NIA Project Registration and PEA Document

Date of Submission

Feb 2022

Project Reference Number

NIA_UKPN0076

Project Registration

Project Title

Neighbourhood Green

Project Reference Number

NIA_UKPN0076

Project Licensee(s)

UK Power Networks

Project Start

February 2022

Project Duration

2 years and 1 month

Nominated Project Contact(s)

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Project Budget

£818,000.00

Summary

New technologies connecting to electricity networks in the delivery of Net Zero will lead to increased domestic demand and a change in diversity factors as well as load profiles. There is a need to understand what normal domestic loads and After Diversity Maximum Demand (ADMD) will be in the future, and the impacts that these are likely to have on network operational performance, so that networks can be planned and managed appropriately.

This must be done in a timely manner for optimum efficiency. This project aims to develop understanding of the clustering effect of all low carbon technologies (LCTs), propose an industry standard view on diversity factors for heat, and understand the potential of flexibility.

Nominated Contact Email Address(es)

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Problem Being Solved

New technologies connecting to electricity networks in the delivery of Net Zero will lead to increased domestic demand and a change in diversity factors as well as load profiles. There is a need to understand what normal domestic loads and After Diversity Maximum Demand (ADMD) will be in the future, and the impacts that these are likely to have on network operational performance, so that networks can be planned and managed appropriately.

If this is not done in a timely manner, it puts at risk the industry-wide goal of upgrading the electricity network in an efficient cost-effective manner.

The three key problems this project will address are:

1. There is no industry standard view on diversity factors for heat, and the ENA does not have a view either, including through the relevant working groups;

2. Low understanding of the clustering effect of all low carbon technologies (LCTs); and
3. Potential of flexibility not fully explored especially for LCT clusters.

Method(s)

This project will leverage the Whole Energy Systems Accelerator (WESA) which is a collaboration between the Energy Systems Catapult (ESC) and the Power Networks Demonstration Centre (PNDC). It will virtually cluster the Living Lab participants' homes with electric heating and other LCTs across the UK and monitor their energy usage over time and in different weather conditions. The clustered data streams will be analysed to assess ADMD, network response and flexibility potential through extensive modelling and trials.

The methods used in the project will include desktop analysis to gather data/insight from Living Lab homes and other large-scale trials for different electric heating technologies, including heat pumps, energy storage and other low carbon technologies. From this, an assessment of likely ADMD resulting from the combination of an increased uptake of electric heating technologies and other LCTs will be performed.

The project will then design and carry out a trial based on Living Lab homes. Methods used will be qualitative research with customers including diary study and interviews to understand their requirements and experience of the transition journey to LCTs. Network testing will then be carried out at the PNDC to recreate profiles experienced in the Living Lab on agreed network topologies. Analysis will be performed to assess the impact of clustered consumer response. Using known network data, an ADMD assessment based on the existing uptake of LCTs at UK Power Networks will also be carried out. Network studies will be done to quantify the impact across each voltage level. A comparison will be made from the Living Lab/PNDC trial and desktop network assessment.

All data used within this project is for the purposes described above, and therefore quality will be measured on this basis. The project will follow all data quality rules, logging, and prioritising issues as they arise in line with the approved methodology set out in our Enterprise Data Management Policy, which forms part of the UK Power Networks Integrated Management System.

Data quality will be measured across five dimensions where applicable:

- Accuracy
- Completeness
- Consistency
- Validity
- Uniqueness

Data quality rules for each of the appropriate data quality dimensions above will be set by the project, measuring them closely on a regular basis to identify quality issues.

Data quality issues will be logged in a central location and prioritised using an approved matrix which combines the importance of the issue, and the amount of data affected, this gives an indication of the issue's impact on the project and wider business, considering factors such as:

- The impact on the health and safety of the public and employees
- Whether it may result in a breach of our licence conditions or relevant regulations
- The impact on UK Power Networks' reputation
- The impact on our operations and efficiency
- The financial impact, including project delays and charges from external service providers

The project will then seek support for resolving the issues in priority order. All data and background information will be stored centrally and securely in a project specific Sharepoint folder or in our Enterprise Data Store if required by the wider business in accordance with data protection requirements.

Scope

Work Package 1: ADMD Desktop Analysis

- Gather data/insight from Living Lab homes and other large-scale trials for heat pumps, other electric heating, energy storage and other low carbon technologies.

- For a small number of uptake scenarios, produce an assessment of likely ADMD resulting from increased uptake of heat pumps and other electric heating. This will consider 1 in 20 winter peak and low demand events that could lead to negative pricing.

Work Package 2: Trial Specification

- Determine combinations of in-home LCTs for the trial. This will be based on an assessment of those that are most likely to be taken up by consumers (primary driver) and technologies that have good potential to offer operational flexibility to networks (secondary driver)

- Develop and agree exemplar network topologies to be used in the project.

- Identification and pre-sign up of customers in the Living Lab for participation in the trial.

- Detailed specification of trial.

Work Package 3: Living Lab Trial, PNDC Trial & Customer Engagement

- Onboard trial participants across technology combinations.

- Participants will use the LCTs as they would normally. The project will conduct research including diary study and interviews to understand the use patterns in the home.

- Test value propositions with participants via interviews based on the qualitative research and the analysis of the PNDC simulation outputs.

- Network testing at PNDC: Recreate profiles experienced in the Living Lab on different network topologies.

- Assess impact of clustered consumer response.

Work Package 4: UK Power Networks ADMD Study

- Using known network data, validate ADMDs for a number of normal home types. This would look at existing loads and number of customers to identify ADMD levels that currently exist on the network.

- Carry out analysis of the impact of diversity across all voltage levels

- Compare this study to the learnings from Work Package 3

Work Package 5: Insights and Next Steps

- Final reporting and analysis of trial, including assessment of ADMD and the impact of flexibility and LCT clustering

- Summarise the likely impact on exemplar electricity networks of increased LCT loading within homes, the network value of flexible demand and the price signals needed to influence consumer response.

- Propose an industry standard view on diversity factors for heat based on project learnings.

- Identify next steps towards the practical implementation of the project findings, including proposals for further trials if required.

Objective(s)

The objective of the project is to understand the impact of LCT clusters (electric heating technologies and others) on different network topologies (rural, urban), and provide insight to the potential DNO/DSO response to manage these loads in the most cost-effective and inclusive manner.

A key output of the project will be a proposal for an industry standard view on diversity factors for heat based on the project learnings.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

There are disabled, vulnerable and fuel-poor customers who are participating in the Living Lab. We will work with ESC to ensure that the right selection of vulnerable customers have been chosen so that our observations are inclusive by design.

Our stakeholder engagement activities during Work Package 3 will cover this important topic area. The data collection aspect of the trial is passive and does not impact the consumers. We will offer all participants the opportunity to request any support they might need to connect their smart meter and therefore provide data to enable participation in the consumer research activities associated with the trial (i.e. surveys, interviews, focus groups). As the flexibility propositions will only be discussed and not trialled as part of this research, we don't foresee any potential distributional impacts of participation, but the research will help us to identify any that might arise if they were to be implemented. We will sensitively explore with participants why particular propositions might appeal or be problematic for

them, and will highlight potential distributional impacts the propositions might pose for different consumers in our reporting.

Success Criteria

The project will be deemed successful when we have:

- Completed a desktop analysis of ADMD based on historical information available from the Living Lab, and other industry datasets.
- Designed and carried out a trial across with participants from the Energy Systems Catapult's Living Lab.
- Virtually cluster homes from the Living Lab and recreating the combined electrical load at the PNDC representing different network topographies.
- Completed a network study across the majority of voltages at UK Power Networks
- Proposed a GB standard view on diversity factors for heat based on project learnings.

Project Partners and External Funding

This project is partnering with the Energy Systems Catapult and the Power Networks Demonstration Centre. The project will make use of the ESC Living Lab. More information here: https://es.catapult.org.uk/tools-and-labs/living-lab/

There is no external funding support beyond the NIA for this project.

Potential for New Learning

This project will produce learning around heat pump and other LCT usage, diversity and flexibility matters. These will be covered in the main project deliverables, to be shared with stakeholders at project conclusion.

Project results will be shared in the final project report, and at a dissemination event. The main expected output that will benefit external stakeholders is a proposed ADMD curve shared with all DNOs.

Scale of Project

The project trial will be recruiting 30-60 homes in the Living Lab. Although the sample size of homes is relatively small, this gives a good balance between project cost and outcome delivery; the learnings from the project will provide significant insight on electric heat diversity. It is believed that this is the minimum number of homes that would still lead to a useable dataset for virtually clustering loads at the PNDC on a real network.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The Living Lab participants are customers based all around the UK. The data gathered from these will be aggregated and replicated on the PNDC network in Scotland.

Revenue Allowed for the RIIO Settlement

No funding was included in the current RIIO settlement to research future diversity trends of the uptake of low carbon electric heating.

Indicative Total NIA Project Expenditure

The project will require £736,200 of NIA funding.

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:

Developing enhanced understanding of the diversity and other network impacts of significant low carbon technology uptake will be crucial to enable networks to facilitate the energy transition in the most efficient way possible. Without the learnings from this project, networks will rely on historical design and management methods, which could lead to unnecessarily inefficient network investment and management.

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

The project will develop an enhanced understanding of how consumers in vulnerable situations use their energy and how they would behave in different heating flexibility propositions. Without this information, future heating flexibility offerings might be applicable only to some customers and not those in vulnerable situations. We will sensitively explore with participants why particular propositions might appeal or be problematic for them, and will highlight potential distributional impacts the propositions might pose for different consumers in our reporting.

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 only diversity tables for heat pump operation in the UK are from the Customer Led Network Revolution NIC project and the government Renewable Heat Premium Payment dataset. These suggest ADMD values of 1.3-1.8kW for 50 or more heat pumps. There is a risk that these numbers are too high, which could lead to overinvestment in networks to build capacity that is not needed.

A government target of 600,000 heat pumps per year by 2028 * 1.3kW ADMD per heat pump = 780MW increased electrical load across GB.

If this value is too high by 10%, this means the networks would likely reinforce by an unneeded 78MW per year.

Please provide a calculation of the expected benefits the Solution

This is a research project and therefore this is not required.

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

Updated and more accurate diversity figures for electric heating and clusters of low carbon technologies at the domestic level will be useful to all DNOs to incorporate into their own planning processes.

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

The project will be developing diversity tables for network topographies typical to UK Power Networks. This will be representative of the vast majority of GB electricity networks. To be completely replicable across the whole of the UK, it may be required to test on some additional network topographies. Although further assessment is required, the cost of this is currently estimated to be in the region of £200,000 to update the learnings to be applicable across most of GB.

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

All electricity networks across the UK are experiencing the increased uptake of LCTs. Improved understanding of the diversity of technologies and their network impact will be beneficial to all networks.

Updated diversity figures for electric heating and combinations of LCTs can be used by infrastructure and network planning teams at all DNOs. The figures will also be of interest to our customers and stakeholders such as housing developers and IDNOs.

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

n/a

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.

Below is a list of projects that relate to the network impact of low carbon technologies and how this project differs from them:

1. Low Carbon London: This UK Power Networks LCNF project took place from 2010-2014. This broad project included installation and monitoring of 20 heat pumps (18 of which yielded useful data). This project did not consider the clustering impact of low carbon technologies together.
2. Shift: This UK Power Networks NIA project looked closely at flexibility opportunities and heavily focused on electric vehicles. However, time of use tariffs were used which are applicable to other LCTs. Learnings from this project will be incorporated.
3. Home Response: This BEIS-funded trial was a London-centric trial to test flexible energy solutions in 160 London homes. The

project did not look at technology diversity or clustering, but was more focused on the customer proposition and benefits.

4. Equinox: This Western Power Distribution NIC project bid focuses on unlocking heat flexibility from heat pumps and thermal storage. It also aims to reduce barriers for residential customers to provide flex from LCTs. However, this project does not aim to look at what unmanaged LCT loads and diversities could be.
5. 4D Heat: This National Grid ESO NIA project is exploring matching renewable generation with heating in Scotland to reduce curtailment of generation.
6. Bethesda Home Hub: This Scottish Power Energy Networks NIA project is a domestic demand-side response project. It does not aim to create learnings around network impact of unmitigated uptake of LCTs.
7. Domestic Energy Storage & Control (DESC): This UK Power Networks NIA project focused on how energy is generated, stored and exported to the grid by customers who own solar PV and storage. It did not consider any type of electric heating.
8. Local Energy Oxfordshire: This Scottish & Southern Energy Networks NIC project focuses on technical, market and social conditions needed for transition to smart local energy systems in Oxfordshire. Within it there is heat pump flexibility trial sub-project which is installing 15 heat pumps. However, it will not study what unmanaged LCT loads and diversities could be.
9. Multi-Asset Demand Execution (MADE): This Western Power Distribution NIA project focused on multiple energy assets (EV, hybrid heating, PV) to maximise demand response services. The project did not consider unmitigated ADMD.

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 transition to low carbon heating is now gathering pace with the recent publication of the Heat & Buildings Strategy and the creation of various new funding streams. Work to explore the diversity of domestic properties after the uptake of low carbon heating, transport, generation and storage has not previously been carried out because there were no strong reasons for customers to move away from fossil fuel boilers.

This project is innovative because it is responding to a new change in customer behaviour which will have profound impacts on electricity networks. However, this is still a nascent space, and therefore it is appropriate to carry out a research project to understand more about the future impact.

Relevant Foreground IPR

This Section is not to be completed until we receive IPR guidelines from Ofgem.

Data Access Details

The project team will support the sharing of data third parties on request. There are some potential exceptions to this which may impact on our ability to share fully, this are noted below.

Where possible the datasets used in WP1 in the desk-based assessment of ADMD will be provided, however we may access and use datasets that cannot be made available in the public domain due to third party licence restrictions. This will restrict what we can therefore share publicly.

Data relating to consumers' energy use in homes, and preferences around flexible use of assets will be collected during this project. The Energy Systems Catapult will conduct a Data Protection Impact Assessment during the initial work packages which will assess whether anonymised data from this trial can be shared, to what extent, and what limitations might need to be put in place for those receiving the data and will consider any risk of re-identification of consumers.

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

In section 3.2 of the NIA Governance document, the DNOs are encouraged to pursue different types of Methods and Solutions. This project seeks to understand the network impact of a significant uptake of new technology that has historically been extremely low on the network before such significant uptake occurs.

Due to the risk involved in the project and not fully knowing whether the learnings will lead to benefits can be delivered across UK Power Networks' licence areas, these activities would not form part of business as usual activities. In order to progress an innovative project which carries significant risk in implementation, additional innovation funding is required as a stimulus.

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 noted in the NIA Guidance, certain projects are speculative in nature and yield uncertain commercial returns. This is the case for with this project. There is a technical risk that the work conducted in the project does not lead to an accepted updated ADMD figure for domestic homes with low carbon heating. This could be because the learnings do not reach the level of maturity required for business-as-usual application.

This risk is being mitigated against through early engagement with stakeholders and the completion of a network study in Work Package 4. The specific details regarding the benefits are captured under section 2b of this document.

This project has been approved by a senior member of staff

☑ Yes