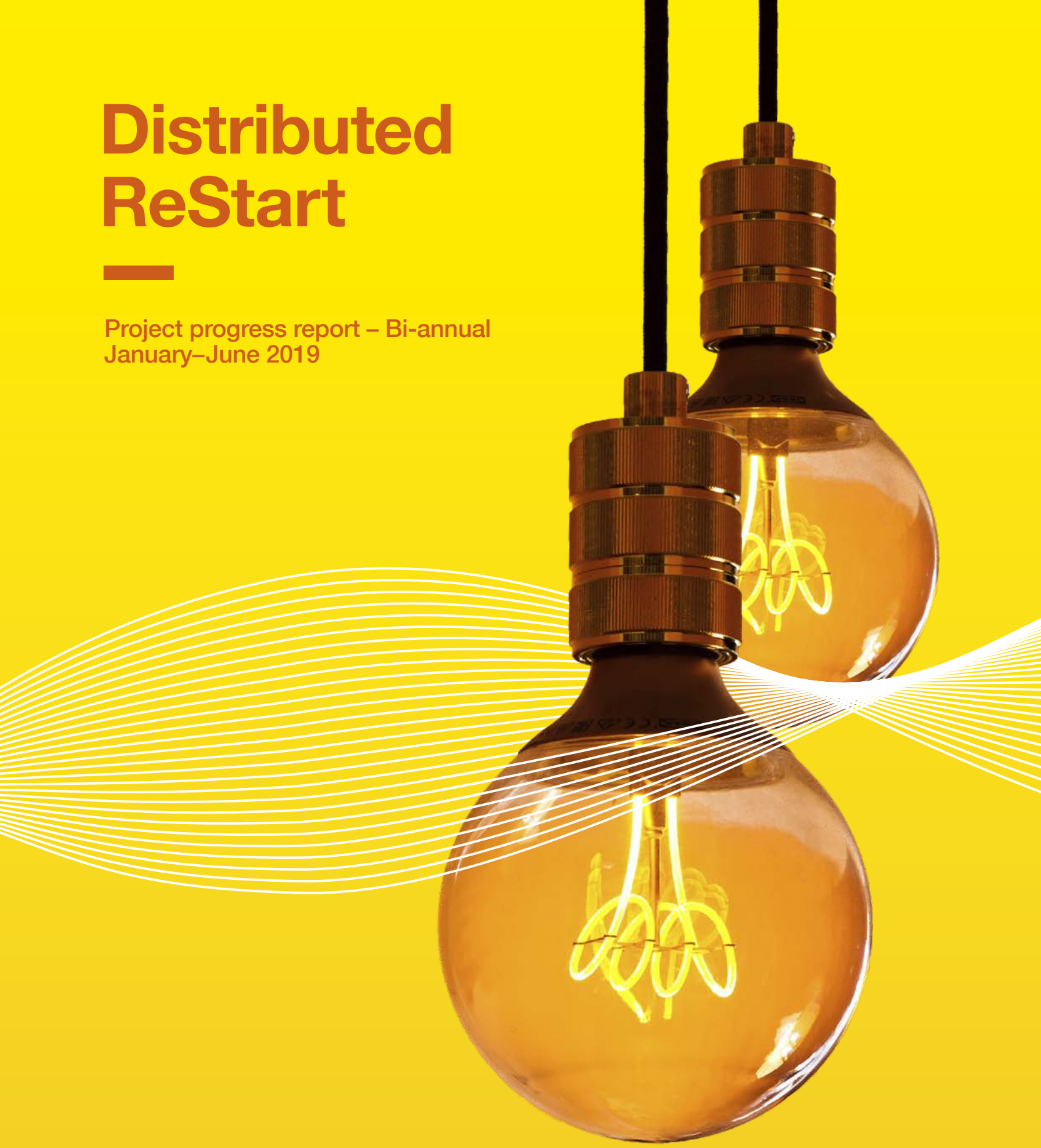
Distributed ReStart

Project progress report – Bi-annual
January–June 2019



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Contents

Introduction

The Distributed ReStart project (formerly known as Black Start from DER) is a Network Innovation Competition funded project that aims to recommend technical, organisational and commercial solutions to create market access for distributed energy resources (DERs) to participate. This will increase competition in the market and deliver reductions in both cost and carbon emissions.

Black Start is the process of restoring power to consumers and restarting the whole of the electricity system, in the event of a blackout. It is envisaged this project will demonstrate a world first – coordinating a bottom-up approach from distribution networks to transmission level to provide a safe and effective Black Start service

Project description

Black Start is currently a transmission-led approach of starting large generators and energising a skeleton transmission network. The GB electricity system is undergoing a revolution driven by decarbonisation and decentralisation and Black Start services need to evolve accordingly. The key problem that this project aims to resolve is how to compose the organisational coordination, the commercial and regulatory frameworks, and the power engineering solutions together to achieve Black Start from DER.

Method(s)

The method(s) that it will use to solve the problem(s): This project will develop and demonstrate ground-breaking new approaches to open the market to DER by designing and then testing technical, organisational, procurement and regulatory solutions.

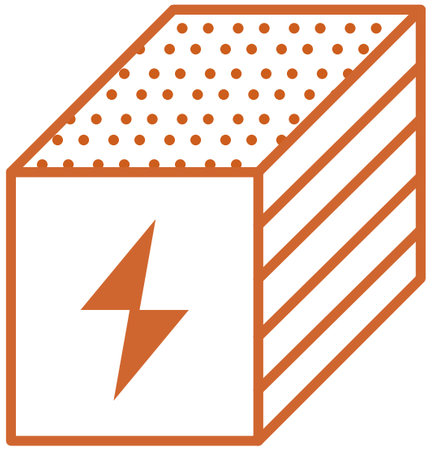
Solution(s)

The solution(s) it is looking to reach by applying the method(s): Enabling DER to provide Black Start services will open a new market for DER (key to a low-carbon, decentralised GB electricity system), will increase competition and diversity in the market, and contribute to adequate Black Start provision in the future.

Benefit(s)

The benefit(s) of the project: Our analysis shows the project can deliver 0.81MT CO_2 reduction (cumulative) by 2050. The net performance value (NPV) of the project is expected to be £115m by 2050 due to increased competition and reduced costs associated with large generator readiness. This would be passed on to GB consumers through reduced Balancing Services Usage of System (BSUoS). This ground-breaking approach is at the forefront of international efforts to devise new Black Start methods and we are engaging widely to share learning.

This report provides a summary of progress across all project workstreams from January 2019–June 2019.



Executive summary

Formally known as Black Start from DER, the project was established in January 2019 and has gained momentum during the spring of 2019, with all project roles recruited and in post. All workstreams mobilised, with Workstream 2 – Power engineering and trials (PET) – the most mature and making excellent progress to deliver its first project deliverable milestone in July 2019.

- Workstream 1 – Project direction.
- Workstream 2 – Power engineering and trials.
- Workstream 3 – Organisational, systems and telecommunications (formerly known as organisational and systems).
- Workstream 4 – Procurement and compliance (formerly known as procurement and regulation).
- Workstream 5 – Knowledge and dissemination.

The power engineering and trials workstream mobilised in January 2019 but has made considerable progress over the last six months.

The key activities completed in this period included:

- mobilising the project team and completing the recruitment process for all lead roles
- identifying key activities in line with the first project milestone deliverables (PD 4) set out in the bid document, version ESOENO01_V03
- attended CIGRE International Symposium Conference – Denmark (4 June–6 June 2019)
- attended and exhibited at Utility Week Live @ NEC Birmingham (21 May and 22 May 2019)
- attended, presented and exhibited at Power Responsive conference in London (26 June 2019)
- successfully hosted 4 workshops with interested stakeholders at Utility Week Live @ NEC Birmingham (21 May and 22 May 2019)
- successfully set up a Stakeholder Advisory Group and secured membership
- the power engineering and trials first industry webinar held on 29 March 2019.

The Distributed ReStart project aims to demonstrate a world first – coordinating several DERs to provide a safe and effective Black Start service by identifying and addressing the commercial, organisational, compliance and technical issues and providing Black Start capability from the distribution networks up to transmission level.

"By 2025, NGESO will have transformed the operation of Great Britain's electricity system and put in place the innovative systems, products and services to ensure that the network is ready to handle 100% zero carbon. The new products and services we will introduce will help reduce the overall cost of operating the system, driving down costs for consumers."

Fintan Slye
Director of ESO

Welcoming legislation to underpin Carbon Net Zero, Keith Anderson, CEO Scottish Power, said:

"The UK now has a very clear commitment to reduce carbon emissions to net zero. In only 30 years' time we need a society that runs on a carbon neutral basis.

To deliver this we will double the amount of electricity we use, therefore we need to quadruple the amount of renewable energy we make. That's going to require bold innovation alongside market and regulatory frameworks that encourage significant and sustained investment."

Keith Anderson
CEO Scottish Power

Project manager report

The Distributed ReStart project received approval by OFGEM in November last year and formal direction was granted in December for the project to start in January. This is the first project progress report, covering the period of January–June 2019.

Workstream 2 – Power engineering and trials (PET) is well underway and on track to deliver the first project milestone deliverable (PD4 – BID document ESOENO01_V03, page 46) in July 2019. Workstream 1 – Project direction is now well established, workstream 3 mobilised on 8 April 2018 and workstreams 4 and 5 mobilised on 1 May 2019.

Delays in recruitment for the project leads and subordinate roles has slightly shifted the forecasted spend to date (this is explained in more detail in a separate document (Distributed ReStart Financial Report January–June 2019).

The majority of roles are now filled, with the only exception in workstream 4 which requires a Coding Specialist. This role is a critical role, we have secured a temporary resource until the end of August 2019. As this is only a temporary fix, we have recorded this as a high risk on the project RAID log no. 17 (page 7).

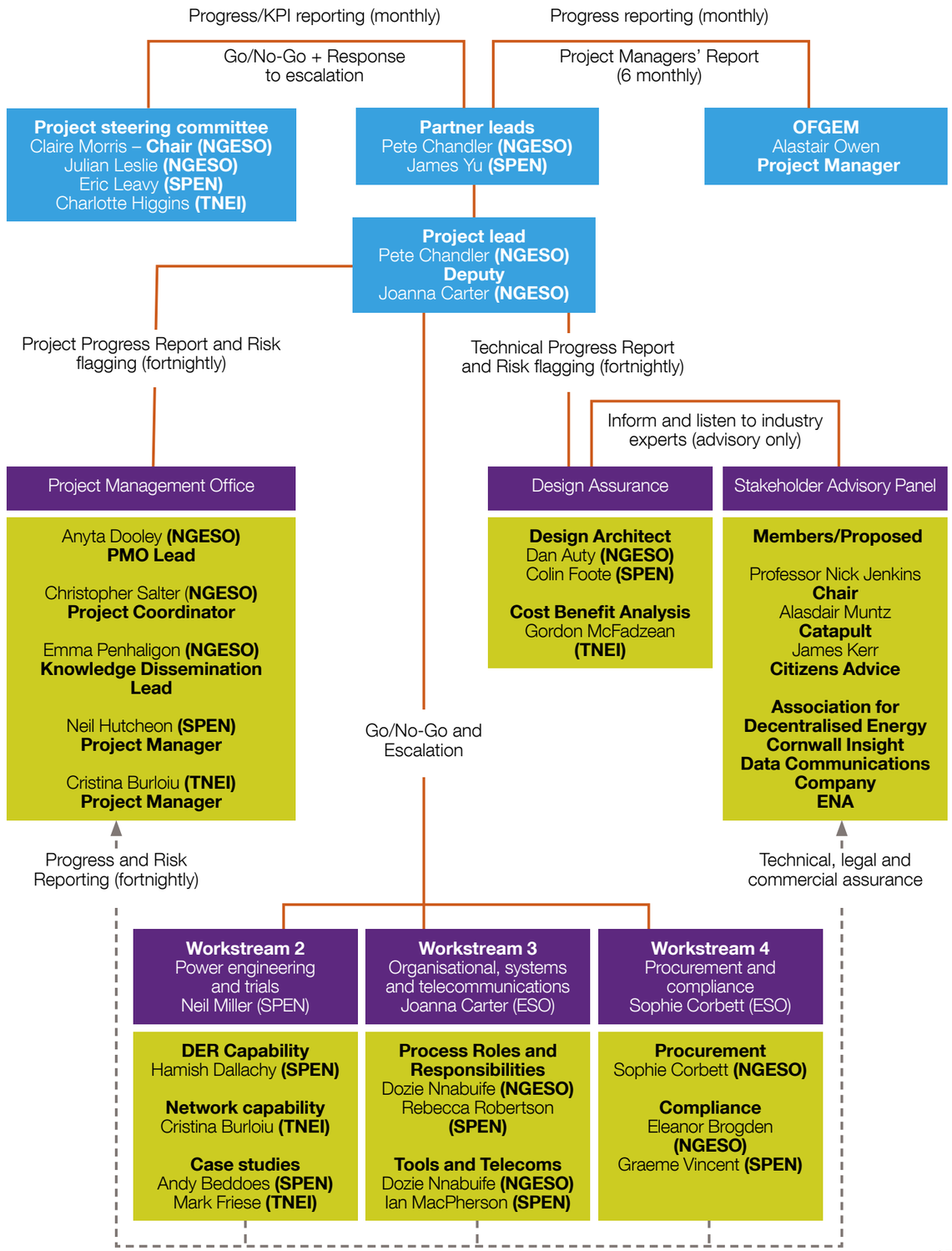
An organigram of the project can be seen in figure 1.1.

Table 1.1
Project achievements: January–June 2019

What we set out to do	What we have achieved to date
Set out the governance structure of the project	Project governance was implemented (Finance Surgeries, Monthly Project Management Board, Monthly Steering Committee, Project Status Reporting, Monthly Executive Updates) across the entire project and in collaboration with the partners.
Resourcing according to the project plan	Majority of resources are now in post. One critical role remains unfilled, recorded as a risk on the project RAID log.
Utility Week Live (UWL) and four workshops	The project attended and exhibited at UWL and also held four workshops over the two days covering – "update on case study selection" and "organisational, systems and telecommunications".
Stakeholder Advisory Group	Identified and secured members.
The anchor (synchronous) and additional (non-synchronous) DER in the ten case studies (sixty four DER in total) were contacted with a view to having a teleconference or meeting to introduce the Distributed ReStart project, and to answer a questionnaire to assess the technical capability and Black Start resilience of their developments. (The questionnaire used is contained in appendix 1.)	To date approximately 40% of the DER developers have formally responded and provided information on their developments and we are continuing to actively engage with the rest to obtain a response. We have gained valuable information on the different technologies such as hydro, biomass, energy from waste and gas engines and their relative suitability and readiness to provide Black Start services.

The table above presents an overview of project achievements so far.

Figure 1.1
Distributed ReStart – organigram



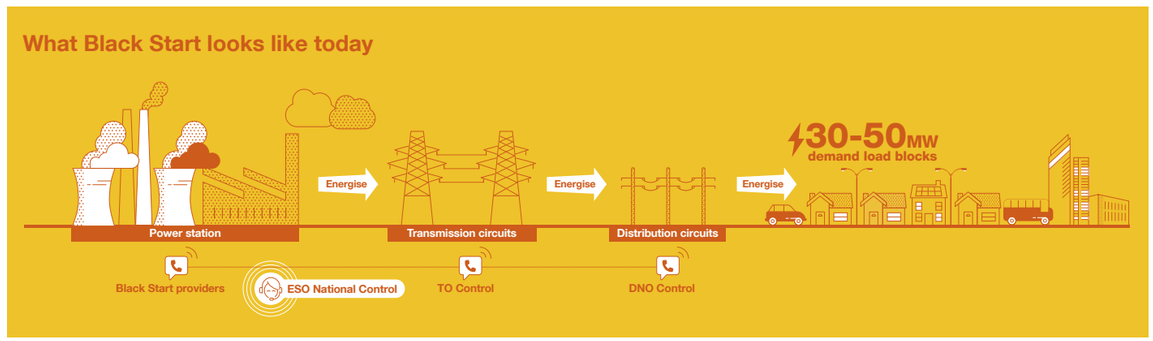
Workstream 1 – Project direction

Responsible for overall project direction. Project lead completed the recruitment within each workstream, ensuring the project has the skills and capability required.

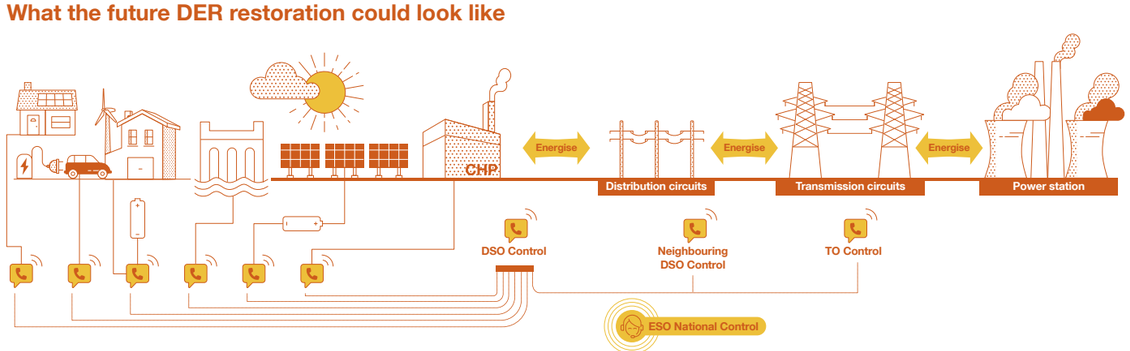
The project lead has coordinated the work across the other workstreams, setting out a joined-up approach to ensure delivery against the project milestones outlined in the bid document (ESOEN01_V03).

Claire Morris chairs the steering committee monthly meetings, providing a robust governance and compliance framework against the agreed project scope. The project lead has set up regular meetings with the Ofgem representative and has represented the project across the wider industry at several stakeholder meetings, industry events and most recently at Utility Week Live in May 2019.

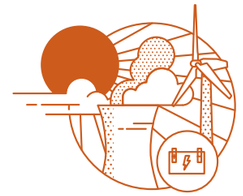
Within this workstream, a Project Management Office has been established and has implemented a pattern for reporting on progress, finances and risks, including monitoring the overall delivery against the published milestone deliverables as set out in the bid document (ESOEN01_V03).



What the future DER restoration could look like



Workstream 2 – Power engineering and trials



The power engineering and trials (PET) workstream is concerned with assessing the technical capability of GB distribution networks, and installed DER, to deliver an effective Black Start service.

This will be done through the selection and analysis of case studies (sample areas of the SP Distribution and SP Manweb networks), and progression through multiple stages of review to identify the technical requirements that should apply on an enduring basis. The work will culminate in demonstrating the Black Start from DER concept with at least two 'live trials' on SPEN networks.

The first stage of the PET workstream is the Options Stage (between January and July 2019), which is primarily a qualitative assessment of the networks and DER to produce the first key deliverable (a report in July 2019 making a preliminary assessment of the viability of Black Start from DER), and to define in more detail the work to be done in the second stage of the project (the Design Stage between July 2019 and July 2020). To facilitate the Options Stage, four packages of work have been initiated in this reporting period (one has been completed to date).

PET Options Stage – work packages

i) PET 0.1 – Define criteria for case study selection (completed).

ii) PET 1.1 – Assess case study viability and options.

iii) PET 1.2 – Functional and testing requirements.

iv) PET 1.3 – Assess potential across GB.

PET 0.1 – Define criteria for case study selection
As part of this work package, two reports were produced in March 2019. The first is entitled, 'Case Study Selection Criteria'. This details the essential and supplementary criteria against which areas of the SP Distribution (SPD) and SP Manweb (SPM) networks have been assessed to identify potential case studies for the project. It also provides a robust and transparent technical foundation for the project.

The second report 'Case Study Proposals' was produced giving an overview of the ten specific case studies selected for the project, and the basis for their inclusion. The proposed case studies include a variety of generator types (e.g. biomass, energy from waste, hydro, wind, solar and energy storage), varying network topologies (radial and meshed) and varying network types (urban and rural) to ensure that there are opportunities to study a diverse range of network scenarios, and the learning is as applicable on a GB-wide basis as possible.

A webinar was held on 29 March 2019 with external stakeholders to give an overview of the project, present the case study criteria and selection reports, and provide an opportunity for questions to be discussed. On the day, there were over one hundred attendees on the webinar, and subsequently written responses have been provided to approximately twenty questions raised on the day. This webinar was an important step in the first stage of the project, ensuring that the technical foundation for the project is developed in conjunction with the wider industry.

PET 1.1 – Assess case study viability and options

Based on the case studies, this work package is concerned with identifying the limitations, and/or gaps in the existing technical capability, of the DER and distribution network operators (DNO) networks in relation to providing a Black Start service. The potential options for network energisation and restoration will be explored. A summary of the technical issues identified will be given, along with potential solutions and/or areas requiring further study, to provide a high level indication of the overall viability of the Black Start from DER (BS DER) concept at this stage. The technical assessment has been divided into the following three areas:

i) **DER:** There are 64 DERs associated with the case studies ('anchor' generators (synchronous generators which are essential to start the power island), and 'additional' generators (non-synchronous generators which would be used to grow the power island)). Each of these has been contacted and a programme of individual meetings/ teleconferences has commenced to introduce the project and complete a 'Black Start Stakeholder Questionnaire' (see appendix 1). This is concerned with understanding issues such as the resilience of the DER installation during a network blackout, what might be required to make the DER self-starting, and the technical capabilities of the generator (e.g. does it have frequency or voltage control).

List of case studies identified

Case study no.	Network name	Total generation capacity[1] (MW)	Anchor (MW)	Additional DER (MW)	Network topology	Case study summary
1	Galloway Region (SPD – Dumfries)	224.0	81.2	140.1	Radial – 132/33kV	• Energising the 132kV network directly from 11kV connected hydro generators. • Energise two 132/33kV GSPs (Glenluce and Newton Stewart) to connect demand and intermittent generation and establish a power island. • Energise New Cumnock 275/132kV substation where in excess of 1 GW of wind generation is contracted.
2	Glenrothes GSP (SPD – Central and Fife)	165.7	112.4	28.5	Radial – 275/33kV	• Establish a power island at Glenrothes GSP with the potential to interconnect at 33kV to two adjacent GSPs (Westfield and Redhouse). Westfield also contains anchor generation thus the potential exists to synchronise two power islands together. (Contracted installation of battery energy systems (BES) at Glenrothes and Redhouse GSPs in 2019).
3	Chapelcross GSP (SPD – Dumfries)	136.5	45.0	78.8	Radial – 132/33kV	• Establish a power island at Chapelcross GSP using a biomass generator as the 'anchor' along with wind generation. • Long rural network (~40km 33kV circuits), DER connected by long 33kV cable circuits (anchor gen ~25km cable). • Back energise the 132kV network and synchronise with NGET at Harker 132kV substation.

Case study no.	Network name	Total generation capacity[1] (MW)	Anchor (MW)	Additional DER (MW)	Network topology	Case study summary
4	Dunbar GSP (SPD – Edinburgh)	165.9	41.3	118.0	Radial – 132/33kV	• Approximately 30% ratio of anchor generation (energy from waste) to additional DER (wind). • Back energise the 132kV network to Torness nuclear power station. • Possibly synchronise with Cockenzie and Portobello to provide a 33kV power island across a wide area.
5	Meadowhead (SP transmission 132kV – Aryshire)	157.75	32.0	99.9	Radial – 132/33kV	• Energise 132kV network from an 11kV CHP generator. • Establish a power island with Saltcoats 132/33kV GSP and its additional DER (predominantly wind). • Energise the 132kV network to Hunterston nuclear power station.
6	Portobello GSP (SPD – Edinburgh)	29.45	15.0	0.0	Radial 275/33kV	• Establish a power island from an energy from waste generator to pick up demand/ embedded 11kV generation. • Interconnection to adjacent 33kV networks. • Back energise to 275kV.
7	Bootle Grid (SPM – Mersey)	53.0	35.0	18.0	Mesh -132/33kV – 2 GT	• Urban network (Liverpool). • 35 MW CHP Anchor; 18 MW Wind. • Potential to back energise to 132kV network (min demand ~13MVA).
8	Legacy (SPM – Wales)	190.0	37.0	125.6	Mesh – 132/33kV – 6 GT	• Rural network 37 MW anchor (two sites, diesel and gas). • ~100 MW additional DER incl ~40 MW solar. • 33kV network has six grid infeed but has the potential to create three smaller power islands.
9	Sankey Bridges (SPM – Cheshire)	287.0	281.0	3.9	Mesh – 132/33kV	• Supplied from the Carrington/Fiddlers Ferry 132kV group which has a 138 MW CHP at Carrington. • Opportunity to energise up to the 132kV or down from the 132kV to 33kV. • Opportunity to synchronise with adjacent 33kV group (Elworth has 48 MW CCGT).
10	Maentwrog (SPM – Wales)	103.0	39.8	46.0	Mesh – 132/33kV – 3 GT	• Additional DER mixture of wind and solar. • 40 MW Anchor (hydro). • Potential to energise to 132kV network.

ii) **NETWORKS:** A key area for investigation is the impact on the existing protection and earthing systems from supplying the distribution and transmission networks from DER only (the fault level will be much lower than normal, and the existing 33kV earthing transformers may not be suitable or in service). Reports by protection specialists have been initiated, on a sample of the case studies, to identify the limitations of existing systems and advise on potential solutions.

In addition, preliminary network studies have commenced on several of the case study networks to record the load flow, voltage step/profile and fault level results during restoration stages when the network is energised from the 'bottom up'. (Full transient and dynamic studies will be undertaken as part of the PET Design Stage from July 2019.)

[1] Includes 11kV generation directly connected to an 11kV busbar as recorded in the Case Study Data sheets.

Work has also been undertaken in the area of 'plant and policies'. That is, what is the impact on network equipment and operability following a Black Start, and what are the current network policies on Black Start resilience. For example, currently at a primary substation (33/11kV), the transformer tap changers would no longer operate when no low-voltage supply is available, and the protection batteries are typically resilient for a maximum of 18 hours–24 hours.

iii) **CONTROL and RESTORATION:** This is concerned with how automation may be employed to aid with initiating a power island (e.g. signalling DER, protection changes), maintaining a stable power island (e.g. frequency control), growing a power island (e.g. controlling load pick up), and returning to normal (e.g. synchronising a distribution island to the wider transmission network). To this end, initial meetings have been held with a number of technology providers (to date Smarter Grid Solutions, ABB, Siemens and GE) to discuss the application of their 'microgrid' products to distribution power islands.

PET 1.2 – Functional and testing requirements

This work package is concerned with identifying the technical and testing requirements which may apply to DER providing Black Start services. Work has commenced on a report identifying the existing requirements for a Black Start service provider, and consideration will be given to how these standards may be relaxed, or otherwise modified for DER.

PET 1.3 – Assess potential across GB

This work package is to assess the potential for Black Start DER services to be rolled out across GB. To this end, an assessment has commenced of all other DNO networks based on the 'case study selection criteria'. This will quantify the number of grid supply point/bulk supply point networks, and the associated MW capacity of DER connected and contracted, to which the Black Start DER concept may be applicable.

In the next reporting period (between June and December 2019), the PET workstream will focus on completing work packages PET 1.1, 1.2 and 1.3, and undertaking detailed analysis of networks and DER to produce firm proposals on the technical requirements for Black Start from DER. This will include:

- progressing with DER stakeholder engagement
- completing reports to identify network protection and earthing issues
- completing preliminary network studies on several case studies
- completing the review of existing substation Black Start resilience and identifying potential future requirements
- providing a 'functional specification' on the application of microgrids within the Black Start DER project for review by the relevant technology companies
- initiating transient and dynamic network studies on selected case studies.

The key deliverable in the next reporting period is a report on the 'Assessment of Black Start from DER viability in GB and proposed functional requirements' scheduled for July 2019. The Options Stage work packages (PET 0.1, 1.1, 1.2 and 1.3) will form the basis of this report.

Project Delivery Milestone 4

Power engineering and trials

- Team initiated from 1 January.
- First report to be published: 31 July 2019.

Workstream 3 – Organisational, systems and telecommunications

This workstream is concerned with defining the organisational, systems and telecommunication specifications to enable management and coordination of DER power islands to provide a safe and effective Black Start service.

The outputs will include definitions of roles and responsibilities for the principal stakeholders, functional specifications for the required systems and telecommunications that would be directly involved in power restoration from DER.

The workstream commenced in April 2019 with the mobilisation and onboarding of the project team. As the team consists of personnel across NGESO and SPEN, a key part of the mobilisation phase was establishing an effective working relationship amongst the team, across the different organisations, and with the other workstreams.

This workstream will:

- explore and analyse the current roles, responsibilities and processes used for coordination, control and management of Black Start, including the capabilities and levels of resilience of both telecommunications and systems currently used;
- review the capabilities and levels of resilience of both telecommunications and systems currently used by DER (non-Black Start);
- assess future requirements to deliver Black Start from DER;
- identify gaps where applicable; and
- identify the most effective enhancements.

These enhancements may require additional functionality to be designed into existing systems or may require new systems for managing Black Start from DER. Alongside this, we will determine relevant processes, and appropriate roles, responsibilities and resources to support this implementation.

The initial workstream deliverable is a report by 8 November 2019, which will document the outcome of analysis for:

- resilience assessment of telecommunications required for Black Start from DER
- resilience and capability assessment of systems relevant to Black Start from DER
- capability assessment of organisational structures and skills required for Black Start from DER with a focus on the main challenges to be addressed in the design of future processes, roles, systems and telecommunications over the remainder of the project.

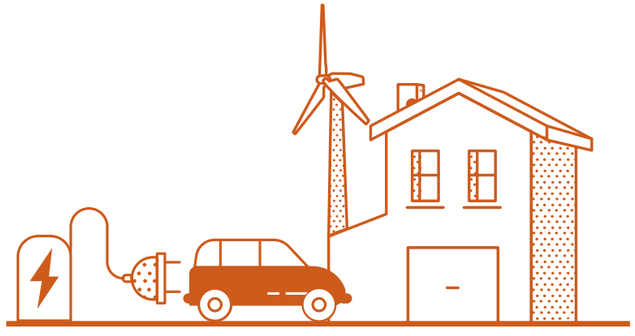
The workstream will use the outcomes from the activities, in the following table, to explore a full range of organisational structures for managing Black Start from DER. This assessment will be the basis for [deliverable 1 report, delivered by 8 November, 2019.] and will include the potential options for the underlining systems and telecommunication infrastructure to support each different organisational option identified; and identification of the main challenges for each option.

Project Delivery Milestone 1

Organisational, Systems and Telecommunications

- Team initiated from 1 April.
- First report to be published 8 November 2019.

Kick off	Activity	Progress to date
Workstream mobilisation		Effective working relationship established amongst the team; across the different organisations; and with other workstreams.
Requirement for [deliverable 1]:	**Activity**	**Progress to date**
Capability assessment of organisational structures and skills.	Assess current roles, responsibilities and processes of: • the project stakeholders • other DNO/TO • DER • others, including 'new players'/ aggregators.	We have conducted workshops within the project and gathered information on current Black Start processes; roles and responsibilities (including skill sets); systems; and telecommunications used by the project partners and [the DER approached by the PET workstream in developing the case studies]. We have engaged with a range of external stakeholders at the Utility Week Live (UWL) (for example) and developed questionnaires to follow up and gather further information. We have also developed a strategy to use other organisations and groups to reach out to other potential participants for Black Start from DER over the coming months. This includes a range of stakeholders in terms of size, type and geographical location.
Resilience assessment of telecomms and capability assessment of systems relevant.	Current use and resilience (project stakeholders; other DNO/TO; DER; 'new players'/aggregators).	We have reviewed the systems and telecommunication infrastructure as used by the existing traditional Black Start stakeholders. We are in the process of reviewing the systems and telecommunication infrastructure used between DERs and NGESO/ DNOs; by aggregators etc., including their capability for assisting the creation, control and management of a DER power island.
	Options available and resilience (manufacturers; academia)	We have just commenced a high level review of the options available for voice and data communication between all parties that could be involved in Black Start from DER.



Workstream 4 – Procurement and compliance

Workstream 4 started in May 2019 and is responsible for proposing recommendations for procuring Black Start services from DER and changes to relevant codes and licence conditions to enable this.

For the procurement element, this will include: designing a commercial and contractual framework and market mechanism; determining how to value service components: and redefining the process to ensure that the entire process lifecycle is developed with the future in mind.

For the compliance element, this will include identifying elements of codes and licence conditions that at present could prevent procuring a service from DER and developing and socialising recommendations for changes where required with industry to ensure that DER can participate.

So far, we have:

- **mobilised the workstream** – although not fully resourced, where resource has been agreed the team are working together to mobilise.
- **held kick-off workshop** – to develop the workstream programme plan as a team and commit to deliverables and timelines for producing the functional requirements report. The plan has been produced and will be used to monitor progress.
- **connected with the other workstreams** – we have peer reviewed plans across the workstreams to identify any gaps, overlap or touch points where there are dependencies or where input will be required, and we are agreeing ways of working. This will form a solid foundation for working efficiently together throughout the project.
- **agreed to further develop** a cross-workstream structure to use as a framework for options assessment across the project.
- **developed key areas for engagement** this year through the whole project engagement plan.

Project Deliverable Milestone 7

Procurement and Compliance

- Team initiated from 1 May.
- First report to be published 8 November 2019.

Workstream 5 – Knowledge and dissemination

We have been holding, attending and presenting at key stakeholder events to support the workstreams and have a suite of marketing collateral to support our vision.

Utility Week Live, Power Responsive and CIGRE has been targeted to capture specific stakeholder groups and ensure that we are reaching a national and international audience. This ensures that we are gaining opinion and views from a broad audience with opposing opinions and ideas, with data being presented back to the project team.

The next six months will see the roll-out of a series of targeted working groups including Distribution Network Operators (DNO), Transmission Owner (TO), Independent distribution network operators, Academia and workstream specific workshops, including regular webinars, newsletters and webpage updates. Mailshots will advise on findings and progress with outcomes overseen by the Stakeholder Advisory Panel. Push and pull marketing strategies will be adopted to ensure fresh buy-in throughout the lifecycle of the project by capitalising on existing relationships and reaching out to new contacts.

Events – conferences

Workshop/conference	Date and location	Why we attended/hosted	What we got out of it
Webinar – case study selection criteria	29 March 2019	Hosted a webinar to inform interested parties and gain industry input into challenges we might face.	Introduced our audience from the NIA to the NIC project. Input and challenges to our approach from industry have been noted.
GC0128 Workgroup 'EU Code Restoration – Requirements Resulting from System Restoration Plan'	25 April 2019 NGESO – Faraday House	Grid Code modifications are all about implementation of the EU Codes.	Informed on modifications which may affect the **Distributed ReStart**[2] concept.
Utility Week Live	21 May and 22 May 2019 NEC Birmingham	Exhibited and hosted four workshops.	Raised awareness with an informed and interested audience, made significant contacts to support shaping the future of Black Start.

[2] www.nationalgrideso.com/project-black-start-from-der

Workshop/conference	Date and location	Why we attended/hosted	What we got out of it
CIGRE – Council Large Electricity Systems	4 June–6 June 2019 Denmark	International working group, discuss technical issues, protection issues, new developments and share challenges.	A broader understanding of what is happening outside the UK. Invitation to join working group – Power system restoration, accounting for a rapidly changing power system and generation mix. See appendix 2.
Power Responsive – NGESO Event	26 June 2019 London	Exhibiting and presenting to target power responsive specific audience.	Secured ADE and Cornwall Insights to Stakeholder Panel.
LCNI – Lower Carbon and Network Innovation	30 October–31 October 2019 Scottish Event Campus Glasgow	Presenting	

Stakeholder analysis and mapping is due to commence to populate a targeted engagement plan and will be critical through the transition of the project. The key priorities will be to:

- ensure that recommended solutions are fit for purpose
- ensure we are aligned with industry expectation
- mitigate the risk of challenge.

They will perform an impartial collation of data for review, using mechanisms such as colleague net promoter score (CNPS) and Qualtrics (survey tool).

This workstream is working closely with other streams to ensure regular and consistent communication.

Stakeholder sentiment and feedback will be captured and overseen by the Customer and Stakeholder Strategy Team based in ESO.

Highlights of Utility Week Live

Stakeholders

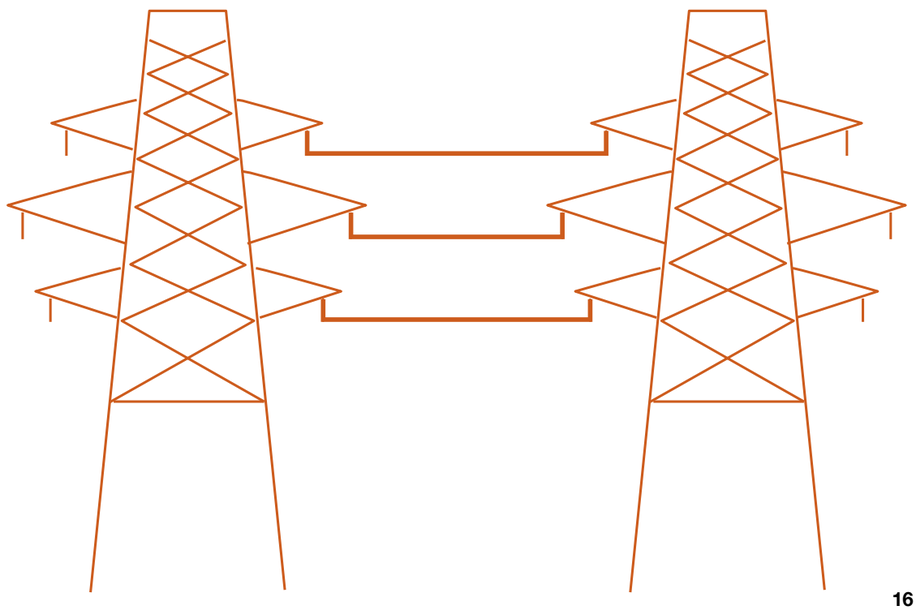
- **Excellent outputs from workshops, 'high quality discussions'.**
- **Offers of 'complimentary' equipment to facilitate the trials.**
- **Offers to scope out systems required without fee.**
- **Cumulative 360 targeted contacts built up from across the industry.**
- **Approaches made for Stakeholder Advisory Panel.**

Awareness

- **Improved overall industry awareness of the project and the partner companies.**

Team working

- **Improved on working relationships across the companies for a more collaborative future approach.**



Project manager report

Distributed ReStart was established in January 2019 and has gained momentum during the spring of 2019, with all project roles recruited, except for the NGESO Code Specialist. All workstreams mobilised, with Workstream 2 – Power engineering and trials – the most mature and making excellent progress to deliver its first project deliverable milestone in July 2019.

- Workstream 1 – Project direction.
- Workstream 2 – Power engineering and trials.
- Workstream 3 – Organisational, systems and telecommunications (formerly known as organisational and systems).
- Workstream 4 – Procurement and compliance (formerly known as procurement and regulation).
- Workstream 5 – Knowledge and dissemination.

The power engineering and trials (PET) workstream has made considerable progress over the last six months.

The power engineering and trials (PET) workstream is the most mature across the Distributed ReStart project and has mostly focused on assessing the technical capability of GB distribution networks, and installed DER, to deliver an effective Black Start service. This is being done by the selection and analysis of case studies (sample areas of the SP Distribution and SP Manweb networks), and progression through multiple stages of review to identify the technical requirements that should apply on an enduring basis. The work will culminate in demonstrating the Black Start from DER concept with at least two 'live trials' on SPEN networks.

The organisational, systems and telecommunications workstream mobilised in April 2019, working towards the initial workstream milestone deliverable (PD1), as set out in the BID document ESOEN01_V03. The following activities have commenced: resilence assessment of telecommunications required for Black Start from DER; resilience and capability assessment of systems relevant to Black Start from DER; and capability assessment of organisational structures and skills required for Black Start from DER.

The procurement and compliance workstream mobilised in May 2019 and in the first few weeks has managed to secure a temporary NGESO Code Specialist, although this is still a risk, as a more permanent resource needs to be secured. This workstream has also run its first cross functional workshop, peer workstream plan review to identify any common risks, gaps and touch points and is working towards delivering their first project milestone deliverable (PD7) as outlined in the Bid Document ESOEN01_V03.

The knowledge and dissemination – Workstream mobilised in May 2019 and has led the exhibiting of the project at Utility Week Live, prepared all the marketing material, including a pamphlet to provide an overview of the project. This workstream has also released a press release at UWL, supported by social media updates. This workstream is working very closely with the other workstreams to ensure regular, consistent communications.

- Delays in recruitment have significantly shown an underspend until 1 April 2019.
- Milestone deliverables (PD 4), set out in the bid document version ESOENO01_V03, remains on track to deliver.
- Attended and exhibited at Utility Week Live @ NEC Birmingham (21 May and 22 May 2019).
- Successfully hosted 4 workshops with interested stakeholders at Utility Week Live @ NEC Birmingham (21 May and 22 May 2019).

Business case update

The robust business case that was part of the Network Innovation Competition bid process has not changed.

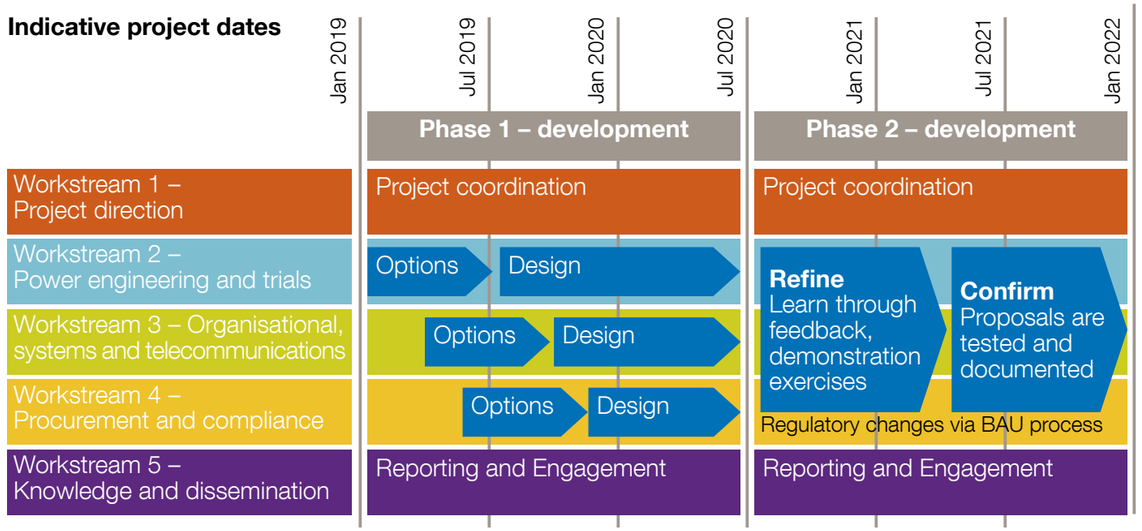
Progress against plan

The overall project is on track to deliver on schedule against the objective set out in the bid documentation. For more detail on the progress made by the project against deliverables, please see the workstreams update section of this paper.

Progress against budget

Overall, the project has significant underspend despite delivering to schedule. This is due to resourcing and re-planning of works. Work which was not critical for delivery of PD4 and PD1 has been moved from the 2018/2019 financial year into 2019/2020. This does not affect overall project spend but reduces the amount incurred in 2018/2019 to a significantly lower figure. The intended project start date was shifted by one month from December 2018 to January 2019.

Indicative project dates



Project bank account

National Grid ESO's partner contribution is in place in the project account, NGESO Ltd NIC Black Start. This was actually delayed from the expected contribution date, prior to 1 April 2019, due to legal separation of National Grid Electricity System Operator from National Grid Electricity Transmission. To ensure compliance with the funding direction requirements, an existing NIC account was used to hold these monies in the interim. The Distributed ReStart bank account is now live and contains NGESO and Ofgem payments – see separate paper for more details – Distributed Financial Report January–June 2019.

Progress against successful delivery reward criteria (SDRC)

The project is in the early stage of implementation, with work progressing in accordance with the project plan. SDRC 9.4 is to provide an assessment of Black Start from DER viability in GB and proposed functions and is due on 31 July 2019. This report will be written by workstream 2 lead and reviewed by the core project team and is proceeding through the final stages of the governance process prior to submission.

Details of all SDRC are outlined in the bid document (ESOEN01_V03) (page 45-47).

Project steering committee

The project name used in the bid document (ESOEN01_V03) has changed to 'Distributed ReStart'. The team consist of National Grid Electricity System Operator, SP Energy Networks and TNEI – experts that share a common goal to explore whether Black Start services can be provided from distributed energy resources (DER) to energise the transmission and distribution networks in the event of a blackout.

The steering committee is well established and has been meeting every month, discussing project progress, identifying risks, and agreeing contract terms relating to the project. The steering committee has also been involved in supporting the recruitment of the right resources to the right vacancies and accepting any risks associated with this. To date we have held three steering committee meetings, one via telecon and two face-to-face.

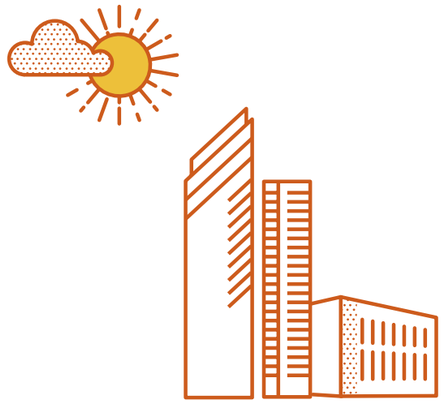
Learning outcomes

During the bid preparation, and in the first months of the project, the project team has carried out design option workshops with the aim to incorporate relevant learnings from other innovation projects into this project. The project leads have held lessons learned sessions with NIC projects (Power Potential, CLOCC and EFCC (Enhanced frequency control capability)).

RAID log

ID	Risk description and impact	Deliverable impacted	Mitigation actions and contingency	Status
1	Project tasks not completed in a timely manner.	Project direction	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	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. A thorough handover process for individual roles will be in place.	Risk
3	The eventual organisational and systems design restricts capability to a limited number of DNO areas. This could reduce project benefits.	Organisational, systems and telecoms	Expected modifications to case study networks to facilitate testing of Black Start from DERs have been included in the project budget. During the development phase, we will assess the technical suitability of the case study networks. A key criterion for progression to online testing will be the cost of network modifications required.	Risk
4	Roles and responsibilities may be difficult to effectively split and DSO transition adds uncertainty.	Project direction	Joint discussions across workstreams and forward planning to manage the risk.	Risk
5	Live testing to DER generator equipment could lead to suspension of the project due to safety concerns.	Power engineering and trails	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.	Risk
6	Lack of DER commitment in participating in live trials, this could lead to not being able to carry out the live trials.	Project direction	Early engagement in managing the contract agreement and gaining signatures to ensure DER commitment for live trials; early engagement with the necessary legal teams will ensure the right support levels are in place.	Risk
7	Delays to preparation and installation for offline and online trials. This could result in project delays.	Power engineering and trails	Early findings following stage 1 of the PET report will determine the level of reliance required on third parties, early engagement right from the start also helps mange the risk of any delays.	Risk
8	Procurement time scales may be longer than expected. This could result in project delays.	Power engineering and trails, procurement and compliance	The procurement process will begin as early as possible. Apart from the procurement of DER services for testing, there is limited procurement of other products or services. Design for contracting of DER for testing will start being developing during Phase 1 – Development.	Risk
9	Numbers of control engineers required due to complexity in power islands is not practical for existing relevant system operators.	Organisational, systems and telecoms	This is an options risk, relevant to any options considered during the lifespan of the project.	Risk
10	Organisational, technical, procurement and regulatory proposals do not align. This could reduce project benefits.	Project direction	Design Architects are included in the project team to align outcomes across various workstreams, including workstream lead weekly meetings, which will support the mitigation against this risk. This is based on learning from previous innovation projects.	Risk

ID	Risk description and impact	Deliverable impacted	Mitigation actions and contingency	Status
11	Partner companies may not maintain/provide resource at planned levels. This could result in project delays.	Project direction	All partner companies have a nominated Project Management function to ensure internal resourcing remains at the required levels to meet deliverables.	Risk
12	Roles and skillsets required for DER are challenging to resource.	Org, systems and telecoms	Optioneering will determine the skillsets and will need to be managed carefully.	Dependency
13	High cost of providing sufficient resilience in telecoms means focusing on a small number of large resources, limiting involvement of smaller DERs.	Org, systems and telecoms	Identified as a high dependency, will need careful managing during optioneering.	Dependency
14	High dependency on external work, projects and technical developments.	Org, systems and telecoms	Black Start Standard – requirement on telecoms resilience is dependent on how long the telecoms network can operate without power. Optioneering dependency.	Dependency
15	Black Start Task Group – roll-out of Black Start resilience.	Project direction	Rollout of Black Start Standard is a high dependency on the optioneering stages.	Dependency
16	Procurement and Compliance is heavily dependant on Workstream 2 and 3 outputs.	Procurement and compliance	The outputs of workstream 2 and 3 need to be agreed and signed off prior to the design of a procurement solution.	Dependency
17	Workstream 4 – Code Specialist.	Procurement and compliance	There is a need for a more permanent recruitment for the role of NGESO Code Specialist – temporary resource in post.	Risk



Accuracy assurance statement

This progress report has been produced in agreement with the entire project hierarchy. The report has been written and reviewed by all project partners. The report has been approved by the Distributed ReStart steering committee and by Julian Leslie, the Project Sponsor. Every effort has been made to ensure all information in the report is true and accurate.

Name	**Julian Leslie, Head of National Control**
Signed	Julian Leslie

List of abbreviations

Acronym	Description
BES	Battery energy storage
BEIS	Business, Energy and Industrial Strategy
BSUoS	Balancing services use of system
CCGT	Combined cycle gas turbine
CLOCC	Customer low cost connections
CNPS	Colleague net promoter score
DER	Distributed energy resources
DNO	Distribution Network Operator
DSO	Distribution System Operator
EFCC	Enhanced frequency control capability
ESO	Electricity System Operator
GSP	Generator supply point
HVDC	High voltage direct current
NGESO	National Grid Electricity System Operator
NGET	National Grid Electricity Transmission
NIA	Network Innovation Allowance
NIC	Network Innovation Competition
NPV	Net present value
PET	Power engineering and trials
RAID	Risk assumptions issues and dependencies
SPEN	SP Energy Networks
TO	Transmission Owner
TSO	Transmission System Operator
VSC	Voltage source convertor
WG	Working group

Appendices

Appendix 1

Distributed ReStart

Stakeholder Engagement questionnaire

Name	
Role	
Date	
Name of organisation	
Type of distributed energy resource (DER) technology	
Name of DER plant(s)	
Location of plant(s) (Closest town)	
Size of plant(s) (MW)	

	Comments
Grid connection supply loss and restoration	
1. What is the current procedure following a loss of the grid connection (DNO low voltage supply still available)? What is the impact/requirements if the grid supply is not restored within one, two or three days?	
2. What is the current procedure/timescale to reconnect to the distribution network when the DNO supply is restored? (Does this vary depending on outage duration?)	

Black Start resilience (loss of grid connection and DNO L.V supply)	
3. What is the site Black Start resilience timeline? (e.g after three hours batteries dead, after X standby generator out of fuel, after X boiler/turbine cools down requiring X days to restart, manual intervention required after X etc.)	
4. How is the site currently controlled? E.g manned/unmanned, remote via control room? What is the resilience of these communications?	
Power supplies	
5. Does your site have emergency power and if so for what essential services? Capacity (e.g kVA), resilience (time)?	
6. Does your site have auxiliary power (for restarting or maintaining availability of plant? (If so, please provide details or if not what capacity might be required?)	
Resilience of supply	
7. Synchronous generator – can the generator operate at rated output for 72 hours? If not, what would be required to obtain this?	
8. Synchronous generator – What is the Black Start resilience of the fuel supply (e.g gas supply)?	
9. Can the generator perform at least three sequential start-ups/resync?	
10. What is the approximate % annual availability of the site?	

Technical	
11. Do you have existing voltage control capability? (If so, where is the voltage measured?)	
12. Do you have existing frequency control capability?	
13. Other relevant technical capability if known/applicable. For example: • What is the minimum operating MW level? • Can you provide reactive capability if no wind (for WFs)? • Fault infeed? • Others?	

Contacts	
14. Who is the best point of contact for this project?	
15. Is there a technical or manufacturer contact?	

Appendix 2

Attendance at CIGRE Symposium, Aalborg Denmark, 4 June–7 June 2019 for inclusion into project update report by Dan Auty.

Summary

Part of the Distributed ReStart project's external engagement included project representation at this year's CIGRE Symposium. The benefits for the project were two-fold; namely the inclusion of a member on a newly convened working group and awareness of global activities that are relevant. Separately the project has submitted a synopsis paper for consideration at CIGRE Paris 2020, this is detailed in appendix 3.

CIGRE working group background

Working groups (WGs) undertake research on behalf of study committees. WGs work to a pre-defined scope and time period and individual WG members are nominated by national committees and are expected to hold further education qualifications as a minimum. National Grid ESO has historically had a relationship with CIGRE with involvement in many WGs, committees and submission of papers, recent examples including Power Potential, another innovative project, adding real-time inertia on the NGESO system. NGESO hold corporate membership which gives us excellent access to CIGRE's intellectual facilities.

Following initial contact via Julian Leslie, Head of National Control, NGESO representation was requested at the newly convened WG:

CIGRE WG 2.26 power system restoration accounting for a rapidly changing power system and generation mix

This clearly has many synergies with this NIC project. The group was convened by Babak Badrzadeh who has been instrumental in the investigation and reporting of the 2016 Southern Australian shut-down.

Advantages of WG representation include:

- collaboration with leading industry and other formal organisations' key personal on relevant topics
- sharing of key papers, knowledge and experience from around the world via KMS (Knowledge Management System)
- awareness of emerging technologies and the most recent developments within technical spheres
- a forum to present NIC project development and gain feedback/guidance from a wide variety of experts in many fields
- identify possible collaboration and other opportunities outside of the usual sphere of influence
- exposure to manufacturers and other practical solutions which may form part of our solution.

Following successful nomination by CIGRE's UK national committee our representative from the project was given access to KMS and other CIGRE systems and invited to join the WG.

CIGRE WG report

The working group inaugural meeting was attended by around 16 representatives with each member introducing themselves, organisation and reason for interest in the group. The diversity of membership spread across five continents, 15 countries and included ESO, TSO, manufacturers, generators and other interested bodies such as universities and consultants.

Most members gave a brief presentation, many of which were relevant to this NIC project. These will be shared with the project via sharepoint. No non-publicly available information was shared by the NIC project representative. Questions following presentation of the NIC project indicated a high level of understanding amongst the group with direct questioning and challenges of a detailed nature.

The potential benefit of the work from this WG is hoped to be:

- commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this WG
- existing or future high interest in the work from a wide range of stakeholders
- work is likely to contribute to new or revised industry standards or with other long-term interest for the electricity industry
- state-of-the-art innovative solutions or new technical directions
- guide or survey related to existing techniques; or an update on past or previous technical brochures
- work likely to contribute to improved safety
- work addressing environmental requirement and sustainable development goals.

Appendix 3

The following synopsis has been submitted for a paper to be published at the CIGRE Congress in Paris in 2020.

Restoration of power networks utilising distributed energy resources

As the generation mix in many countries transitions to become decarbonised and decentralised, it is no longer appropriate or even possible to rely solely on large synchronous generators connected directly to the transmission network for restoration of a power system following the low probability high impact event of a total or partial system shutdown. This paper will present findings from projects in GB that are exploring all aspects of utilising distributed energy resources to facilitate the restoration of our power system following such an event.

An OFGEM funded NIA (Network Innovation Allowance) project has assessed the Black Start capabilities of non-traditional technologies. The capabilities of wind, solar, storage, demand side response (DSR) and electric vehicles (EVs) have been considered. Extensive stakeholder engagement and early stage research has given insight into these technologies in providing ancillary services to the system operator during a system restoration. Whilst it is evident that no single technology can provide restoration services in the way that Black Start providers currently do, each has the potential to play an important role in system restoration at present, and a significant role if some key interventions are enabled.

A summary of the key capabilities of the technologies will be presented, alongside some of the key interventions that could unlock the huge potential for DER to support system restoration. The technology readiness level (TRL) of each DER technology type to provide the range of services will also be presented.

The paper then describes the work being undertaken as part of the OFGEM funded NIC (Network Innovation Competition) project “Distributed ReStart”. This collaborative project investigates how the theoretical prospects of Black Start utilising DER can be made a practical reality by assessing the challenges, then developing and testing potential solutions leading to demonstrations with live trials.

Extensive stakeholder engagement is regarded as crucial to ensure the design of solutions recognises the specific needs and capabilities of different technologies and organisations and to ensure the project is outward looking, learning from previous restoration events around the world. This engagement includes having project representation on the newly formed CIGRE WG 2.26 (Power system restoration accounting for a rapidly changing power system and generation mix) to influence the debate globally.

Aside from the technical challenges, it is also recognised there are significant commercial and organisational challenges and, as such, our project has been organised into three workstreams (power engineering and trials; organisational, systems and telecommunications; and procurement and compliance) with Design Architects ensuring integration across all three. This will ensure the significantly more complex activity in terms of communications and control and the fundamentally different roles and responsibilities across many more parties is considered so that we arrive at realistic market-driven solutions.

The paper will cover the design of new restoration processes from case study selection criteria to high-level methodology in each of ten case studies from 33 and 132 kV networks in GB. These case studies all include DER technologies that have self-starting, grid-forming capability in combination with other DER that can help to grow power islands, including intermittent, renewable sources such as wind and solar. Power system studies explore the requirements and solutions for how Black Start capability could be established to restore supplies at distribution level then potentially energise upwards to the transmission system. The case studies selected for two live tests will be chosen to demonstrate as diverse a mix of network topologies (radial and interconnected), generation sources and innovative technologies as will be practical to deliver a workable real-life solution. This has been ensured by considering technology with a required minimum technology readiness level score.

Black Start from DER would mean a ‘bottom-up’ approach to restoration with multiple power islands being formed at distribution level before energising upwards to transmission level and re-synchronising the various islands. The goal is to have a range of options available that make possible hybrid solutions which combine DER with conventional ‘top-down’ restoration processes as well as emerging options like voltage source converter (VSC) HVDC.

Finally, restoration performance following any large blackout event is difficult to predict as real-world tests are impractical, so we are limited to estimates based on emergency plans and trial exercises. New methodologies are being developed to better quantify restoration timescales, focusing on a ‘Black Start Standard’. These show timescales for load restored. In anticipation of this standard, we have developed new modelling techniques employing Monte-Carlo methods which simulate restoration across a wide range of circumstances and assumptions.

By replicating major restoration activities, the model can benchmark the likelihood of meeting specific restoration goals (time taken to meet a stated objective, minimal societal impact and unsupplied energy etc.) for a given cost which will ensure maximum consumer value from Black Start restoration investment.

Notes

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