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

Mar 2022

Project Reference

NIA_WPD_066

Project Registration

Project Title

Smart Meter Innovations and Test Network (SMITN)

Project Reference

NIA_WPD_066

Project Licensee(s)

Western Power Distribution

Project Start

March 2022

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Jenny Woodruff

Project Budget

£914,771.00

Summary

SMITN uses aggregated half hourly load data and MPAN specific voltage data within algorithms to determine customer phase and feeder connectivity, detect Low Carbon Technologies (LCTs) and generate feeder and substation profiles for planning purposes. The algorithms are applied on a test network where phase and feeder connectivity has been validated by a physical survey using an existing phase identification unit and a feeder finder developed as part of the project. As smart meter data availability improves this offers a means to improve LV network data, improving the accuracy of planning and enabling better use of monitoring equipment.

Nominated Contact Email Address(es)

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Problem Being Solved

The phase to which a single phase customer is connected has historically not been captured and where given has often been shown to be incorrect. Similarly the feeder to which a customer is connected has not always been captured correctly. With the expected increases in load at LV from heat pumps and Electric Vehicle charge points, there is a risk that the degree of unbalance on a network could become significant and that assuming a balanced network would not be a reasonable planning assumption. There are still issues with low carbon technology installations not being registered with Distribution Network Operators (DNOs) and without correct records the accuracy of network planning will be affected. At the same time, most LV networks are not monitored and the profiles used for planning do not incorporate the data that is becoming available from smart meters. This project aims to solve the problems of

missing or incorrect data for LV networks by applying algorithms to smart meter data in novel ways.

Method(s)

The project will resolve the issue of missing or incorrect data for LV networks via a series of work packages.

The first work package will determine the test area to be used including substations of different types intended to reflect the variety of our service areas. It also includes researching the algorithms available using smart meter data to address the issues, select those that are appropriate and propose amendments to take into account the data available. The research into available algorithms will include a workshop with other DNOs to avoid duplicating the work that has already taken place in this area such as the work from Scottish Power's NCEWS project (Network Constraint Early Warning System) which has been reflected in their NAVI platform.

In order to be certain that the data for the test network is correct, a phase survey will confirm the phase to which customers are associated. This work package also covers determining and setting up the data processing architecture to be used during the project. Data processing to evaluate the algorithms will take place in a custom built environment provided with suitable data from WPD systems, survey results, monitoring data and smart meter data. The data processing environment is then validated by GHD to ensure that the algorithms have been set up correctly. Smart meter load data will be aggregated to avoid privacy issues but where possible these aggregation groups will involve smaller sections of LV feeders than previously used. Similarly voltage data will be captured at MPAN level to determine whether this can provide valuable insights.

Work Packages 2-4 apply the algorithms to the defined test network for phase identification, low carbon technology detection and to create estimates for feeder and distribution substation load that can be compared to data from site monitoring. This will reflect the methods used for settlement of non-half hourly metered customers as well as incorporating the available smart meter data. Each work package will create a report capturing the learning.

Work Package 5 includes the development of the feeder finder tool so that it can be used on another survey to confirm the feeders to which customers are associated without requiring access within customers' premises. Once developed and tested this feeder finder tool will be used to carry out a survey of part of the test network to allow the feeder association algorithm to be evaluated.

Finally Work Package 6 involves gathering the learning together from the separate work packages to create a final report before delivering a dissemination event.

Scope

The scope of the project involves investigating and applying algorithms that use smart meter data for the following use cases.

1) Customer to Phase connection prediction.

2) Customer to Feeder connection prediction.

3) Low Carbon Technology identification of potential locations and types.

4) Provision of LV feeder and Distribution substation planning profiles for use in network planning.

It the project is successful, it will lead to improvements in data quality and availability which will then allow for;

1) More accurate planning by modelling unbalanced three phased networks.

2) Reduced losses through better phase selection for new connections.

3) Reduced fuse operations from imbalanced phases.

4) Enhanced data available for LV Fault Location.

5) Improved IIS reporting.

6) Reduction of sites that require monitoring and more effective targeting of.

7) Reduced costs to confirm customer phase.

8) Identifying and fixing data errors ahead of need.

9) Enabling LV self-serve facilities.

10) Improved use of our data by third parties.

The financial benefits from these improved outcomes is approximately £740k per annum within WPD's licence areas made up of;

- Savings from reduced losses when connections are made to existing networks estimated assuming 20,00 connections each year to existing unbalanced networks and a 10% reduction of losses resulting from reduced imbalance. (approx. 11k).
- A reduction in fuse operations by improved management of phase imbalance and altering fuses where this is seen via modelling to be a high risk resulting in approx. £79 k per annum saving based on 100 events a year at £790 each.
- A reduction in excavating at inaccurately identified fault locations due to incorrect customer connectivity saving approx. £340k per annum assuming that this is avoided 200 times a year at a cost of £1.7k per event.
- A reduction in the cost of monitoring the network by having better data to better select locations where monitoring is required and being able to omit some locations where monitoring is not required.

Objective(s)

The objectives of the project are;

1) To determine a representative test network of selected distribution substations and validate the key features of this network by carrying out surveys.

2) To capture smart meter data using new aggregation groups.

3) To develop algorithms using smart meter data for the following use cases.

- Customer to Phase connection prediction.
- Customer to Feeder connection prediction.
- Low Carbon Technology identification of potential locations and types.
- Provision of LV feeder and Distribution substation planning profiles for use in network planning.

4) To apply the algorithms for data relating to the test network.

5) To assess the performance of the algorithms and where possible identify the factors that affect accuracy.

6) To capture the learning from the project and disseminate this to interested parties.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Not Applicable

Success Criteria

The success of the project will result in;

- A set of phase validated networks and a subset where customer-to-feeder association has also been validated that can be used to test future innovations beyond this project.
- An understanding of how well the smart meter data can be used to support phase identification and what factors affect the accuracy of the algorithms used.
- An understanding of whether smart meter data can be used to support the identification of unregistered LCT and what factors affect the accuracy of the algorithms used.
- An understanding of whether smart meter data can be used to support the validation of customer-to-LV feeder associations and what factors affect the accuracy of the algorithms used.
- An understanding of how well aggregated smart meter data can be combined with other data available to DNOs to create estimated LV feeder load profiles and what factors affect the accuracy of these estimates.
- An understanding of the practical issues for using the newly developed feature for validating customer-to-LV feeder association without requiring connection to the customer's wiring and confirmation that the new feature is fit-for-purpose
- An increased insight of the phase imbalance on the test networks.
- A view of the value of disaggregated data from smart meters rather than the default position of aggregation at the LV feeder level.

Project Partners and External Funding

SMITN has four project partners;

- CGI who will be creating the data processing environment and managing the execution of the algorithms and the evaluation of their performance. CGI are contributing £72k to the project funding.
- Loughborough University who will be determining the test area and providing academic review of the project outputs.
- Haysys will be providing the surveys and developing the feeder finder tool.
- GHD will be working with Loughborough and CGI to determine the algorithms to be used and providing quality checks on the data processing environment configuration.

Potential for New Learning

The knowledge dissemination activity will cover the learning from the practical implementation of the algorithms to identify the phase, feeder for a given MPAN and any unregistered LCT for an MPAN or small group of MPANs.

This will outline how well they worked and what factors affect the success rate such as smart meter coverage. The learning from the feeder and substation level profile estimation methods will identify whether the additional complexity of replicating the settlement process results in improved results compared to simpler methods. It will also detail the accuracy of the profiles and how they were adapted for use in Connect LV.

The learning will also include that from the development of the Feeder Finder, how it was validated to ensure it was suitable for use and practical issues that were encountered during the survey.

Learning will be disseminated during the project externally via;

- One or two SMITN Webinars
- ENIC
- Innovation Showcase

Scale of Project

The scale of the test area has estimated the number of substations has been set at 40 which should be sufficient to allow sufficient substations in each category.

- Terrace streets – older cable types and short distances between properties, short service cables.
- 1960s housing – e.g. Milton Keynes, relatively dense but longer services, possibly looped.
- 1990s+ housing – e.g. ‘Privet Drive’ – better cables and higher housing density, lower voltage drops etc., off-street parking so EVs more likely.
- Larger suburban/rural – possibly older, fewer houses per feeder, longer distance between houses, longer service cables.
- Recent high-density development, better insulation, possibly LCTs, houses typically very close to the kerb so short service cables.
- Rural – village type locations, ideally including customers who do not have mains gas and where early adoption of heat pumps may be more likely.
- Rural – overhead – phases obvious on single-phase transformer, though feeder allocation isn’t, and the algorithm still needs to function if all the phases are the same.

The selection of substations will also aim to include both low and high existing concentrations of LCTs. While all of the test area would be surveyed for phase the feeder validation survey is expected to be more targeted.

To test the load profiles it is proposed to extend this functionality beyond the core test network to include up to 100 distribution substations depending on the availability of monitoring data.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

To make use of existing monitored sites the bulk of the test network is expected to be located around the Milton Keynes area but will include other areas as required. There is no need for the test area to be made up of sites that are adjacent to each other.

Revenue Allowed for the RIIO Settlement

Not Applicable

Indicative Total NIA Project Expenditure

Project budget = £914,771

WPD DNO Contribution = £98,677

Funding from NIA = £823,294

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:

Not applicable

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

Not applicable

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 project has the potential to generate savings of approximately £740k a year.

Please provide a calculation of the expected benefits the Solution

Savings from reduced losses

Where new connections are made to existing networks, an understanding of the existing phase imbalance can be used to determine the optimum phase for the new load to connect to. Reducing phase imbalance in this way will reduce losses. (Similarly if consumer equipment such as heat-pumps and showers are associated with a different phase than the rest of the load as in Parc Eirin, there are opportunities to determine the best phase connection arrangements)

Number of new connections to existing networks a year estimated at 20,000
Average annual consumption of LV connected customer estimated as 5000kWh = 5MWh
Average losses at LV including distribution transformer losses = 1.47%
Average reduction of losses due to reduced phase imbalance = 10%
Average cost of losses = £75/MWh.
Saving per year = 20,000*5*1.47/100*0.1*75 = approx. **£11k per annum.**

Savings from reduced fuse operations

Reduction of fuse operations a year by managing phase imbalance or altering fuses as appropriate estimated at 100 per year
Cost of attending a fuse operation = £500
CML/CI costs associated with fuse operations = £290
Cost per fuse operation incident = £790
Saving per year = 790*100 = **£79k per annum**

Savings from improved fault locations

Number of LV faults per year across all WPD regions on underground networks 100,000
Number of times a year an erroneous fault location is avoided – estimated at 1/500
Cost of digging a hole for fault exploration = £1,700

Saving per year = 100000/500*1.7= **£340k per annum**

Savings from reduced network monitoring

Providing better profile data will reduce the number of sites that require monitoring and will ensure that the monitoring equipment is targeted at the sites where it adds most value.

Number of monitoring sites planned to be installed per year = =15,500/5 = 3100
Reduction in number of monitoring sites required through greater accuracy = 5%
Cost per monitoring installation = £2k
Savings per year = 2*3100/20 = **£310k per annum**

Total = 740k

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

The method would be completely replicable across GB as all DNOs will have access to smart meter data and to their equivalent datasets to those used for WPD.

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

Assuming the algorithms could be applied to other DNOS without modification then roll out costs would be limited to the cost of data processing by each DNO. Say 200k per licence area for upgrading equipment and implementing the algorithms. This would equate to UK costs of 11 DNO areas x 200k per area = £2.2m.

Scaling annual benefits by DNO area suggests approx. £185k per DNO per licence area = 14*185k = £2.59m per annum.

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

n/a

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

Not required

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.

The project has been designed to build on previous work from the losses investigation and LCT detection projects without duplicating the work within those projects. While we are hoping to make use of existing algorithms for using smart meter data we also expect to customise these to reflect the data we have available.

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

Not Applicable

Additional Governance And Document Upload

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

The project includes a number of different strands of innovation. Firstly, we are testing algorithms using smart meter data that we have not applied before, so for example while we have examined consumption data as a means to identify unregistered LCT this project will look at the use of voltage data. Similarly, previous work has looked at smart meter demand data in isolation. Here, we are combining this with other operational data such as EACs. We are also testing this with real data, rather than simulated, to test the viability of the algorithms in the context of Business As Usual data quality.

Creating a validated test network to be used for a variety of use cases is innovative as it solves the immediate issue of being able to determine the accuracy of the algorithms but provides an ongoing test environment for future algorithms or new equipment.

Lastly, Haysys are developing and testing the new Feeder Finder tool that will identify the connected Feeder to a property, without needing access to the inside of the property. This will use the already proven methods used for the Phase finder tool, reducing the risk that a tool cannot be developed in the project timescales, but will need to develop new methods appropriate to feeder identification. While the ultimate aim is to be able to confirm connectivity arrangements as much as possible using smart meter data, there may be cases where this is not possible and having an alternative method to validate connectivity that is easier to deploy than existing methods is a valuable addition.

Relevant Foreground IPR

There is known background IPR associated with the processing algorithms to replicate the settlement process held by DGI which would be needed by others to use the Foreground IPR. The IPR developed by Loughborough university while working on the losses investigation project which will be used by SMITN is expected to be very helpful but not absolutely necessary to make use of the Foreground IPR.

The algorithms applied to identify phase, feeder, or unregistered LCT are not expected to be protected by prohibitive IPR arrangements such as requiring licencing for use, but rather being published in academic papers or developed by the SMITN team themselves.

The development of the Feeder Finder will generate new foreground IPR which will be held by Haysys but made available to third parties in accordance with NIA requirements.

Data Access Details

It is likely that the majority of underlying data which relates to individual MPANs cannot be shared. However the data behind charts in

the final report and any suitably aggregated data will be made available on request. The data sharing policy is available here.

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

The low TRL level at the start of the project and risk that no algorithms will provide acceptable results means this would not be considered for BAU funding.

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

As well as the commercial risk identified above, the project has a significant operational risk. This is because it has complex resource requirements which are outside the ability for WPD to provide internally,and therefore external funding for the specialist partners is required.

This project has been approved by a senior member of staff

☑ Yes