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NIA Project Annual Progress Report Document

Date of Submission

Jul 2023

Project Reference Number

NIA2_NGESO047

Project Progress

Project Title

Distributed ReStart – Redhouse Live Trial

Project Reference Number

NIA2_NGESO047

Project Start Date

February 2023

Project Duration

0 years and 11 months

Nominated Project Contact(s)

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Scope

Several types of DERs were considered in the Distributed ReStart NIC project, to demonstrate that the solution is applicable across technology types and across all of GB. The project focussed on DERs that have reached at least a TRL 4 in the context of providing Restoration services (thermal power stations, small hydro stations, wind farms and small gas or diesel stations) whilst remaining open to considering other technologies. The case studies identified have a mixture of synchronous and non-synchronous generation types, from both dispatchable and intermittent resources, this will provide an opportunity to explore technology options.

This project is designed to deliver tested and proven concepts and frameworks that can be directly implemented into BAU, assuming the concept is technically and economically viable. It will enable a restoration from any DER technology once certain TRL levels are attained.

This follow-on NIA project will support an additional live trial at Redhouse GSP will demonstrate the use of a battery energy storage system (BESS) with grid-forming technology to restart the network and use of a prototype Distribution Restoration Zone Controller (DRZC) to stabilise and maintain the power island within voltage and frequency limits.

Objectives

Following the completion of the second live trial at Chapelcross in July 2022, the project has successfully met all 10 of its original and agreed objectives. These were agreed with Ofgem at the start of the project, and were designated as deliverables in the Project Direction:

Organisation, Systems & Telecoms (OST):

- Defined the communications requirements for this process including automation via a new DRZC (Deliverable 1).
- Confirmed the new organisational design, roles, and responsibilities (Deliverable 2).
- Demonstrated how the restoration process and joint action would work in practice between the Electricity System Operator (ESO), Transmission Owners (TOs), Distribution Network Operators (DNOs), and Distributed Energy Resources (DERs) via desk-top exercises (Deliverable 3).

Power Engineering & Trials (PET):

- Defined the technical capabilities required to enable a feasible Distribution Restoration Zone (DRZ) (Deliverables 4 and 5).
- The Live Trials at Galloway and Chapelcross demonstrated the use of different technology types to prove successful energisation (Deliverable 6).
- In partnership with the Organisational, Systems and Telecoms (OST) workstream, we defined, developed and factory-tested a prototype Distribution Restoration Zone Controller (DRZC).

Procurement & Compliance (P&C):

- Defined the approach and process to procure services from DER providers (Deliverable 7).
- This was demonstrated via our procurement test event (Deliverable 8)
- Facilitated distribution restoration through ongoing industry code changes (Deliverable 9).

Ofgem Deliverable 10 is designated as the Project Closedown report, which is in the process of final development ahead of the formal closedown of the project in October 2023.

In addition, the project has progressed further than the original project plan with the inclusion of the build and test of a Distribution Restoration Zone Controller (DRZC) prototype that allows for automation (with control room engineer direction) of the creation and stabilisation of a local power island.

We have also requested a further extension to the project to 31 October 2023 (with a proportionate addition to our funding via this NIA request) to deliver a third live trial at the RedhouseGSP. This will involve use of a battery energy storage system (BESS) with grid-forming technology to restart the network and use of the prototype DRZC to stabilise and maintain the power island within voltage and frequency limits. The project plan now includes two new trial aims, split across three distinct phases over a two-week test period from 29th May – 9th June 2023:

Phase 1

Deliver Phase 1 proving grid forming capability of Distributed Battery Energy Storage System (On 3rd party network only).

Phase 2

Deliver Phase 2 proving grid forming capability of BESS and ability energise both 33kV and 132kV transformers / network.

Additional Goals (Phase 3):

- Include Middle Balbeggie Solar farm within tests to demonstrate ability of multiple DER to contribute to islanded grid.
- Implement DRZC control of island to demonstrate ability to simply respond to disturbances or have complete control of island.

Success Criteria

The original aims, objectives, and success criteria defined at the bid submission stage, were to consider as many different types of DERs as feasible to demonstrate that the solution is applicable across technology types and across all Great Britain.

The project focused on DERs that have reached TRL 4-8 in the context of providing electricity system restoration services. The case studies identified for the resulting live trials, had a mixture of synchronous and non-synchronous generation types, from both dispatchable and intermittent resources, and this provided an opportunity to explore technology options.

This project was designed to deliver tested and proven concepts and frameworks that can be implemented into BAU, assuming the specific implementation is technically and economically viable, and the outcomes of the project demonstrate that this has been achieved in a way that goes beyond the original aims and objectives. Thus, the project has exceeded the original success criteria.

All required Ofgem deliverables have now been met and the project has delivered enhanced value and learning through the innovative development of the DRZC concept and the additional live trial at Redhouse planned for June 2023. In terms of success criteria, this will be measured across two Phases as detailed in Section 2.4 above.

Phase 1 – successful manual restoration of the Redhouse GSP by:

- Proving grid forming capability of Distributed Battery Energy Storage System (On 3rd party network only).
- Proving grid forming capability of BESS and ability energise both 33kV and 132kV transformers / network.

Phase 2 – successful automated restoration of the Redhouse GSP by:

- Implement DRZC control of stable power island to demonstrate ability to simply respond to disturbances or have complete control of island.
- Include Middle Balbeggie Solar farm within tests to demonstrate ability of multiple DER to contribute to islanded grid.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

National Grid Electricity System Operator (“NGESO”) has endeavoured to prepare the published report (“Report”) in respect of Distributed ReStart – Redhouse Live Trial, NIA2_NGESO47 (“Project”) in a manner which is, as far as possible, objective, using information collected and compiled by NG and its Project partners (“Publishers”). Any intellectual property rights developed in the course of the Project and used in the Report shall be owned by the Publishers (as agreed between NG and the Project partners).

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The bid submission document, [Black Start from Distributed Energy Resources](#), stated: “The key problem to solve is how to pull the organisational coordination, the commercial and regulatory frameworks, and the power engineering solutions together to achieve electricity system restoration from DER. This project subsequently developed and demonstrated ground-breaking new approaches to open the market to DER by designing and then testing technical, organisational, procurement and regulatory solutions”.

In addressing the issue described above, the project has managed to create a viable means of restarting the GB network, using renewable DER for an innovative “bottom-up” approach. It did this by defining and testing solutions for the many challenges faced by the main actors involved in such a restoration event (DERs, DNOs, TOs and ESO) that allow the restoration to happen. Whether it involves network protection studies, regulatory and codes changes, organisational restructuring, resilient and cyber-secure systems and communications or new ways of procuring and contracting, the project has delivered solutions for all of these challenges.

Project Overview

The Distributed Restart NIC project is exploring how Distributed Energy Resources (DERs) can be used to restore power in the event of a total or partial shutdown of the GB Electricity Network. Current approaches rely on large power stations and interconnectors but, as the UK moves to cleaner and more decentralised energy, new options must be developed, leading to reductions in both cost and carbon emissions.

Two live trials have been completed at Galloway and Chapelcross Grid Supply Points (GPSs). This follow-on NIA project will support an additional live trial at Redhouse GSP to demonstrate the use of a battery energy storage system (BESS) with grid-forming technology to restart the network and use of a prototype Distribution Restoration Zone Controller (DRZC) to stabilise and maintain the power island within voltage and frequency limits.

Throughout this document, references to ‘The Project’ refer to the past activities and Ofgem mandated deliverables of the Distributed Restart NIC-funded Innovation project. References to the Redhouse Live Trial, refer to the additional live trial of a Battery and Solar Farm at the Redhouse Grid Supply Point (GSP), which will demonstrate the ability of non-synchronous generation at the Distribution level to restart the network, and energise the local SPEN transmission network, utilising the automation made possible by the Distributed Restart Project’s Distribution Restoration Zone Controller (DRZC). This live trial is delivered via NIA and will extend the original project’s deliverables to as close to a BAU implementation as possible.

Project Plan

Based on the latest project cost/benefit analysis, the developed method has the potential to deliver financial benefits of at least £115m (net present value in 2018/19 prices) and carbon benefits of 0.81MT of cumulative avoided CO₂e for consumers by 2050, breaking even by 2027 (within 5 years of the end of the project).

Extending the project to deliver the Redhouse live trial within this NIA project will bring additional benefits to the consumer (using economies of scale and existing expertise via the project vs. time and financial costs in starting a new ‘Redhouse’ project from scratch) and industry by ‘de-risking’ the rollout of the new Electricity System Restoration Standard (ESRS), demonstrating that automation is achievable in an operational/BAU environment.

The Redhouse live trial is scheduled to begin on Monday, 19th June 2023 and will conclude two weeks after, on the 30th June.

Next and final steps for this project, consists of delivery (by our project partners SP Energy Networks) of the Redhouse live trial, as detailed in the Objectives & Success Criteria sections previously discussed in this NIA progress report. Following what we hope will be a successful trial, the project will publicize the 3rd and final Power Engineering & Trials workstream report on our website and communicate out to our Stakeholder database – we may plan some additional publicity and engagement activities, as this will coincide with the formal project closure activities, closure of the project bank and the return of any unspent funds to the appropriate funding bodies (NIA and NIC/SIF).

Project Activities

Although this is the first project progress report for NIA2_NGESO047, a lot of additional progress has been made inside the Distributed Restart project. In April, in partnership with GE and The National HVDC Centre, the project delivered a webinar to launch the final testing report for the Distributed Restoration Zone Controller (DRZC) independent testing in an RTDS environment. This report can be found and downloaded from the project website by clicking [here](#).

The monitoring and control of a distribution restoration zone (DRZ) is complex, as it involves co-ordinated control of several resources with different technical characteristics within a zone to maintain power balance and stable frequency as load is restored. The system must also accommodate varying loads and renewable generation, and ride through unplanned disturbances while the network is in an unusual and fragile state. The testing and validation of the monitoring and control system is an important element of successful deployment of DRZs.

The Distributed ReStart project explored methods of testing various aspects of the system.

The learning obtained from the project is important for defining the process to qualify monitoring and control to co-ordinate the operation of a zone. Testing is required to confirm each part of the system, as well as the functioning of the whole scheme.

The learning from Distributed ReStart is fed into the Redhouse Live Trial and also helps to create the testing practices that are appropriate for further business-as-usual (BAU) roll out of the approach. In general, the testing process for BAU should be:

- systematic to prove the whole system performance
- streamlined for an efficient, repeatable, and standardised process
- aligned with project flow for zone deployment without holding up implementation.

In addition to the DRZC Automation testing report, the Distributed ReStart NIC project has also published a consolidated '[Frequently Asked Questions](#)' document, which gathered together all questions and our answers across the 4 years of the project. The questions came from across industry and were captured via a variety of methods, including events, webinars, presentations, podcasts, and face-face meetings, and represent a unique and lasting reference source for organisations embarking on their roll-out of individual programmes and projects

Required Modifications to the Planned Approach During the Course of the Project

Changes to scope and approach

There have been no material changes to the original project aims, objectives and success criteria.

Changes to cost

Project costs identified in the PEA submission have remained unchanged, and we are maintaining our robust approach to management of project finances as we progress towards completion of our remaining activities in support of the forthcoming Redhouse live trial.

Changes to programme

There are no planned changes to the project, and we remain confident that our existing approach will deliver a successful live trial, follow-on workstream final report and provide confirmation to industry that use of asynchronous renewable generation, coupled with innovative automation will deliver 'business as usual' planned benefits to consumers, starting in 2025.

Lessons Learnt for Future Projects

The Distributed ReStart project has led to the development of clear and detailed information to allow other network operators and industry stakeholders to understand how distributed energy resources (DERs) can be used to restore power in the highly unlikely event of a total or partial shutdown of the national electricity transmission system (NETS).

To provide a central, focused point for accessing this information, the outcomes of the project are presented in our [‘Final Findings and Proposals for Electricity System Restoration from DERs’](#) report, allowing interested parties involved in the BAU rollout of contracting for distributed generation, to be able to understand how Distributed ReStart can be applied on their networks, and where detailed supporting information can be found.

Review of benefits case

The 2018 funding submission to Ofgem for Distributed ReStart included a Cost Benefit Analysis (CBA). This appraised the potential benefits to the system and consumers of having access to restoration services from distributed energy resources.

The original 2018 CBA calculated a net present value (NPV) of up to £115m by 2050. A small update to this CBA, based on interim project learning, was then provided in the 2020 end of year report. This resulted in an increased NPV of £145m. In our formal Closedown report for the original 10 Ofgem deliverables, we provided a further update to the CBA which, compared to the original 2018 version, incorporates further project learning, updated data and assumptions, and some refinements of the overall modelling methodology. The updates described above have resulted in an updated calculated net present value of £130m.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

Interim project outcomes

Since the award of NIA funding in February 2023, the project team has been busy preparing for the forthcoming live trial at Redhouse, including preparation of the necessary legal agreements for the Redhouse trial to go ahead with the trial generators. These have now been successfully completed, but remain confidential, so are not going to be publicly available on our website. Interested parties with a legitimate need to view these agreements may refer to the statement at the end of this document if required. In addition, we have produced two additional reports on our web site:

1. [The DRZC Independent System Testing Report](#) – this was the final stage for the prototype controller built by GE Digital, and used Hardware-in-the-loop testing within an RTDS environment to demonstrate the functionality. The testing and validation of the monitoring and control system is an important element of successful deployment of distribution restoration zones (DRZs). The Distributed ReStart project explored methods of testing various aspects of the system. The learning obtained from the project is important for defining the process to qualify monitoring and control to co-ordinate the operation of a zone. Testing is required to confirm each part of the system, as well as the functioning of the whole scheme. Distributed ReStart delivers learning on testing perspectives, processes, and required outcomes. The learning from Distributed ReStart helps to create the testing practices that are appropriate for further business-as-usual (BAU) roll out of the approach. In general, the testing process for BAU should be:

- systematic to prove the whole system performance
- streamlined for an efficient, repeatable, and standardised process
- aligned with project flow for zone deployment without holding up implementation.

2. [Frequently Asked Questions \(FAQ\)](#) - Distributed ReStart aims to incorporate the views of wider industry at every opportunity, bringing in the diverse expertise found across the electricity market to solve this world first challenge of black start using distributed energy resources (DER). Across all our stakeholder events we have captured the questions posed and used these to inform our future outputs. However, we are aware that these questions may be valuable to wider industry or prompt further questions which drive innovative approaches. All key questions to date have been responded to and are included in this document to provoke thought and further discussion. If you have any queries or comments stemming from these, don't hesitate to contact us at ReStart@nationalgrideso.com.

Data Access

Details on how network or consumption data arising in the course of NIA funded projects can be requested by interested parties, and the terms on which such data will be made available by National Grid can be found in our publicly available “Data sharing policy related to NIC/NIA projects” and www.nationalgrideso.com/innovation.

National Grid Electricity System Operator already publishes much of the data arising from our NIC/NIA/SIF projects on the Smarter Networks Portal (www.smarternetworks.org) and National Grid ESO Data Portal (data.nationalgrideso.com). You may wish to check these websites before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

For a comprehensive list of all our foreground IP developed by the project, please refer to the Documents Library section of our project

website, by clicking [here](#).