Date of Submission

NIA Project Registration and PEA Document

Notes on Completion: Please refer to the **NIA Governance Document** to assist in the completion of this form. Please use the default font (Calibri font size 10) in your submission. Please ensure all content is contained within the boundaries of the text areas. The full-completed submission should not exceed 7 pages in total.

Project Registration

Project Title		Project Reference
System HILP Event Demand Disconnection (SHEDD)		**NIA_NGESO0034**
Funding Licensee(s)	**Project Start Date**	**Project Duration**
National Grid Electricity System Operator Western Power Distribution	*April 2020*	24 months
Nominated Project Contact(s)		**Project Budget**
Can Li, Yiango Mavrocostanti, Innovation and Low Carbon Networks Engineer, Western Power Distribution		*£ 400k*

Contact Email Address

.box.SO.innovation@nationalgrid.com

Lead Sector

Electricity Distribution	☒	**Gas Transmission**	☐
Electricity Transmission	☒	**Gas Distribution**	☐

Other Sectors

Electricity Distribution	☒	**Gas Transmission**	☐
Electricity Transmission	☒	**Gas Distribution**	☐

Research Area

ET - Network improvements and system operability	☒
ET - Transition to low carbon future	☐
ET - New technologies and commercial evolution	☒
ET - Customer and stakeholder focus	☐
ET - Safety, health and environment	☐

Problem(s) **Briefly state the main problem / technology / issue to be solved**

Low Frequency Demand Disconnection (LFDD) is designed to limit the fall in frequency for extreme events beyond those defined as 'secured' events in the SQSS and Operating Code OC6 (Demand Control) of the Grid Code.

Under exceptional circumstances where the frequency deviates for more than 60 seconds (e.g. loss of more than one large generator) there may be certain circumstances where the normal contracted frequency response may not be sufficient to maintain the system frequency between the statutory limits where the total loss of generation exceeds the amount secured for and a deficit of generation arises. In order to reduce the generation deficit (or excess in demand) to maintain stability, Distribution Network Operators (DNOs) have low frequency relays to disconnect demand (LFDD).

The current LFDD schemes do not take into account the move to decarbonize through growth of distributed generation and decreasing system inertia. This reduces the effectiveness of LFDD schemes which could potentially put the whole system at risk; while if the response results in sub-optimal economic disconnection of customers, the economic impact (and so cost to consumers) of High Impact Low Probability events will be higher than necessary.

Method(s) **Deliverables – outline the R&D scope of work for this project**

The following deliverables will be explored:

- Review the year-round performance of the LFDD scheme as the uptake of Low Carbon Technologies (LCTs) increase to identify opportunities to improve its technical and commercial performance in the short and medium term.
- Consider a range of options for redesign of the current LFDD scheme to maximise its performance in the short term and for a new "smart" alternative to the LFDD scheme in the medium term.
- Assess those options for redesign, including testing within "war game" simulations to demonstrate performance under simulated HILP events.
- Identify the optimal solution for both short and medium term improvements to the LFDD scheme, and develop a plan for the way in which it could be rolled out, completed by the necessary technical specifications.

Scope **Background / History of the problem / Where you can more fully explain the problem statement above**

Frequency plays a very important role in power transmission and distribution in relation to the balance between the demand and generation requirements of the network. The maintenance of system frequency within set levels is required to maintain stability and prevent a full system collapse. Under normal operating conditions National Grid Electricity System Operator (NGESO) is obligated to maintain the system frequency between 49.8 and 50.2 Hz.

Under exceptional circumstances (e.g. loss of a large generator) the frequency should not deviate outside the range 49.5 to 50.5Hz for more than 60 seconds. In order to achieve this, NGESO contracts frequency response to secure the power system for a number of events. There may be certain circumstances where the contracted frequency response may not be sufficient to maintain the system frequency between the statutory limits where the total loss of generation exceeds the amount secured for and a deficit of generation arises.

In order to reduce the generation deficit (or excess in demand) to maintain stability, Distribution Network Operators (DNOs) have low frequency relays to disconnect demand (LFDD). To comply with the requirements of the Grid Code, Western Power Distribution as a DNO is obligated to install LFDD schemes. The schemes are designed to automatically disconnect at least 60% of the total DNO demand on a stage by stage basis at the time of the forecasted national electricity transmission system peak demand. The demand subject to automatic low frequency disconnection is divided into 9 predetermined discrete MW blocks which are disconnected at defined low frequency levels. Each block of demand is distributed across each license area, so far as reasonably practical, so that the demand at different Grid Supply Point (GSP) sites is reduced evenly.

The current LFDD schemes do not take into account the growth of distributed generation and decreasing system inertia. The growth of distributed generation connected on DNO networks at voltage levels below where the LFDD relays are installed is likely to impact on the effectiveness of the scheme. If the level of distributed generation output is high when the relay is triggered, the amount of demand disconnected may be lower than expected. In addition, levels of system inertia are decreasing (e.g. due to the closure of traditional generation) along with net transmission system demand.

This reduces the effectiveness of LFDD schemes as changes in frequency will be faster and larger. Should the frequency fall at a high rate, more than one LFDD stage could operate resulting in too much demand being disconnected. These increasing changes risk the effectiveness of LFDD, impacting security of supply, unnecessary customer interruptions and price impact. If the LFDD scheme does not deliver the demand reductions required, the whole system is at risk; while if the response results in sub-optimal economic disconnection of customers, the economic impact (and so cost to consumers) of High Impact Low Probability events will be higher than necessary. Furthermore, an ineffective LFDD scheme could increase the risk of rolling brownouts / blackouts.

For example:

- The LFDD scheme is simplistic in design and overestimates the demand reduction achieved by operating LFDD relays
    - Evidenced by 9 August event
    - Current approach to determining magnitude of demand reduction from each relay is simplistic
    - Unknown what volume of DG is also lost when a relay operates
- Load shedding does not take into account the variation in Value of Lost Load (VoLL) for different customer types.
- Vulnerable customers and safety critical loads are also not sufficiently protected by the current LFDD scheme.
- The performance of the scheme is decreasing as the uptake of Distributed Generation increases, and system inertia falls. This degradation of performance is expected to worsen with time.

Objective(s) **Please be aware the Objective can not be changed or amended on future change controls. Should be short – few sentences stating output and should not include background / problem**

The objectives of the project is to design and test a new LFDD scheme to maximise its future performance as the network continues to decarbonisation, Distribution Generation (DG) integration increases, and system inertia continues to decrease.

Success Criteria **Please be aware the Success Criteria can not be changed or amended on future change controls**

The project will be deemed a success if a proposed new LFDD design is proven successful in simulations and examined to be viable by Subject Matter Experts.

Technology Readiness Level at Start TRL 2	Technology Readiness Level at Completion TRL 4
2	4

Project Partners and External Funding

The work is to be undertaken by a consortium made up of WSP, Cornwall Insight and Complete Strategy. The work will be supported by National Grid ESO and Western Power Distribution. The work will be joint funded by National Grid ESO and WPD.

Electricity North West will also participate in the project as non-funding stakeholder.

Potential for New Learning

The learnings of the project are designed to be fit for other Network Licensees and all learnings from the project will be documented, including a detailed plan for delivery of the proposed improved process.

Scale of Project

The project will mainly be desk based, working with a range of stakeholders. This will take approximately 18months.

Geographical Area

The project will mainly focus on a specific electricity distribution area in WPD.

Revenue Allowed for in the RIIO Settlement

None

Indicative Total NIA Project Expenditure

The total forecast NIA expenditure for this project is £400k split equally between NGESO and WPD.

NGESO: £200k
WPD: £200k

Each network entity will recover 90% of the project costs (detailed above) via the NIA allowance. The remaining 10% will be funded by NGESO and WPD as per the NIA Governance document.

Project Eligibility Assessment

Specific Requirements 1

1a. A 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 systems and 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	☐

Specific Requirements 2

2a. Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees ☒

Please answer one of the following:

i) Please explain how the learning that will be generated could be used by relevant Network Licenses.

The learnings of the project are designed to be fit for other Network Licensees and all learnings from the project will be documented, including a detailed plan for delivery of the proposed improved process.

ii) Please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the Project.

This project fits against the following strategic priority areas as identified by the ESO in its Innovation Strategy published March 2020:

- System Stability
- Whole Electricity System
- System Restoration

Is the default IPR position being applied?

Yes ☒

No ☐

If no, please answer i, ii, iii before continuing:

i) Demonstrate how the learning from the Project can be successfully disseminated to Network Licensees and other interested parties

ii) Describe how any potential constraints or costs caused, or resulting from, the imposed IPR arrangements

iii) Justify why the proposed IPR arrangements provide value for money for customers

2b. Has the Potential to Deliver Net Financial Benefits to Customers ☒

Please provide an estimate of the saving if the Problem is solved.

A potential GB annual benefit of £6.4m has been calculated. This will be refined further within the project once the Value of Lost Load (VoLL) and an economic waiting has been established within the design of the LFDD scheme.

Firstly, the VoLL (£/MWh) was calculated for the 9th August outage for LPN using the outputs from the VoLL studies completed by ENWL for domestic and I&C customers. The MWh disconnected by the LFDD for LPN was reported as approximately 131 MWh.

Then, if the customer group least impacted by network outages (I&C) were disconnected by the LFDD instead of those with the highest VoLL (SMEs) then approximately £5.8m in VoLL would have been saved. From this the following calculation gives the total benefits associated with the optimal performance of the LFDD scheme across Great Britain (GB):

£5.8m (LPN) x 10 licensed areas x 1.1 / an event every 10 years = £6.4 annual benefit

Note: 1.1 refers to a 10% reduction in the number of customers disconnected by the LFDD scheme through the optimal performance of the LFDD scheme (i.e. avoiding the disconnection of DG)

Further Benefits include:

Reputational:

- *"Fury at power cut that brought Britain to its knees: Government launches probe..."* **Daily Mail, 9th August 2019**

Social:

- Customers are disconnected based on impact.
- Fuel Poor, vulnerable customers, and critical loads are prioritised or heavily weighted

Safety:

- Less disconnection of safety critical loads

Environmental:

- Less green Distributed Generation (DG) is disconnected by LFDD scheme

Please provide a calculation of the expected financial benefits of a Development or Demonstration Project (not required for Research Projects). (Base Cost – Method Cost, Against Agreed Baseline).

This benefit is made up of two parts:

1) the benefit associated with disconnecting the cheapest group of customers (customer groups with the lowest VOLL)
2) The financial benefit associated with disconnecting less load by improving the functionality of the LFDD.

Please provide an estimate of how replicable the Method is across GB in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

The project aims to provide a universal methodology that could be rolled out to all DNO areas.

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

The project has identified a number of potential methodologies with different costs associated and the output of the project will be the most economic and efficient.

2c. Does Not Lead to Unnecessary Duplication ☒

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

The research activities outlined in the project are unique and haven't been trialed before based on the latest information.

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

Additional Governance Requirements

Please identify that the project is innovative (i.e. not business as usual) and has an unproven business case where the risk warrants a limited Research, Development or Demonstration Project to demonstrate its effectiveness ☒

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

The project is the first innovation project looking to design the LFDD scheme in an economic and effective way. Previous activities mainly focused on the effectiveness of the scheme.

ii) Please identify why the Network Licensee will not fund such a Project as part of its business as usual activities

The scope of work involved in this innovation project involves research and development activities and the models created will require validation before the outputs can be utilised to support system operations.

The proposed methodology has not been tried before, the development and testing of a fundamentally new LFDD scheme requires the specialist skills and knowledge of the consortium.

iii) 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

The project allows the collaboration of multiple project partners and the learnings from the project can be shared more widely to the Network Licensees which couldn't be achieved if deemed as BAU activities.

Please confirm this project has been approved by a senior member of staff ☒