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## NIA Project Registration and PEA Document

### Date of Submission

Jan 2019

### Project Reference Number

NIA\_NGSO0022

## Project Registration

### Project Title

Black Start Capabilities from Non-traditional Technologies

### Project Reference Number

NIA\_NGSO0022

### Project Licensee(s)

National Grid Electricity System Operator

### Project Start

January 2019

### Project Duration

0 years and 8 months

### Nominated Project Contact(s)

Mark Jones

### Project Budget

£200,000.00

## Summary

This innovation project will study the technical capability of non-traditional technologies to contribute to Black Start and evaluate how these can be best utilised during a system restoration.

The project will evaluate the operational impact that these technologies will have on the growth of a Power Island by reviewing international experience and performing detailed desktop analysis.

### Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

## Problem Being Solved

Black Start is the process of restoring National Electricity Transmission System (NETS) following the highly unlikely, but highly impactful, event of a partial or total shutdown. National Grid Electricity System Operator (ESO) is responsible for ensuring there is an adequate provision for NETS restoration. The current restoration process has been deemed adequate for many years, based on a transmission-led approach of starting large generators, energising a skeleton transmission network, and controlling demand.

An increasing amount of non-traditional and decentralised energy technologies is connecting to the GB electricity system, a substantial proportion of which is intermittent. This presents new challenges to the planning and operation of the network, as well as opportunities for these technologies to contribute to system services such as Black Start. However, the ability of these technologies to deliver Black Start services and contribute positively to restoration is not currently known. The operation and growth of a Power Island using a range of non-traditional technology types has also not been explored in detail.

There is therefore a need for the ESO to improve its understanding of the Black Start capability of different types of non-traditional technologies, such as wind with self-start capability, solar, storage, DSR and EVs, and the changes that may be needed to make these resources Black Start-capable.

## Method(s)

This innovation project will study the technical capability of non-traditional technologies to contribute to Black Start and evaluate how

these can be best utilised during a system restoration.

The project will evaluate the operational impact that these technologies will have on the growth of a Power Island by reviewing international experience and performing detailed desktop analysis.

The findings will then be consolidated to determine the Technology Readiness Level (TRL) of each technology in regards to Black Start capability. The outcomes will recommend what needs to be done to either further develop or support the technology to a point where its Black Start capability can be demonstrated.

The project will consist of the following three work packages:

### **Work Package 1 (WP1) - Capability and Requirements:**

Each of the identified technologies will be assessed to determine its capability with respect to:

- self-starting;
- energisation and reactive range;
- block-loading;
- synchronisation and stability; and
- resilience of communications and control.

This assessment will be based on comparison with existing Black Start requirements as well as requirements that are envisaged at lower voltage levels where Black Start services are not currently procured. Capability will be explored in detail through desktop research, analysis and bilateral engagement with manufacturers, developers and operators of these technologies.

### **Work Package 2 (WP2) - Operational Impacts:**

The impact these technologies will have on the growth and management of a Power Island will be studied in more detail in this work package.

Some of these technologies are intermittent and do not contribute to system inertia, resulting in increasing operational challenges for the ESO. These challenges will potentially worsen in the operation and growth of a Power Island during emergency conditions. The impact of these technologies will be based on reviews of international studies on microgrids (and engagement with study authors where appropriate), input from experts within the ESO, TO, DNOs and internationally, and detailed desktop analysis.

### **Work Package 3 (WP3) - Readiness and Next Steps:**

In this work package, the findings of Work Packages 1 and 2 will be consolidated to determine the Technology Readiness Level (TRL) of each solution with respect to Black Start. A robust methodology for doing this will be developed and applied.

This work package will also summarise the next steps that the industry should pursue to realise the opportunities for these technologies in Black Start.

## **Scope**

This innovation project involves investigation of different types of non-traditional technologies such as wind with self-start capability, solar, storage, DSR and EVs which, in the context of Black Start and restoration, are not well understood and have a low TRL.

## **Objective(s)**

This project aims to evaluate the capability of various non-traditional technologies to support Black Start restoration for the GB electricity system, and the changes that are needed to make these resources Black Start-capable.

## **Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)**

n/a

## **Success Criteria**

The project will be successful if it can help the ESO and technology manufacturers / developers in the following ways:

1. Improve understanding of the Black Start capability of the different types of non-traditional technologies identified.
2. Develop a methodology that helps determine the TRL of each technology in regards to Black Start capability.
3. Recommend what needs to be done to accelerate the technology to a point where its Black Start capability can be demonstrated.

## **Project Partners and External Funding**

The project will involve collaboration between ESO's Black Start & Business Continuity team, SP Energy Networks (SPEN) and TNEI Services Ltd (TNEI). There is no external funding involved in this project.

## Potential for New Learning

The project is expected to generate the following new learning:

1. An understanding of current technology capabilities, and what the gaps are, with respect to Black Start requirements for each technology (WP1).
2. An assessment of how these technologies would interact, and how they would impact the operational limitations of Power Islands (WP2).
3. An up-to-date view of TRL for each technology based on detailed research from WP1 (WP3).
4. A roadmap of developments required for these technologies to provide Black Start services in the future (WP3).

## Scale of Project

The project will predominantly involve desk-based research, expert interviews and data analysis at ESO, SPEN and TNEI.

### Technology Readiness at Start

TRL2 Invention and Research

### Technology Readiness at End

TRL4 Bench Scale Research

## Geographical Area

This work will take place on a national scale and will benefit the GB Black Start restoration capability.

## Revenue Allowed for the RIIO Settlement

None.

## Indicative Total NIA Project Expenditure

The total indicative NIA expenditure for this project is £200,000.

## Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

### Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

#### How the Project has the potential to facilitate the energy system transition:

n/a

#### How the Project has potential to benefit consumer in vulnerable situations:

n/a

### Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

#### Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

The outcomes of this innovation project will inform other future innovation projects and will also provide the foundations of a methodology for the cost-benefit analysis of Black Start from DERs to be quantified.

Black Start costs for 2017/2018 financial year came to £57.7m to maintain an adequate service level provision. This number has increased dramatically in recent years due to the worsening economics of coal and gas-fired power plants resulting in significantly higher costs associated with keeping these stations warm and ready for Black Start.

This project aims to further the confidence of non-traditional technologies ability to contribute to Black Start and restoration, enabling them to be demonstrated and eventually brought into the Black Start provider pool. This should result in significant Black Start cost savings to consumers through increased competition and reduced costs associated with thermal plant readiness. There will be costs associated with developing markets, processes and organisations to enable these technologies to participate in Black Start, as well as costs for the industry to develop the technologies themselves, however we believe that the benefits will far outweigh these overall costs.

#### Please provide a calculation of the expected benefits the Solution

This is not required for this research project.

#### Please provide an estimate of how replicable the Method is across GB

The project will create learnings of current capability on a generic basis, by technology, that will inform operational and industry guidelines across all GB network licensees. Gaps in Black Start capabilities for each technology will be identified, documented and published to enable the industry to drive developments fill those gaps, bettering the capability and enabling a wider range of technologies to have the potential to contribute to a Black Start.

The learnings will be applicable to all electricity Network Licensee systems and equipment manufacturers.

#### Please provide an outline of the costs of rolling out the Method across GB.

This project will further industry confidence in the capability of non-traditional technologies to provide Black Start Services. However, following this project, there will be further work required before these technologies can be included in the Black Start provider pool:

1. The technologies themselves may need to be developed further, e.g. to include self-start capability or certain control systems
2. The technologies must be demonstrated in a real-world situation
3. Technical, commercial, organisational and regulatory frameworks may need to adapt to include these new technologies

These costs are not yet known, and this project will not explicitly quantify them. However:

- The costs associated with Point 1 above will be able to be evaluated by industry, based on the technology development roadmaps produced by this project, and
- The costs associated with Points 2 and 3 should be able to be determined using the learnings and frameworks produced in the ESO NIC project, Black Start from DER (awaiting final funding decision from Ofgem)

### Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

- A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).
- A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)
- A specific novel operational practice directly related to the operation of the Network Licensees system
- A specific novel commercial arrangement

RIIO-2 Projects

- A specific piece of new equipment (including monitoring, control and communications systems and software)
- A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven
- A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)
- A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology
- A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution
- A specific novel commercial arrangement

### Specific Requirements 4 / 2a

#### Please explain how the learning that will be generated could be used by the relevant Network Licensees

The outcomes and learnings from this innovation project will be disseminated through the National Grid SO Innovation website, the ENA website, and the annual Low Carbon Network Innovation conference.

It is expected that the outcomes from the work carried out in this innovation project will give GB network licensees and wider industry an improved understanding of the Black Start and restoration capabilities of different types of non-traditional technologies.

The project learnings will be shared with the industry in the form of reports, presentations and workshops.

Finally, the learnings from this project will be fed immediately and directly into the ESO-led NIC project, Black Start from Distributed Energy Resources (DER) (awaiting final funding decision from Ofgem), in partnership with SPEN and TNEI. This NIC project aims to develop and demonstrate groundbreaking new approaches to open the Black Start market to DER by designing and then testing technical, organisational, procurement and regulatory solutions. The NIC project is focused on DER technologies with TRL high enough to be demonstrated. This NIA project will inform the NIC project in 2 critical ways:

1. If this NIA determines that any of the non-traditional technologies are of a TRL high enough to demonstrate, that technology will be immediately included for consideration in the NIC trials
2. All technical, organisation, procurement and regulatory solutions proposed in the NIC project will be developed based on the learnings from this NIA project, to ensure that no future technology is ruled out or disadvantaged in the new Black Start market

#### Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This project will directly address the strategic innovation areas "Reimagining system restoration" and "Developing DSOs & whole system operability" from the SO Innovation Strategy, published in February 2018.

The project will also indirectly address, "Enabling more non-synchronous connections", "Creating markets for the future", "Supporting voltage and reactive power", "Unlocking flexibility" and "Enhancing visibility of DER".

Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

### Is the default IPR position being applied?

Yes

## Project Eligibility Assessment Part 2

### Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

### Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

No unnecessary duplication will occur as a result of this project. There are no other known innovation projects investigating the scope of work proposed in this innovation project.

### If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

## Additional Governance And Document Upload

### Please identify why the project is innovative and has not been tried before

The scale and speed at which non-traditional energy technologies have penetrated the GB electricity system has recently been so great that they now represent a significant proportion of the electricity generation mix, and are forecast to continue to grow rapidly. E.g. the current and projected installed capacity of Distributed Energy Resources (DER), excluding wind, solar and battery storage - currently ~10GW, rising to 25GW by the mid-2030s. This presents a huge opportunity to significantly increase participation in the Black Start market. This innovation project is aimed at assessing the technical capability of those non-traditional solutions that, when it comes to Black Start capability, are at a low Technology Readiness Level (TRL). Given that these technologies were not connecting at such pace until more recently, it did not make sense to assess capability and operational impact in detail prior to now. The project will therefore be the first of its kind to study the technical and operational adequacy of these non-traditional solutions to provide Black Start. It will furthermore support the development of many of these technologies to help them reach a TRL that can reflect their Black Start capability, thus enabling them to be considered for market involvement.

### Relevant Foreground IPR

n/a

### Data Access Details

n/a

### Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

The ESO currently undertakes Black-Start feasibility studies on potential providers and technologies (coal, gas, hydro, interconnectors) that are deemed technically capable of being able to serve Black Start duty under current market frameworks. The cost of these studies is initially covered by the ESO, then reclaimed from consumers following approval by Ofgem, via the Black Start Allowed Revenue Report. For the new and unproven technologies being analysed in this project, the Black Start Capability TRL is currently too low to be able to justify expenditure on individual feasibility studies at each potential provider site – the risk of failure, and therefore wasted expense, is simply too high. The most cost-effective way to proceed is to undertake an innovation research project to study non-traditional technologies at a general level first, to understand their capability to provide Black Start, and to identify the gaps that are preventing ESO to be confident enough to test individual providers and sites. Furthermore, the NIA framework ensures that all learnings and development roadmaps will be disseminated to the industry rather than being shared bilaterally with individual providers as they are in BAU feasibility studies. The successful outcome of this project is dependent on the specialist skills and knowledge of the chosen innovation partners, SP Energy Networks and TNEI Services.

### Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

This project requires NIA funding for the following reasons: 1. This project will investigate a number of technologies across all network levels whose Black Start and restoration capabilities are not well understood at this point. These must be evaluated in more detail and the technology gaps understood before suitable technical, regulatory, organisational and commercial solutions can be proposed, validated and implemented as BAU. The ESO Innovation approach, complemented by the NIA funding framework, is the most cost-effective way to do this. 2. The NIA approach will facilitate collaboration with the chosen innovation partners (SP Energy Networks and

TNEI) to access their specialist skills and expertise in a cost-effective and timely manner. 3. NIA provides an established framework to easily disseminate the key learnings from the project to the energy sector and to GB network licensees. The insights from this project are expected to benefit many stakeholders - enabling non-traditional energy technologies to find new revenue streams, increasing competition in Black Start thus keeping costs competitive for consumers, and furthering the development of the Distribution System Operator (DSO) model.

**This project has been approved by a senior member of staff**

Yes