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## NIA Project Registration and PEA Document

### Date of Submission

Jul 2023

### Project Reference Number

NIA\_UKPN0090

## Project Registration

### Project Title

Flex Heat Networks

### Project Reference Number

NIA\_UKPN0090

### Project Licensee(s)

UK Power Networks

### Project Start

July 2023

### Project Duration

2 years and 2 months

### Nominated Project Contact(s)

Sofia Gonçalves

### Project Budget

£501,600.00

## Summary

The project aims to investigate how all-electric heat networks could affect the power grid and how the Distribution Network Operator can manage them flexibly. The project will conduct a thorough analysis to determine if it's possible to free up capacity in the network by using a smarter design that's suitable for flexible connections. UK Power Networks will partner with a Heat Network developer/operator that has an operational heat network in the area to test and validate a design optimization methodology through a one-year trial.

### Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

## Problem Being Solved

Heat networks are seen as crucial for achieving the nation's Net Zero goals. Heat networks distribute heat from a central source to multiple buildings using a system of pipes, utilising various technologies like heat pumps, gas CHP, electric boilers, or waste heat. Shifting from gas to heat pumps or heat networks for building heating will have a significant impact on the country's electricity infrastructure capacity. Currently, heat networks account for 2% of heat demand in the UK but are projected to increase to 20% by 2030.

The lack of electricity network capacity in urban areas is a major challenge for the network planning team. UK Power Networks currently overlooks the strategic advantages of city-scale heat networks in budget assessments, disregarding the benefits of demand-side management. Heat networks with thermal stores offer significant flexibility to the local electricity distribution system by operating heat pumps during periods of low electricity demand and storing the generated heat for later use. By considering the potential flexibility of heat networks through thermal storage during the design stage, peak demand could be reduced by 20-40%, leading to a decreased need for overall capacity.

Considering the potential flexibility of heat networks through thermal storage in the design stage could reduce peak demand by 20-40%, lowering the overall capacity required. If proven effective, this approach would enable profiled connections to substations,

optimising the network's profile. Providing flexible connections to heat network operators would improve network economics, utilise existing electricity network capacity more efficiently, and potentially eliminate the need for network reinforcements.

## Method(s)

This project will be developing the following activities:

1. Perform a market procurement exercise to identify a suitable heat network developer/operator to become a project partner (The continuation of the project is subject to finding a suitable project partner for the trial)
2. Desktop analysis and engagement with heat network developers to: understand in more detail the challenges faced with regards to grid connections in the context of the rapid electrification of heat, understand the typical load profiles, key design and operational variables of a heat network.
3. Develop an optimisation methodology for supporting the design of heat networks by considering trade-offs between the electricity connection costs and optimal heat network performance. [
4. Validate the optimisation methodology via a techno-economic analysis of one example heat network for two scenarios, brand new buildings/retrofitted buildings or those with low level of insulation. This process will seek to analyse what is the cost of optimising the heat network design to minimise connection costs vs business as usual, from the perspective of the heat network developer.
5. Scale up the business case for UK Power Networks' areas determining the increased capacity and associated reduction/deferral in reinforcement by applying the optimised load profile at substation level for the scenarios agreed in the feasibility stage

To proceed to Gate C (stage gate), the following conditions need to be met:

1. A heat network partner has agreed to support the project by providing data and make the site available for trial
2. The techno-economic analysis shows a clear positive business case, with benefits to be delivered in UK Power Networks' areas.

If proceeding to Gate C, then the following activities will take place:

6. Engagement with DSO control team and network planners to determine the impact of optimised heat network electrical profiles on the connections assessment and connection offers (timed/profiled), as well as network planning processes.
7. Develop a trial strategy and trial design through engagement with heat network developer chosen as trial partner in feasibility phase and internal UK Power Networks' teams
8. Run a one -year trial within the heat network site to determine if the optimised profile can be adopted by the heat network developer, throughout the whole year (four different seasons)
9. Summarise trial results and engagement with UK Power Networks' internal stakeholders (DSO connections, network planning & innovation) to discuss key factors to consider in the implementation plan.
10. Understand and map out the regulatory, commercial, and technical barriers that would need to be addressed in the design of the connection offer to the heat networks
11. Develop a clear BAU transition plan establishing the required operational procedures that is supported by key internal UK Power Networks stakeholders & heat network developers.

Create a methodology/toolbox to assist heat network developers and BAU team managing profiled connections in defining their optimal electrical profile, monitoring the heat network connection, and requirements needed.

## Scope

As defined in method, this project is delivered through three main Workstreams (WS) with the following deliverables:

WS1: Feasibility Phase:

1. Data Collection and Stakeholder Interviews

2. Optimisation methodology and techno-economic analysis, including full description, results and recommendations
3. Business case scale-up
4. Final report and presentation WS1

WS2: Trial Design and setup:

5. Trial strategy & design document (trial entry & exit criteria, data requirements, and data analysis approach)
6. Solution build report (current approaches and proposed updates, requirements & process for adopting optimised load profiles)
7. Final report and presentation WS2

WS3: Trial Delivery & BAU transition:

8. Installation of monitoring units and integration with visualisation tool in a heat network site
9. Trial Data results – field evaluation report providing feedback from field trials from analysis of data and engagement with trial participants.
10. Final trial report – final trial report summarising trial results & conclusions.
11. Methodology/toolbox developed to assist heat network developers and BAU team managing profiled connections.
12. BAU implementation plan – report with BAU implementation plan incl. activities, timelines, risks & mitigation, responsibilities for deployment after engagement with internal teams.

## Objective(s)

The project aims to explore the impact of fully or almost fully electric heat networks on the electricity distribution network and how to manage them flexibly. The key objectives are as follows:

- Gain a better understanding of modelling heat network connections by identifying optimization variables that balance electricity connection and reinforcement costs with performance efficiency. [Feasibility Phase- gate B to C]
- Investigate the financial benefits of implementing this solution in high-capacity constrained areas and across the entire UK Power Networks area. [Feasibility Phase]
- Develop and validate an optimisation design methodology that considers the variables of heat networks and electricity network costs using real data at a theoretical level. [Feasibility Phase]
- Assess the implications of applying a new design approach for heat network projects that account for electrical and heat constraints by studying a real heat network. Determine the necessary connection products within DNOs to facilitate large-scale electrification of heat. [Solution Design & Initial Business Case]
- Evaluate the feasibility of a heat network developer following pseudo-optimised load profiles for a specific site during a trial and establish an agreed profiled or timed connection. Additionally, assess the viability of offering flexible services. [Trial phase & BAU Transition]
- Create a methodology/toolbox to assist heat network developers and BAU team managing profiled connections in defining their optimal electrical profile, monitoring the heat network connection, and establishing the required procedures. [Trial phase & BAU Transition]

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The project enables consumers, including those in vulnerable circumstances, to benefit from the energy transition, by allowing more accessible and affordable heat networks since the project will be using the network flexibility to decrease the costs of connecting heat networks to the DNO. During the Feasibility stage, when developing the network impact assessment, we will prioritise local areas with high incidence of vulnerable customers or fuel poverty to assess how the DNOs can bring more benefits to these customers by enabling an easier access to heat networks.

## Success Criteria

The Project will be successful if:

1. Success Criteria: Identify and document optimisation variables that effectively balance electricity connection and reinforcement costs with performance efficiency.
2. Success Criteria: Conduct a cost-benefit analysis to quantify potential cost savings and financial benefits, providing a report.
3. Success Criteria: Develop a methodology that considers heat network and electricity network costs and validate its effectiveness using real data from theoretical scenarios.
4. Success Criteria: Analyse the impact of the new design approach on a real heat network project, documenting findings and providing recommendations.
5. Success Criteria: Assess the practicality of implementing optimised load profiles and flexible services in collaboration with a heat network developer in an existing site and provide a feasibility report.
6. Success Criteria: Create a plan outlining step-by-step procedures and guidance for both heat network developers and BAU team managing profiled connections.

## Project Partners and External Funding

Engagement with partner organisations to deliver the three workstreams has started but the selection will be through a competitive tender process. The collaboration will include technical/expert advice; Provision of supporting analysis; Provision of resources.

To ensure this project delivers valuable outputs that will be beneficial to both the DNO and heat network operators, UK Power Networks are seeking a heat network owner/operator within one of their licence area to partner with on this project.

There is no additional external funding to this project at this stage.

## Potential for New Learning

The new learnings are described in the project objectives section and are focusing on:

- Better understanding of modelling heat network connections.
- New optimisation design methodology that accounts for optimisation variables that effectively balance electricity connection and reinforcement costs with performance efficiency.
- Feasibility of a real live heat network to follow optimised load profiles and/or flexible services through the trial results.
- Methodology to support both heat network developers and BAU team managing profiled connections.

## Scale of Project

In order to ensure that the project's findings are applicable to all DNOs the trial will be conducted for a full calendar year to obtain reliable and representative results. The trial will likely concentrate on congested areas of our network to ensure that the findings are relevant to the use case being studied. This extensive research and engagement are essential to test the external validity of our findings.

## Technology Readiness at Start

TRL5 Pilot Scale

## Technology Readiness at End

TRL8 Active Commissioning

## Geographical Area

This is still dependent on the heat network developer site available, but the intention is to carry out the project in LPN.

## Revenue Allowed for the RII Settlement

There is no revenue allowed for in RII-ED2 for this project.

## Indicative Total NIA Project Expenditure

We estimate the UK Power Networks' NIA expenditure to be £501,600 of which £451,440 (90%) will be recovered from NIA.

## Project Eligibility Assessment Part 1

There are slightly differing requirements for RII0-1 and RII0-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RII0-2 / RII0-1).

### 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 RII0-2 projects only)

Please answer **at least one** of the following:

#### How the Project has the potential to facilitate the energy system transition:

The project enables the end-consumers in the energy transition, by enabling more accessible and affordable heat networks since the project will be using the network flexibility to decrease connection costs for heat networks and increase speed.

#### 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 (RII0-1 projects only)

N/A

#### Please provide a calculation of the expected benefits the Solution

The total benefit of this project is estimated based on the following points:

The electrical peak load on a primary substation can be reduced up to 40% if the heat network uses the thermal storage flexibility compared to a counterfactual. We assumed a conservative scenario where UK Power Networks could offer profiled or timed connections to the highest demanding heat network customers, representing 25% of the total number of primary substations in LPN, EPN and SPN. This method will reduce the district heat (or heat network) pump winter peak load (Strategic Forecasting System data) by 10% (25% of 40%) in all UK Power Networks areas. Therefore, this method will avoid use of capacity in the network and avoid reinforcements.

Based on the above assumptions, the project is estimated to reduce reinforcement costs by a range of £80k-£400k annually.

Therefore, the overall anticipated benefits from this project following a BAU transition is forecasted to be £0.77m by the end of RII0-ED2 and an NPV £4.32m cumulative by end of RII0-ED3.

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

If successful, the solution has the potential to be replicable across all other DNOs in similar areas of congestion. The BAU implementation plan deliverable of the project will assist with this.

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

The costs of rolling out the method across GB will be accessed during WP2. Assuming UK Power Networks has one third of UK customers, the GB wide NPV would be around £2.32m by the end of RII0-ED2.

### 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 project will:

- o Create and make available a new optimisation design methodology that accounts for heat networks optimisation variables that effectively balance electricity connection and reinforcement costs with performance/efficiency. This will allow licensees to accurately forecast and plan mitigations, including flexibility and profiled connections, minimising costs for the connected and connecting customer.

- o Establish a methodology/toolbox to assist:

- \* heat network developers (customers) in defining their optimal electrical profile outputs suitable for the their end customers demand and to be able to conform to an agreed profiled connection.

- \* the DNOs internal teams managing profiled connections in monitoring the heat network electrical profiles connection, establishing the required monitoring procedures, alert systems. This will allow licensees to enable quicker and more streamlined connection processes for these types of customers.

### 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.

We have undertaken:

- a review of the ENA Smarter Networks Portal;
- initial engagement with stakeholders and DNOs;

We have not found a similar project that has looked at the feasibility analysis and trial we are planning. While there are projects that have looked/are looking at:

- Investigating the scale and location of district heating in the UK and consequential impact on power and gas systems lead by National Gas Transmission PLC in 2015
- Net Zero Community Energy Hubs by SGN through SIF Discovery - Round 2 is developing a novel technoeconomic approach to operating hybrid heat networks alongside other flexible assets (thermal storage, hydrogen boilers, heat pumps) alongside with using the existing gas infrastructure for the transition to hydrogen. While this project while provide significant learnings on feasibility of heat delivery to residential and commercial buildings through multiple flexible assets operating together behind-the-meter, it is not analysing the electricity DNO impact and perspective.
- Heat balance (within SIF discovery- Round 1) explored the commercial and technical feasibility of network flexibility from large-scale thermal energy storage in conjunction with heat networks, to reduce peak demand on the transmission and distribution networks over multiple timescales, reducing the need for network reinforcement. In this project, the main objective was to demonstrate large-scale thermal energy storage (LTES) to exploit curtailed wind and support inter-seasonal alignment of wind generation and thermal demand.

## 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

RIO-1 projects must include description of why they have not been tried before.

This project will be the first attempt for a DNO to understand how the impact of a smart optimisation modelling coupled with thermal storage from the heat network design can impact the electrical the network. Additionally, the solution being investigated and developed (methodology to apply flexible/profiled connections for heat networks) has been designed with EV fleets as the main target and therefore has not been deployed to this type of customers (heat networks) in BAU.

### Relevant Foreground IPR

The data created, outputs and deliverables produced as part of the project will conform to the default treatment of IPR.

The supplier background IPR will be essential to use some of the foreground IPR. However, since the supplier tender is still to be completed, the details on the respective background IPR that allows the replicability of this project are not yet known.

### Data Access Details

To view the full Innovation Data Sharing Policy, please visit UK Power Networks' website here:

<https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2021/11/UK-Power-Networks-Innovation-Data-Sharing-Policy-.pdf>

UK Power Networks recognises that Innovation projects may produce network and consumption data, and that this data may be useful to others. This data may be shared with interested parties, whenever it is practicable and legal to do so, and it is in the interest of GB



electricity customers. In accordance with the Innovation Data Sharing Policy, UK Power Networks aim to make available all non-personal, non-confidential/non-sensitive data on request, so that interested parties can benefit from this data.

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

The project's objective is to test a new and innovative framework with a stakeholder (heat networks) that has not been previously implemented in the industry. As a result, the project is considered high-risk for the business to undertake without prior validation. However, if the project succeeds in achieving its objectives, the innovation could accelerate the adoption of this technology, making it easier for the business to transition using it as part of its regular operations.

**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 NIA funding will enable UK Power Networks to undertake a project which has technical and operational risks associated with it, is speculative in nature and yields uncertain commercial returns.

**This project has been approved by a senior member of staff**

Yes