with existing ANM infrastructure but with requirements for new low latency and cyber secure communications protocols.

3.2.4 Conclusions

The key outcomes of the Design Stage I and Design Stage II OST reports are summarised below:

- Shared responsibility is needed between National Grid ESO and the DNOs to enable an effective restoration procedure. This Central Model is illustrated in figure 1.
- Automation through use of a DRZ-C is essential to mitigate against a large organisational burden to deliver a bottom-up restoration process.
- Private LTE, microwave and fibre are all suitable technologies for delivering against the latency, bandwidth and resilience requirements included in the voice and data functional specification.
- The cost of providing each individual Black Start Voice Service typically equates to £2,000 per annum normalised over the 15-year life time of the voice service although in some instances this could be as high as £9,000 per annum dependent on the technology required or deployed. These costs are primarily driven by the power resilience requirements of the Black Start services and not by the voice element of the service.
- The additional costs of providing the low latency data service are less significant (average £400 per annum but could be up to £2,000 per annum).
- An end-to-end cyber security review has provided recommendations to the project on ensuring a cyber compliant design and reviewed the gaps between BEIS cyber guidance and requirements for the project.
- An initial review of DER communication and control protocols has demonstrated that a key driver for the communications installed at a site is compliance with G59 or G99 Engineering Recommendations with G99 introducing minimum communications standards between the DNO and DER for all cases.
- A comparison between DRZ-C requirements and ANM schemes has highlighted significant parallels in approach but with a new requirement for low latency communication protocols.

3.3 Workstream Delivery

The Organisational, Systems and Telecommunications workstream has delivered against all design stage requirements from bid documentation as outlined in table 4.

Delivery Criteria	Status	Action
A process map with task allocations	Published in Design Stage I report	Desktop exercises will refine proposals from the design stage publications.
Organisational structures including roles and responsibilities	Published in Design Stage I report	Desktop exercises will refine proposals from the design stage publications.
Requirements for systems or tools with initial outline design concepts	Published in Design Stage I and Design Stage II reports	DRZ-C build and testing work has been kicked off and is in tender stage. Detailed cyber security analysis is included within this scope of works.
Telecommunications functional requirements	Published in Design Stage II report	To be refined through further stakeholder engagement and final system outputs.
Use a stakeholder-led approach	Ongoing across all workstreams	Stakeholder review is prioritised.

Table 4: OST design stage successful delivery criteria

3.4 Workstream Technical Challenges

A key output of the viability report was to identify the significant challenges which need to be addressed through the design stage and assess the possible impact. Table 5 summarises these and the current activities the workstream is undertaking to ensure they are appropriately answered.

Challenge	Current Supporting Activities
There is not a consistent operational communications or system interface with DERs	A review has been conducted by an external consultancy with experience in DER control design covering both a-synchronous and synchronous energy resources.
Wider industry changes could impact on systems and Black Start participants' responsibilities	Continual engagement with wider industry projects and initiatives including Strategic Telecoms Group (STG), ENA Open Networks and Europe Utility Technology Council (EUTC).
An increased number of stakeholders will have significant impact on the delivery of resilient, secure operational telecommunications	A functional specification has been developed for operational telecommunications and a review of suitable communications options is presented in the Design Stage II report.
DERs do not currently participate in Black Start so new processes and training will be required.	Process design has sought to minimise the impact on all parties though use of the Central Model. Desktop exercises will provide a model for training and refine overall process design.
Provision of cyber secure end-to-end operational telecommunications	An end-to-end cyber security review has been conducted to highlight risks and resilience concerns and mitigations. Further cyber security design will form part of the DRZ-C design and hardware-in-the-loop testing.

Table 5: Challenges for the OST workstream

3.5 Workstream Plan

The high-level delivery plan for the demonstration phase of OST is provided in the table below.

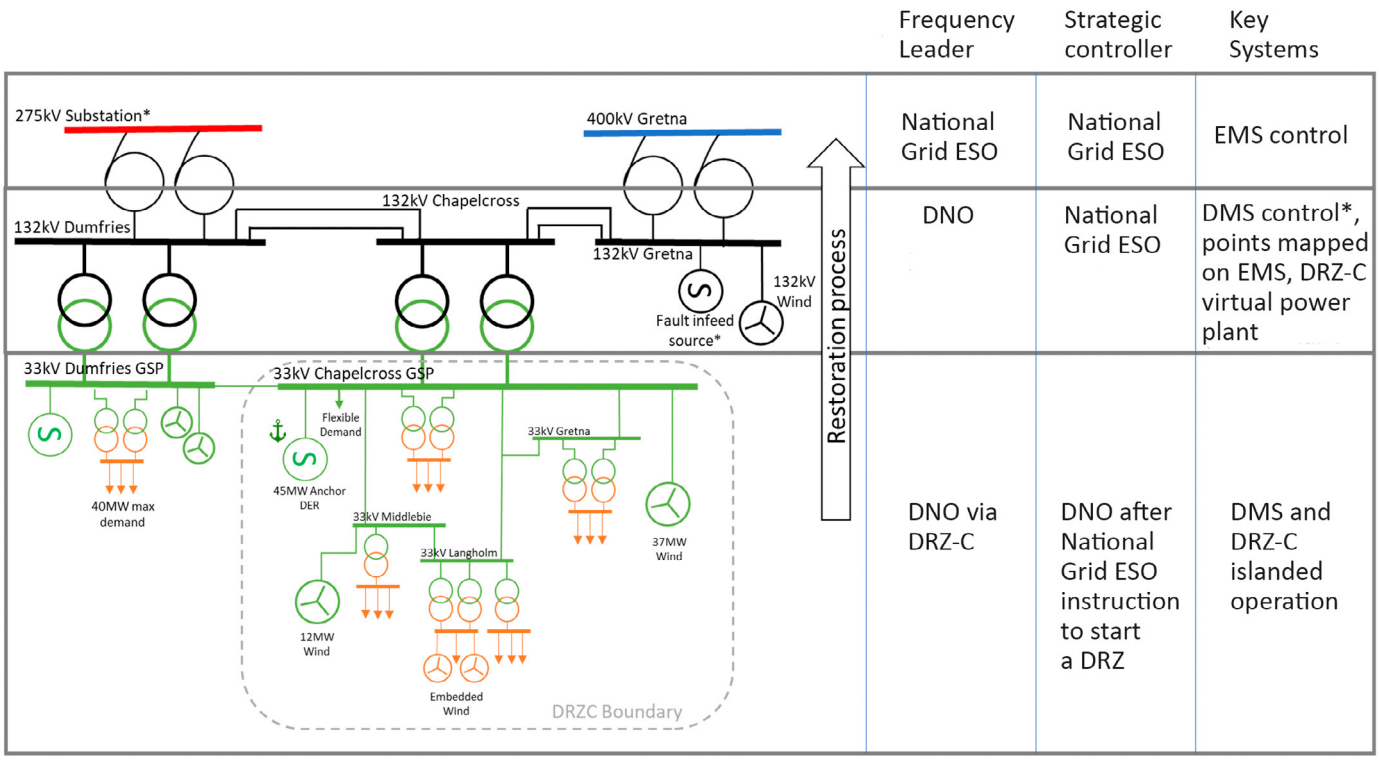
Activities	Target Date
DER interface review	January 2021
Desktop exercises (multiple)	April–July 2021
Organisational structure agreed with network operator companies and National Grid ESO	August 2021
DRZ-C build	August 2021
DRZ-C cyber secure communication design	August 2021
DRZ-C hardware-in-the-loop testing	October 2021
Operational communication consultation	Ongoing
Operational telecommunications included in draft service terms	September 2021
Organisational and systems requirements for DER included in draft in service terms	September 2021

Table 6: Organisational, Systems and Telecommunications demonstration phase plan

3.6 Anticipated Change Requirements

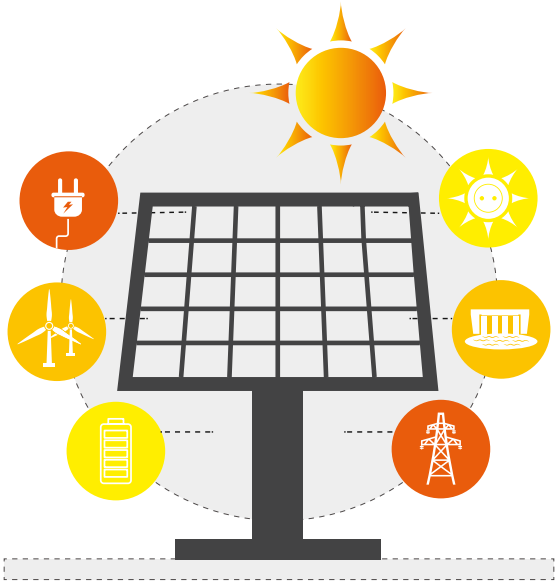
A DRZ-C is considered essential to mitigate against the organisational burden of managing more than one restoration zone. This will require introduction of new, cyber secure and power resilient operational communications channels. In addition, the low latency requirements for fast acting changes in active power require use of new communications protocols between the DNO and the DER.

The specific organisational impact of managing a DRZ-C will be tested through desktop exercises. This will allow consideration of specific changes to a DNO, National Grid ESO or DER operational procedures to facilitate the required restoration actions.



* In Scotland 132kV is a transmission level voltage so responsibility for these actions will revert to the transmission control engineer in place of the distribution control engineer.

Figure 1: Indicative Central Model key responsibility allocations mapped for Chapelcross case study, Energy Management System (EMS), Distribution Management System (DMS)



4. Procurement and Compliance

A key aspect of this project is to develop a viable route to market that ensures value for end consumers through transparency, competition and increased participation. The aim of the workstream is to develop a fit-for-purpose, stakeholder endorsed, end-to-end process, that meets the commercial objectives of the project.

4.1 Workstream Summary

The Procurement and Compliance (P&C) workstream is due to move into the refine stage following delivery of the design stage report.

The workstream has met its development phase delivery requirements.

The longer-term goals of the workstream are to develop a proposal for the procurement process and commercial structures that create a route to market for a future Black Start service from DER, which will be enabled through proposed code changes. Proposals and approaches developed by the workstream will be refined by engaging with industry stakeholders.

4.2 Workstream Outputs

The outputs from the design stage included an iteration of the strategy development process from the Functional Requirements for P&C (FRPC) report (published in November 2019), which facilitated the development of three proposed procurement approaches. The report makes the recommendation that 'approach two', explained below, should be taken forward for further development.

A review of the industry codes has progressed from the initial high level assessment presented in FRPC, a more detailed and comprehensive examination of specific codes and clauses has been carried out and is presented in the report.

The P&C stakeholder plan identified a broad range of industry colleagues who may have an interest in the workstream, and used tailored methods to get targeted feedback. A summary of the engagement events is available in table 7.

Event Details	Details	Value Unlocked
Distributed ReStart conference	30 January 2020	A conference focused on project outputs and wider industry concerns related to the project. Including presentations from the steering committee and multiple guest speakers.
Objectives survey	26 May 2020–4 June 2020	Ranking undertaken by stakeholders on the importance of the proposed commercial objectives.
Objectives one-to-one engagement sessions (15 mins)	1 June 2020–4 June 2020 16 sessions offered	Further discussion and review of commercial objectives from stakeholders to inform refinement of the objectives.
Distributed ReStart virtual conference	30 June 2020–2 July 2020	Presentations on the development work undertaken in P&C, across both commercial (proposed procurement approaches) and the codes work.
Commercial interactive sessions (20 mins)	30 June 2020–16 July 2020 14 sessions offered	Stakeholder review of proposed procurement approaches.
Codes interactive sessions (30 mins)	1 July 2020–9 July 2020 6 sessions offered	Stakeholder review of thinking around required code changes.
ENA Open Networks WS1A Liaison	June/July 2020	Liaison with WS1A leading to contact with the relevant DNO teams.
DNO interactive sessions	16 July 2020–28 July 2020 6 sessions	DNO stakeholder review of procurement approaches and potential contracting structures.
DNO/TO workshop	30 November 2020	Event targeted at distribution and transmission network operators for review of approach two to gather feedback.

Table 7: P&C stakeholder events

4.2.1 Procurement

The strategy development process involves five stages: Objectives, Inputs and Analysis, Initiatives, Refine, and Implement. The design stage focused on refining the Objectives, and Inputs and Analysis, through stakeholder engagement, and developing initiatives.

The commercial objectives are proposed to be structured as follows, with four sub-categories of two high-level objectives:

- Accelerated restoration times
  - Functional route to market for new service
- Financial value for the end consumer
  - Increased transparency
  - Increased competition
  - Reduced barriers to entry.

The PET workstream has developed a set of required technical capabilities that are necessary for forming a DRZ, which are summarised in table 8.

Necessity	Capability
Essential for each DRZ	Anchor generator
Potential for each/some DRZ	Fast MW response Fast MVAr response Energy (MWh) Fault infeed Inertia Demand

Table 8: Required technical capabilities in a 'lotting' structure

P&C have split these into two ‘lots’ or categories of capabilities, ‘anchor generator’ (AG) capability, and ‘top-up’ services (TUS). In addition to the technical capabilities required, ‘demand’ has been included as a potential third ‘lot’, or ‘top-up service’, though whether it is operationally feasible to include contracted demand (as a separate commercial service) in a DRZ will need to be given further consideration.

The three procurement approaches developed, to access these services, are as follows:

- **Approach 1:** there is one contract between the party responsible for contracting and a lead service provider for each DRZ, for all required services (both the anchor generator and top-up services). The lead service provider is likely to be the owner/operator of the anchor generator and may want to sub-contract for any required top-up services.
- **Approach 2:** the contracting party contracts for all of the required elements of a DRZ, with whichever parties create the best value proposition. They can hold one or multiple contracts per DRZ. The procuring entity would procure the anchor generator and top-up services separately (as required). The top-up services could be procured in different combinations (individually, all together or a combination of the two).
- **Approach 3:** while the anchor generator is still contracted for, the proposal is that the top-up elements would be accessed through code mandated capability during market suspension in a Black Start situation, as opposed to contracted for ahead of time.

Following stakeholder engagement, P&C is recommending moving forward with the refinement of approach two, as it provides the most flexibility for the procuring entity around the specific design of the service and it also offers the lowest barriers to entry for potential providers.

As it is assumed that DNOs will be responsible for local operational actions to restore the DRZ 'on the day’, it is proposed that the contracts for the services should be between the DNO/DSO and the service providers. However, this does not necessarily mean that the DNO/DSOs must be the ones to conduct the procurement activity, which could be done by either the DNO/DSO, National Grid ESO, or another independent party.

4.2.2 Codes

A review of the industry policies, regulations, codes and standards was carried out previously, highlighting how some of these may have to be changed and adapted to enable a Distributed ReStart. Following this initial review, a much more detailed and comprehensive review has been undertaken, highlighting the specific sections and clauses where codes will need to be changed or adapted.

The main industry codes that will require changes are the Grid Code and Distribution Code, where operational, contractual and engineering elements of the Distributed ReStart process will need to be added into the codes. There are continuing dependencies on the PET, OST and P&C workstreams for the input to the codes work.

Refinement of and input to code change work is continuing to be progressed through National Grid ESO and SPEN code change teams, with involvement in the Emergency and Restoration Phase II workgroup (which aligns to the Distributed ReStart project) and drafting of code change requirements.

4.2.3 Conclusions, Next Steps and Dependencies

Stakeholder engagement has been key to the development of the procurement approaches and commercial structures and will continue as P&C moves into the refine stage of the project.

The next steps for procurement and commercial involve refining the recommended procurement approach and begin to define the contract principles and draft contract terms. The next steps for the codes work involves feeding in to the Emergency and Restoration Phase II workgroup and continuing to craft the specific code modifications required for Distributed ReStart.

There are several key enablers and dependencies across the project, in particular, confirmation of the functional requirements, the coordination and control structure of the service and ‘rules of play’ between anchor generators and top-up services.

4.3 Workstream Delivery

Table 9 outlines the 2020 Procurement and Compliance workstream report's objectives. A download of the full Procurement and Compliance report can be found on the Distributed ReStart webpage: nationalgrideso.com/document/178266/download

Delivery Criteria	Status	Action
Draft procurement design	Developed and published in the *Commercial and regulatory arrangements* report	The project will now move towards refining the developed procurement approach.
Draft contractual arrangements	Under development, with dependencies on the other workstreams	The project will now start to develop the contract principles and structures to support drafting the contracts, subject to dependencies.
Regulatory and funding arrangements	Under development, engagement with relevant parties is being sought	Discussions with DNOs and other relevant parties, to understand potential funding and licence changes required, are being planned.
Required changes to codes and licence requirements	Under development	Refinement of required code changes is in progress, dependent on outputs from the other workstreams.
Use a stakeholder-led approach	Ongoing	Stakeholder review is prioritised across all workstreams.

Table 9: Successful delivery criteria for P&C design stage

4.4 Delivery Challenges

There are a number of key challenges for the P&C workstream:

- There are dependencies on PET and OST workstream outputs for developing the contract principles and drafting contractual terms. This risk to timelines is being managed carefully through whole project planning.
- Organising and running a successful dummy procurement event will inform the refinement of the procurement approach and contract drafting. There are significant dependencies on the other workstreams that will determine whether a dummy event will be possible.
- In the initial stages of a potential rollout, it is likely to require a phased implementation because there is a high likelihood that processes will be manual, there will be a necessity to test and learn from any processes and there needs to be availability and readiness of DER to participate.

4.5 Workstream Plan

Activities	Target Date
Industry stakeholder engagement	On-going
Engagement with PET and OST to address dependencies	November 2020–January 2021
Refinement of the recommended procurement approach	February 2021–June 2021
Design and delivery of a dummy procurement event subject to dependencies	November 2020–August 2021
Development of contract principles to support contract drafting	June 2021–October 2021
Development of code change proposals and input to relevant code modification workgroups	November 2020–August 2021

Table 10: Procurement and Compliance workstream plan

4.6 Anticipated Change Requirements

The commercial contracts and structures will be developed subject to dependencies over the course of the project.

Any licence condition or code change requirements will continue to be determined throughout the refine stage with support from internal National Grid ESO and SPEN code experts.

Through continued development and iteration, and in line with the inputs considered within the design stage (including stakeholder engagement and updated project assumptions), it has been possible to create an updated roadmap of how an incremental rollout could occur, once the project comes to its conclusion in March 2022 and activities begin to transition into BAU teams for implementation.

The roadmap is purely for illustrative purposes, it is based on assumptions that may be amended as the project develops and is subject to the outcomes of the project and the requirement for Distributed ReStart/Black Start services.

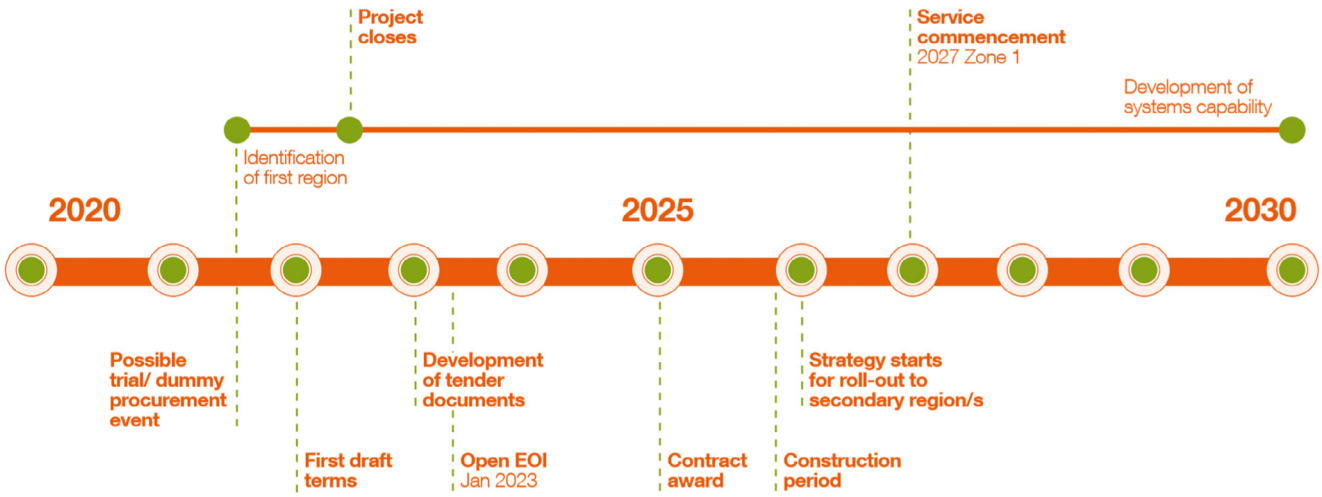


Figure 2: Example roadmap for phased roll out of future services

5. Cost Benefit Analysis

We have updated some of the assumptions within our original cost benefit analysis, which was submitted as part of our funding submission in 2018. These updates have increased the calculated level of potential benefit from £115m to £145m. We have also confirmed that the CBA is consistent with the new Future Energy Scenarios.

5.1 Overview

We prepared a Cost Benefit Analysis (CBA) of the potential benefits of Distributed ReStart as part of our funding submission to Ofgem in 2018. This CBA combined three core sets of inputs:

- The cost of Black Start services from different types of generation technology, captured as a £/MW/year cost, including core service costs, technology retrofit costs, and costs associated with ensuring readiness for thermal generation that would otherwise not be dispatched.
- A volume, in MW, of Black Start capability in each year out to 2050, separated out by different types of generation technology on the distribution and transmission networks.
- A total requirement for Black Start services in each Black Start zone. This is defined in MW and is equivalent to the current practice of procuring three providers within each zone.

These three sets of inputs are combined in the CBA to identify, within each zone, what types of generation would be procured to provide Black Start services at the lowest cost, and the associated carbon impacts.

In general, our CBA adopted relatively pessimistic assumptions in order to provide a conservative view of the possible benefits. For example, it is assumed that, without the Distributed ReStart project, DERs would still be able to be involved in restoration, but this would just happen later and in a less efficient way. In addition, we used the 2017 'Slow Progression Future Energy' scenario as the basis of our analysis.

The CBA suggested potential benefits with a net present value of up to £115m.

5.2 Updated Assumptions

We have been able to update a number of the assumptions included within the original CBA. These updates are described here, along with a description of some of the inputs that we have not been able to revisit.

5.2.1 2020 Future Energy Scenarios (FES)

We have included the 2020 FES into the CBA, replacing the original 2017 'Slow Progression' scenario. The model now includes inputs for the capacity of different generation types by zone for each of the four core 2020 FES:

- Leading the Way
- System Transformation
- Consumer Transformation
- Steady Progression.

The CBA also requires inputs about the required volume (in MWh per MW per year) of redispatch for each technology to ensure readiness of thermal generation. In the original submission, this was based on some detailed analysis of granular outputs from the FES analysis, including half-hourly dispatch profiles produced by National Grid ESO's economics team which are produced as part of the Network Options Assessment (NOA).

Unfortunately, it has not been possible to redo this detailed analysis for this CBA update. Instead, a simplified relationship has been identified between the required volume of redispatch and the load factor of the generation, based on the analysis that was completed in 2017.

In addition, the detailed information of the number of generators by type in each zone was not available. This is used in the CBA to consider the potential benefits associated with improving the liquidity of the market for Black Start services. We have therefore made a **change to the model's calculations**, which now takes the average installed capacity for each provider type in each year, again based on the original 2017 data.

5.2.2 De-Rating of Variable Generation

Our CBA includes the prospect of variable generation, including offshore wind, onshore wind, and solar PV, providing Black Start services. However, we recognised that the variable nature of this generation meant that it could not be relied upon to the same extent as dispatchable generation. We therefore included de-rating factors for all generation, which essentially increased the cost per MW of effective service, with greater increases in cost for more severe de-rating.

We originally used capacity market de-rating factors where available, but, at the time, such de-rating factors were not available for variable generation. We therefore adapted typical annual load factors (e.g. ~30–40% for wind and ~15% for solar).

Since then, National Grid ESO has published de-rating factors for these variable generators for the capacity market. We have adopted these latest factors within the CBA, replacing the original simple use of load factors.

5.2.3 Retrofit Costs of Transmission Providers

We assume that retrofit costs for new equipment for transmission providers, such as Automatic Voltage Regulators (AVRs) and reactive compensation, are recovered over several years. However, recent experience suggests that this period will be shorter than we had assumed in the initial CBA, which will increase the annual costs of the service as provided by these transmission providers.

For example, some costs that were originally expected to be spread over a 10-year contract, but recent experience suggests that this would now be expected to be more like 5–10 years. We have therefore increased retrofit transmission costs to account or this.

5.2.4 DER Costs

A small error in the processing of the DER retrofit costs meant that some costs, associated with the IT and telecommunications infrastructure at the Grid Supply Points, were double counted. We have corrected this minor error in the updated CBA.

5.2.5 Assumptions That Haven't Been Revisited

There are some assumptions within the CBA that will eventually change due to the findings of the project, but which we haven't yet been able to revisit.

In particular, the project will provide insight on the types of equipment, and associated costs, of making restoration from DER technically feasible. We have already improved our understanding of some of these costs based on the project's experience with the live trial sites.

However, the conclusions of these workstreams are not yet clear enough to allow for a detailed update of the costs that we included for DER within the CBA. We will, instead, revisit this as part of a further update to be completed at the conclusion of the project. We have also explored the sensitivity of the CBA outputs to DER costs within this update, as described below.

5.3 Updated Findings

5.3.1 Incremental Effect of Updates

The incremental effect of making updates to the model is presented in figure 3 below. The overall impact of these changes is an increase in net present value (NPV) benefit by 2050, from ~£115m to ~£145m.

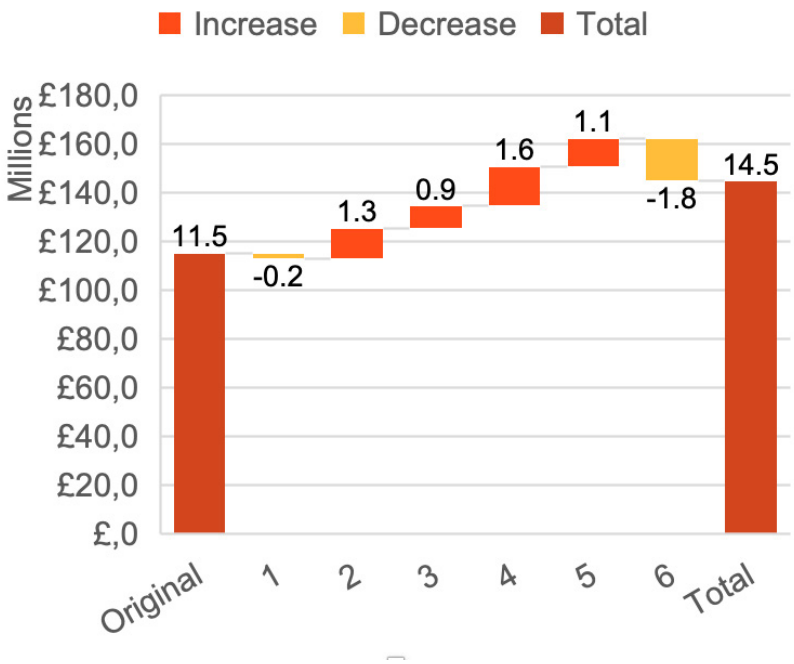


Figure 3: Waterfall chart of changes to CBA

The changes are:

1. Modifying the calculations in the model to use average generator sizes. This has a very minor impact on the benefits.
2. Changing the net present value to discount costs to 2020, rather than 2018. This increases benefits, as the time where benefits start to be realised are less far in the future.
3. Correct the DER retrofit costs for IT and telecommunications, to remove double counting. This increases the CBA's benefits by making DER appear more cost-effective compared to transmission providers.
4. Updating the transmission costs to recover retrofit capital costs over shorter durations. This leads to a fairly significant increase in benefits, as it makes transmission providers appear less cost-effective compared to distribution providers.
5. Changing the de-rating factors for variable generation. This essentially makes variable generation unviable on their own for Black Start services – they were previously used quite a lot in the counterfactual (e.g. transmission connected offshore wind) leading to an increase in benefit.
6. Changing from the 2017 Slow Progression scenario to the 2020 Steady Progression scenario. This reduces the benefit.

The impact of changing the variable generation factors highlights that they are not likely to be able to provide a Black Start service economically when considered in isolation. Instead they will need to be used in combination with grid forming anchor DER. However, this increases the benefit of the Distributed ReStart model as it requires this co-location for all resource types so is less impacted than conventional Black Start by this lower availability de-rating.

This is also consistent with the findings of our NIA project (completed in early 2019), where we considered the prospect of wind farms contributing to system restoration. In that analysis, we concluded that in investment planning timescales, it would be very difficult to rely on wind farms to contribute towards system restoration, but that wind could potentially play a very significant role in operational planning timescales e.g. due to the ability to forego re-despatching generation for readiness during periods where it is already very windy.

5.3.2 Benefits across Different Scenarios

Within the updated CBA, we can now compare the potential benefits across all of the 2020 FES scenarios. This is presented in figure 4, which shows that the benefits are robust to the choice of scenario.

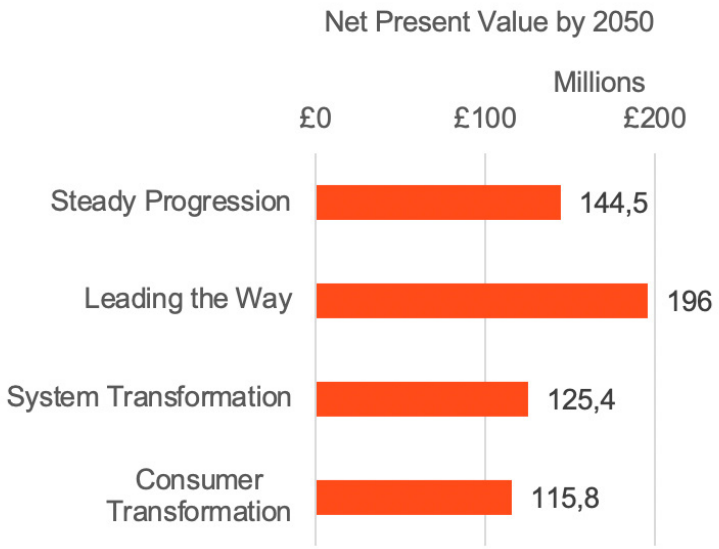


Figure 4: Net present value across scenarios

One interesting outcome is that the benefits are higher for the Steady Progression scenario, highest for the Leading the Way scenario, but lower for the System Transformation and Consumer Transformation scenarios. Initial inspection of the scenarios suggests that this due to a combination of factors:

- The Leading the Way scenario sees the most rapid decline of thermal generation in the energy market, leading to low load factors and high costs associated with readiness and re-dispatch. In the counterfactual, there are few alternatives to incurring this cost, but with DERs available to provide Black Start much of this cost can be avoided.
- On the other hand, the Steady Progression scenario has the highest volumes of dispatchable generation on the distribution networks, which is the most effective in the CBA at providing Black Start services (these generators would effectively be the 'anchor generators'.

This illustrates the complexity of the scenarios, which seek to condense all the possible ways in which the energy system might change in the future along just two axes.

5.3.3 Sensitivity to DER Costs

The cost of procuring Black Start services from DERs will be central in determining the level of benefit which the Distributed ReStart method ultimately enables.

Establishing this cost is ultimately part of the project's scope, as it depends on, for example, the technical requirements associated with energising from the distribution network, and the organisational and systems requirements. The project is not yet at a stage of being able to report these costs in more detail.

However, we have considered the robustness of the benefits case to different levels of cost, based on some very early engagement for trial costs. This builds on the sensitivities which we explored as part of the original submission. We have considered three alternatives:

- **Small increase:** The cost of DER restoration services is 15% higher than our central assumption.
- **Medium increase:** The cost of DER restoration services is 50% higher than our central assumption.
- **High increase:** The cost of DER restoration services is 90% higher than our central assumption.

The calculated level of benefits in the baseline and these three alternatives is presented in figure 5. Unsurprisingly, increasing the DER costs results in a reduction in benefit, with higher cost increases leading to greater reductions in benefits.

This shows that the CBA is robust to varying levels of DER cost, but reinforces the importance of establishing in more detail what these costs will be.

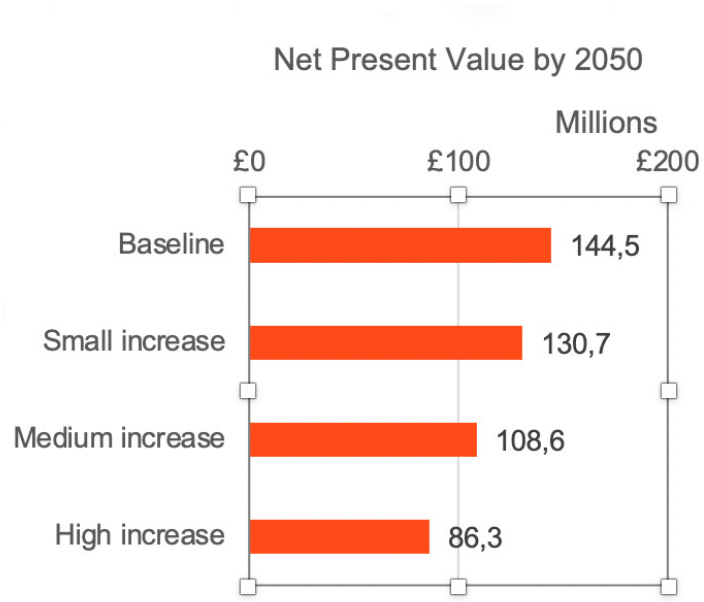


Figure 5: Net present value with different DER costs

5.4 Next Steps

The updated CBA reaffirms that Distributed ReStart has potential benefits exceeding £115 million across all the different future energy scenarios and is robust for varying levels of DER cost. The work in 2021 will focus on updating the DER retrofit costs informed by the live trials as well as updated generation technology redispatch volumes, and will also focus on refining the model to inform investment decisions.

6. Knowledge and Dissemination

All workstreams have relied on a stakeholder-led approach to uncovering challenges, establishing existing capabilities and developing future options. This approach has been facilitated through the Knowledge and Dissemination workstream.

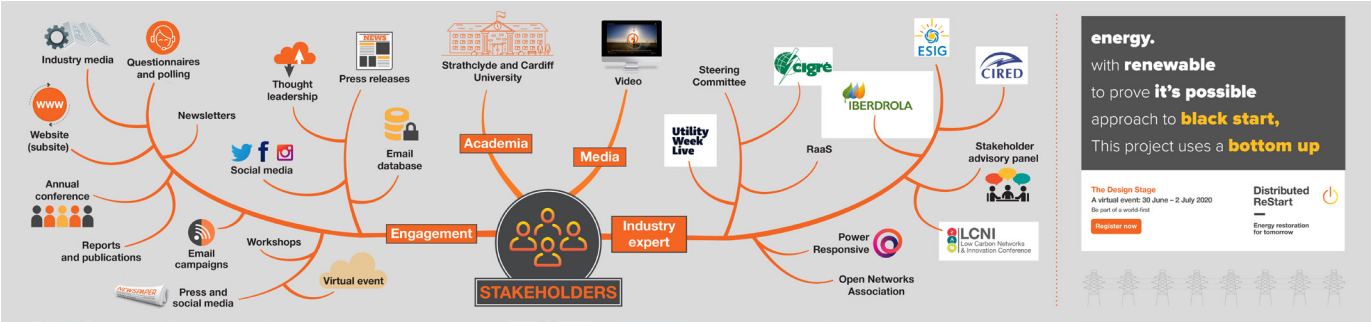


Figure 6: Stakeholder map showing points of interaction for the project alongside a social media promotion for the virtual event

6.1 Stakeholder Analysis

Knowledge and Dissemination plays a key role in disseminating project learnings to a variety of stakeholders ranging from DERs and network operators through to academics, policy makers and end consumers.

Effective stakeholder engagement is not only crucial for sharing key findings and challenges but also for incorporating valuable feedback into the project.

The project is now able to monitor and track via statistical analysis our findings through:

- regular engagement with our stakeholders, building relationships and ensuring constructive feedback to inform the project, future events and communications
- key channels including email campaigns, social media, events and webinars
- constantly monitoring the performance of our communications using email and web analytics
- our email database allowing us to identify and target stakeholder segments to meet their specific needs and interests, e.g. DNO/TO workshops and workstream promotions
- interactive events and workshops enabling stakeholders to ask questions and have panel discussions with senior project members and industry experts
- creative and engaging content that meets 'best practice' for digital communications guidance
- messaging and identity branding needed to reflect the importance of the project as a world first initiative
- email campaigns providing clearer customer journeys, using subject lines and layouts to ensure maximum openings and clicks
- utilising social media to convey strong creative executions to drive response and grow audiences.

Considering the pandemic, a three-day virtual event was held on 30 June–2 July 2020. The purpose of the event was to discuss with stakeholders our ideas for the power engineering technical findings, organisational, systems and telecommunications designs and our approach to procurement and codes to be taken forward to the refine and demonstration phases of the project. As a result of positive feedback, we are aware that this format works for our target audience.

This event helped to grow our engagement database from 326 to 728 interested parties, an increase of 112%. The dashboard view below highlights the success of this event. The post event evaluation reviewed:

Email registration campaign: open rate vs global average, email click rate vs global average and email unique clicks by global average. All figures reviewed showed an above average pick up indicating that the messaging landed as intended.

Number of registrants: number of attendees that directly registered via the webpage exceeded expectations at over 1000.

Overall attendance: broken down into each day and via presentation slot, indicating that we have strong stakeholder interaction.

Audience participation: over 120 technical questions were raised by the audience and answered, with follow up being published in the post event email campaign.

Post event/on demand: a huge success, with over 238 replays of the recorded presentations averaging 28 minutes per session.

Feedback: collated via Survey Monkey, 73% of participants rated the event as either excellent or very good with the remaining 27% rating the event as good.

We plan to keep all events in a virtual format while COVID-19 restrictions remain in force.

The webpages have been redesigned to maximise engagement and ease of reference after a critical review of our web analytics.

On our webpages you will find an animation, high level description of project outputs and the project infographic explaining current and potential future Black Start processes:
nationalgrideso.com/innovation/projects/distributed-restart

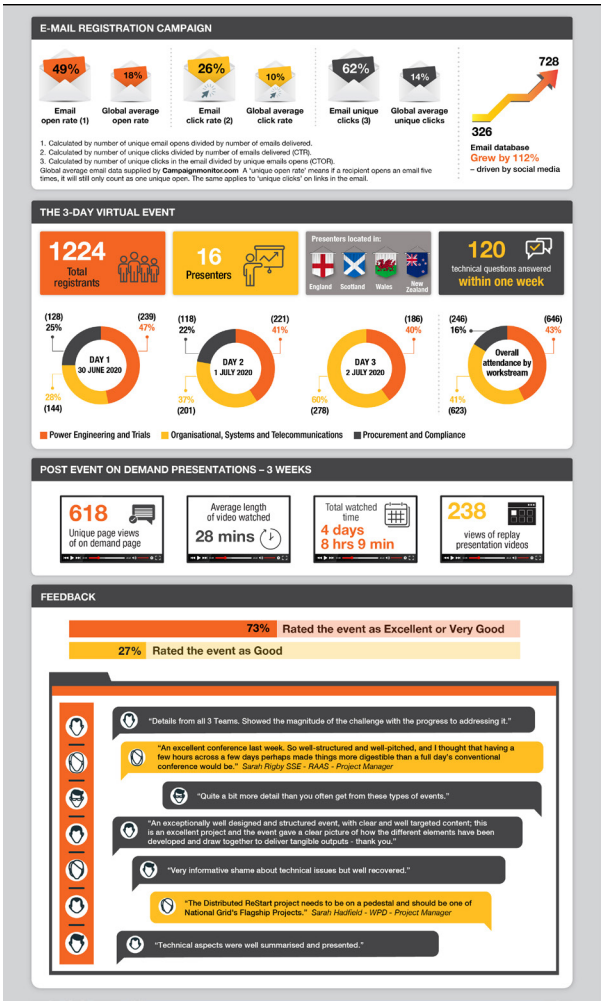


Figure 7: Virtual event engagement dashboard

6.2 Engagement Activities

We have an active distribution list of over 720 registered interested parties and use this as a channel to engage with people globally through 'lightbulb moment' email updates, sharing pertinent project information and news, webinars discussing specific project deliverables and challenges, and to promote attendance at specific industry events.

Examples of our key engagement activities are shown in table 11.

Event	Value Unlocked
Distributed ReStart Webinar on OST and P&C outputs **8 January 2020**	Knowledge share with over 100 interested people specifically sharing key outputs from the viability stage publications.
Distributed ReStart Conference 2020 **30 January 2020**	A conference focused on project outputs and wider industry concerns related to the project. Including presentations from the steering committee and multiple guest speakers.
Speaker at Future Networks **25 February 2020**	Engagement with broad industry stakeholders specifically interested in the future of energy networks.
CIGRE Paper accepted	A project publication has been delivered and presented on at the CIGRE & CIRED 2020 conferences, providing a further channel for expert review.
Project Virtual Event **30 June–2 July 2020**	Engagement with a broad audience interested in Black Start, disseminating design stage learnings through detailed presentations across three days.
Energy Networks Innovation Conference (formerly LCNI) **8–9 December 2020**	Project engagement with audience with a specific interest in lower carbon innovation projects.

Table 11: Engagement activities

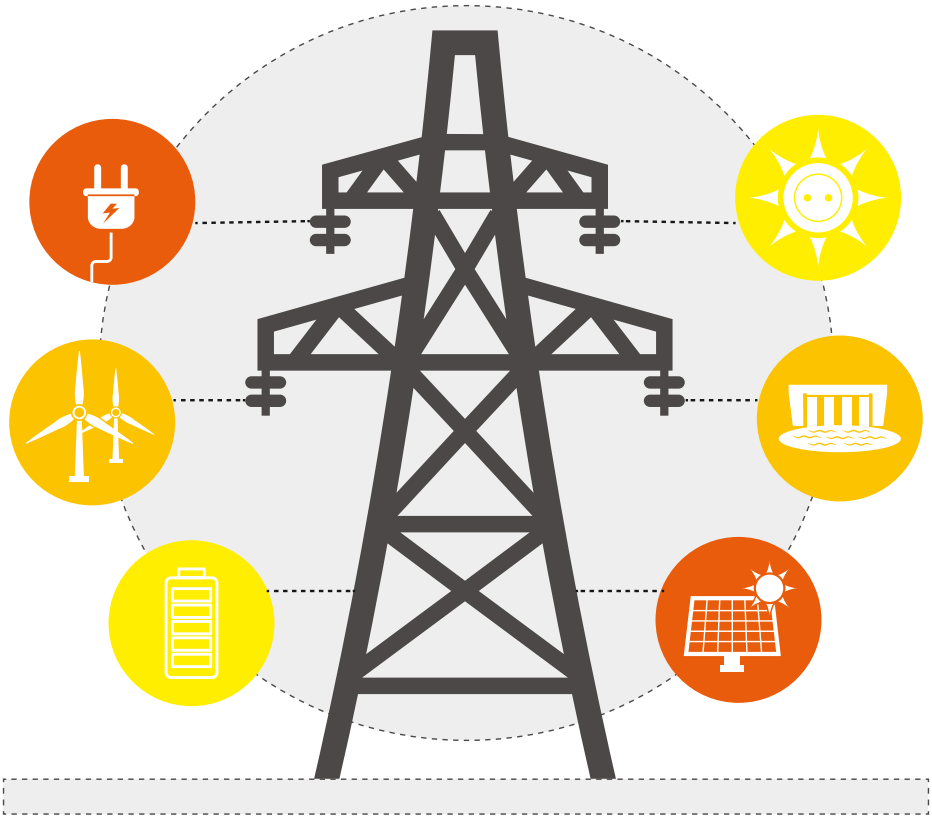
6.3 Targeted Stakeholder Review and Challenge

The project has taken part in numerous targeted industry consultations. Inclusive of membership of working groups and hosting workshops. This allows direct input to project deliverables drawing on knowledge of subject matter experts inclusive of rigorous challenge.

Event	Value Unlocked
Strategic Telecoms Group **Ongoing collaboration**	Ongoing working group. Direct input and challenge to the telecommunications functional requirements, ensuring representative views from network operators across GB.
Electric Power Research Workshop **23 June 2020**	International knowledge share through the Electric Power Research institution.
Energy Systems Integration Group **22 July 2020**	Presented to a Global forum dedicated to engineering education and research.
Knowledge sharing with Resilience as a Service NIC project **Ongoing collaboration**	Ongoing engagement in line with agreement with Ofgem. Now a member of the project stakeholder advisory panel.

Energy Networks Association Open Networks (WS1A and WS1B) **Ongoing collaboration**	Ongoing feedback and presentations including a dedicated OST workstream presentation to ensure project alignment with National Grid ESO and DSO developments.
European Utilities Telecoms Council Knowledge share **Ongoing collaboration**	Article on OST developments in the EUTC April newsletter with ongoing operational telecommunications input based on Europe wide developments.
Imperial College Networks engagement	Monthly calls on operational telecommunications and cyber security.
Energy Emergencies Executive Committee Cyber Security Task Force (E3CC) meetings	Presented functional requirements designs for resilient and cyber secure operational telecommunications to E3CC in September and November 2020.
British Electrotechnical and Alloy Manufacturers Association **Ongoing collaboration**	Ongoing engagement with the UK trade association for manufacturers and providers of energy infrastructure technologies and systems.
Joint Radio Company Annual Conference **15 October 2020**	Invited as a guest speaker to present the Central Model output with key telecommunications and network stakeholders.
DNO/TO workshop **30 November 2020**	Event targeted at distribution and transmission network operators to provide critical review and insight to design outputs.

Table 12: Table of specific industry consultation activities



6.4 Email Campaigns

As more reliance falls upon digital communications and virtual interactions, the need to evaluate and benchmark our delivery will become greater. People's expectations are growing at a rapid rate due to the pickup of this format during the pandemic. The information below shows a graphical representation of the volume and success rates associated with our email campaigns.

Summary December 2019–November 2020	Statistics
Campaigns (including virtual event)	29
Emails	14,649
Delivery rate	99.50%
Bounce rate	0.50%
Open rate	40%
Click rate	34%
Engagement • Active • Inactive	 34% 66%
Segmentation • DNO/TO • Industry experts • Stakeholders	 7% 27% 66%

Table 13: Summary of stakeholder engagement activity

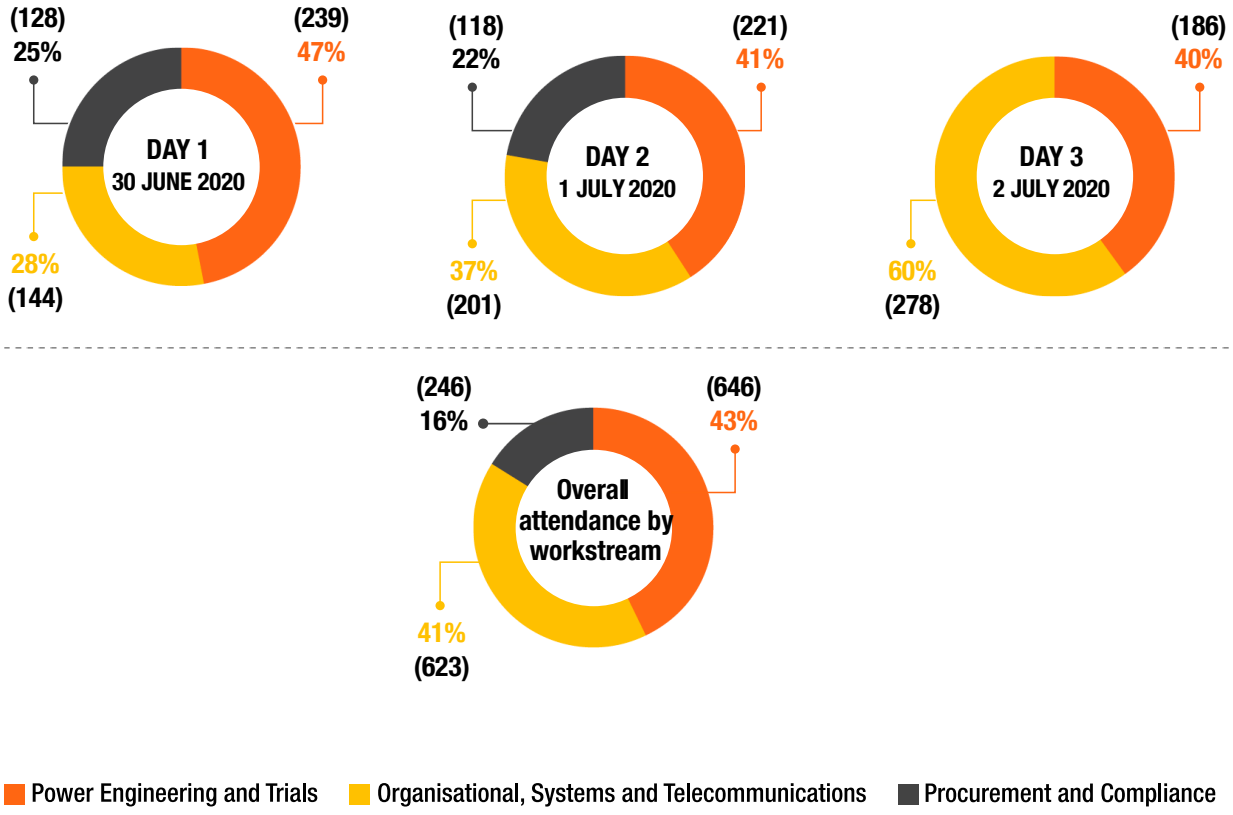


Figure 8: Stakeholder engagement analysis

6.5 Planned Future Engagement

Throughout the design stage of the project, stakeholder input has been key to building on existing knowledge and ensuring an inclusive solution. The team commits to continue attending and hosting events throughout 2021. Table 14 details our planned engagement but this will be continually revised and added to throughout the project.

We have taken into consideration the impact of COVID-19 upon the project and its ability to interact in open forums. We have developed a virtual event format which we intend to continue as a result of the positive feedback.

Event	Date
Stakeholder Advisory Panel	Ongoing via teleconferencing
Strategic Telecommunications Group	Ongoing via teleconferencing
CIGRE Black Start working group	Ongoing via teleconferencing

Table 14: Planned stakeholder events

6.6 Knowledge Sharing

As a project team it is important to us that all stakeholders are listened to and the knowledge gained from an interaction is passed on to everyone. If this report has prompted any questions of your own email us at: ReStart@nationalgrideso.com

Project Governance

Data Access

Every effort is made to disseminate all project learnings through our webpages:
nationalgrideso.com/innovation/projects/distributed-restart

Should any further information be required such as access to raw data this may be requested subject to conditions on background IP. This request should be sent to:
ReStart@nationalgrideso.com

Intellectual Property

No specific intellectual property has been developed which has not been shared openly in reports at this time.

Contracts with third parties are structured so that their background intellectual property is protected but the project can share findings on designs and solutions proposed for Black Start from DER.

Material Changes

A non-material change was made within this reporting period. The project delivered the functional requirements through additional reports in December 2020 in place of integration within reports in October 2020. This was done with prior agreement from Ofgem and the steering committee.

No material changes have been made to deliverables or budgets within the reporting period.

Accuracy Statement

The contents of this document are accurate and representative of our current project progress as of 10 December 2020.

Gavin Brown

Gavin Brown
Distributed ReStart Steering Committee Chair

Appendix 1: Progress to Date

Options Stage

Power Engineering and Trials

Delivery Criteria	Status	Action
Choice of case studies and options for network re-energisation in each case	Complete and published	List of 10 case studies produced with load flow study outputs published for restoration options.
Initial proposals for the functional testing requirements to apply for Black Start from DERs	Complete and published	A holistic review of existing assurance test practice produced with initial change proposals made to make this applicable to a DER led restoration.
The potential for roll out across GB	Complete and published	A review of the long-term development plans of all DNOs was used to demonstrate that initial proposals are suitable GB wide. In addition, case studies have been selected to ensure they are representative of the range of networks and DERs across GB.
Use a stakeholder-led approach	Ongoing	Questionnaire issued to all DNOs, DNO/TO workshop and multiple stakeholder events held/attended.

Organisational, Systems and Telecommunications

Delivery Criteria	Status	Action
Resilience assessment of telecommunications	Complete and published	A list of telecommunication options for resilience produced. The project team is a member of the STG and has used existing resilience analysis to prevent duplication.
Resilience and capability assessment of systems	Complete and published	A review of existing operational systems published, alongside requirements for an automated controller (DRZ-C).
Capability assessment of organisational structures and skills	Complete and published	All organisational capabilities have been baselined and assessed against proposed organisational models.
Identify key areas of focus for the design stage	Complete and published	All delivery criteria above highlighted potential areas of change and focus. Key elements include: flexibility, familiarity and resilience.
Use a stakeholder-led approach	Ongoing	Questionnaire issued to all DNOs, DNO/TO workshop and multiple stakeholder events held/attended.

Procurement and Compliance

Delivery Criteria	Status	Action
Procurement options and selection criteria	Complete and published	A review of existing procurement practice has been produced. Along side potential procurement options to be adapted based on stakeholder review and wider project outcomes.
Commercial design	Complete and published	Commercial considerations published. This outlines the anticipated changes from any commercial structure and will feed into the draft procurement and contractual design.
Gaps and blockers in code licences to enable the service	Complete and published	A thorough review of existing codes has been produced outlining any gaps or blockers with proposed areas of focus.
Use a stakeholder-led approach	Ongoing	A horizon scan of innovation projects with commercial implications has been produced and multiple stakeholder events held/attended. In addition a horizon scan exercise has been used to ensure the project is aware of risks and opportunities from future codified arrangements.

Development Phase

Power Engineering and Trials

Delivery Criteria	Status	Action
Detailed assessment of the power engineering aspects of Black Start from DER	Complete and published	Detailed power systems studies have been produced and published across the design stage reports.
Examples of power engineering through case studies including firm live trial proposals	Complete and published	Three case studies are progressing with contract negotiations, one intial trial completed.
Support of conclusions through power system studies	Complete and published	Restoration routes mapped and modelled inclusive of extensive steady state and dynamic modelling with an RTDS model developed for HiL testing of the DRZ-C.
Enable Steering Group and DERs to make informed live trial decisions	Complete and published	Three case studies are progressing with contract negotiations, one initial trial completed. Steering group have approved the overall approach and costing.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Organisational, Systems and Telecomunicaitons

Delivery Criteria	Status	Action
A process map with task allocations	Complete and published	Currently undergoing external consultation to refine process maps.
Organisational structures including roles and responsibilities	Complete and published	Process maps include responsibilities. Organisational structures will follow this.
Requirements for system or tools with initial outline design concepts	Complete and published	DRZ-C functional specification has been delivered, further work will build a prototype for HiL testing.
Telecommunications functional requirements	Complete and published	Functional requirements have been published for both manual and automated procedures and will be further refined across the remaining project through consultation.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Procurement and Compliance

Delivery Criteria	Status	Action
Draft procurement design	Complete and published	A procurement design has been published including a preferred option.
Draft contractual arrangements	Ongoing	The services to be procured and contractual structure are outlined in the P&C design report.
Draft regulatory and funding arrangements	Ongoing	Legal guidance has been given on the impact of organisational models.
Required changes to codes and licence requirements	Complete and published	Affected code change requirements identified. The project is currently drafting the code change recommendations for BAU consultation processes to take forwards.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Deliverables for the Demonstration Phase

Power Engineering and Trials

Delivery Criteria	Status	Action
Delivery of live trial(s)	Initial trial delivered 4 more tests across 3 case studies planned	Contract negotiations with live trial participants and supplies are ongoing against a draft participation agreement framework.
Outcomes and learnings of live trials	Ongoing	A key learning from the initial live trial is the value in the staggered approach adopted, furthermore PoW relays have been identified as an essential component through this trial. Learnings will continue to be documented and shared as further trials are conducted.
Refine the functional specification	For review	A functional specification has been published in the second design report for the PET workstream. This will be refined as a result of stakeholder feedback and live trial outcomes.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Organisational, Systems and Telecommunications

Delivery Criteria	Status	Action
Desktop exercise to test the organisational capability and process	Planning	The project is currently selecting a vendor for the emulation environment.
Desktop exercise to test to systems and telecommunications (if appropriate)	Built into desktop exercise plan	We will use desktop exercises to define the HMI requirements for a DRZ-C and the voice communication requirements.
Design of systems and telecommunications for live trials	Not needed	We have identified that there are no dependencies on telecommunications or new systems for facilitating live trials. The functional specification outlines the telecommunications which would be needed.
Offline tests to prove capability of systems via hardware-in-the-loop testing	Planned	The only new system identified as being required is the DRZ-C which is planned for RTDS HiL testing at the HVDC Centre.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Procurement and Compliance

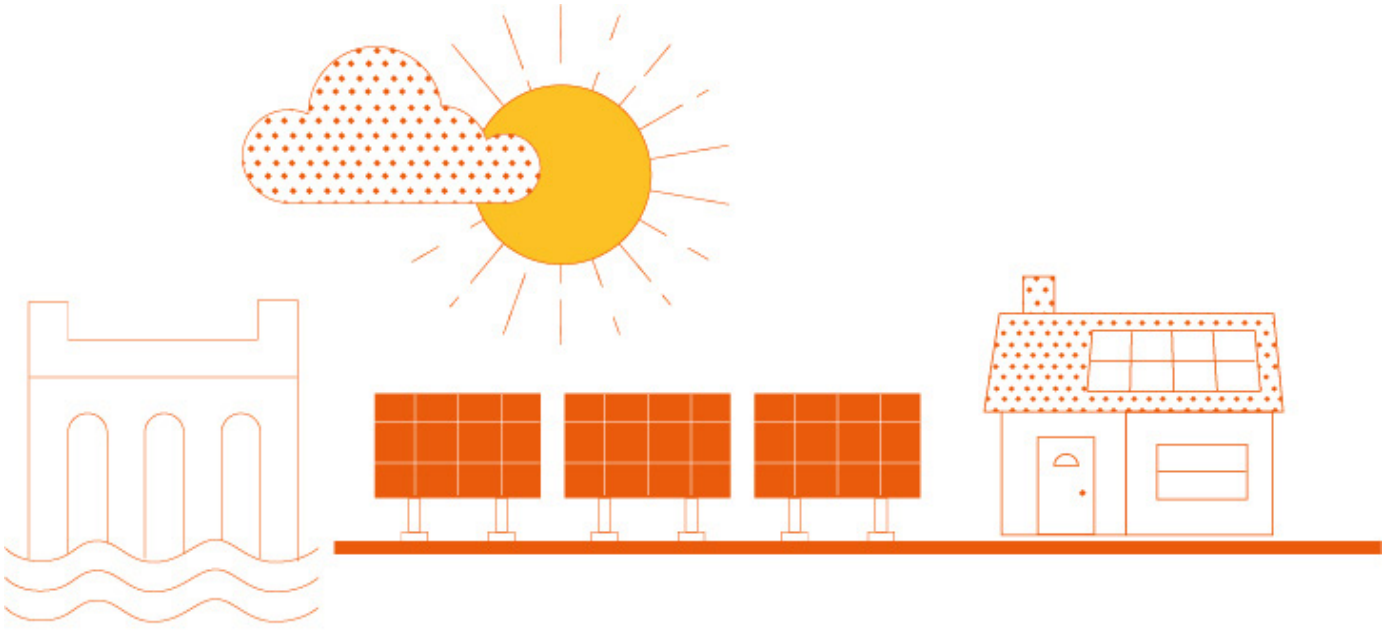
Delivery Criteria	Status	Action
Generic standard terms of contract for procurement	Planned	Terms will continue to be consulted on and developed across the remaining project stage.
Contractual obligations on each party	Planned	Terms will continue to be consulted on and developed across the remaining project stage.
Final commercial arrangements	Planned	A test procurement event is planned to demonstrate the efficacy of the commercial arrangements outlined at the design stage and further refine through stakeholder feedback.
Use a stakeholder-led approach	Ongoing	Across all workstreams stakeholder review is prioritised.

Appendix 2: Risks and Dependencies

ID	Risk Description & Impact	Deliverable Impacted	Project or Solution Risk	Mitigation Actions and Contingency	Status
1	There is a risk that the project tasks are not completed in a timely manner.	Project Direction	Project	We have produced a project plan which is under continual review from workstream leads with consistent governance and reporting to the Project Direction workstream.	Risk
2	Critical staff leave National Grid ESO, SPEN or TNEI. This could result in project delays due to loss of expertise.	Project Direction	Project	Knowledge of, and responsibility for, the project will not rest with one person through a well-designed team structure. Ensure that documentation and guidance exists to assist anyone joining project team. Each workstream lead will include a deputy role to mitigate this risk.	Risk
3	The eventual organisational & systems design restricts capability to a limited number of DNO areas. This could reduce project benefits.	Organisational, Systems and Telecommunications	Project	Our design process includes extensive stakeholder engagement with DNOs across GB to ensure all DNOs are considered during all project phases. Desktop exercises and DNO/TO workshops will be central to this organisational design. Continued engagement on ICCP links.	Risk
4	Roles & responsibilities may be difficult to effectively split and DSO transition adds uncertainty.	Organisational, Systems and Telecommunications	Project	Joint discussions across workstreams and forward planning to manage the risk. Continual engagement with Open Networks and ENA over the proposed Central Model. Desktop exercise learnings will further inform this.	Risk
5	Live testing to DER generator equipment could lead to suspension of the project due to safety concern – Difficulties in DER contracting to participate in live trials. This could lead to not being able to carry out the live trials - Delays to installation of equipment. This could result in project delays.	Power Engineering & Trials	Project	We will thoroughly design and plan specific procedures before carrying out live testing, including individual risk assessments for each test to ensure that risks are carefully managed and mitigated. A go/no go criteria will be signed off as part of the process. Early engagement with the necessary legal teams will ensure the right support levels are in place.	Risk
6	Procurement time scales may be longer than expected. This could result in project delays.	All	Project	All procurement will continue to be kicked off as early as possible including legal and technical agreements with trial participants and DRZ-C phase 2 developer(s), will remain a risk to timeline. Procurement processes will be mapped in advance wherever possible to take account of this lag.	Risk

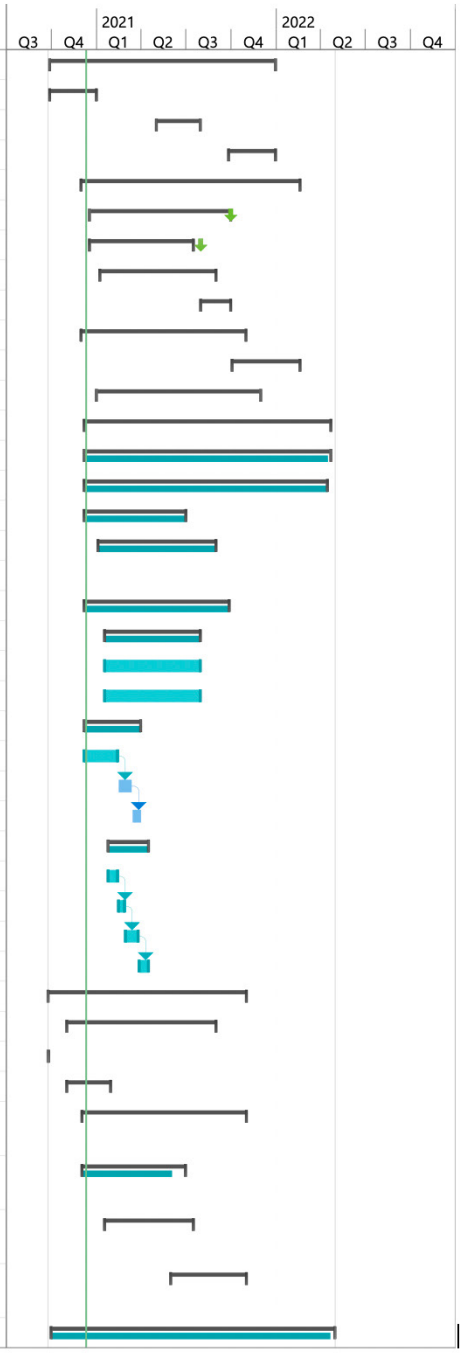
ID	Risk Description & Impact	Deliverable Impacted	Project or Solution Risk	Mitigation Actions and Contingency	Status
7	Organisational, technical, procurement and regulatory proposals do not align. This could reduce project benefits.	All	Project	Design architects are included in the project team to align outcomes across various workstreams. They attend regular design architect meetings to support the mitigation against this risk. This is based on learning from previous innovation projects. Design Assumptions log created & being refined.	Risk
8	Partner companies may not maintain/provide resource at planned levels. This could result in project delays.	All	Project	All partner companies have a nominated project management function to ensure internal resourcing remains at the required levels to meet deliverables.	Risk
9	Numbers of control engineers required due to complexity in power islands is not practical for existing relevant system operators.	Organisational, Systems and Telecommunications	Solution	This is an options risk, relevant to any options considered during the lifespan of the project. DRZ-C mitigates against large numbers of operational staff under Central Model analysis. Further analysis and desktop exercises will confirm this.	Risk
10	Roles & skillsets required for DER are challenging to resource.	Organisational, Systems and Telecommunications	Solution	Optioneering will determine the skillsets and will need to be managed carefully. Mitigation as above.	Risk
11	High cost of providing sufficient resilience in telecoms means focusing on a small number of large resources, limiting involvement of smaller DER's.	Organisational, Systems and Telecommunications	Solution	Functional specification developed and costed, designs will be refined through stakeholder input. This is a risk to rollout benefits.	Risk
12	High dependency on external work, projects & technical developments.	All	Project	Project review and engagement across dependent work including: Electricity Restoration Standard, Open Networks & other innovation projects. Wherever possible adopt learnings from external projects and work.	Dependency
13	Black Start Task Group roll out of Black Start resilience.	Organisational, Systems and Telecommunications	Project & Solution	Roll out of Electricity Restoration Standard is due to be approved and enforced. Due to timelines, assumptions have been made on included resilience requirements of 72hrs.	Dependency
14	Firm technical models will not be available for procurement design. Live trial delays may impact on commercial structure development.	Procurement and Compliance	Project	The outputs of workstream 2 and 3 need to be agreed and signed off prior to the final design of a procurement solution. Mitigating action: Consider the procurement impact in conjunction with the PET and OST workstream outputs, reciprocal dependency – determine what can be centrally provided and what is an obligation on the DER as well as applicable timescales. Mitigating action should center around planning the work which can be done in advance.	Risk
15	Project milestone 8	Procurement & Compliance	Project	There is a risk that the structure of the commercial contract is unrealistic due to the technical output timings. Contract drafting cannot start until all technical inputs agreed.	Risk
16	Cyber security	Organisational, Systems and Telecommunications	Project	Key aspect of resilience across the full project - it is not mentioned specifically in the BID, this may incur additional cost and effort. National Grid global DRS continued stakeholder engagement.	Risk

Appendix 3: Project Finances (redacted)



Appendix 4: Project Plan

ID	Task Name	Start	Finish
1	**Project Direction**	**Mon 28/09/20**	**Fri 31/12/21**
2	**Project progress report (mandatory)**	**Mon 28/09/20**	**Thu 31/12/20**
24	**Project progress report (Optional)**	**Mon 03/05/21**	**Fri 30/07/21**
45	**Project progress report (mandatory)**	**Mon 27/09/21**	**Fri 31/12/21**
67	**OST**	**Tue 01/12/20**	**Fri 18/02/22**
68	**Refine Stage**	**Fri 18/12/20**	**Thu 30/09/21**
69	**Desktop exercises**	**Fri 18/12/20**	**Fri 16/07/21**
109	**Refine OT functional spec**	**Fri 08/01/21**	**Tue 31/08/21**
114	**Refine stage report**	**Sun 01/08/21**	**Thu 30/09/21**
118	**DRZC2**	**Tue 01/12/20**	**Sun 31/10/21**
124	**DRZC DMS/EMS integration assessment**	**Mon 04/10/21**	**Fri 18/02/22**
134	**Develop OST contractual requirements**	**Fri 01/01/21**	**Tue 30/11/21**
142	**PET**	**Mon 07/12/20**	**Fri 22/04/22**
143	**LIVE TRIALS**	**Mon 07/12/20**	**Fri 22/04/22**
144	**Steven's Croft - Chapelcross**	**Mon 07/12/20**	**Fri 15/04/22**
174	**Drax - Galloway**	**Mon 07/12/20**	**Thu 01/07/21**
191	**Redhouse Battery - Greenspan**	**Mon 04/01/21**	**Tue 31/08/21**
195	Cefn Mawr - Legacy ON HOLD		
196	**DRZ CONTROLLER - PHASE 2**	**Mon 07/12/20**	**Mon 27/09/21**
207	**Strathclyde University**	**Mon 18/01/21**	**Fri 30/07/21**
208	Protection	Mon 18/01/21	Fri 30/07/21
209	Grid Forming Studies	Mon 18/01/21	Fri 30/07/21
210	**HVDC Centre**	**Mon 07/12/20**	**Wed 31/03/21**
211	RTDS Simulation Studies	Mon 07/12/20	Fri 12/02/21
212	HiL Testing - Siemens & PoW	Mon 15/02/21	Fri 12/03/21
213	Report	Mon 15/03/21	Wed 31/03/21
214	**Iberdrola Qatar - PNDC**	**Mon 25/01/21**	**Fri 16/04/21**
215	Test Specification	Mon 25/01/21	Fri 12/02/21
216	DPSL Restoration Scenarios	Mon 15/02/21	Fri 26/02/21
217	RTDS Model Deployment Testing	Mon 01/03/21	Fri 26/03/21
218	Report	Mon 29/03/21	Fri 16/04/21
219	**P&C**	**Fri 25/09/20**	**Mon 01/11/21**
220	**Codes work**	**Mon 02/11/20**	**Tue 31/08/21**
224	**Stakeholder engagement**	**Fri 25/09/20**	**Fri 25/09/20**
229	**Project Engagement**	**Mon 02/11/20**	**Fri 29/01/21**
232	**Define contractual requirements & scoring methodology**	**Thu 03/12/20**	**Mon 01/11/21**
233	***Functional requirements for both anchor generator and top-up services***	**Thu 03/12/20**	**Wed 30/06/21**
241	***Define the rules of play for anchor generators and top-up services to form a feasible DRZ***	**Mon 18/01/21**	**Fri 16/07/21**
247	***Define the assessment principles for a Black Start from DER service***	**Tue 01/06/21**	**Mon 01/11/21**
257	**KD**	**Thu 01/10/20**	**Sat 30/04/22**



National Grid Electricity System Operator
Faraday House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA
United Kingdom

Registered in England and Wales
No. 11014226

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