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

May 2020

Project Reference Number

NIA_NGSO0033

Project Registration

Project Title

4D Heat

Project Reference Number

NIA_NGSO0033

Project Licensee(s)

National Energy System Operator

Project Start

May 2020

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Cian McLeavey-Reville (NGESO) and Matthew Myers (Delta-EE)

Project Budget

£230,000.00

Summary

The project will explore whether controlling electrified residential heating in Scotland can be used to reduce the curtailment of renewable generation, without adversely impacting the distribution network.

Preceding Projects

NIA_SSEN_0039 - An Electric Heat Pathway – Looking Beyond Heat Pumps

CET2001 - Customer-Led Network Revolution

NIA_WPD_040 - Multi Asset Demand Execution (MADE)

NIA_UKPN0050 - Urban Energy Club

NIA_NGSO0025 - Residential Response

NIA_NGGT0154 - Spatial GB Clean Heat Pathway Model

Nominated Contact Email Address(es)

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Problem Being Solved

The National Grid Electricity System Operator (ESO) currently experiences considerable constraint issues on the transmission network, much of which is related to renewables production. Balancing Mechanism constraint payments to wind farms reached ~£140m in 2019. There are billions of pounds of reinforcements recommended for Scotland in the Network Options Assessment to manage constraints.

Electrification of heat is a key requirement if GB is to reach its Net Zero targets. In many areas this shift to electric heating has the potential to reduce fuel poverty, particularly in many areas of rural Scotland. Scottish and Southern Electricity Networks (SSEN) is the DNO in the North of Scotland. Approximately 66% of properties in its area are on gas, and with Scottish Government introducing new targets to ensure all new homes built in Scotland use renewable or low-carbon heating by 2024, it is important to understand the impact of increased uptake in electric heating on the LV distribution network.

There are many ways to electrify heat (storage heating, heat pumps etc), each with different load profiles and flexibility potential. There is an opportunity for the ESO and DNOs to help accelerate the decarbonisation of heat, by understanding the system and network impacts of increased electricity demand from the electrification of heat, as well as the value of the associated flexibility in managing network constraints.

Method(s)

The project will explore whether controlling electrified residential heating in Scotland can be used to reduce the curtailment of renewable generation, without adversely impacting the distribution network.

This desk-based study uses an area within the SSEN license area as a case study. The study will largely rely on excel-based technical modelling of the availability of flexibility from domestic electric heating and matching this with distribution and transmission network constraints. The study will also use further desk-based research to assess existing consumer perspectives on the potential use of domestic heating to provide flexibility services. It will build on learnings from various innovation projects that have already looked at aspects of electrification of heat.

Further excel-based techno-economic modelling will aim to calculate the cost benefit analysis of using the flexibility of domestic heating compared to traditional solutions to manage constraints (curtailing renewable generation and network reinforcement).

Lastly, potential business models to deliver these benefits will be explored based on desk-based research and analysis of existing business models, and potentially exploring new, novel business models.

Scope

The project will examine and model the temporal and spatial nature of the ESO and DNO constraints limited to a representative area in the north of Scotland (SSEN license area – exact location to be identified as part of study). The available flexibility on the customer side of the meter will be analysed. The degree to which achievable flexibility from customer heating and ESO and DNO constraints match will be determined.

The above will help investigate how onshore wind constraints can be partly mitigated through electric heat demand turn up and DNO network capacity issues can be partly mitigated by demand reduction.

Appropriate business models required to drive customer behaviour will also be investigated. These analyses will be used to develop a detailed cost benefit analysis. The model will focus on current and potential future constraints.

The potential benefits to the GB transmission and distribution systems are informed by what the ESO and DNO currently pay to alleviate constraints. These prices reflect the value to the ESO and DNO of constraint alleviation services. Specifically:

- Current and future ESO constraint costs.
- Current and future DNO constraint costs.
- There are 380k off-gas grid homes in Scotland. This is informed by Citizens Advice Scotland
- Typical flexibility per home
- Cost of controls.

Objective(s)

Project objectives:

- Analyse how well DNO and ESO constraints match with available flexibility from electric heating
- Conduct cost benefit analysis (CBA) to identify if this is this cost effective, and how it scales up to all off-gas grid Scotland.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Project success will be defined by:

- Quantification of the scale and cost-effectiveness (including a CBA) of flexibility from domestic heat to help solve both ESO and DNO constraints.
- Producing a set of wider conclusions for Scotland and beyond how domestic heat can address ESO and DNO constraints (building on the An Electric Heat Pathway project).
- Identifying the quick wins: List of 'quick win 'recommendations that can be straightforwardly implemented under the ESO's Power Responsive initiative today.
- Producing recommendations that help pave the way for a live trial (CBA outcome dependent).

Project Partners and External Funding

Project partners: National Grid ESO (lead party) with Scottish and Southern Electricity Networks. A consortium made up of Delta-EE, Everoze, PassivSystems will be undertaking the work.

External funding: NA

Potential for New Learning

This project presents a unique opportunity to learn to what degree the smart control of electric heating can be used to help solve constraints on both the distribution and transmission network, and how that stacks up against traditional solutions such as curtailment and reinforcement. It also seeks to learn how to drive the end consumer to act to deliver these network benefits based on the potential savings / revenues available.

These learnings will be disseminated via:

- The full 4D Heat final report continuing all methods, assessments, results and conclusions
- A short, accessible executive summary type document drawing out the key findings
- A public webinar to disseminate the key findings.

Scale of Project

This project will span 6 months involving a total of 5 project partners.

The objectives and outputs of the project require an investment of this scale to be fully developed at an appropriate level of detail in order to assess the true potential of using domestic electric heating to help solve transmission and distribution network constraints. This includes:

- The research required to select a representative off-gas grid region to model.
- Analysing the temporal and spatial nature of the DNO and ESO constraints.
- Characterising the available flexibility (in reference to counterfactual) from electric heating. Based on house-heating technology combinations.
- Modelling (includes designing the overarching model methods and interactions as well as auditing the model inputs, calculations and outputs) any match between demand for and supply of flexibility.
- Researching consumer perspectives regarding flexing their domestic heating technologies to provide system benefits.
- Conducting a cost benefit analysis (CBA) to identify if this is this cost effective versus the counterfactual, and how it scales up to all off-gas grid Scotland.
- Probing the commercial architecture and business models available to deliver the potential benefits.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The project will examine and model the temporal and spatial nature of the ESO and DNO constraints limited to a representative area in the north of Scotland (SSEN license area – exact location to be identified as part of study).

The desk-based nature of this study means that the research and analyses will be conducted at the offices of Delta-EE, Everoze and PassivSystems.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

£230,000 split evenly between NGESO and SSEN.

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)

High-level estimate of £10 - £30m per year for the ESO (depending on household participation levels). The project will consider other network savings relevant for DNOs

Furthermore, the method should realise carbon savings by reducing the amount of zero-carbon renewable generation that is curtailed, and reducing the associated fossil generation that would be bid on south of the constraint to make up for the lost generation.

Please provide a calculation of the expected benefits the Solution

This is a research project. However, the above value is estimated based on a host of assumptions that will be tested and validated during the project.

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

The method is highly replicable and could be applied to any network area across GB.

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

The cost of repeating this type of study for each DNO license area would be an additional £300,000-£500,000

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 learnings from this project could help inform how the smart control of domestic electric heating could be used to alleviate distribution and transmission network constrains across the entire GB network. Therefore the 4D Heat project concept has the potential to benefit any network licensee area that experiences (distribution or transmission) constraints in a more cost effective way - ultimately delivering benefits to the end customer.

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

☑ 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 innovation projects to date have examined how both distribution and transmission level constraints can be solved through the use of domestic electric heating using a whole system approach.

This project will build upon all previous innovation projects that have looked at electrification of heat and impact on networks, including:

- NIA_SSEN_0039: An Electric Heat Pathway – Looking Beyond Heat Pumps.
- NIA_WPD_040: Multi Asset Demand Execution (MADE)
- NIA_UKPN_0050: Urban Energy Club
- CET2001: LCNF – Customer-Led Network Revolution
- NIA_NGSO_0025: Residential Response
- NIA_NGGT0154: Spatial GB Clean Heat Pathway Model
- BEIS Innovative Domestic Demand-Side Response Competition:
- No Regrets Renewable Responsive Heating Project
- Power of HOMEs

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

This project is unique in that it is the first project of its kind to look at: - The degree to which the flexibility of domestic heating assets can be used to help solve both DSO and ESO constraints – specifically related to network constraints in mainland Scotland - Create a cost benefit analysis (CBA) to investigate if the use of domestic assets is a cheaper alternative than conventional network reinforcement and curtailment payments - Look at what business models and learnings can be used to incentivise customer engagement

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

This concept has never been considered before, and we do not know if it will work. This inexpensive feasibility study and CBA will give us the confidence we need to develop a large-scale trial, or it will let us know that it is not worth pursuing any further.

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 use of domestic assets to help solve both constraints on the distribution and transmission network is yet unproven. Creating a market for this flexibility would require a large-scale trial to prove its viability, which will be very expensive. This NIA project will prove the concept theoretically, hugely derisking any further investment. There is also significant risk to consumers in terms of their comfort, finances and general well being if we were to roll out this market without testing it first.

This project has been approved by a senior member of staff

- [x] Yes