Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Jun 2019

Project Reference Number

NPG_NIA_033

Project Registration

Project Title

Impact of LCTs on the design of the LV networks

Project Reference Number

NPG_NIA_033

Project Licensee(s)

Northern Powergrid

Project Start

June 2019

Project Duration

1 year and 4 months

Nominated Project Contact(s)

Paris Hadjiodysseos

Project Budget

£145,000.00

Summary

Initial assessment of the impact of LCTs on cold load pickup

Nominated Contact Email Address(es)

yourpowergrid@northernpowergrid.com

Problem Being Solved

The UK electricity distribution systems were considerably expanded in 1950s and 60s to meet the increasing customer needs for electricity. The networks were developed in accordance with network planning and design standards that have stood the test of time and are still relevant today. For example, the current planning and design standards for LV distribution networks (ER P5/518; ACE Report 4919) are broadly fit for the purpose to which they were designed, in that they are widely acknowledged to have delivered a reasonable level of security of supply at an appropriate level of capital cost.

However, at the time these network planning and design standards were developed, the integration of distributed generation and new electricity demand technologies (e.g. electric vehicles, heat pumps) were not considered as part of the network design criterion during the statistical analysis. Thus, the move towards a decarbonised, decentralised and digitalised electricity system prompts the need to establish how these new technologies should be treated in the design and planning of distribution networks and to establish whether modifications to the design standards should be made.

Method(s)

The significant integration of Electric Vehicles (EVs) presents various challenges to the development and operation of the LV network. High penetrations of EVs can lead to substantial increases in the demand being required for the purposes of charging the EV batteries. This introduced new customer demand patterns at the distribution level, which could cause adverse effect to network areas where large groups of EVs are charging simultaneously. Such effects could include excessive voltage variations, increased thermal loading, higher network losses and possibly harmonic distortions, which in turn, could lead to violations of the DNO planning limits and industry standards.

Furthermore, the increased level of demand on LV feeders associated with the restoration of service after an outage, i.e. Cold Load

Pick Up (CLPU), is of concern as it can be significantly higher than pre-outage levels, even exceeding the peak demand on the feeder that is observed under normal operating conditions. This increase in demand is mostly due to a loss of diversity among loads that are process controlled and/or thermostatically controlled such as heat pumps. The electrification of the heat sector is expected to drive the update of heat pumps potentially worsening the levels of CLPU on LV feeders. These high levels of CLPU demand that can persist for prolonged periods may increase the thermal loading of equipment, risking LV fusing operation, increasing restoration times and potentially damaging equipment. A CLPU event can be characterised by the magnitude and duration of the overload following supply restoration after an outage. Both quantities are necessary to: quantify the thermal impact to electrical equipment; inform the sizing of distribution network equipment; foresee potential problems during restoration; develop restoration plans; or assess insulation loss of life.

Based on the above, this project seeks to understand:

- · The technical impact the significant integration of EV charging load cause on the LV networks and explore how to translate the impact into LV design and planning practices. This project will quantify and assess the impact caused by EV load on the thermal and voltage limits and devise a simple and robust framework that designers can apply and use; and
- The technical impact that the significant integration of heat pump load causes on the LV networks during CLPU events. This project will assess the impact the magnitude and duration of CLPU, associated with different scenarios (feeder type, heat pump penetration level, season of year, time of day, outage duration etc.) has on the thermal and voltage limits.

Scope

This project seeks to understand:

- · The technical impact the significant integration of EV charging load cause on the LV networks and explore how to translate the impact into LV design and planning practices. This project will quantify and assess the impact caused by EV load on the thermal and voltage limits and devise a simple and robust framework that designers can apply and use; and

- · The technical impact that the significant integration of heat pump load causes on the LV networks during CLPU events. This project will assess the impact the magnitude and duration of CLPU, associated with different scenarios (feeder type, heat pump penetration level, season of year, time of day, outage duration etc.) has on the thermal and voltage limits.

Objective(s)

The objective of this project is to undertake data analysis and modelling to:

- · Assess and quantify the technical impact of significant integration of EVs on LV networks;
- · Assess and quantify the technical impact that the significant integration of HP load causes on LV networks during CLPU events; and
- · Provide an LV network design framework that will allow network planers to account for the impact of EV load and HP load during CLPU events on the design of LV network feeders.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed a success if it ends with some definite conclusions on the impact of residential EV charging load and HP load during CLPU and proposes a framework for their assessment. It will not be a failure if the project finds that the proposed framework is no different to the existing one but it will be a failure if the results are inconclusive.

Project Partners and External Funding

None

Potential for New Learning

It is anticipated that this project will build upon previous network innovation project outputs by using customer load profile data for EV and HP as well as other relevant learning to thoroughly quantify their impact on the LV network. This project will go beyond the previous network innovation project by devising a simple and robust framework that will enable LV planners and designers to account for the impact caused by residential EV and HP loads on their day-to-day network design and planning practices. Specifically this project will:

- · Quantify and assess the technical impact that significant integration of electric vehicle charging load causes on the LV networks and will explore how to translate those impacts into current LV network design and planning practices. From an LV network design and planning perspective, the project will quantify and assess the impacts caused by EV customers on the thermal limits of the

network assets and on compliance with voltage limits. The project will then devise a simple and robust framework that designers can apply and use with confidence; and

- Quantify and assess the technical impact that the significant integration of heat pump load causes on the LV networks during CLPU events. From an LV network design and planning perspective, the project will quantify and assess the impact that the magnitude and duration of CLPU, associated with different scenarios (feeder type, penetration level of heat pumps, season of year, time of day, duration of outage, etc.), has on the thermal limits of the network assets and on compliance with voltage limits.

Scale of Project

The project will be limited to data analysis and network modelling. No network equipment will be installed.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

N/A

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£145k

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)

Assessing and quantifying the impact EV charging points have on the network as well as the increased level of demand HP bring to the network following an outage (Cold Load Pick Up), may potentially allow a greater number of these technologies to get connected without the need for costly and disruptive network reinforcement.

Furthermore, better understanding on HP load following a CLPU may also reduce both customer interruptions and customer minutes los (CI and CML).

The connection of more EVs and HP supports the GB targets for increasing the amount of renewable generation. By building on and adding to the existing design data created by innovation projects to date we shall improve the robustness of the resultant design parameters which can then be used by Northern Powergrid and all other DNOs to form a set of design principles that will efficiently and effectively assess how best to accommodate both EVs and HPs applications.

Looking at just the avoidance of reinforcement cost, this project could save over 90 times its costs over a RIIO regulatory period, using a modest assumption as follows:

Reinforcement costs associated with a EV and/or HP cluster could be:

- Loop service unbundling (£720 per service)
- The replacement of all or part of the LV main (£130 per metre)
- The replacement of the distribution transformer (£14,500 per transformer)

So, if it were possible to avoid the replacement of a transformer, 300m of LV cable and the unbundling of 10 services, the avoided reinforcement costs would be in the region of £60.7k. If each DNO license area were able to save reinforcement costs on just 2 schemes per year, then the total avoided costs would be in the region of £1.7m pa or £13.5m per price control period, which over 90 times more than the cost of this project.

Please provide a calculation of the expected benefits the Solution

Low TRl project, not required.

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

The method will be applicable to all DNOs looking to assess the connection of EVs and HPs on the LV network.Current trends indicate that this will be increasingly relevant to licensees.

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

No roll-out costs.

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 data from this project will be used by Northern Powergrid and other DNOs to form a set of design rules that will efficiently and effectively assess how best to take into account EV load as well as HP load following a Cold Load Pick Up.
If conclusive, the output of this project will also be used to provide updates into relevant Northern Powergrid design policies and input into the periodic review of Engineering Recommendation P5

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 assess the technical impact that the significant integration of EV causes on the LV network as well as the impact of HP CLPU.
The project fits within the scope of our innovation strategy portfolio as set out in Annex 5.1 to our Innovation Strategy: Technology Application Assessment; namely to develop improved network planning and design tools (for EV and HP) and to improve network reliability and availability (HP CLPU). There is also the potential to use the project's output as an operational prediction tool, estimating the near-future demand of EV and HP as a part of the system operator role. Further, this potentially supports our explicit strategy activity to develop the DSO role.

☑ 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.

This project will build upon the learning from previous network innovation projects such as NPg's CLNR, SSEN's My Electric Avenue, WPD's Electric Nation, UKPN's Low Carbon London, ENWL's Low Voltage Network Solutions that have developed and implemented real-world field trials to understand customer behaviour and interaction with LCTs and to characterise the shape of the new demand patterns associated with those technologies. Furthermore, some of these innovation projects assessed the impact on these LCTs on the development and operation of electricity distribution networks.
In addition to the above, this project will look into the HP load following a CLPU which none of the projects to date have done.

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

To date the level of pentration of various low carbon technologies has not been sufficient to give potential problems with cold-load pick-up

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 project outcomes are low TRL and will not directly lead to a final solution to the problem. Further innovation or other development activities will be required. The outcomes are also likely to have medium to long term implications and will inform future investment decsions, probaly ED2 and beyond, that faciloitate a future energy systems transformation.

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

Other sources of funding to support this high risk low TRL work cannot be identified within the ED1 settlement. The nature of this work is informative will not lead to a direct commercial return within the iommediate future.

This project has been approved by a senior member of staff

☑ Yes