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.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

NIA Project Close Down Report Document

Date of Submission

Jul 2025

Project Reference Number

NIA_UKPN0083

Project Progress

Project Title

NeatHeat

Project Reference Number

NIA_UKPN0083

Funding Licensee(s)

UKPN - Eastern Power Networks Plc

Project Start Date

September 2022

Project Duration

1 year and 10 months

Nominated Project Contact(s)

Rona Mitchell

Scope

The development of this project will be divided into six work packages which are set out as follows:

1) Project planning and setup:

The initial project setup will be conducted as part of this work package. This includes preparation and signature of terms and conditions as well as agreements with all parties. It will also include the identification of installers and providing all necessary training.

2) Customer recruitment:

As part of this work package, a customer research plan will be implemented. A marketing strategy will be executed, and eligible participating customers will be onboarded. Terms and conditions and a list of FAQs will also be put in place to aid with the process.

3) Product installation:

The installation phase is aimed to be quick to allow for more monitoring time. All installations and the activities associated with it are to be carried out by Tepeo and its sub-contracted installers. Any required domestic fuse upgrades would be part of this work package as well as all the necessary testing of the complete heating system.

4) Product monitoring:

All installed systems will be monitored for the duration of the project. The process is not intended to provide a live feed. The exact specification of collected data would be based on the outcome of work package 1. This is envisioned to indicate the power draw, heat output and reliability of the product.

5) Customer research:

This work package will focus on the customer experience and their satisfaction with the product. Surveys are intended to be carried out as part of this activity. The methods planned to be used are Customer Satisfaction Score (CSAT) vs Net Promoter Score (NPS).

6) End of project analysis and reporting:

The work package marks the last phase of the project where all the findings would be collated, summarised and made available/uploaded to the relevant portals. The roll-out of findings to Business as Usual (BAU) will be delivered as part of this work package.

Objectives

The objectives of the project are to:

- Understand customer attitudes to low carbon heating options and perceptions of ZEBs.
- Understand the practicalities for installation – property suitability, logistics, duration etc.
- Evaluate the potential network impacts – fuse upgrades, service cable suitability, peak load, and wider network impacts.
- Explore what the implications are if customers have both an EV and a ZEB.
- Understand running costs and how time-of-use tariffs can deliver competitive heating costs vs fossil fuels

The outcomes of the project are:

- Inform policy decisions by supporting Local Authorities and the Department for Business, Energy and Industrial Strategy (BEIS) with data and evidence
- Understand the impact of ZEBs on the network and ensure readiness
- Understand customer perception and experience with regards to this technology as an alternative to heat pumps
- Understand the operational cost of ZEBs to the customers
- Validate the benefits from smart operating the ZEB’s charging patterns

Success Criteria

The project will be deemed successful when we have:

- Demonstrated the successful installation and operation of the smart storage heater in the designated housing archetypes
- Gained insights into the impact of such low carbon solution on the network operation
- Understood how the load profiles of customers within various housing archetypes would look like under smart operation of the unit
- Understood the operational costs of this solution and the impact of that on customers
- Understood the overall customer journey and the areas where DNOs, and others, can play a key role in the decarbonisation journey

Performance Compared to the Original Project Aims, Objectives and Success Criteria

The project successfully completed all work packages. The objectives and success criteria are detailed below, along with details of the project’s performance against them.
Objectives:
Understand customer attitudes to low carbon heating options and perceptions of ZEBs
We engaged with participants before installation and after the trial to understand their baseline appetite for low carbon heating and their experience with and perception of the ZEB after a year of use. Before installation most participants did not have any specific dislikes about their old system but, the general consensus was that it was not environmentally friendly or energy efficient. For a few, the increase in energy prices was also a concern and some participants found it easier to opt for the ZEB rather than an alternative heating system, such as heat pumps, due to the higher costs and space requirements of the latter. After the trial, all participants who were interviewed (20 out of 28 participants) would recommend the ZEB to others
The perceived cost of the system was mixed with most customers entering the trial expecting costs to rise. The credit system did also create confusion for customers evaluating the final performance of the system
Living with the ZEB changed many participant’s attitudes towards sustainability and created salience around their energy use
The size, noise, and heating comfort levels of the system were also acceptable for most trial participants
Understand the practicalities for installation – property suitability, logistics, duration, etc.
Average installation time across the project was 1-2 days and the majority of customers described the overall installation as seamless, with minimal disruption caused within their households
There were key learnings from the installation and survey phase around the suitability of different property types for the solution. We found that the requirement for hot water storage as well as the ZEB means many flats simply don’t have the internal space required for the equipment. The weight and manoeuvrability of the ZEB also presented a challenge for flats which may have weak/non-load bearing access points which were not suitable for loading in the ZEB

The installations completed in the trial successfully confirmed that the solution was easily installed in terraced homes, even with limited outside space where heat pumps might have been difficult to install
Evaluate the potential network impacts – fuse upgrades, service cable suitability, peak load, and wider network impacts
Across all ZEBs installed, for the entire project duration (December 2022 to May 2024), we saw that >95% of total energy consumption was drawn outside of the four most expensive hours provided by the NeatHeat energy price curve (15:00 - 19:00). In terms of implications for the network, this means that the ZEBs are not significantly contributing to peak load while still allowing customers to heat their homes over this period
The trial also collected data on ZEB voltage, grid frequency and current draw to share with partners and UK Power Networks. We detected voltage variation across the NeatHeat ZEBs throughout the trial. The range is ~14V across the fleet, but this represents ~500W of power input difference across the sample. In a typical four-hour charging window, this could lead to some customers missing 2kWh of low-cost energy. Given the price difference between off-peak and peak electricity prices from typical time-of-use tariffs in 2024, this could cost ~30p per day whenever peak charging is required. For a typical ZEB owner, this equates to approximately £20-50 per year in additional peak charging costs that customers with higher supply voltages would not incur. One potential use raised for this monitoring was to provide voltage anomaly detection if sufficient volumes of ZEBs could be deployed across the network
In terms of enabling the technology at a domestic level, the project found that fuse & supply upgrades would be required for homes with 60A or less who participated in the trial or who might want to install a ZEB in future
Explore what the implications are if customers have both an EV and a ZEB
The trial recruited four participants who had a 7kW EV charger in addition to the newly installed ZEB. Throughout the trial, the consumption of the EV chargers was not monitored separately but the total power consumption for these households was monitored. There were no significant or unique technological issues raised over the course of the trial for these EV owners other than those typically related to the installation of Low Carbon Technologies (LCTs) (e.g. fuse upgrades, de-looping supply)
Looking at the charging patterns of the ZEBs in the trial, the ZEB tended to charge in the early morning with the highest power draw at 3AM and then in the early afternoon to provide heating for the evening heating period. When combined with EV charging, there may be some herding behaviour in charging at the lowest price periods but the work completed through this trial has suggested that flexibility signals from the DSO would likely be sufficient to spread ZEB charging along similarly priced periods
OVO Energy additionally offers a type-of-use tariff for EV charging (the “charge anytime add-on”) which provided a simple user experience for trial participants whereby both LCTs operated on a type-of-use credit system
Understand running costs and how time-of-use tariffs can deliver competitive heating costs vs fossil fuels
Each customer's running costs have varied depending on their usage and home size. Many anticipated higher running costs at the start of the trial and were happy to accept these for a cleaner heating solution. The structure of the credit system used in the trial made it difficult for participants to reflect on their running costs which was further exacerbated by the energy crisis. Some participants did experience lower bills, but this is mainly as they have other smart systems or LCTs which are contributing to overall household cost savings. The fact that participants were satisfied and would recommend the ZEB to others does indicate that even if costs associated with running the ZEB are higher than fossil fuel alternatives, this solution is still attractive to consumers
Comparing these costs to their original heating solution is complicated as customers had varied heating systems and tariffs at the start of the trial with differing degrees of data on past running costs. This was then compounded by the energy price changes during the project and the fact that the type-of-use NeatHeat tariff was specifically designed to test the ZEB's ability to respond to price signals, not to create a commercially viable product to compare pricing. Given these factors we were not able to quantify any change in heating costs for consumers during the trial. The participant interviews and surveys discussed above do show broad levels of customer satisfaction with the solution qualitatively

Success Criteria:
Demonstrated the successful installation and operation of the smart storage heater in the designated housing archetypes
The project met its initial aim to trial the use of electrical storage heating systems in housing archetypes with spatial constraints or limited access to external wall space
Nine of the 30 ZEBs installed were installed in terraced homes and flats which typically have less external wall/garden space. This lack of space may have made a heat pump difficult to install either due to physical space constraints or the implications for planning permission and proximity to neighbours
Gained insights into the impact of such low carbon solutions on network operation
The trial confirmed that the ZEB is able to draw 95% of its power requirement outside of the most expensive four hours of the price curve which coincide with times of high load on the network. This suggests that ZEBs or other similar technologies are able to operate flexibly, resulting in little impact on the network if the correct pricing/network signals are developed
Some concerns were raised in the project around price herding whereby large volumes of LCTs are incentivised to charge during a very narrow window (targeting the periods when prices are lowest) which could create a new peak. However, given the differences in energy pricing are often negligible, it would be possible to spread charging more evenly across these periods, without material impact to energy retailers/customers. Even with a moderate signal from DSOs, the risk of herding could be significantly reduced
Analysing the data from the trial we found that a combination of heat pump deployment and ZEBs would likely provide the system with diversified power consumption where heat pumps (in a typical mode of operation) run at a lower kW power draw, but increase their power consumption during periods of peak demand, while ZEBs consume more power, but leverage the network capacity available

and target the lowest-cost energy outside of peak period
Given these results and the projected install numbers for the ZEB we have elected not to update our forecasts to include these technologies. The development of the regional energy strategic plan (RESP) and the future of forecasting at the DSO level (including the level of control over the technologies modelled) is also uncertain, underscoring our decision to not invest in additional work into incorporating these results into our forecasting at this stage
Understood how the load profiles of customers within various housing archetypes would look under smart operation of the unit
Throughout the trial, tepeo collected data on the energy draw of the ZEB systems and any heating output delivered by the device. They have shared these heating profiles alongside metadata for each home with UK Power Networks and OVO Energy. This data shows the electricity draw and heat delivery from each device
Participant feedback also highlighted difference in performance across housing types. In the post-trial engagement and diary studies, participants with larger homes (four or more bedrooms) were more likely to report a variation in comfort levels and slower heating speeds. Participants in smaller homes experienced quicker heating delivery and more consistent comfort levels
Understood the operational costs of this solution and the impact on customers
While the credit system used in the trial added some confusion around the final cost of the solution for trial participants, all customers who were interviewed at the close of the trial indicated that they would recommend the ZEB and intended to keep the boiler after the trial
The credit system reimbursed customers for the difference between their tariff and the discounted trial price of 12p/kWh for any electricity used by the ZEB. This price was chosen to simulate a trial-specific type of use tariff where electricity used for heating was discounted. After trial close, OVO Energy elected to end the NeatHeat credit system but will continue to work with tepeo to develop tariffs and/or tariff add-ons which would support ZEB owners. Evolving energy prices throughout the trial period further complicated the task of comparing the cost of the ZEB to a counterfactual heating system and agreeing a credit price long-term
tepeo is continuing to develop price comparison tools for customers (Cost and Carbon Savings - Comparison | tepeo) which show that, in many cases, the running costs of the ZEB are less than electric boilers. tepeo are also currently working with DESNZ and ESC to develop a robust dataset of customer use and cost
Understood the overall customer journey and the areas where DNOs and others can play a key role in the decarbonisation journey
As discussed above, engagement with participants throughout the trial helped to understand the customer journey from initial awareness/interest in the solution to the close of the trial. The customer recruitment process indicated that there is significant appetite across the UK for the solution
The installation phase confirmed that the ZEB was easy to install in most properties with minimal disruption over 1-2 days. This also confirmed the suitability of the solution for terraced homes with limited outdoor space which may have otherwise not been suitable for heat pumps. However, there were some space constraints raised for the ZEB in smaller flats where manoeuvrability is limited
Throughout the trial, customers were mostly satisfied with the performance of their systems and the comfort of their homes. At the close of the trial, all participants surveyed indicated that they would recommend the solution
The trial also raised areas where customers may need additional support in their decarbonisation journey. After installation of the ZEB and removal of the old gas meter, some participants were still billed the standing charge for their gas for up to 10 weeks which they found frustrating. Further support from energy suppliers for customers who transition off fossil fuels would help resolve some of this confusion and frustration
The project also identified a role for DNOs in developing flexibility signals to supplement pricing signals in the market to avoid price herding. Where there is very little difference in price in the lowest priced periods, a flexibility signal from the DSO may help spread charging more evenly across these periods without material impact on consumers

Required Modifications to the Planned Approach During the Course of the Project

There were no alterations to the approach or methodology throughout the project.

Lessons Learnt for Future Projects

The trial results show that ZEBs are a promising option for heating decarbonisation, especially in homes with limited space for heat pumps. Participants were satisfied with the solution, and its charging optimisation effectively reduced network load during peak times.

The project identified several key areas for improvement some, which are discussed below (a full list can be found in the final reporting for the project):
Customer understanding of existing heating systems is limited – understandably, many people do not know if their system is regular or system, combi or conventional boiler. tepeo pivoted early in the project eligibility assessments to simply ask whether customers had a hot water tank as this is naturally more widely known
Customers are often planning other heating/hot water upgrades – when installing a new heating system, particularly low carbon options like the ZEB or heat pumps, customers consider their controls, hot water solution and radiators. In general, less disruption is preferable, but customers understand there can be benefits to upgrading various parts of their home/heating system if this is affordable. One of the benefits of the ZEB is that these changes do not need to happen at the outset, allowing customers to phase

upgrade and achieve lower running costs over time
ZEB understanding & confidence – the ZEB is a new product, which operates in a familiar way in terms of heating (thermostat, programmer, boiler responds and delivers heating to radiators), but the charging side of how a thermal store works was new to all customers in the trial. Coming out of winter into mild weather and summer, customers needed support in their understanding of how the ZEB would respond, and whether and how to use additional features such as an away mode which disables smart charging while customers are away of prologued periods of time . Using smart charging to automatically optimise heating in the home simultaneously reduced the need for customers to micro-manage their ZEB but could create a sense of uncertainty about when and how much their boiler would charge. As part of the learnings from this project, and other smart charging customers, tepeo are investigating how to display planned charging to customers. This will allow them to better understand what the ZEB intends to do, intervene if they disagree, and improve the overall confidence in automatic charging based on the energy system need. We believe this will be crucial for mass market adoption of any automatically scheduled devices (EV chargers, home batteries, hot water stores etc). Customers may agree with the schedules calculated by automated, intelligent systems, but may expect greater transparency than the ZEB provides today
Knowledge of heating systems – this was low across the customers that participated in the trial. With a new product type, there is also a learning curve on how different parts of the heating system work – particularly for customers who have installed other technologies at the same time (thermal store, new heating controls e.g. smart thermostats). For users of new systems to have a positive experience, from which they can become advocates of LCTs and support the wider adoption across the country (word-of-mouth marketing & norm-forming), installers, energy suppliers and manufacturers will need to develop clear and concise educational materials which build user understanding over time. If it is possible to design-out the need for in-depth user understanding, this is generally preferable
Heating requirements & user preferences – personal attitudes, household/family dynamics and heating system configuration created a wide range of expectations and preferences for heat provision. Within the NeatHeat project, there were a range of preferences. Broadly these can be divided into cost-focus vs comfort-focus. Some customers wanted the ZEB to optimise for the lowest running cost possible, even if this runs the risk of poor/compromised heating performance e.g. a ZEB that charges to the minimum expected heat demand and may not have a reserve of low-cost energy available if user demand or weather changes result in greater-than predicted heat demand. Other customers prioritised comfort above running cost, preferring their ZEB to maintain a float or reserve charge level to cover variability, unpredicted heat demand or just to ensure the fastest possible reheat time from a ZEB at a higher state-of-charge (heating output is greatest at higher states of charge)

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The project explored alternative options to support heating decarbonisation through electrification (ZEBs) given that heat pumps and heat networks may not be a suitable solution for ~20-25% of homes in the UK. This is often due to space constraints, geographic suitability for a heat network, cost, and the ease of installation. Innovative pricing structures (type of use tariff) were trialled to explore the cost competitiveness with traditional heating, while testing the performance of the system when paired with other LCTs helped the project to further develop confidence in the solution.
The project installed the ZEB system in 30 homes and completed monitoring throughout the trial for 28 homes. The ZEBs performed as a suitable replacement for oil and gas boilers for trial participants, with all surveyed participants indicating that they would recommend the solution. The optimised charging of the ZEBs was also successful as the systems were able to draw >95% of their electricity outside of the four most expensive price periods within the energy price curve.
Key findings include:
Customer interest in the ZEB was high - with over 2,000 sign ups across the UK. In many cases, the ZEB was being considered as an alternative to a heat pump, where the latter may not have been suitable or the preferred option by the customer
Installations were quick and non-disruptive, taking 1-2 days on average throughout the project
The experience of heating was unchanged with a ZEB vs a fossil fuel system, with no major issues raised regarding the experience of heating by the project participants
All participants interviewed would recommend a ZEB, with stronger support from customers with low heat demand and lowest running costs
Some constraints in the project led to issues with customers' understanding of ZEB charging patterns, running cost and overall control of the system. During the project, participants had to leave automatic charging enabled at all times, preventing direct intervention. This was an unavoidable restriction for the project only, but highlights the importance of providing user control, even over largely automated systems
Separation/decoupling of electricity consumption and heating provision was a huge success. ZEBs were able to draw >95% of the electricity required outside of the four most expensive price periods within the energy price curve. This shows how ZEBs can be highly flexible in their power consumption in response to market signals
Even in winter conditions, where 67% of the heating demand fell during the most expensive system price periods (morning & evening), the ZEBs drew <10% of their total power requirement at peak times
The project also highlighted the headroom available for DSO & ESO signals to complement energy price signals. Doing so can help

avoid herding and spread electricity consumption across similarly-priced periods to alleviate network congestion and optimally utilise network capacity

There is far more to be investigated on the role thermal storage can play in the transition to Net Zero. NeatHeat shows the huge potential for technologies like the ZEB to provide network flexibility services, system balancing and delivering user comfort with a familiar heating experience. We have also identified new sources of potential value such as: using behind-the-meter data to support network monitoring; and using the ZEB as an option for distressed/emergency purchase (a scenario other low carbon solutions struggle to solve).

It is also clear that policy change is required to make these technologies more accessible and compelling to homeowners. Running costs, given the price of electricity vs fossil fuels, are still a barrier/concern for many customers and the lack of policy support for thermal storage (VAT relief and access to the Boiler Upgrade Scheme in particular) means that customers who cannot get a heat pump are left covering the full cost of installing an alternative. For thermal storage to become a widely adopted solution, policy changes are needed alongside improvements in technology, tariffs, customer proposition and awareness.

Data Access

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 aims to make available all non-personal, non-confidential/non-sensitive data on request, so that interested parties can benefit from this data.

UK Power Networks will support the sharing of data to third parties on request where practical. To view the full Innovation Data Sharing Policy, please visit UK Power Networks' website here:

https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/UKPN-InnovationDataSharingPolicy-Nov-23-v1.0.pdf

Foreground IPR

The data generated (ZEB profiles and participant feedback), analysis and the final report produced as part of the NeatHeat project are the key outputs from this project. UK Power Networks has retained the IPR for all project outputs for knowledge dissemination, as per NIA Governance.

Planned Implementation

The NeatHeat project was a research initiative aimed at assessing the viability and reliability of the proposed solution in filling a gap in decarbonising homes and understanding the impacts on the electricity network.

As discussed earlier, the trial found that the ZEB was easy to install in most properties, including terraced homes with limited outdoor space. The optimised charging functionality also proved successful with the ZEB units in the trial drawing >95% of their electricity requirements outside of peak hours. This flexibility indicates that the solution is not likely to have a significant impact on peak load within UK Power Networks' network at current levels of deployment.

The forecasting currently done as part of the Distribution Future Energy Scenarios (DFES) is focused on mature technologies with higher deployment levels. The ZEB technology is promising (as shown by this trial) but it has yet to reach high levels of commercial deployment. We expect to only have ~37,000 ZEBs in our licence areas by the end of ED3. Given this, we are not adding ZEBs to our DFES or our internal forecasting model at this time. Should ZEB deployment become widespread, UK Power Networks can utilise the profiles from this trial to update our forecasting.

Net Benefit Statement

NeatHeat was a research project and as detailed in Section 10, there is currently no planned implementation into business-as-usual with the insights gathered, so a quantitate benefits forecast has not been calculated. The benefits from this trial and the ZEB technology are summarised at a high level below:

Flexible heating – The optimised charging functionality trialled in this project reduces the overall peak demand on the network (when compared to an electrified heating system which does not store heat or optimise its behaviour). The system can also participate in flexibility markets, directly contributing to enhancing the reliability and availability of the network.

Options for decarbonisation – Based on the research conducted for scoping and launching this project, a large percentage of customers within our area live in homes where heat pumps are physically challenging to install (e.g. terraced homes or flats). This project has proven the viability of the ZEB as an alternative for these households.

Improved planning – A better understanding of the load profile of this technology as developed by this project can be used to enhance our forecasting models, allowing us to plan network investment more effectively. At this stage this additional step is not needed as the deployment of the technology is limited.
Carbon savings – ZEBs are a low carbon alternative to using fossil fuel heating systems and will provide carbon savings as a result.

Other Comments

Not applicable.

Standards Documents

Not applicable.