elementenergy

Heat Pump Ready

Stream 1 Phase 1

Greenwich TIME

Final Project Report

for

The Department for Business, Energy and Industrial Strategy

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Executive Summary

The Heat Pump Ready Programme, Stream 1, Solutions for High-Density Heat Pump Deployment Competition, aims to design and demonstrate innovative, optimised solutions and methodologies that deliver cost-effective and high-density deployment of domestic heat pumps.

Greenwich TIME (Thermal Infrastructure Motivating Electrification) has brought together a consortium of organisations that would not otherwise have come together in partnership due to commercial, logistical and financial barriers. Each partner and sub-contractor has brought unique skills and knowledge with a common purpose. Greenwich TIME delivers a replicable, coordinated methodology for street-by-street mass decarbonisation of on-gas homes in urban areas.

This report sets out the methodology, findings and recommendations from Phase 1 of Greenwich TIME, which aims to deploy heat pumps at high density in the Royal Borough of Greenwich.

The key objectives of Phase 1 are:

- To develop and carry out a comprehensive process for **selecting locations and households** where high-density heat pump uptake is feasible and achievable.
- To design a **mobilisation and deployment strategy** that could be employed in Phase 2 of the Heat Pump Ready Stream 1 programme. Phase 2 refers to the next phase of detailed planning and deployment which would take place to deliver the coordinated methodology in a given location.
- To achieve the objectives above in a manner that is **replicable** beyond the parameters of the Greenwich TIME programme.

It should be noted that the Greenwich TIME project will not be moving to Phase 2 within the Heat Pump Ready programme, but the Phase 2 actions outlined in this report are expected to apply to any deployment of the proposed coordinated methodology.

Selecting locations and households

Greenwich was selected in part due to the high density of terraced housing with EPC D/E ratings – often termed ‘hard to decarbonise’. These often do not have the garden or porch space for an individual air-source heat pump unit or their own borehole for a ground-source heat pump. These streets are also often not dense enough for central plant district heating. This location is perfect for the solution selected to be deployed: networked ground-source heat pumps. Exactly like the gas network today, boreholes will be placed in the public roads, funded & operated by a utility, with each home having a ground-source heat pump connected to it inside their property (exactly like their gas boiler connected to the gas network today).

It was recognised early on that at today’s relatively high electricity:gas price ratios (which is higher in the UK than in most other European countries) and cost of heat pumps, the saving from running a heat pump alone wouldn’t make the case for most households to switch from a gas boiler. The case would therefore also rely on the benefit of cooling provided by a ground-source heat pump, making the biggest possible impact on your carbon footprint and the equity value uplift in installing a heat pump in your home.

Detailed area analysis in Phase 1 has combined property data and customer profiling to identify areas within Greenwich that are most likely to contain buildings and occupants best suited to take advantage of the customer proposition in the current economic circumstances, in the project timescales. This methodology provides a **targeted, localised street-by-street approach to mobilise heat transition at scale and pace**.

The networked ground source heat pump solution was the chosen low carbon heating solution for the Greenwich TIME from the start of the project which means that high uptake on individual streets targeted will be required to provide the best offer to consumers. The nature of the financial aspects of the consumer offer also meant that, even with the boiler upgrade scheme grant in place, a specific subset of consumers would need to be targeted: the ‘able-to-pay’ groups. It is noted that this would have been the case with any form of private retrofit heat pump solution today. This meant that consumer and location targeting could be quite specific, helping to narrow down to areas of most interest, but may have some associated risks in terms of ensuring high enough uptake in quite small geographical areas.

Obtaining detailed grid capacity information to inform the location selection was one of the more challenging components of the process, and further work will need to be done in Phase 2 to establish the impact of connecting large numbers of ground source heat pumps to the grid over a relatively short space of time. This is also critical for industry & Government to address more widely, so that grid capacity and upgrades do not become the blocker to the decarbonisation of heat.

Mobilisation and deployment strategy

The initial consumer engagement carried out in the Phase 1 feasibility study highlighted the low awareness and understanding of heat pumps, even in areas where consumers were targeted due to predicted high degrees of interest in reducing their carbon footprint. The consumer engagement also indicated that the most trusted party to deliver the scheme was the Royal Borough of Greenwich Council. The consortium was aware from the outset that local, community-level engagement was likely to be a key component of Phase 2; the Phase 1 learnings confirmed this.

For the deployment phase (Phase 2), **a comprehensive consumer engagement and journey strategy has been developed to overcome evidenced engagement barriers**, and takes a local, personal engagement approach, aiming to bring the community along on the journey. The strategy will provide phased and layered consumer information, starting with area-wide awareness to develop familiarity, gradually adding more detail to avoid overloading (and losing) customers.

Greenwich TIME will remove much of the complexity currently associated with trying to have a heat pump installed, by providing **one continuous point of contact** that will provide general advice and information, as well as link consumers to retrofit coordinators, trained installers, and post-install support. By the program’s time-limited offer, combined with the simplicity of one point of contact throughout, Greenwich TIME also generates a trigger point rather than relying on the transition to low carbon heating happening organically for each household.

Phase 1 analysis of the supply chain to deliver the heat pump installations and home retrofits required highlighted the challenges that need to be overcome to deliver a resilient supply chain. These include the need for a more streamlined and coordinated supply chain to enable higher quality installations, reduced uncertainty, limited supplier knowledge around heat pump installs, partly due to a lack of high-quality training, an ageing workforce, and a lack of new entrants to the market.

Engagement with, and training of the local supply chain by experts within the Greenwich TIME partnership will **ensure installers are ready to deliver the heat pump deployment**, whilst also being able to take these skills onto future projects.

Greenwich TIME will **embed monitoring, evaluation and reflective learning** throughout Phase 2, leading to continual improvement, and creating a feedback mechanism to influence future policy and regulation to assist future heat decarbonisation. This will apply to the consumer engagement rounds, where the community energy champions and retrofit advisors will feed back learnings to inform the subsequent rounds, and to the installations themselves, through a comprehensive quality assurance process.

Replicability

The methodology developed has focused on replicability to ensure it is adaptable to different geographies, building types, and consumer types, to enable widespread heat pump roll-out. The solution developed in the Greenwich TIME project is optimal for older properties (especially pre-1930s, representing ~33% of UK homes), which are often referred to as ‘hard to decarbonise’ due to the difficulty and cost involved in decarbonising them. Greenwich TIME focuses on providing a networked ground-source heat pump (GSHP) as a highly efficient low-carbon heating solution with a long lifetime that can reduce annual costs to consumers without the magnitude of upfront costs generally associated with GSHPs.

However, there are some potential limitations to the replicability of the Greenwich TIME model. For example, it will remain challenging to extend the Greenwich TIME model to other consumer types without a more favourable financial offering, and the consumer engagement will have to be adapted to suit the particular location that is targeted.

The coordinated methodology

In Greenwich TIME, the involvement of several key parties was highly beneficial to the outcomes of the project:

- Direct involvement of the heat pump manufacturer led to a highly informed project in terms of both the technical requirements and the financial considerations of the project.
- Involvement of local organisations was also important for the early stages of consumer engagement in the feasibility study, and to provide a more in depth understanding of local community considerations and potential drivers for heat pump uptake.
- Due to the highly targeted approach required for the networked ground source heat pump solution, where high uptake needs to be achieved at the level of individual streets, it was important to develop a carefully considered and focused effort to the consumer targeting and engagement process, factoring local socio-economics, tenure types, housing stock condition/age, and a wide range of other aspects.
- In Greenwich TIME, the local organisations worked with also provided the direct link to the Council, which emerged as a highly trusted organisation in the local area. This highlights the importance of Council involvement in future projects of this kind, noting however that the level of trust in the Council compared to other organisations will vary from area to area.

Feasibility for Phase 2

The feasibility of the consumer mobilisation and heat pump deployment plan for Phase 2 relies on the efficacy of the consumer engagement plan. Critical components of this will be:

- Engendering trust with consumers
- Educating consumers on the benefits of heat pumps
- Consumers choosing to take up the offer despite it not providing assured financial savings, given electricity:gas price unpredictability. Uptake will rely also on the basis of the home equity value uplift, the benefit of cooling provision, the large carbon footprint reduction and the energy security benefits.

Into the installation stage, the following are identified to be likely factors for success:

- Having well-coordinated interaction between home retrofit updates and heat pump deployment, to support the consumer journey and heat pump effectiveness
- Minimising the number of visits to each household as part of the deployment and ensuring high satisfaction rates with the work and in meeting time and cost expectations
- Capturing and reporting on early success for the wider community and potential consumers, supporting continued uptake by other residents. A clear monitoring and evaluation approach is part of this, with relevant and measurable KPIs.

The success of Phase 2 also relies on the seamlessness of the consumer journey, with the experience of early adopters potentially affecting the success of the later deployment phases.

Challenges remaining

Despite the innovative approach developed in Phase 1, significant barriers remain to widespread heat pump uptake, especially under current economic circumstances. **Upfront costs remain higher than that of a gas boiler, with the Boiler Upgrade Scheme not doing enough to cover this difference for the mass market**. **Ongoing costs also remain high**, with the combination of fuel bills and standing charge in the same region as fuel costs for a gas boiler. These cost comparisons are highly sensitive to changes in gas and electricity prices making long term projections highly uncertain in the current climate.

Awareness of heat pumps also remains very low, with the standing charge associated with the shared ground loop being a particularly unfamiliar component. The innovative engagement strategy developed in Phase 1 of the Greenwich TIME project will engage residents at a community level to better understand the benefits associated with heat pumps. However, more widespread uptake of heat pumps will require clear communication of the benefits at a larger scale (e.g., through information campaigns), where industry and Government have an opportunity to work together. This will be critical for any program seeking to deploy heat pumps at high density, especially before mass adoption becomes commonplace. It is expected any program to have a similar focus in the early stages on consumer awareness and education before proceeding with detailing the offer.

Any further projects run on high-density uptake of heat pumps are likely to continue to need to take an **active role in upskilling the local supply chain**, especially in areas where there has been little heat pump uptake so far. In many ways providing certainty of a high-density rollout to come in that area can provide certainty of work for local businesses to upskill and re-train. This can be further helped by Government legislating for a ban on gas boiler replacement (e.g. from 2033, or earlier, as advocated for by Chris Skidmore in his Net Zero Review).

Recommendations to tackling these challenges

Leading industry players have collaborated to deliver the best possible heat pump solution for high-density, on-gas urban areas like Greenwich. Through this work, key accelerants to increasing mass heat pump uptake have been identified. **Bringing green finance and mortgage providers on for a ‘net zero home’ package**: this would include solar PV and EV charging as well. There are clear benefits to mortgage providers in supporting the upfront cost for heat pumps: households that are cheaper to heat are therefore more likely to be able to pay their mortgage, and they’re more likely to fully heat their homes, limiting damp and mould damage. More mortgage providers offering green finance products, and lower stamp duty when purchasing a net zero home, will help the overall economic case.

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Authors

This report was brought together by Element Energy with inputs provided by OVO Energy, DG Cities and the Kensa Group.

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Acronyms

ASHP	Air Source Heat Pump
CoP	Coefficient of performance
BUS	Boiler Upgrade Scheme
DNO	District Network Operator
DSR	Demand Side Response
ECO	Energy Company Obligation
EE	Element Energy
ENA	Energy Networks Association
EPC	Energy Performance Certificate
EV	Electric Vehicle
FCA	Financial Conduct Authority
FTE	Full Time Equivalent
GDPR	General Data Protection Regulations
GIS	Geographic Information Systems
GSHP	Ground Source Heat Pump
HPA	Heat Pump Association
HV	High Voltage
ICL	Imperial College London
IMD	Index of Multiple Deprivation
IRR	Internal Rate of Return
KPI	Key Performance Indicator
NDA	Non-disclosure agreement
NEED	National Energy Efficiency Data
ONS	Office for National Statistics
RBG	Royal Borough of Greenwich
SAP	Standard Assessment Procedure
SELCE	South London Community Energy
SGL	Shared ground loop
TE	Techno-economic

ToU	Time of Use (tariff)
UCL	University College London
UKPN	UK Power Networks
WP	Work Packages

1 Introduction

The Heat Pump Ready Programme, Stream 1, Solutions for High-Density Heat Pump Deployment Competition, aims to design and demonstrate innovative, optimised solutions and methodologies which deliver more cost-effective and high-density deployment of domestic heat pumps[1].

In **Phase 1**, the main subject of this report, the goal was to undertake a feasibility study to understand if and how high-density heat pump deployment could be achieved in the chosen area. No deployment of heat pumps was carried out in Phase 1.

In **Phase 2**, to commence in 2023, the goal will be to take the methodology developed in Phase 1 and implement it to mobilise consumers and deploy the heat pumps.

This report sets out the methodology, findings and recommendations from the Phase 1 feasibility study for the Greenwich TIME (Thermal Infrastructure Motivating Electrification), project which aims to deploy heat pumps at high density in the Royal Borough of Greenwich.

1.1 Local context

The Royal Borough of Greenwich (the 'Council') recognises that to achieve its net-zero ambitions by 2030, it must overcome the significant challenge of retrofitting and decarbonising housing. The Council has deployed some heat pump solutions in its social housing stock and has been exploring options to address the challenge of high-density deployment throughout much of the privately owned stock archetypes in the borough. This project tackles this challenge in a consumer-centred manner, whilst maximising operating efficiency and achieving a deployment model with costs that can reasonably be taken up by the target consumer. It also looks to achieve a straightforward direct boiler swap-out model with the outcome of solving the supply chain challenge by identifying a method to easily transition the existing installation trade workforce.

1.2 Phase 1: The Greenwich TIME feasibility study

The Phase 1 feasibility study focused on understanding the most effective ways to coordinate a methodology for high-density heat pump deployment.

The key objectives of Phase 1 were:

- To develop and carry out a comprehensive process for targeting locations and households where high-density heat pump uptake is feasible and achievable.
- To design a mobilisation and deployment strategy that could be employed in Phase 2 of the Heat Pump Ready Stream 1 programme.
- To achieve the objectives above in a manner that is replicable beyond the parameters of the Greenwich TIME programme.

The feasibility of high-density heat pump deployment in the Greenwich TIME project was assessed based on proven networked heat pumps distributed on a shared ground array, also known as an ambient heat loop or network. This was chosen because of the presence of largely terraced housing, which due to space constraints are often difficult to decarbonise with individual heat pumps (air-source or ground-source). This is due to the lack of garden or porch space to place the heat pump units or the boreholes. In addition, terraced housing

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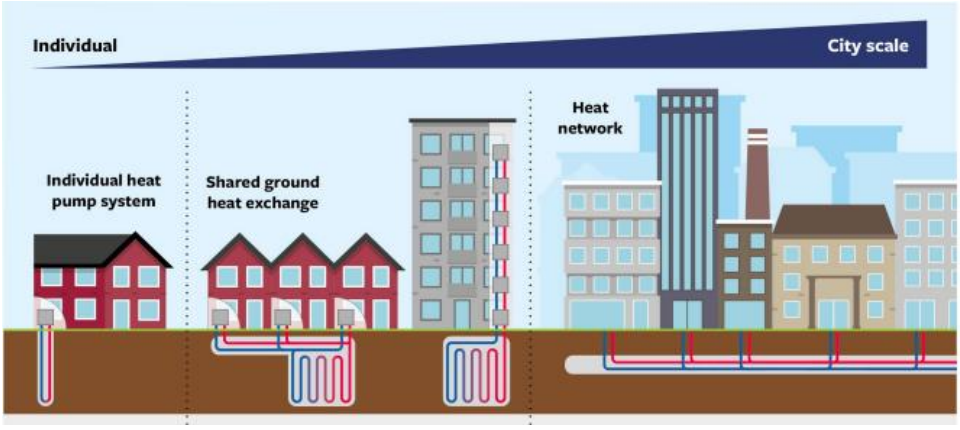
[1] Heat Pump Ready Programme: apply for Stream 1 opportunities - GOV.UK (www.gov.uk)

often does not have sufficiently dense heating loads to justify central plant district heating. This leaves networked heat pumps as the most sensible solution. A study by the University of Leeds (Bale, Barnes, Turner) came to the same conclusion, with the following diagram used to explain:



Phase 1 explored and assessed the potential to decouple the upfront capital cost barrier of the ground side installation from customers via financing in a manner similar to how existing domestic services are funded, i.e., water, gas, electricity and data. This consumer offer will then be made to householders within Phase 2 of the project to enable consumers to replace their boiler with a networked heat pump in a way that is simple to understand and adopt, with minimal household disruption. This solution also offers significantly higher efficiencies and lower operating costs, compared to air source heat pumps or gas boilers[2].

During Phase 1, a home service package was developed, including: a mains connection, easy appliance swap-out, and low long-term running cost. This was coupled with testing varied consumer engagement and adoption methods to better understand the optimal service offer and method of communication needed for rapid uptake. Phase 1 also explored the benefits to the electricity grid including reduced peak load and increased demand side flexibility, minimising the requirement for local network reinforcement. During Phase 1, and continuing into Phase 2, the project explores the whole system benefits and trade-offs between installation of low-cost heat infrastructure, avoidance of high-cost electricity generation capacity and distribution infrastructure, and the lowest requirement for upskilling local installer trades.

The result of this project is a fully developed and costed feasibility study that will inform the delivery of Phase 2 of the project.

The Phase 1 consortium consisted of an array of organisations that would not typically work together in a project such as this. Phase 1 members are summarised in Figure 1.1 below:

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[2] Climate Change Committee: The Sixth Carbon Budget Buildings https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Buildings.pdf (page 14) *published 2021*

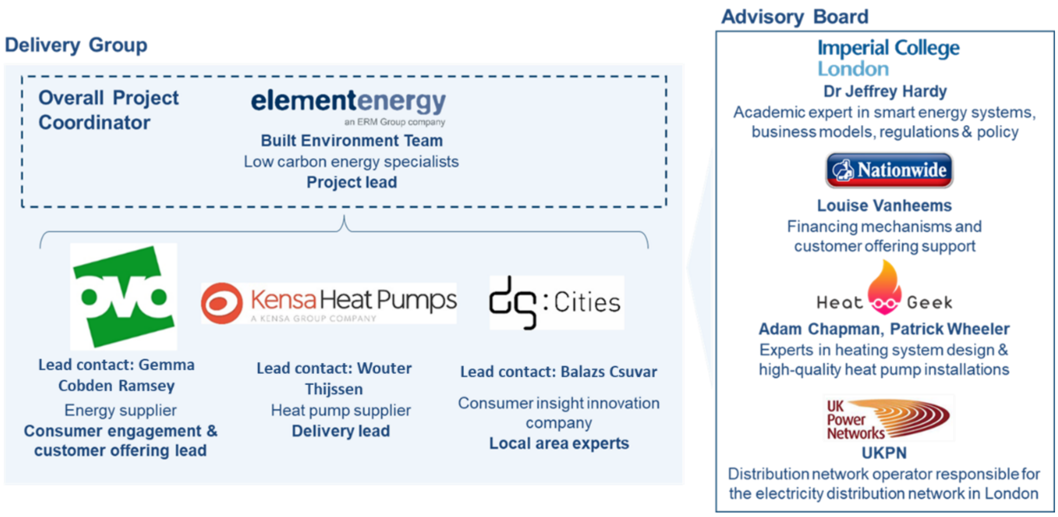

Figure 1.1. Phase 1 consortium members

Element Energy, a specialist strategic low carbon energy consultancy, were the project lead for Phase 1. As the project lead and project managers, Element Energy acted as a coordinating party that brought the necessary parties together, ensured smooth communication between parties and had an overview of all tasks.

OVO Energy, a major UK energy supplier, led on the consumer journey for Phase 1, helping to identify key consumer types to target based on the consumer offer available and setting out the journey consumers would go on through the mobilisation and deployment stages of Phase 2. For Phase 2 OVO were envisaged as the 'handholding' party who could provide a consistent point of contact for consumers. However, the current energy climate means that OVO have had to pull back from Phase 2 of the Greenwich TIME project to prioritise protecting consumers. In their place, and to bring a more locally focused approach to the consumer journey, the role of leading the consumer journey in Phase 2 will be taken by the South East London Community Energy (SELCE). SELCE is a community energy group tackling climate change and fuel poverty across South East London with extensive experience in coordinating community retrofit and low-carbon energy projects, and are skilled in retrofit assessment and coordination, energy advice and engagement with community groups.

Kensa were the technology partner in Phase 1 and will deliver the heat pump solution as the UK's specialist delivery partner for Fifth Generation District Heating networks featuring Ground Source Heat Pumps and Shared Ground Loop Arrays. With Kensa on board, the technology choice for Greenwich TIME was predetermined, and this allowed for a focused consumer offer. Kensa also played a key role in identifying suitable locations for heat pump and ground loop installations.

DG Cities acted as the consumer engagement partner for Phase 1, and led on including investigating the metrics on which consumers are targeted, understanding key challenges specific to the target consumers and designing engagement methodologies for overcoming those challenges. DG Cities are wholly owned by the Royal Borough of Greenwich and provided the direct link to the Council throughout Phase 1, keeping the Council updated through their regular meetings.

Additional advisory partners included:

- **Dr Jeffrey Hardy**, a Senior Research Fellow at the Grantham Institute - Climate Change and the Environment at Imperial College London (ICL), where he researches smart local energy systems, zero-carbon energy business models, and future energy policy and regulation. Dr Hardy played an advisory and guiding role in Phase 1, helping to provide independent oversight of the work and fill gaps in the knowledge of other partners.
- **UK Power Networks (**UKPN), the local distribution network operator supported the project in Phase 1 by providing some information on grid capacity in the target areas. However, in Phase 2 a key aim would be to engage more closely with UKPN to identify shared learnings from the project.
- **Heat Geek**, a heating design consultancy, provided advice around installer training and sense checks on the consumer offer (i.e., are the consumers targeted those that Heat Geek typically see buying heat pumps at the moment).
- **Nationwide Building Society** supported Phase 1 by providing advice on the financial solutions that could support high density uptake of ground source heat pumps.

The above consortium would not typically come together outside the framework of a programme such as Heat Pump Ready because it doesn’t drive a commercial return on time invested for every organisation today. It builds up a future market and methodology which then can be replicated, but the time required to develop the methodology would not ordinarily be spent by organisations needing to make a return.

2 Aims, Expected Outcomes and Objectives

This section provides a high-level summary of the aims, expected outcomes and objectives of Greenwich TIME. More detailed aims, tasks and deliverables for the specific work packages within Phase 1 are described in section 3 (Summary of Work Packages).

Aims

The broad aims of Phase 1 of the Greenwich TIME project are:

To understand the barriers to heat pump uptake and how the project methodology can address these by:

- Setting out the costs to consumer, including comparison with the counterfactual and the biggest levers for reducing these costs
- Understanding consumer attitudes, including
    - The level of general awareness of heat pumps amongst consumers, which is then used to determine the level of 'handholding' and education required
    - Appetite amongst consumers for decoupling the upfront cost of a GSHP system via a split-ownership/financing model.
- Minimising disruption in the home
- Upskilling local installers and strengthening the supply chain
- Understanding local grid constraints and the potential impact of these on the project

→ *Understanding the barriers was critical to developing a robust consumer offer and consumer journey. Understanding costs early on allowed the consumer offer to be framed in a realistic and accurate way – this then fed through into almost all the other activities in Phase 1: identifying the target consumer, developing the consumer engagement strategy and consumer journey for Phase 2.*

To develop a consumer mobilisation methodology and consumer journey that can overcome the above barriers to uptake.

→ *Following on from an understanding of the barriers, it was critical that a consumer mobilisation methodology for Phase 2 was developed with the specific limitations in mind. The consortium was able to use a firm understanding of the constraints of the consumer offer to develop an engagement and deployment strategy that would be attractive to consumers.*

To develop a deployment methodology that is suitable for or adaptable to the most common UK housing types (e.g. retrofits, common property types, on and off-gas homes, owner occupied homes)

- *To trial the methodology on the most common UK housing types (retrofit, pre-1919 terraced homes, on gas, owner occupied).*
- *These homes are typically considered 'hard to decarbonise', providing proof of concept for these homes allows the methodology to be extended to much of the UK housing stock.*

To develop a methodology that can be replicated in other areas in the UK with other partners, i.e., a methodology that does not rely solely on any single partner, such that it can be used for accelerating heat pump deployment across UK homes.

- *It was important in Phase 1 to develop a methodology that considered what factors were unique to the Greenwich case, and which could be taken away and replicated elsewhere.*

The specific aims of each Phase 1 work package are set out in more detail in section 3.

Expected outcomes

The key expected outcomes of the Phase 1 work are:

- A technoeconomic model that can be used to develop and assess the consumer offer, relative to other heating options
- A consumer archetyping approach to guide targeting of consumers whose motivations and abilities best match the consumer offer available
- A location selection methodology that takes into account house type, electricity grid constraints, local restrictions and consumer archetypes (see below)
- A detailed and accessible user journey for a set of customer personas covering all aspects of the user experience
- A supply chain engagement strategy to develop installer skills and strengthen the local supply chain for heat pump installations
- A comprehensive consumer mobilisation and heat pump deployment strategy for Phase 2
- Findings and learnings related to all of the above, including an understanding of the general requirements of a coordinated methodology for high-density heat pump deployment.

Objectives

The key objectives of Phase 1 are:

- To develop and carry out a comprehensive process for targeting locations and households where high-density heat pump uptake is feasible and achievable

- To design a mobilisation and deployment strategy that could be employed in Phase 2 of the Heat Pump Ready Stream 1 programme

- To achieve the objectives above in a manner that is replicable beyond the parameters of the Greenwich TIME programme.

3 Summary of Work Packages

This section sets out the structure of delivery for Phase 1 work, outlining work packages, key activities, milestones and deliverables. Work package structures and responsible partners are set out in Figure 3.1. Phase 1 deliverables (D), milestones (M) and timelines are given in the Appendices, and referred to in the work package summaries below.

Following commencement of the project, there were some changes made to the consortium structure and some minor scope adjustments (the latter of which is dealt with in relevant subsections, and summarised briefly below). These changes were as follows:

- Heat Geek were originally scoped under WP5 to provide guidance and direction from their experience of training a large number of, mostly gas engineers and plumbing traders, in heat pump installation steps, as well as coordinating the MCS certification processes and work pipelines for a large number of suppliers (see more in section 3.5). Unfortunately Heat Geek were unable to be involved as anticipated, therefore were only able to provide limited support to DG Cities for WP5. Whilst more robust insights from industry experts were not available for the project, there was enough understanding and experience across the consortium partners to develop a suitable methodology for interacting with the supply chain.
- OVO were scoped to undertake surveys and consumer interactions under WP4 (see section 3.4), however it was established early on that the organisation had already carried out this work and thus this task item was not required. Existing information and data were already readily available from OVO on this topic, which was highly useful to completing WP4 to develop the consumer engagement strategy.
- The expectation at the outset of the project was that Nationwide and OVO may be able to develop a customer offering under WP3 that provided a finance and tariff structure amenable to homes in the Greenwich area. It was quickly realised by OVO that their heat pump-specific tariff offering was no longer available, and that the market for green lending and financing of heat pumps/home improvements to accommodate heat pumps was not developed enough for Nationwide to provide helpful insights into what a finance package might look like for customers. For this reason Nationwide took more of an advisory role on the project, with OVO still involved in a number of other WPs. The project took an alternative route to financing and supporting ongoing costs of heat pumps for customers that can be found in the following subsections.

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3.1 WP1 Project Scoping

The WP1 tasks were designed to gain a wider understanding of the landscape in which the Greenwich TIME project sits, WP1 acted as a miniature feasibility study within the larger Phase 1 feasibility study.

WP1 was a critical part of the coordinated methodology as it set the expectations of the consortium members right at the start:

- Creating a joint project vision was an important early step in forming an effective and engaged consortium motivated by similar factors
- Setting out the consumer offer early on was critical to ensuring that all consortium members understood the nature of the offer and how this would affect the WPs they were each feeding into.

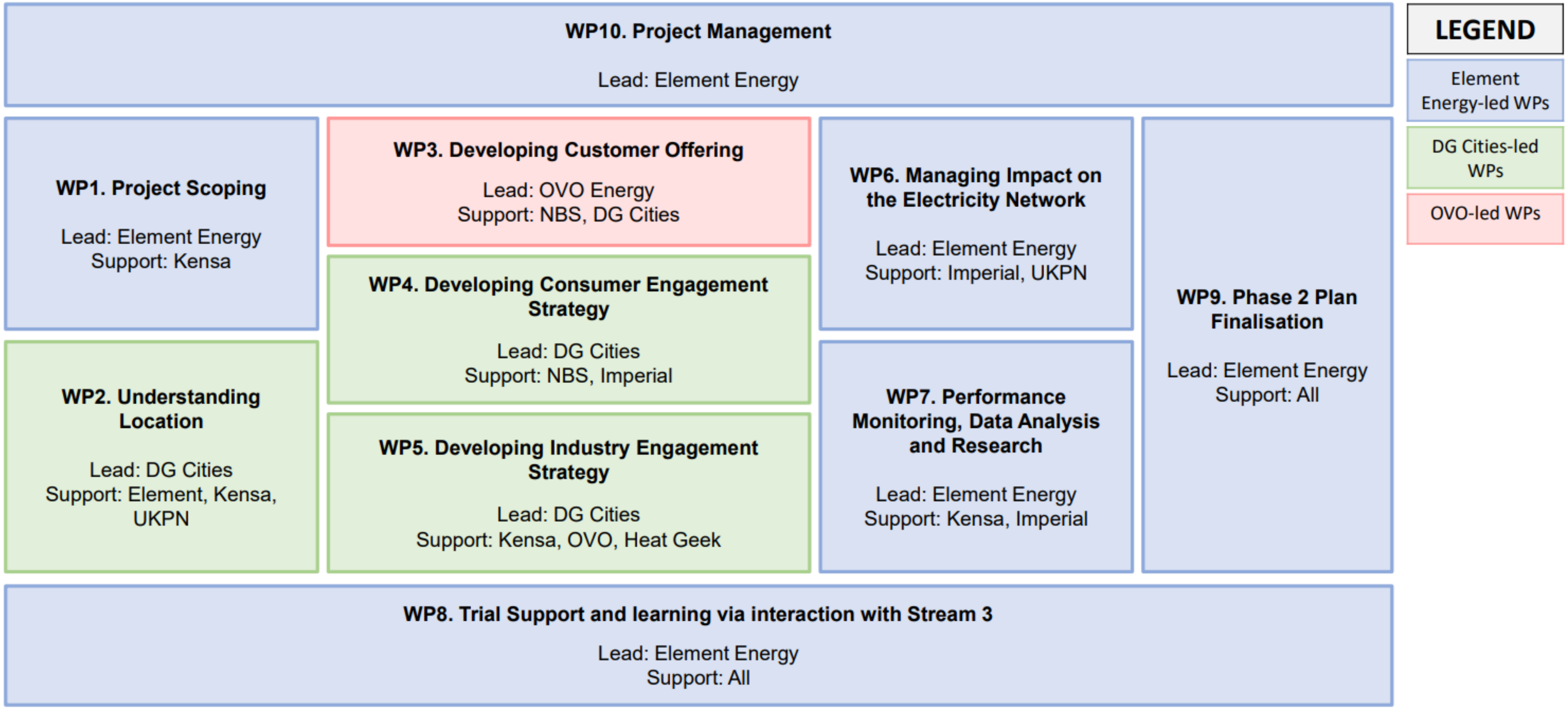
The aims and tasks from the Phase 1 proposal are listed below.

Aims

- Ensure a collective vision for the project between all project partners and BEIS, with key metrics agreed between all partners
- Ensure the assumptions and calculations made in the proposal stage are still valid
- Quantify the technoeconomic basis for the project including impact on fuel costs
- Understand the breadth and depth of consumer engagement required to achieve the intended deployment numbers

Tasks

- Review the inputs and outcomes from the proposal to ensure assumptions and calculations are still valid, with project vision and objectives agreed across all partners (M1.1/D1a)
- Review case studies to gauge the level of consumer engagement required.
- Undertake technoeconomic modelling of the GSHP Shared Ground Loop (SGL), both from the consumer side and the investor side. Include sensitivity analysis on changes in fuel prices. (M1.3/D1b)
- Scope the expected electricity network impacts to inform discussions with UKPN (feed into WP6)



WP10. Project Management
Lead: Element Energy

WP1. Project Scoping
Lead: Element Energy
Support: Kensa

WP2. Understanding Location
Lead: DG Cities
Support: Element, Kensa, UKPN

WP3. Developing Customer Offering
Lead: OVO Energy
Support: NBS, DG Cities

WP4. Developing Consumer Engagement Strategy
Lead: DG Cities
Support: NBS, Imperial

WP5. Developing Industry Engagement Strategy
Lead: DG Cities
Support: Kensa, OVO, Heat Geek

WP6. Managing Impact on the Electricity Network
Lead: Element Energy
Support: Imperial, UKPN

WP7. Performance Monitoring, Data Analysis and Research
Lead: Element Energy
Support: Kensa, Imperial

WP9. Phase 2 Plan Finalisation
Lead: Element Energy
Support: All

WP8. Trial Support and learning via interaction with Stream 3
Lead: Element Energy
Support: All

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- 🟦 Element Energy-led WPs
- 🟩 DG Cities-led WPs
- 🟥 OVO-led WPs

Figure 3.1. Summary of Phase 1 Work Packages.

3.2 WP2 Location Selection & Methodology Development

WP2 focused on developing a methodology for understanding where high-density deployment would be most viable and applying this to Greenwich. The developed methodology is one that can be adapted to other locations across the UK.

WP2 was a critical part of the coordinated methodology with strong links to:

- WP3 Developing the consumer offering which defined which consumer types should be targeted in the location selection methodology and
- WP6 Understanding Grid Impacts and Requirements which fed in an understanding of where grid constraints might present barriers to heat pump deployment.

Aims

- Develop a methodology for determining suitable locations for shared ground loop (SGL) deployment
- Identify potential target areas within Greenwich, their specific physical barriers and opportunities
- Explore how SGLs can be a viable solution for areas with high fuel poverty levels
- Understand the local electricity network constraints and identify how these can be managed
- Design for location specific GSHP systems

Tasks

- Undertake desk-based research to identify candidate locations (M2.1)
    - Conduct detailed archetyping process to quantify property heat loss, annual heating consumption, grid capacity, available waste heat and geological conditions
    - Repeat location identification based on findings from customer engagement and any other issues identified.
- Identify key barriers to fuel poor consumers and establish mechanisms for overcoming these, including policy intervention.
- Liaise with UKPN to understand any local network constraints (interaction with WP6). (M2.3)
- Bring the tasks above together to create a methodology for assessing suitability of locations for shared ground loop deployment including building types, technical suitability and social factors (willingness and ability to engage). (M2.4, D2)
- Design of GSHP systems compatible with the identified building archetypes and local ground conditions/availability, to be refined further in Phase 2

3.3 WP3 Developing the Customer Offering

In the Phase 1 proposal, WP3 focussed on the financial side of the customer offering but developed to have a strong focus on the consumer journey, the steps of that journey and the likely barriers.

WP3 was a central part of the coordinated methodology which defined the consumer types to be targeted, which in turn:

- Influenced the location selection (WP2)
- Defined the nature of the consumer engagement required for Phase 2 (WP4).

Aims

- Develop a financial offering that is commercially viable yet affordable and attractive to different types of consumers
- Understand the role of private and public investment in creating a viable financial offering
- Evaluate the developed customer offering

Tasks

- Identify a set of consumer archetypes, understanding their motivations and potential opportunities for engagement (M3.1)
- Review financial models currently available, understand their suitability for this project and assess the level of success they have achieved.
- Use the technoeconomic modelling from WP1 to model:
    - cost to customers (upfront costs, fuel bill impact, maintenance costs)
    - requirement for investment from public and private sectors.
- Develop a financial offering that considers all relevant customer archetypes, upfront costs, ongoing costs and payback mechanisms that also takes into account the additional benefits offered by heat pumps. (M3.2/M3.3)
- Engage with financial and regulatory experts to evaluate the financial offering(s) proposed. (M3.4/D3)
- Map out the consumer journey and develop a plan for how to support customers through that journey

3.4 WP4 Developing the Consumer Engagement Strategy

WP4 focussed on the consumer engagement strategy: understanding consumer attitudes to heat pumps, understanding the consumer challenges likely to be faced by the project in Phase 2 and developing a strategy for Phase 2 that will generate the uptake required for Phase 2 to be successful.

WP4 was strongly influenced and shaped by outcomes in WPs 1-3:

- Early on, WP1 defined the financial offer available to consumers and shaped the vision for the project – both of which shaped how consumers should be engaged to achieve high density heat pump deployment
- WP2 defined location, which in turn shapes to an extent how best to engage with communities in those locations
- WP3 defined the consumer offer that the engagement work will have to sell.

Aims

- Understand local attitudes to heat pumps
- Develop a communication strategy to engage a wide range of potential participants and raise the profile of the trial
- Develop a consumer engagement strategy that will enable Phase 2 deployment considering all elements of the consumer journey

Tasks

- Consumer interaction through surveys, interviews and workshops targeting key groups (householders, communities, installers and other supply chain organisations): (M4.1ac)

  - understand local attitudes and perceptions towards heat pumps
  - capture specific challenges related to the geography and local socioeconomic characteristics
  - codesign interventions with members of the public, and suppliers and customers from the supply chain.
- Use learnings from consumer interaction to create a detailed and accessible user journey and set of consumer personas describing the ideal user experience, from prepurchase marketing through to signup, installation, and day-to-day management. (M4.2/D4)
- Evaluate user journey plan

3.5 WP5 Developing an Industry Engagement Strategy

WP5 focussed on the supply chain elements key to facilitating deployment within Phase 2. This work focussed on understanding the barriers specific to the supply chain and mechanisms to overcome these to ensure Phase 2 nurtures the local supply chain in Greenwich.

Aims

- Understand the steps required to build a resilient supply chain

Tasks

- Develop a framework of clear principles and practices that all members of the supply chain will adopt to ensure they deliver against the joint purpose, vision, and values. This framework will be road tested and iterated with key stakeholders through co-design and engagement workshops. (M5.1ad)
- Carry out supply chain interviews, and extensive mapping of current and future supply chain actors to understand how to build a resilient supply chain. (M5.2)
- Identify key themes that promote capacity and innovation in the UK’s heat pump supply chain, including: a stable regulatory framework, government commitment and strategy to the industry. (D5)

3.6 WP6 Understanding Grid Impacts and Requirements

WP6 focussed on understanding the impact that the Greenwich TIME project is likely to have on the local electricity network and the likelihood of grid constraints in the target areas.

Aims

- Understand local grid conditions and impacts of deployment on the local grid
- Plan for any mitigation strategies required
- Understand the impact of upfront planning for high density deployment on grid planning and operation
- Investigate replicability of the agreed solutions

Tasks

- Model the impact of GSHP installation and operation on the local electricity grid. (M6.1)
- Engage with the DNO to understand (M6.2)
  - capacity constraints
  - any planned upgrades in the area

  - the network benefits of managing high-density GSHP deployments in partnership with the DNO.
- Assess the likelihood of network constraints (M6.3)
- Where constraints are identified, investigate mechanisms for either managing the load (e.g., through flexibility) or upgrading the network, and associated implications on the proposed consumer offering. (M6.4)
- Assess the replicability of the analysis, issues identified and management strategies identified to other areas. (D6)

3.7 WP7 Data Analysis and Research

The focus of WP7 was split between the quantitative analysis elements, feeding into other WPs where appropriate, and ensuring the learnings from the project were captured.

WP7 was a key connecting work package for many of the other WPs. While analysis was required in most WPs, WP7 acted as a support to many of the outputs and analysis tasks in other work packages.

Aims

- Quantify the reduction in total and peak local energy demand in association with the project through high efficiency GSHP systems
- Quantify the impact on fuel bills in moving from current heating systems to GSHPs
- Quantify the carbon emission reductions associated with the project from both energy demand reduction and moving from gas to electric heating
- Understand the potential energy system flexibility afforded by GSHPs
- Establish a monitoring strategy for installations within Phase 2
- Establish key learnings from the project to
  - Further the commercial potential of the consumer offering developed within the project
  - Provide evidence on which to base future policy decisions
  - Guide future investment in similar projects
- Understand customer attitudes to both the installation and customer offering

Tasks

- Model the expected energy demand reductions from moving from predominantly gas boilers to GSHPs including a comparison with other forms of low-carbon heating. (M7.1a). Quantify the impact on:
  - Household fuel bills (including fuel costs sensitivities)
  - Carbon emissions
  - Local energy demands (total and peak demands) (M7.1b)
- Undertake energy system modelling to understand the potential for energy system flexibility afforded by GSHPs and the potential to increase that flexibility through measures such as demand side response (DSR) (M7.2/D7.2)
- Develop a monitoring strategy for Phase 2 installations to rapidly identify any issues with installations and to understand energy use, demand profiles and opportunities for flexibility (D7.4)
- Monitor customer attitudes/satisfaction levels with installation, customer offering and ongoing service
- Analyse the wider potential of the consumer offering developed and the requirements for replicability including (D7.3)

  - Any legislative or regulatory updates required to facilitate commercialisation (e.g., derogations through regulatory sandboxes)
  - Understand the investment required for scale up and the achievable balance between public and private funding

3.8 WP8 Trial Support & Learning via Interaction with Stream 3

WP8 covered the proscribed interactions between Stream 1 and Stream 3.

Aims

- Facilitate interaction with Stream 3 activities
- Provide information, data and learning to Stream 3 parties to support dissemination activities

Tasks

- Interaction with Stream 3 to facilitate learning and collaboration. (M8.1a/b)
- Provide information for the research and evaluation activities within stream 3. (D8)

3.9 WP9 Finalisation of Phase 2 Plan

WP9 covered preparations for the submission for Phase 2 of the Heat Pump Ready Programme.

Aims

- Collate the finalised aspects of each work package
- Finalise the cost and delivery plan for Phase 2
- Understand the implications for policy from lessons learned within Phase 1
- Understand the legislative/regulatory requirements/implications
- Submit Phase 2 proposal

Tasks

- Agree the finalised deployment approach, locations, customer offering, aspects of the customer journey, financial planning, timeline and network impacts. (M9.1/D9.1)
- Consider the policy implications plus any legislative or regulatory requirements for Phase 2 (M9.2)
- Put together proposal for Phase 2 deployment study (D9.1)
- Creation of prototype marketing materials for Phase 2 (D9.3)

3.10 WP10 Project Management

WP10 covered the project management and coordination elements of the Greenwich TIME project.

Aim

- The overall aim of WP10 is to provide an efficient and effective project management structure and control to the project.

Tasks

- Planning/chairing regular consortium meetings during Phases 1 and 2 (M10.1a/b)
- Maintaining minutes (D10)

- Collating and quality checking deliverables, tracking progress against defined project KPIs
- Ongoing contact with BEIS as the lead contact

4 Methodology for Work Packages

This section summarises the methodology for work packages in Phase 1. Each sub-section provides a description of the methodology used or developed in the WP, the key inputs in terms of data and information, collaborations, barriers and challenges, and the replicability of the approach taken.

4.1 WP1 Project Scoping

4.1.1 Project vision and review of proposal assumptions

Put with the technoeconomic modelling, the WP1 tasks were designed to gain a wider understanding of the landscape in which the Greenwich TIME project sits. Effectively, WP1 acted as a miniature feasibility study within the larger Phase 1 feasibility study. In the Phase 1 proposal, the WP1 aims were listed as:

- Ensure a collective vision for the project between all project partners and BEIS, with key metrics agreed between all partners
- Ensure the assumptions and calculations made in the proposal stage are still valid
- Understand the breadth and depth of consumer engagement required to achieve the intended deployment numbers
- Review the inputs and outcomes from the proposal to ensure assumptions and calculations are still valid
- Review case studies to gauge the level of consumer engagement required.

After the in-person kick off meeting with BEIS, it was agreed within the consortium that another in-person meeting would be valuable. The partners came together at the OVO offices in London for an in-person meeting to discuss the project, agree a project vision and to discuss the early technoeconomic modelling. The items in the list above were discussed at this meeting, with Kensa bringing in experience from recent case studies of networked GSHP deployments, for both social housing and owner-occupied projects. OVO offered insights on the type and portion of customers likely to be interested in such an offer based on previous consumer engagement. Bringing this information together allowed the consortium to understand what the project was likely to look like, the key motivating factors for consumers and the type of consumers the project was likely to target.

4.1.2 Technoeconomic (TE) modelling

Overview

The aim of the technoeconomic modelling was to understand the costs to consumer of installing a networked GSHP system as part of the Greenwich TIME project. In the context of the wider project, the aims were to understand costs to consumer, to allow research of consumer attitudes towards costs and financing models, and to understand the biggest levers for reducing costs to consumers.

The technoeconomic modelling was carried out over 2 phases:

- an initial simple technoeconomic model
- a more detailed model built upon and adapted throughout the study.

The purpose of the two phase technoeconomic modelling process was to ensure that a basic version of the potential financial offer being made as part of the Greenwich TIME project was visible to all parties in the consortium as early as possible. Using a simple model allowed this financial overview to be provided to the consortium very early in the project and for all partners to be able to understand the key inputs and levers. This approach was taken to ensure all parties understood the likely financial offering that could be made in the project early on, minimising the risk of misunderstanding between parties and ensuring efforts to minimise consumer costs were directed at the biggest levers.

The more detailed technoeconomic model was developed throughout the project as options were investigated and decisions were made. Updates included:

- incorporation of a simple time of use tariff (off-peak/on-peak only) by splitting space heating and hot water demand and setting the cost of water heating to the off-peak rate
- inclusion of light retrofit measures, loft insulation and draughtproofing, that are low cost and low disruption but have a significant impact on the heat demand of the home
- inclusion of a fuel cost sensitivity calculation where the user can set basic assumptions around future energy costs
- inclusion of a sheet that projected costs out to 2050 and calculated cumulative costs and compared ground source heat pump costs to air source heat pumps, a gas boiler and other electric options (electric boiler and storage heaters).

Inputs

The inputs required for the task were:

1 Fuel bills

1.1 Fuel costs (p/kWh and standing charges)

Unit fuel costs were based on Ofgem price caps values for April-Sept 2022[3]. Costs were later updated to Ofgem costs from October 2022[4] (under the Energy Price Guarantee). Subsequently the BEIS recommended cost of 30p/kWh for electricity was used in the figures presented and the costs calculators submitted in the Phase 2 application, but gas unit costs used remained those of the price cap for the Energy Price Guarantee which commenced in October 2022[4]. Fuel cost projections were taken from BEIS Green Book[5]. The model contains options to apply simple adjustments to the projections to explore options for future price scenarios. The model is set up to easily accommodate updated data. However, it is unclear when updated forecasts will be available and the how reliable those forecasts can realistically be, given current uncertainty in energy prices.

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[3] Ofgem: Default tariff cap level: 1 April 2022 to 30 September 2022 https://www.ofgem.gov.uk/publications/default-tariff-cap-level-1-april-2022-30-september-2022 *accessed 19 December 2022*

[4] Ofgem: Energy Price Cap https://www.ofgem.gov.uk/energy-advice-households/check-if-energy-price-cap-affects-you *accessed 19 December 2022*

[5] UK Gov, BEIS Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal *accessed 19 December 2022*

1.2 Fuel demand

The **heat demand** of the house archetypes was taken from NEED data for property archetypes[14]. NEED data was used instead of EPC data, which is commonly used here, as EPC calculations typically overestimate the heat demand of a property and heat demand reductions associated with installing energy saving measures. The initial set of archetypes for the initial modelling was based on the most common house types in NEED data for Greater London; the final archetype information was based on building stock analysis of the target regions in Greenwich from EPC certificates.

For future iterations of this project, more accurate data on both the property characteristics and the energy demand from the properties would be valuable. EPC certificates offer a large dataset for properties across the UK but the data on individual properties is notoriously inaccurate and the predicted heat demands are generally much higher than the real usage[6]. The ideal datasets on which to base calculations like those carried out here would be smart meter data coupled with up to date, accurate information about the property characteristics, the kind of data that would be included in a building passport if these came about.

The source of data for the **efficiency of heating system** was generally from previous Element Energy studies. GSHP efficiencies were taken from Element Energy study for Kensa, modelled by Genius Energy Labs.[35] This data is consistent with values for communal GSHP system efficiencies used in Element Energy's study for the CCC’s Sixth Carbon Budget[7]. The current efficiency of gas boilers, electric boiler and storage heaters was taken from Element Energy's study for the CCC’s Sixth Carbon Budget[7].

2 Capital costs

Capital costs by archetype were based on Kensa estimates from their in-house engineers. Costs were split into the **cost of groundworks (boreholes and trenching) and fabric improvements** and **cost of the unit and installation**. Note that the fabric improvements and cost of unit plus the installation are specific to individual properties, whilst the groundwork capital costs are shared between the connected properties. Groundwork and fabric improvement costs were assumed to be repaid via a standing charge. The repayment of groundworks via a standing charge emulates the arrangements with the gas network today, as consumers do not pay upfront for their own gas pipes feeding their property, they pay this through the standing charge. The inclusion of fabric improvement costs within the standing charge allows consumers to avoid the typically high upfront costs of retrofit works and repay over a longer period.

3 Ongoing costs (apart from fuel costs)

The main ongoing costs are 1) the **standing charge** calculated from IRR of 6% over 40 years on capex of groundworks and fabric improvements - values based on input from

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[6] This is a well-recognised effect in EPCs known as the ‘rebound effect’ where predicted energy usage in metrics such as SAP calculations do not accurately reflect actual energy use in the home, as they do not take into account how individuals behave in their homes. An example study of this is: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/789775/Comparison_of_theoretical_energy_consumption_with_actual_usage.pdf

[7] Climate Change Committee: Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget (Element Energy) https://www.theccc.org.uk/publication/development-of-trajectories-for-residential-heat-decarbonisation-to-inform-the-sixth-carbon-budget-element-energy/ *published April 2021*

Kensa, and 2) any **financing required for the upfront cost to householder**, with interest rates based on Nationwide's current typical green financing products[8]. Maintenance costs are assumed to be minimal for the GSHP system (~£30 per annum).

The IRR is considered a key lever in the financial offering within the Greenwich TIME methodology and one that has significant potential for reduction. The rate of 6% used in the Greenwich TIME study was the highest considered in the study and is expected to come down to 4% with increased investor confidence in the networked GSHP solution. These numbers are based on conversations had and offers made to Kensa from investment organisations.

Another avenue for reducing the IRR value, and therefore the standing charge, is the use of green financing secured through a local authority. These green loans could be repaid at rates of 3%, which reduces the annual standing charge by about 30% compared to a 6% rate. This option was considered for the Greenwich TIME project with Greenwich Council but decided against on two considerations: firstly, the Council is hesitant to take on the risk associated with offering a loan at 3%, for which the private sector currently want 6%; secondly, if the Council were to take out this loan, they would prefer to put money into areas of high fuel poverty rather than an able-to-pay area. The option of green finance secured via the local authority therefore remains an open option for future iterations of the project in Greenwich and elsewhere.

4 Cumulative costs

The model also calculated cumulative costs of the proposed GSHP system and compared this to the costs associated with an ASHP, gas boiler and other electric options (electric boiler and storage heaters).

5 Additional inputs

A very basic estimation of savings from an E7 time of use tariff was also provided as part of the TE model. For this an estimation of the energy consumption of the heat pump over a typical 24-hour period was used, taken from a previous study[9]. In previous Element Energy work, the split of energy consumption for space heating vs hot water (a ratio of 3.5:1) in the homes has also been used to determine the day versus night-time heating demand, with all hot water heating demands assumed to be during the night. In future, a larger dataset of day and night-time electricity use for heat pumps (perhaps taken from smart meter data) would be useful to refine these estimates, as heating requirements are expected to vary significantly with house type: for example, a much larger portion of the heat demands in new builds comes from hot water than in older properties, where space heating is the dominant demand.

It would also be useful to know the specific efficiency of the current boiler system to estimate savings, considering boiler age and type.

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[8] Louise Vanheems, Nationwide, *pers. comm. October 2022*

[9] Jenny Love, Andrew Z.P. Smith, Stephen Watson, Eleni Oikonomou, Alex Summerfield, Colin Gleeson, Phillip Biddulph, Lai Fong Chiu, Jez Wingfield, Chris Martin, Andy Stone, Robert Lowe, The addition of heat pump electricity load profiles to GB electricity demand: Evidence from a heat pump field trial, Applied Energy, Volume 204, 2017, Pages 332-342, ISSN 0306-2619, https://doi.org/10.1016/j.apenergy.2017.07.026.

Collaborations

Kensa

The calculations in the technoeconomic (TE) model were largely based on calculations carried out as part of a previous study by Element Energy for Kensa.[35] This gave the project a head start on modelling the system as well as base costs to use as dummy numbers for sense checking the model.

The costs provided by Kensa specific to the Greenwich TIME project were integral to the TE modelling, and therefore also to the consumer offer, and the types of customers and homes that could be targeted. Kensa gave costs for most common archetypes in the target area. These costs were calculated by Kensa engineers, via the project contacts at Kensa.

There is an issue here that the costs are very Kensa-specific, and therefore less replicable with other project partners (although the figures should be in the same ballpark). It would be ideal to take costs from a wider database e.g., MCS[10] or Home Energy Scotland[11] but few datasets are sufficiently large to support this analysis yet (the newly released MCS data dashboard may prove useful here).[12] Costs would also have to be split into groundworks and other costs; it is difficult to pull apart component costs such as that of system design and project management. There is a further issue in that the variation within an archetype can be very high, with items like piping replacements likely to be an issue in a portion of homes across most archetypes that can require several thousand pounds worth of works. It is therefore difficult to get accurate costs until more about the properties is known. A key advantage of the networked GSHP based solution is that homes within a certain area are likely to have been built at the same time, and are likely to have the same level of suitability for various measures and ancillary works, reducing the time and costs associated with surveying, designing and installing the systems.

The collaboration between the WP1 lead, Element Energy, and Kensa was managed by via regular calls, both one-to-one and as part of the wider consortium. Iterations of the TE model were discussed with Kensa to highlight the input required, discuss how the TE model should account for various factors, and ensure the TE model captured all aspects (e.g., annual maintenance costs). Element Energy and Kensa held calls between both the project leads on each side and with the engineers on the Kensa side who were doing the detailed cost modelling to ensure the inputs being used in the Kensa modelling and those in the Greenwich TIME technoeconomic modelling were aligned. There was a clear aim to this collaboration: to understand the costs to consumer of the networked GSHP heating solution for the homes under consideration in Greenwich.

OVO

Collaboration with OVO provided useful discussions around the possibility of incorporating a heat pump tariff into the consumer offer. OVO investigated a heat pump tariff within the confines of a previous study, Greater Manchester Local Energy Market project (GM LEM)[13]. The heat pump tariff in the previous study had a system where the electricity used for the heat pump was charged at a unit cost 5p lower than the electricity unit cost for other

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[10] MCS https://mcscertified.com/ *accessed 19 December 2022*
[11] Home Energy Scotland https://www.homeenergyscotland.org/ *accessed 19 December 2022*
[12] MCS data dashboard https://mcscertified.com/about-the-mcs-data-dashboard/ *accessed November 2022*
[13] Greater Manchester Combined Authority: Energy Supply https://www.greatermanchester-ca.gov.uk/what-we-do/environment/energy-supply/ *accessed 22 December 2022*

purposes. An extension or adaption of this tariff was discussed with OVO and Kensa, with the ideal situation being the development of a GSHP-specific tariff optimised for GSHP operation. The GSHP tariff options did not come to fruition during this project due to a mixture of the current energy climate and the instruction from BEIS that no new commercial products were to be developed and trialled on consumers within Stream 1 of the Heat Pump Ready Programme.

In discussions around potential future options for reducing the cost of the networked GSHP solution, OVO brought forward their expertise on the methodology used to generate the previous heat pump tariff and have indicated that they are open to revisiting it in the future. Once tariff options open up more, following stabilisation of gas and electricity prices, the ToU tariff is likely to be critical to effective heat pump rollout, encouraging homeowners to use the heat pump in the most effective way by:

1. running at low temperatures for longer time periods
2. minimising the impact on the local grid by avoiding peak times
3. saving money by heating water at times of cheap electricity.

The Element Energy/OVO relationship required more input at the start of the project as OVO’s role was the least well defined of the partners at the bidding stage. More one-to-one calls were set up initially to establish OVO’s role as WP3 lead but once established, the partners at OVO showed strong leadership and brought critical expertise to the project through their general experience with dealing with a large customer base and designing customer journeys, as well as their specific experience on the recent Electrification of Heat project. The discussions around tariffs are ongoing and have been taking place between other partners (not Element Energy), although any final agreements will need to be tested in the model and fed into a final version of the consumer offer in Phase 2.

Nationwide Building Society

Nationwide provided information on green finance products, interest rates and timeframes. Much of the quantitative information was available online but the Nationwide representative within the consortium was able to offer insights on the potential flexibility of those products and, most valuably, consumer interest and uptake of green finance products. The length of payback time was found to be a key lever in the attempt to bring annual costs equal to or below gas boiler levels when the in-house works were not being paid in full upfront.

Nationwide additionally pointed out that most green finance products, or at least the most favourable ones, were only available to existing Nationwide customers (who had been with Nationwide six months or more) but that other mortgage providers were likely to have similar offers available to customers.

Nationwide were not in a position to consider financing the groundworks, which had been a potential option from Kensa’s point of view. The potential for large, familiar investors like Nationwide to invest in the groundwork infrastructure remains of interest for future iterations of the project.

Barriers and challenges

Key challenges in the development of the TE model were:

- Obtaining accurate costs that still accounted for the range that might be found within an archetype
- The fact that the basic TE model showed that this solution was found to not be cheaper than a gas boiler, at least for a large portion of properties
    - This had a major impact on the kind of consumers and property types that could be targeted
    - Relatively rough numbers were used to set up the initial basic TE model, standard electricity prices, average cost of works from Kensa, average gas demand values for London homes
    - Having a basic initial TE model allowed it to be shown to partners early, for partners to be able to play with the model themselves and to establish the biggest levers on the costs
    - Had the costs not been shown to the whole consortium until later, the messaging, site selection, consumer offer would all have been affected
    - The more detailed TE model allows the impact of things like ToU tariffs to be taken into account.

Replication

This work relied on a knowledge of the system offered by Kensa and the input costs provided by Kensa. A reasonable level of excel knowledge is required to set the up but nothing specialised, so this work could be carried out by a consultancy or an analyst within a partner organisation.

Cost information from Kensa was integral to the process, as was knowledge of how the finances for the networked ground source system were set up but Element Energy already had this knowledge from previous work.

There is nothing in the methodology used here that is specific to Greenwich. The costs would need to be updated for different house types but there is no house type that could not be considered. Various inputs to the model could be updated to account for changes such as fuel cost changes, different IRRs and additional measures to reduce the heat demand of the buildings.

4.1.3 Scoping grid impacts

Information on scoping of the grid impacts is given in the details of WP6 and is not repeated here.

4.2 WP2 Location Selection & Methodology Development

Overview

The aim of the WP2 was to identify potential locations within Greenwich suitable for Phase 2 of the Greenwich TIME project using a methodology that would be replicable for other sites.

The technical solution being deployed in the Greenwich TIME project, networked GSHPs, has most commonly been deployed in blocks of flats, which make up around 12% of the UK housing stock.[14] Terraced housing is the most common house type in the UK, with 32% of the housing stock, followed by semi-detached homes at 29%. The aim of the Greenwich TIME project is to demonstrate the opportunities for decarbonising large sections of the UK housing stock through the deployment of high-density heat pumps via a networked GSHP solution. From the technical side, a row of terraced houses is very similar to a block of flats on its side, such that the technical solution being considered is ideally suited to rows of terraced housing, though it could be adapted to detached and semi-detached homes that are in close proximity to each other. As such, there was no restriction placed on the house types in this study but there was a strong preference for pre-1919 terraced homes to make up the bulk of deployments to make the results from this study replicable as possible on other sites.

Understanding the housing stock

The first stage of the location methodology was to understand the housing stock in Greenwich, both in terms of building characteristics and the socioeconomics of the residents. Table 4-1 outlines the average rates of various property characteristics of dwellings and of socioeconomic factors in Greenwich and the UK. Around 20% of the homes in in Greenwich did not have an EPC rating (a total data sample of 84,000 out of the 106,000 homes in Greenwich). Tenure data, also obtained from the EPC dataset, was not known for all the homes. This is one of the limitations of the data, which are detailed further below, though being able to characterise areas in their local and wider representativeness, and their property-socioeconomic interactions, was an important process of the site selection.

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[14] NEED Energy Consumption Tables 2019 https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-consumption-data-tables-2021 *accessed August 2022*

Table 4-1. Average rates of various property characteristics used to assess areas for networked GSHP deployment as part of the Greenwich TIME study.

Characteristic	Greenwich averages	UK/ England averages
Income deprivation *IMD (2019)*	RBG has 9 LSOAs in the worst 10% of the UK for income deprivation, and 32 in the worst 20%. Greenwich's average LSOA ranking is 11,738/ 32,844 total LSOAs	n/a
Fuel poverty *BEIS LILEE data (2020)*[15]	12.9% households in fuel poverty (3rd highest of outer London boroughs)	11% in fuel poverty in London 13% in fuel poverty in England
EPC *EPC open data DLUHC (2022)*[16]*; ONS data (2021)*[17]	Average EPC rating D for RBG properties 44% share with poor EPC (below C)	Average EPC rating D for national dwellings (rating of 60); 58% in England are below EPC C
Heating fuel source *EPC open data (2022), English Housing Survey (2019)*	72% of the Borough homes are estimated to be using mains gas (or community level) as the main fuel source of heating.	86% of UK homes are heated by gas.
Property age *London datastore (2015)*[18] *ONS property data summary (2021)*[19],[20]	● 17% pre-1900 ● 27% pre-1939 ● 17% pre-1964 ● 14% pre-1982 ● 8% pre-1999 ● 15% pre-2015	England: ● 15% pre-1900 ● 46% between 1930 and 1982 ● 7% in 2012 or later
Property type *London datastore (2015)* *ONS data (2021)*	● 51,050 flats (48%), ● 38,260 terraced houses (36%) ● 13,910 semi (13%) ● 2,310 detached (3%) ● 840 bungalows (1%)	● 28% terraced ● 26% semi-detached ● 16% detached ● 20% flat ● 9% bungalow
Property tenure *EPC open data, DLUHC (2022)*	● 39% (47%) owner occupied ● 19.5% (24%) private rental ● 23.5% (29%) social rented ● *18.5% unknown (removed %s)*	● 64% owner occupied ● 19% private rental ● 10% socially rented from private providers ● 7% socially rented from local authority

*Tenure data with unknown properties is presented in brackets in the above table.

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[15] UK Government: Fuel poverty statistics https://www.gov.uk/government/collections/fuel-poverty-statistics *accessed August 2022*

[16] Energy Performance of Buildings Data: England and Wales https://epc.opendatacommunities.org/ *accessed August 2022*

[17] Office for National Statistics: Age of the property is the biggest single factor in energy efficiency of homes https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/ageofthepropertyisthebiggestsinglefactorinenergyefficiencyofhomes/2021-11-01 *published 6th January 2022*

[18] London Datastore: Dwellings by Property Build Period and Type, LSOA and MSOA https://data.london.gov.uk/dataset/property-build-period-lsoa *accessed August 2022*

[19] UK Government national statistics: Dwelling stock estimates in England: 2021 Dwelling stock estimates in England: 2021 - GOV.UK *accessed August 2022*

[20] BRE Trust: The Housing Stock of The United Kingdom https://files.bregroup.com/bretrust/The-Housing-Stock-of-the-United-Kingdom_Report_BRE-Trust.pdf *accessed August 2022, data from 2017*

For future studies, more complete datasets would be valuable to better understand the areas under consideration. An obvious dataset would be Home Analytics[21], compiled by Energy Saving Trust from EPC data and OS data. The use of this data was investigated during this project initially via Greenwich Council, to see if the Council already had access to Home Analytics data for Greenwich. Getting Home Analytics data for the project was then investigated but the cost and time taken to license and access the data had to be weighed up against the extra value it gave. For the Greenwich project, where the area was well known to the project partners and the target house types already understood, it was deemed that the current data would suffice. For future iterations of the project, however, the use of more detailed and complete data like Home Analytics could be valuable.

In the experience of project partners, accessing this data has taken a number of weeks even where the local authority has the appropriate license in place already. The organisation that is requesting the license, such as the local authority, needs to have an OS contractor license as Home Analytics data uses OS data. The party analysing the data then needs to sign an OS contractor license form with the party that has the license, e.g. the local authority. It can take many weeks to get the license set up and signed, plus more time for Energy Saving Trust to bring the data together. The detail in Home Analytics data is valuable but the short timeframe of the HPR Phase 1 feasibility study meant that the time to access the data was prohibitive, especially when weighing up the extra information it could provide over the relatively small areas being considered.

Initial site selection

To narrow down the areas considered in the site selection, Kensa identified an initial list of 10 areas (through a high-level mapping exercise using google maps) that appeared to be representative of the property characteristics in Greenwich (in terms of housing property type and age). Kensa was able to provide these starter areas due to the initial discussion that had taken place around targeting very common house types, e.g., pre-1919 terraced houses, and due to the localised nature of the project i.e., within Greenwich. Had these starting parameters been different, for example if properties with high EPCs or high rates of fuel poverty were being targeted, this initial first sweep of sites would be conducted by mapping the sites with the key target characteristics and picking the sites that most closely match the desired criteria.

Data driven mapping

To progress from the initial long list of sites, DG Cities conducted a data driven mapping exercise to map the initially identified sites in GIS. This process investigated the property archetypes (age, type, tenure), household population density, social housing presence, wider replicability, and grid constraints. The process for site selection is illustrated in Figure 4.1.

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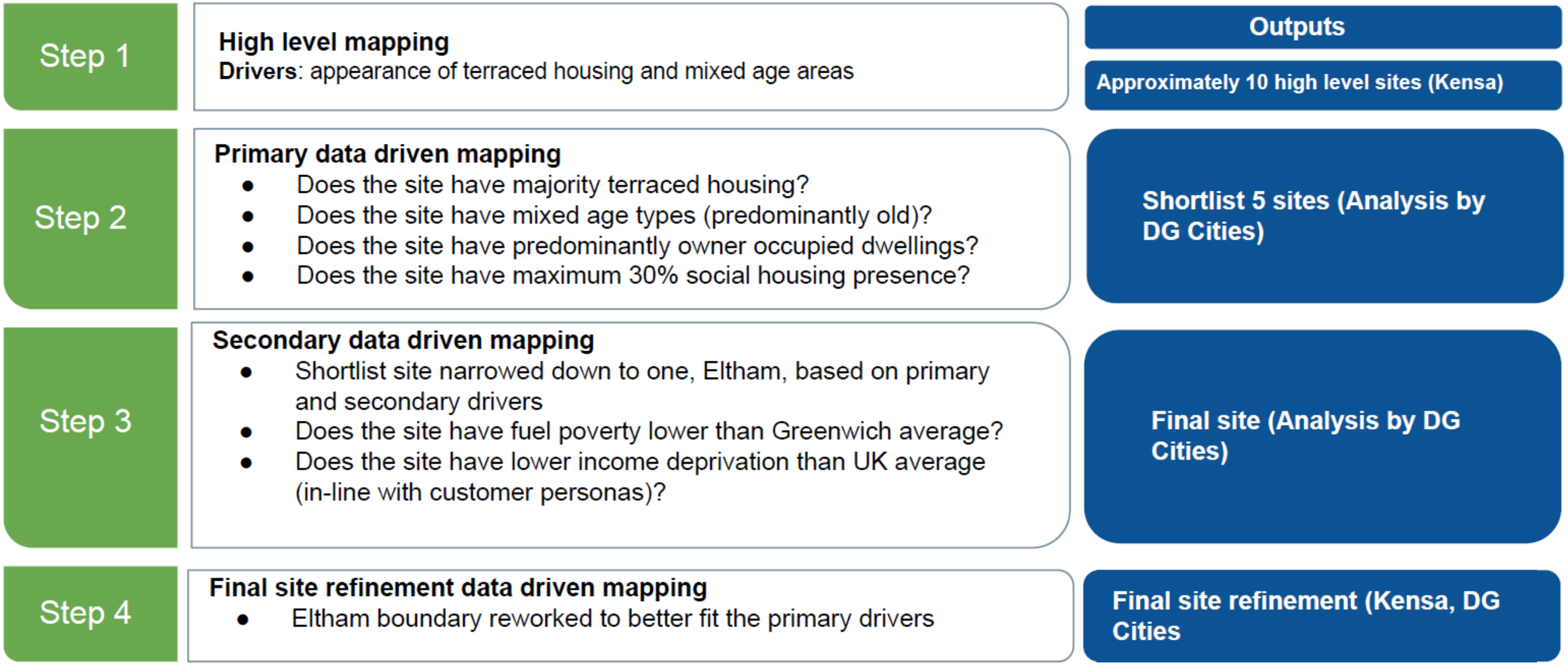
[21] https://energysavingtrust.org.uk/service/home-analytics/



		Outputs
Step 1	**High level mapping** **Drivers**: appearance of terraced housing and mixed age areas	Approximately 10 high level sites (Kensa)
Step 2	**Primary data driven mapping** • Does the site have majority terraced housing? • Does the site have mixed age types (predominantly old)? • Does the site have predominantly owner occupied dwellings? • Does the site have maximum 30% social housing presence?	Shortlist 5 sites (Analysis by DG Cities)
Step 3	**Secondary data driven mapping** • Shortlist site narrowed down to one, Eltham, based on primary and secondary drivers • Does the site have fuel poverty lower than Greenwich average? • Does the site have lower income deprivation than UK average (in-line with customer personas)?	Final site (Analysis by DG Cities)
Step 4	**Final site refinement data driven mapping** • Eltham boundary reworked to better fit the primary drivers	Final site refinement (Kensa, DG Cities

Figure 4.1: Illustration of the process taken for site selection in the Greenwich TIME project.

A series of inputs were used for the data driven mapping exercise, each categorised as primary or secondary drivers. The primary drivers were used to shortlist a number of potential sites in the borough, which were further refined to three sites. The secondary drivers were then used to help determine the most suitable site. These inputs were mainly obtained from various publicly available data sources, and information from project partners (e.g., UKPN and OVO Energy).

4.2.1 Primary Drivers

This section summarises the primary drivers for the identification of suitable target households for high-density heat pump deployment, the data that was used to support assessment of each driver and how it was used, the replicability of the data in other projects and the limitations of the approach.

1. **Building types** (age, types, tenure), **density, and EPC**

- **Data source:**
  - The property building data (age, type) was obtained from two sources: the London Datastore dwellings data, which reflects the latest (2015) publicly available property type (including room breakdowns) and age data at an LSOA level.[18] This dataset covers 106,000 homes in Greenwich.
  - EPC data was obtained from publicly available data.[16] The EPC data is based on inspection data from 2008 to 2022, capturing EPC certificate assessment scores for energy efficiency alongside other property data. The latest dates were used to identify EPC ratings. The EPC data was provided at property and post-code level, which was also therefore mapped to LSOAs; the dataset was cleaned to remove duplicates and to use the latest EPC certificate for the households, reflecting 84,000 homes (of the 106,000 homes) across Greenwich. The EPC dataset provided household EPC ratings and property tenure (by property type) variables.
- **Use within the project:**
  - These data points were used to understand the provision and distribution of different building types within Greenwich at an LSOA level. The age of the building did not directly determine site selection but was useful characteristic data to check how representative the area was.
  - Various sites were selected for initial consideration, with terraced housing being a preferred housing type (through mapping search). The London Datastore data was then used to clarify the types of property present in the potential areas (flat, terraced, semi and detached properties).
  - This data also enabled the team to select a site that has a mixed nature that is representative of Greenwich and wider UK urban areas in terms of its property type and age. The analysis included Greenwich and UK wide averages for each variable to allow these representative checks to be made. The project aimed to select a representative site to ensure lessons learned are applicable and developed solutions are replicable across the UK.
- **Data Replicability:**
  - This data is available for all LSOAs within the UK, making it beneficial for use outside of this project.

- **Limitations:**
    - As the latest London Datastore data is from the year 2015, homes built after this time period are not reflected. The EPC dataset reflects only a proportion (80%) of Greenwich's total housing stock and some of the properties have an EPC certificate that is several years old and may be out of date.
    - This is a key caveat to the analysis and means this stage of site understanding and selection is necessarily indicative and a first stage. This process is ultimately refined with the project's local engagement and with understanding of local areas from DG Cities and RBG.

2. Minimum site size - household population

- **Overview:**
    - The minimum site size primary driver was created to meet the BEIS requirements that the project deploy in 25% of homes on a certain level of grid connection and that the project represent a significant increase in heat pump deployment in that area (second requirement later removed)
    - The Greenwich TIME project originally intended to target 1,000 heat pump deployments
    - At a minimum, 85% of these households also need to be on mains gas (this was a requirement of the Heat Pump Ready project). The EPC dataset included the variable of heating fuel source so this could be checked to ensure the site contained a sufficient household population on a mains gas.
    - The minimum site size is also influenced by NESTA (2021) research which indicates that approximately 32% of householders would be willing to pay for a heat pump, the same percentage as required from BEIS for the high-density deployment criteria (the NESTA values were taken as indicative only, and a key part of this work is to develop and present an attractive consumer offer)**Error! Bookmark not defined.**
    - The deployment of 1,000 heat pumps at an uptake rate of 25% therefore required target areas in the region of 4,000 homes.
- **Data source:**
    - The population size is based on population households' data at an LSOA level, obtained from the latest (2020) BEIS sub-regional Fuel Poverty dataset.
- **Replicability:**
    - The data used is available across the UK and research such as that by NESTA and further emerging research, such as that developed through this project, can be used to inform consumer uptake of heat pumps across the UK.

3. Maximum 30% social housing in an area

- **Overview:**
    - This driver is one of the main requirements outlined by BEIS for this funding opportunity.

- **Data source:**
    - To ensure that the selected area does not exceed 30% of social housing, the provision of social housing within the borough was obtained from the Royal Borough of Greenwich to check the site area retained the minimum household population.
- **Use within the project:**
    - The social housing presence was mapped in GIS for the entire borough. Areas with significant social housing presence, and in breach of other primary drivers, were not selected.

4. Wider replicability

- **Overview:**
    - This driver is one of the main requirements outlined by BEIS for this funding opportunity and key to the success of Greenwich TIME methodology as a commercial solution for heat pump deployment.
- **Data source:**
    - This driver is based on various data sources (e.g., building age, type and EPC ratings) mapped within Greenwich, and compared to national provision. Areas that have similar characteristics (e.g., building typology averages) to the national averages were given higher preference when selecting a site for heat pump deployment.

5. Level of grid constraints and substation 25% coverage

- **Overview:**
    - This driver is one of the main requirements outlined by BEIS for this funding opportunity.
    - More generally, high density deployment of heat pumps will have an impact on the local grid and is therefore important to investigate as part of a methodology for high density deployment
- **Data source:**
    - DG Cities used a dataset published by UKPN to support EV charging rollout. This dataset provides a view of approximate available local substation capacity by indicating whether 150kW+ or 50kW+ chargers could be installed connected to those substations. A manual process was used in translating the data from the UKPN platform to be integrated in a GIS analysis. Sites were used that indicated the availability of headroom for chargers of over 150kW as proxies for available grid capacity for heat pump rollout.
    - Following this analysis a subset of the substations were assessed by UKPN. Areas with limited grid capacity were not considered for further analysis. Further grid constraint analysis was conducted to determine which of the potentially suitable sites would have sufficient capacity for a minimum of 1,000 households to install heat pumps and utilise the grid network.

4.2.2 Secondary Considerations

1. Customer profiles

- **Overview:**
    - Following those developed in one of their previous heat pump engagement studies, OVO Energy identified consumer profiles to help determine which groups would likely be interested in investing in a heat pump (more details in section 4.3.1). The consumer profiles from OVO Energy are:
    - **Intellectual Passion:** mid-career individuals with a higher income, kids, and are generally early adopters of new technologies. They need guidance to access to new products/info about environmental choices.
    - **Paying it Back:** want to look after the community, are older and have families, and have high income. They are community oriented and have capital to spend. They are already doing the basics to reduce their climate impact.
- **Data source**:
    - The above consumer profiles were matched with publicly available data, in order to map the consumer profiles within GIS and across the shortlisted sites.
        - **'Intellectual Passion' Persona was mapped using:** Least deprived communities (income deprivation Index, from the IMD data 2019) and percentage of residents with higher education levels (NVQ4+) obtained from the Census data 2011).
        - **'Paying it Back' Persona was mapped using:** Least deprived communities (income deprivation Index, from the IMD data 2019) and percentage of people over 50 years old (from the ONS, 2022)
- **Use within the project**:
    - Each LSOA was analysed using the above data points to identify the highest achieving areas. For example, for the 'Intellectual Passion' persona, the LSOAs with the least deprived communities were cross referenced with LSOAs with high education levels. Areas which performed well in both aspects were highlighted and mapped as part of the persona.
- **Limitations**:
    - It is important to note that the data used here is only indicative of where the consumer profiles may be well concentrated within Greenwich, but the data is limited by its date, and it is through the project's engagement and research (qualitative interviews and survey) that these profiles and their presence will be better understood, especially as they reflect, at their core, people's attitudes and perspectives as well as their willingness and ability to pay.

2. Fuel poverty

- **Data source**:
    - Fuel poverty data was retrieved from BEIS.[15] The BEIS Fuel Poverty data used here is the latest release from 2022 of the 2020 data. This data uses the Low-Income Low Energy Efficiency (LILEE) indicator to capture homes that are low income and low energy efficiency, where for each LSOA the share of homes that do meet the LILEE criteria is calculated. At an average 12.9% of Greenwich's homes were in fuel poverty so each area could be compared to the Greenwich and UK levels to see how representative they are.

    - It is important to recognise that more households are now falling into fuel poverty due to the energy cost crisis, and that this data, though recent, will soon be outdated. This will be revisited once new data is available.
    - The income deprivation measure as part of the Index of Multiple Deprivation (2019)[22] was also used as a further reference point to understand and narrow site selection to ensure that areas of acute income deprivation were not included.
- **Use within project:**
    - As well as building up the area profiles in this stage of the methodology, the level of fuel poverty was an important site characteristic when it came to selecting between the preferred sites. The final selected site (subject to meeting all primary drivers) performed better on fuel poverty and income deprivation, which is line with the consumer profiles developed for heat pump uptake.
- **Data Replicability:**
    - The data was mapped in GIS, across the various LSOAs within Greenwich. The data was used to reflect fuel poverty and income deprivation across the borough.

3. Waste heat potential and network supporting assets:

This consideration was based on viewing the spatial distribution of uses on google maps and determining where potential waste heat sites are located (at a high level). The intent of this observation was to determine whether there are public and commercial users with potential heat that can be used to provide heat for residents. No sites were identified for this project, but the incorporation of waste heat is expected to feature in future iterations of such projects.

4.3 WP3 Developing the Customer Offering

Introduction and Aim of the Project

OVO's role in Phase 1 of the Greenwich TIME project has been to develop a methodology for a consumer offer in deploying high density ground source heat pump deployment in the Royal Borough of Greenwich.

OVO is a well-established, green energy company with a mission to make energy cheaper, greener and simpler for everyone. The Greenwich TIME project aligns with their core mission - it is looking at ways of tackling heat pump deployment in high density urban areas where an air source heat pump solution is not viable.

Together with the consortium partners, OVO was responsible for developing a consumer offer methodology and detailing the full joined up approach with all partners involved. A key consideration when developing the consumer offer is to ensure that it can be replicated in other similar areas of Great Britain and be sustainable without the future requirement for public funding.

OVO being a national Energy Supplier enables the methodology approach to be replicated in other areas of the country beyond Greenwich. OVO currently stands as the UK's 3rd largest energy supplier, with proven green credentials.

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[22] UK Office for National Statistics: English indices of deprivation 2019 https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019 *accessed August 2022*

The aim of the process through which OVO went through to develop the consumer methodology was to identify the following:

I. Who out of all the consortium members would be best placed and most trusted to own the end-to-end customer journey? This includes being the main touch point for consumer contact.
II. Map out the end-to-end customer journey in order to best plan for an optimal customer experience.
III. Understand and identify key areas of ownership across the value chain of the customer journey.
IV. Create a consumer offer methodology that is appropriate for the identified different persona types

The process of developing the consumer methodology is critical to the delivery of the overall project as it enables an understanding how best to engage with customers and get them to sign up to the Ground Source Heat Network. The consumer journey is complex and so it is key to try and simplify this for the end customer as much as possible.

Inputs required for developing the consumer offer methodology

In order to develop the methodology for the consumer offer a number of inputs were required, particularly in trying to understand and identify target customers for a Ground Source Heat network in Greenwich. The list of inputs is detailed below:

4.3.1 User Research

OVO have conducted prior research around heat pumps, in particular around what role energy suppliers could play in the emerging domestic heat pump market. Through this research OVO identified different personas that could be applied to the thinking and methodology for Greenwich TIME.

The user research was shared with DG cities to help shape their consumer engagement strategy. It included suggestions of how best to communicate with each of the personas.

There were 6 clear personas that emerged when conducting research around heat pump technology with OVO's customer base. The main personas were identified as follows:

1. **'Intellectual Passion'** - consumers who are committed to the cause and making a change
2. **'Paying it Back'** - want to make good use of their resources to benefit family and community
3. **'Care but Can't' (Physical)** - consumers have a positive attitude but have constraints that stop them doing more. They need access to environmentally friendly products that can be implemented in any home.
4. **'Care but Can't' (Time/Money)** - consumers have a positive attitude but have other demands on their time and money
5. **'Convince me'** - have the means to change behaviour but want to know why they should
6. **'Doing my bit already'** - are passive and inert and need active direction or incentives

The detailed OVO consumer research is given in Appendix section 13.3.

Methodology for User Research

The aim of the user research conducted was to;

1. To identify the size of the opportunity of the domestic heat pump market in the UK and the customers who may be most engaged
2. To understand what role energy suppliers can play in terms of offering relevant propositions and helping customers in the purchase journey

The core findings from the research were based on feedback from three streams of research. These were:

- Detailed quantitative research with 2,000 Climate Conscious Homeowners across the UK to understand market potential, core targets, motivators and barriers
- Omnibus research with a nationally representative audience of 2,000 to gain a view of overall market metrics
- Qualitative interviews with 10 heat pump owners to understand opportunities to leverage throughout the customer journey

Financial review

A fundamental part of any consumer offer is the price. Understanding the financial elements that make up the total price to the consumer are crucial to enable the consumer offer to be developed. When talking about the financial impact, this needs to be clear, transparent and easy to understand for the customer.

There were interactions between all stakeholders to understand the cost implications to develop a Ground Source Network and how these costs can best be presented to the customers.

Given the volatility of the energy market, it’s extremely challenging to predict what the running costs will be as the wholesale cost of electricity is currently at its highest. Running costs were calculated based on the Octopus Agile Time of Use Tariff (ToUT)[23] which is a commercially available tariff that would support additional savings on running costs.

Kensa were instrumental in providing the upfront costs of the Ground Source Heat network to a consumer. Given the large upfront costs, in order to make the consumer offer viable, the consortium had to assess various options for finance. The consumer offer would therefore have two payment options:

1. Upfront contribution - The consumer would pay an upfront cost of ~£6,500.
2. Zero Upfront costs - In this option the ~£6,500 upfront cost is paid for through a consumer loan, making it zero cost upfront. Through this, with Nationwide’s involvement in the consortium, the consortium assumed a Nationwide 5-year 3.29% interest loan.

It is recognised that alternative consumer loans would be possible for offer [2], and consumers would be pointed to a range of possible providers when discussing this with

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[23] Octopus Energy: Agile https://octopus.energy/agile/ *accessed 19 December 2022*

them, but the Nationwide 5-year loan was used in this project for indicative terms & modelling.

Mapping out the consumer journey and interactions between partners

In order to understand the end-to-end journey a workshop was run with all consortium partners. This was key to understanding the steps the end consumer would go through, which consortium partner is responsible for each step and how the partners interact with both each other and the customer throughout the journey.

Prior to starting the end-to-end journey mapping process it is key to think about the value chain of a Ground Source Heat Pump Network consumer offer. This helps identify the key steps in the journey and supports thinking around who the key owners of each stage of the value chain should be, these steps are outlined in Figure 4.2.

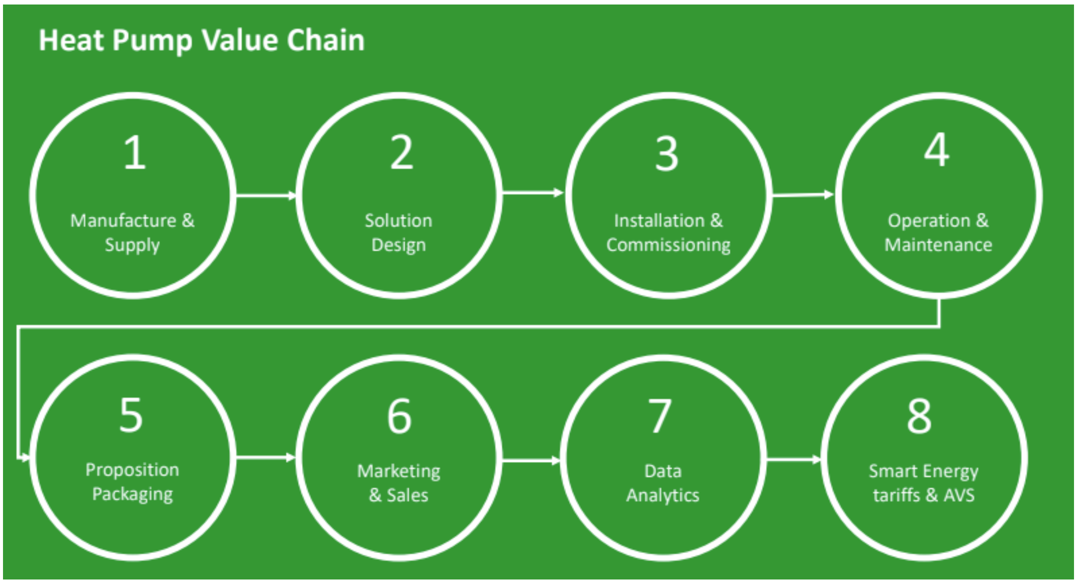

Figure 4.2: Key steps in the journey of the heat pump value chain.

A tool called Miro[24] was used to facilitate the customer end to end journey mapping. The full Miro board is shown in sections in Appendix figures (Figure 13.3 to Figure 13.7).

The different stages of the consumer journey at a high level were identified as follows:

1. Register Interest
2. Eligibility Check
3. Initial Specification & Site Survey
4. Sales - Funding / Payment Plan
5. Sign Up
6. Installation
7. In-Life use and advice

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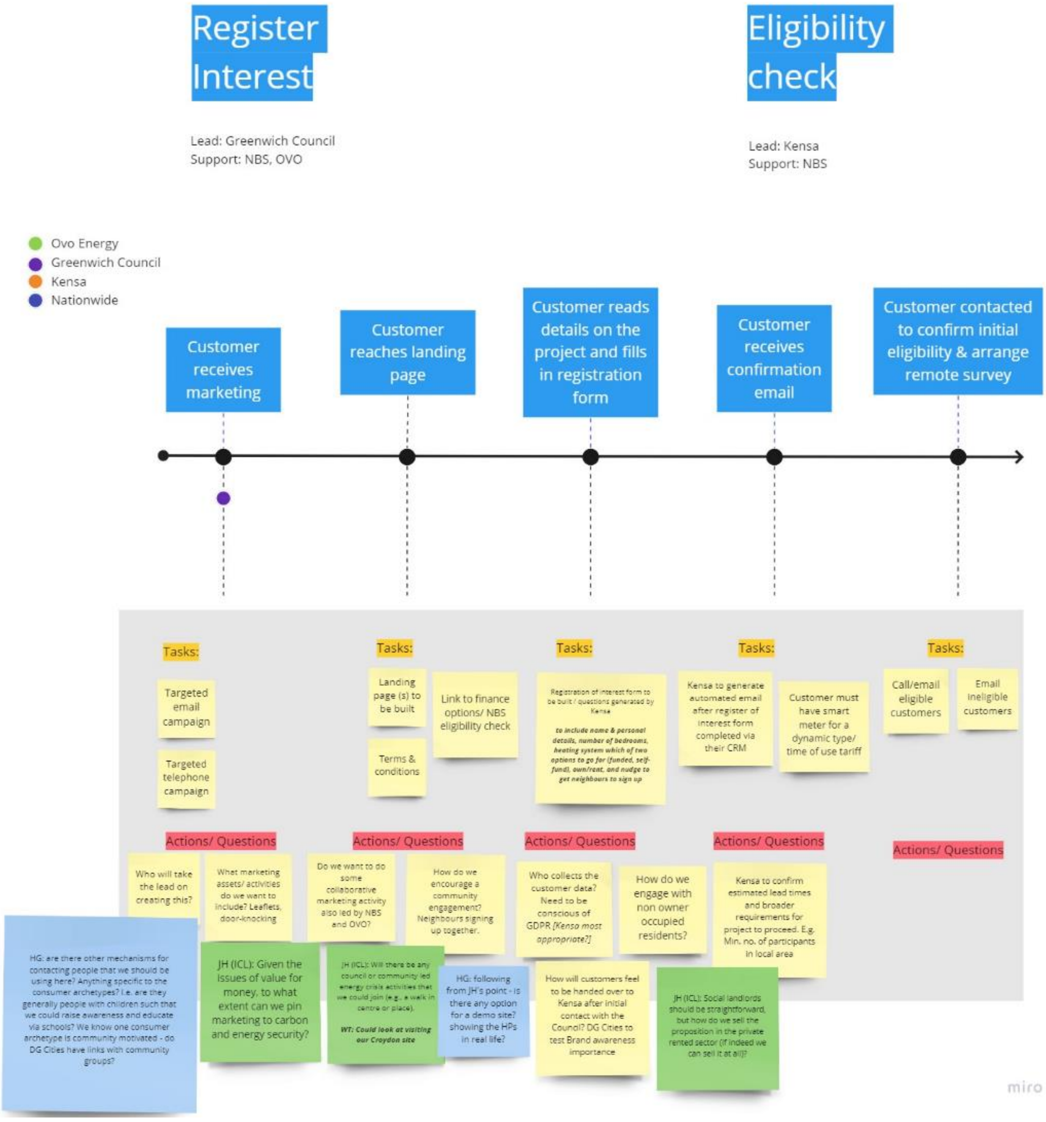
[24] Miro https://miro.com/ *accessed 19 December 2022*

8. End of Project Handover

For each of these high-level stages, the lower level, step-by-step process that the consumer would go through was also identified. Among the consortium, necessary tasks or actions at each stage of the journey were discussed and highlighted. OVO presented the overall board and led a discussion around the tasks at a weekly surgery session, partners were then encouraged to put questions and comments on the board, and to answer any relevant to their party, as shown in **Error! Reference source not found.**.

A detailed review of steps 1 and 2 are shown in Figure 4.3 below:



Targeted email campaign

Targeted telephone campaign

Landing page (s) to be built

Terms & conditions

Link to finance options/ NBS eligibility check

Registration of interest form to be built / questions generated by Kensa

to include name & personal details, number of bedrooms, heating system which of two options to go for (funded, self-fund), own/rent, and nudge to get neighbours to sign up

Kensa to generate automated email after register of interest form completed via their CRM

Customer must have smart meter for a dynamic type/ time of use tariff

Call/email eligible customers

Email ineligible customers

Who will take the lead on creating this?

What marketing assets/ activities do we want to include? Leaflets, door-knocking

Do we want to do some collaborative marketing activity also led by NBS and OVO?

How do we encourage a community engagement? Neighbours signing up together.

Who collects the customer data? Need to be conscious of GDPR *[Kensa most appropriate?]*

How do we engage with non owner occupied residents?

Kensa to confirm estimated lead times and broader requirements for project to proceed. E.g. Min. no. of participants in local area

HG: are there other mechanisms for contacting people that we should be using here? Anything specific to the consumer archetypes? I.e. are they generally people with children such that we could raise awareness and educate via schools? We know one consumer archetype is community motivated - do DG Cities have links with community groups?

JH (ICL): Given the issues of value for money, to what extent can we pin marketing to carbon and energy security?

JH (ICL): Will there be any council or community led energy crisis activities that we could join (e.g., a walk in centre or place).

WT: Could look at visiting our Croydon site

HG: following from JH's point - is there any option for a demo site? showing the HPs in real life?

How will customers feel to be handed over to Kensa after initial contact with the Council? DG Cities to test Brand awareness importance

JH (ICL): Social landlords should be straightforward, but how do we sell the proposition in the private rented sector (if indeed we can sell it at all)?

Figure 4.3. Image of the 'register interest' section of the Miro board showing notes and questions posed by partners.

High-resolution versions of all the Miro boards can be found in Appendix section 13.2.

Methodology for Product and Service design: Creating a value proposition

When creating a value proposition there are many considerations that need to be evaluated.

The high-level steps in creating a consumer offer are outlined below:

1. Identify target market and impacted customers
2. Review customer considerations
    a. Complexity of the consumer offer and barriers
    b. Consumer behaviour
    c. Understand the customer journey and identify key customer interactions in the end-to-end journey
    d. Vulnerability considerations
    e. Stress/ scenario testing in particular around the price point. Also consider any market regulations that will impact how the consumer offer is presented
3. Value for money - ensuring the customer understands the benefits of the proposition and how this will be linked to their property.
4. Distribution considerations
    a. Distribution - How will the product and service be distributed to potential consumers
    b. Communications - what communications will be sent to consumers
5. Operational considerations including;
    a. People - will the delivery of the product and service require additional headcount and what training will be required?
    b. Processes and systems required to deliver the product and service
    c. Data - how it will be stored and transferred between consortium partners in adherence with GDPR

Methodology for surfacing consumer offer via digital channels

OVO primarily advertises all consumer products & services via digital channels.

OVO has a creative studio team that incorporates the following roles:

- copywriters / senior copywriters
- designers
- project managers
- brand managers

OVO's method to bring a consumer offer to life includes writing a brief for the Creative Studio team.

Key criteria required to make a consumer landing page engaging include:

- Clear unique selling proposition (USP)
- Engaging hero shot[25]
- Compelling benefits
- Inspirational social proof[26]

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[25] "The hero shot refers to the primary photograph or video displayed on a website's landing page. It can also describe an image that represents an entire marketing operation. The hero shot should accurately depict a provided service or specific product or action that conveys the website and business's purpose. Virtually any company with an online platform is likely to use a hero shot in some capacity." From Indeed: What is a hero shot? https://www.indeed.com/career-advice/career-development/hero-shot *accessed 5 January 2023*

[26] "Social proof is a term that was coined back in 1984 by author Robert Cialdini in his book Influence. This phenomenon is also called informational social influence, and essentially,

- Strong call to action (CTA)
- Simple and easy to understand language

Methodology for developing a commercial tariff that supports heat pump technologies

OVO does not currently have a commercially available heat pump tariff however OVO has previously had a heat pump-specific tariff as part of another innovation project that was funded by Innovate UK. This project was called the Greater Manchester Local Energy Market Project (GM LEM)[13].

The Heat Pump Pro tariff was created specifically for the Greater Manchester Local Energy Market project and it was a 'Type of Use' tariff, specifically for residents of housing associations that took part in the GM LEM[13] project. Those residents had to have a Daikin heat pump, a smart meter and be on import supply with OVO.

The Heat Pump Pro trial was closed for further applications in May 2022 which means OVO has no commercially available heat pump specific tariff. The methodology for how OVO would look to develop a suitable tariff is outlined in Appendix section 13.4.

4.4 WP4 Developing the Consumer Engagement Strategy

Overview

Consumer engagement and co-design is critical for the acceptance, adoption and long-term use of innovations, and supports sustained behaviour change. The feasibility stage of Greenwich TIME provided valuable insights from qualitative and quantitative data collected through semi-structured interviews and an online survey.

The feasibility study was conducted in Eltham (Section 5.2, Work Package 2), a site containing the two customer persona profiles that were identified by OVO Energy to be the most likely to invest in a net zero transition. The customer profiles consist of households that have relatively higher incomes and education, and would be interested in investing in technological innovations that are good for the environment.

DG Cities conducted semi-structured interviews with residents in Eltham, living on streets where the heat pump offer could be deployed. An online survey was also undertaken with residents of Eltham (a total of 107 respondents) to gather quantitative measures of resident's preferences with regards to the technical aspects of the heat pump offer.

Through this research, the team gathered insights regarding consumer attitudes and perceptions towards the proposed product, to influence the methods that can be deployed in Phase 2 to drive engagement, and to increase uptake and acceptance of the technology.

Objectives of the Phase 1 feasibility study

The feasibility research delivered in Phase 1 was conducted in order to answer the following questions with aim of increasing uptake of the Greenwich TIME offer:

- What type of messaging encourages purchase intentions?

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it's the idea that people copy the actions of others in an attempt to emulate behaviour in certain situations…In marketing, social proof covers a similar idea – when people shop, they look for reviews, recommendations and ways that others have used a product before making their decision." From Sprout Social: What is social proof? https://sproutsocial.com/insights/social-proof/#:~:text=What%20is%20social%20proof%3F *accessed 5 January 2023*

- What is general acceptance, understanding, and knowledge of the proposed solution?
- Which product outline is the best performing against key intent to purchase metrics?
- What design features, including financial, do consumers require in the final design of the solution?
- Which supply chain, design and delivery innovations can best support consumer adoption?

To answer the above questions, DG Cities and through discussions with Kensa, Element Energy and Ovo Energy, determined that a number of key considerations need to be tested with prospective residents in Eltham in order to ensure that the Greenwich TIME offer best meets the needs of the public. The following considerations were identified for testing:

1. **Trust** - It is important to ensure that the scheme is marketed and promoted by a publicly trusted and recognised organisation as this can influence uptake of the offer. As such, in Phase 1, an understanding was sought on who the public would trust the most for overseeing the scheme and for acting as key-point of contact during its roll out and delivery.
2. **Greenwich TIME offer feedback -** In Phase 1 it was important to understand prospective customer feedback on the Greenwich TIME offer, in order to address barriers to its uptake.
3. **Response to prospective Greenwich TIME offer adverts -** Through discussions with Ovo Energy, Element Energy and Kensa, it was deemed important to understand how marketing materials and messaging can be designed to attract and engage more customers. Given the current political and social climate, three types of Greenwich TIME focused marketing adverts with distinct messaging were tested to determine which ones attract more customers:
    a. Greenwich TIME advert with messaging targeted at environmentally conscious customers
    b. Greenwich TIME advert with messaging focused on promoting community energy
    c. Greenwich TIME advert with messaging focused on promoting energy security

4.4.1 Methods to deliver the Phase 1 feasibility study

DG Cities designed and delivered an online survey and semi-structured interviews (through door knocking) in order to gather qualitative and quantitative insights for addressing the above questions. The details of these methods are described below:

Survey

An online survey was developed and marketed in Eltham, where the Greenwich TIME offer is considered eligible. The survey aimed to understand prospective respondent’s:

- Understanding and knowledge of heat pumps, and the boiler upgrade scheme
- Barriers to heat pump uptake
- Views and interest of the proposed scheme
- Views and interest in the payment option

The full survey questions are given in Appendix section 13.5.

Door knocking

“Door knocking” is an opportunity to collect qualitative data from local residents in Eltham, who live on the roads eligible for the heat pump project. Approximately **21 semi-structured interviews** were conducted through door knocking (the full door-knocking script is included in Appendix section 13.5), and aimed to understand people’s:

- Views towards the proposed technical offer (including payment options)
- Views towards potential marketing materials and their impact on attracting customers

The benefits of door knocking are that it allows for the collection of:

- Initial reactions to new information
- In-depth feedback and opinions about heat pumps and the approach

Customer research development

The survey and door-knocking interview questionnaire were developed by DG Cities, with feedback from Kensa and Element Energy. Kensa developed the payment options, and Element Energy provided technical advice (in terms of prospective operational costs and savings for the proposed scheme compared to direct electric heating and ASHPs).

4.4.2 Phase 2 Approach to Consumer Engagement

Phase 2 consumer engagement approach as detailed below is based on findings from Phase 1 with regards to barriers to uptake of the Greenwich TIME offer.

Early engagement plans

Phase 1 findings indicate the awareness of heat pumps is relatively low, suggesting that heavy investment is needed in initial consumer engagement strategies to raise the profile of the Greenwich TIME offer.

A suite of marketing materials will be designed and delivered using Greenwich TIME branding to share information about the scheme and GSHPs. The marketing strategy, including content input, oversight and material distribution, will be managed by DG Cities.

In-depth engagement plans

Approach 1: Champions. Delivered by SELCE with support of DG Cities during Phase 2a and 2b.

SELCE will develop a network of Community Energy Champions - including trained local workers, local resident volunteers, and retrofit coordinators – who will guide and support residents through their consumer journey from recruitment to home survey to installation to post-install support. Champions can build trust and help to encourage uptake and retention to the scheme.

Approach 1 is innovative because:

1. it involves residents who are innovators/early adopters in promoting the scheme to their neighbours, which isn’t done in individual decisions.

2. it provides residents with a single, constant contact point who can handhold them through the entire consumer journey from raising awareness of GSHPs, to initial surveying through to the installation process, building trust.

Awareness phase

Approach 2: “Community Heat Share and Learn” workshops: Delivered by DG Cities with support from Heat Geek & SELCE during Phase 2a.

A series of workshops will be designed and delivered, facilitated by heat pump and climate change experts, and attended by Council representatives. This approach aims to raise awareness and increase knowledge of heat pumps and build strong relationships between the local community and Greenwich TIME stakeholders.

Approach 2 is innovative because it will create a dialogue between residents and stakeholders, offering residents an opportunity to co-design their neighbourhood GSHP solution, by presenting them with solutions integral to the scheme and giving them the opportunity to feedback. This feedback will then be reflected in the scheme, to best meets the needs of the residents. Another innovative aspect is that these interactions will be tracked through TIME’s CRM system, ensuring everyone has personalised knowledge of the needs & wants of a customer spoken to, allowing a hyper-personalised journey for 100s of people at a time.

Consideration phase

Approach 3: “GSHP Scheme Demonstrator Site”. Delivered by Kensa with support from DG Cities during Phase 2a.

Residents will have the opportunity to visit communities in Croydon and Essex, where a Kensa GSHP scheme is operating.

Approach 3 is innovative because it uses the concept of social proof to encourage uptake. Residents of Eltham will be able to hear testimonials from those already using one for their heating and or cooling purposes, ask questions of experts including Kensa, and learn about the practicalities of using a GSHP.

Approach 4: “Energy saving roadshow: schools edition”. Delivered by SELCE with support from DG Cities during Phase 2a.

SELCE with the support of DG Cities will design and deliver five workshops with students to discuss the benefits of renewable heating and energy saving measures at home, as a way to protect the environment and reduce costs.

This approach is innovative because it creates the ‘majority illusion’ whereby potential GSHP consumers (the parents) hear about the scheme via multiple touchpoints, believing that ‘everyone’ is talking about it.

Conversion phase

Approach 5: CRM Consumer Journey – through the process all coordinated parties will log their interactions with residents on one system, so all parties coordinate to provide one single dialogue to a consumer, creating a trusted & personalised consumer journey.

Loyalty and advocacy phase

Approach 6: “Greenwich Community Heat Day” – community engagement events. Delivered by DG Cities with support of SELCE & Heat Geek during Phase 2b with one event each year of the program (2023 and 2024)

Building on the success of the Greenwich Council Community Voting Days to support community networks through the COVID-19 pandemic, a series of Community Heat Days will be run to bring together key stakeholders from across the supply-chain, partners and political stakeholders such as local Councillors to celebrate the programmes progress; support resident outreach and engage with local and regional press. It will be an opportunity for residents participating in the scheme to share their experiences, showcase work-to-date, and provide potential new customers with access to local insights and case studies, and demonstrate to local communities and media the work of the programme to date.

The innovation in the Community Heat Days will show how residents can be inspired to continue with the scheme and encourage further uptake through demonstrating the value of the programme, what residents have got out of it and the benefit of feeling part of something bigger to reduce the energy crisis.

4.5 WP5 Developing an Industry Engagement Strategy

The aim of work package 5 was to understand the steps required to build a resilient supply chain. This work package was led by DG Cities and involved:

- Developing a framework of clear principles and practices that all members of the supply chain.
- Carrying out supply chain interviews, and extensive mapping of current and future supply chain actors to understand how to build a resilient supply chain.
- Identifying key themes that promote capacity and innovation in the UK’s heat pump supply chain.

4.5.1 Collaboration

The Phase 1 partners provided a range and depth of knowledge and experience of the supply chain, including direct working with suppliers for heat pump (including GSHP) deployment and training contractors. This is summarised as -

- Element Energy – understanding of the supply chain process and context to these, and experience and strong understanding of the development and deployment practices and processes for heat pumps.

- Kensa – understanding and experience of developing heat pump technology and of their deployment approaches, including working successful with a range of contractors and providing relevant support and training.

- DG Cities – prior research and understanding of supply chain barriers and challenges and their interaction to the consumer journey for heat pump installation.

- Heat Geek – experience of training a large number of, mostly gas engineers and plumbing traders, in heat pump installation steps, as well as coordinating the MCS certification processes and work pipelines for a large number of suppliers.

- Jeff Hardy, Imperial College London – understanding of the heat pump market and the wider context and barriers to supply chain development, including the regulatory framework, financial and skill needs.

- SELCE – understanding of what consumers need to be provided with by the supply chain to support their consumer journey and build trust and confidence in making energy changes.
- OVO – experience from previous heat pump innovation projects and working closely with retrofit works during the Electrification of Heat project where 128 heat pumps have been installed under the scheme.

DG Cities led work package 5 and was able to bring this partner experience into its key tasks and to test the initial findings from industry engagement. The Royal Borough of Greenwich Council were also able to provide insights on the local installer base and the level of response to past tenders. It was important though that previous experience working with parts of the supply chain did not bias the findings and the ensured that stakeholder interviews were fully transcribed and analysed as a set and separately to the previous literature and partner inputs to understand the nature of both the local and macro challenges.

4.5.2 Inputs

There were two key inputs for work package 5: engagement exercises with the heat pump supply chain and the project's partners, and a literature review. There was also extensive knowledge within the project team from previous experience of developing approaches to and deploying heat pumps, in training and supporting the supply chain, and in understanding the barriers to uptake that concern the supply chain.

Information was also brought together from the Royal Borough of Greenwich Council as the suppliers currently and previously used for domestic heating and energy services and procurement experience for these services, as well as their developing strategy items for Green Skills and decarbonisation.

4.5.3 Literature and best practice

Key literature reviewed for Work Package 5 included:

- Modelling of heat pump adoption work, BIT and NESTA (2021)
- Heat Network Investment Pilot – Evaluation, BEIS (2020)
- Heat Pump and Retrofit Options Analysis, Carbon Trust (2020)
- Heat and Buildings Strategy, BEIS (2021)
- Heat Pump Manufacturing Supply Chain Research Project – Final Report, BEIS (2020)
- Delivering Net Zero: A Roadmap for The Role of Heat Pumps, Heat Pump Association (2019)
- Building the Installer Base for Net Zero Heating, Heat Pump Association (2020).
- Net Zero Technical Report, Committee on Climate Change (2019)
- Green Skills and sectoral skill gap publications, including those produced for Royal Borough of Greenwich
- Content produced by the Independent Networks Association (IPA), Ground Source Heat Pump Association (GSHPA), and the Heating and Hot Water Industry Council (HHIC) (e.g., on gas engineer workforce shortage)

This work enabled the team to further build a consistent and strong understanding on the supply chain processes for delivering (ground source) heat pumps and of the sector-level challenges in meeting individual project needs and the proposed targets for the UK including those of the supply chain and workforce needs. This worked as a clear basis to then add insights and experience from project partners to further map the supply chain and detail its challenges. These inputs also helped design the interview approach and questions for the local installer base and wider supply chain.

The engagement exercise also enabled a series of best practice examples to be brought together, with desktop review and engagement with 'group 3' in the supply chain, for building supply chain resilience and upskilling.

These examples were used to help develop the proposed supply chain approach for Phase 2, set out in the findings (WP5 Developing the Industry Engagement Strategy).

4.5.4 Supplier engagement

The supply chain was categorised into three groups:

Group 1 – Heat Pump Suppliers (installers and associated works) – located in proximity to/ can service Greenwich.

Group 2 – Credible local firms who are in the building work/ installation sector, including heating, plumbing, electricals, ground works, but not yet in heat pumps (but are potentially in wider renewable energy or retrofit space)

Group 3 – An 'enabler' group composing training, coordination, and technical support organisations.

Group 1

The project identified 16 suppliers within 20 miles of Greenwich that are listed on the BEIS MCS certification list, with a further 4 installers provided by Heat Geek as highly credible suppliers who had gone through their training programme. And a further 4 suppliers provided by RBG from previous work undertaken in Greenwich.

These suppliers all provide ASHPs and most also state being able to supply GSHPs. They typically provide either traditional gas and plumbing services or are (typically newer) green energy and home retrofit firms. There are also a small number of groundwork technical suppliers provided with GSHP experience.

A template email and call introduction, interview script and questions were designed for contacting and speaking with these suppliers. The team reached out to the identified suppliers as well as reaching out to the Heat Pump Association to share with their members as a call for research participants.

The interview included 17 questions across:

- Company role and experience in heat pump delivery, and the other services they provide.
- How long they have worked with heat pumps and what attracted them to the market.
- How many they employ for heat pumps, and their experience of recruitment and retainment of staff.
- How they have gone about the certification and training processes, and what worked well and their future plans for certification and training
- How time and labour intensive their part of heat pump work is, who they collaborate with and how these processes could be improved

- Their intentions for the heat pump market e.g., to grow, stay same, reduce
- Any barriers and challenges they have faced.
- What trends they have seen in the market, and what their expectations are for it going forward
- What they believe is needed for heat pump market to grow and meet its targets
- How well they know the wider renewable and retrofit market and work requirements

Telephone interviews were transcribed, and their insights brought together in a qualitative analysis exercise to determine the key themes and findings by question area.

Overall, in Phase 1 the project successfully engaged with six heat pump installers.

Further industry engagement is a key element of Phase 2, and its supply chain approach is set out in the Findings section below.

Group 2

This is a large and mixed group to draw from. ONS NOMIS Business Register and Employment Survey (2021 latest) data shows the number of firms and employees in Greenwich and the wider South East area that work in these relevant services represented by the sectoral SIC codes: 4322: Plumbing, heat and air-conditioning installation; 4321: Electrical installation; 4329: Other construction installation; 4313: Test drilling and boring. This data showed 120 total firms in Greenwich, 115 of which were micro in firm size of having 0-9 employees, in plumbing, heat and air conditioning installation, and 165 in electrical installation with 155 being micro in size. Just 5 firms in drilling and boring were identified for the wider South East area. In terms of employees, this reflected an estimated 600 employees in plumbing, heating and air conditioning installation and 500 in electrical installation.

As well as credible local suppliers identified by RBG Council, the team provided a call for participants by advertising the research and an opportunity to share insights to the South East London Chamber of Commerce. This however did not prove very fruitful, and the team therefore focussed efforts on identifying and contacting local firms through consumer channels that list and review certified local heating and plumbing firms. Those firms with a sufficiently high number of reviews, to proxy for their activity levels, and a rating of 4 or more out of 5 were contacted in turn.

Engagement worked best for group 2 with direct telephone calls where the suppliers are typically small traders and often on site or on the road. These telephone calls were typically shorter than those for group 1, but questions were asked covering:

- The services they provide and experience levels.
- The number they employ and how they have found the recruitment and retention of staff
- How well they know the renewable or retrofit market and whether they provide work or collaborate here
- How well they know the heat pump market and whether they provide work or collaborate here
- What their expectations are for the heat pump market, and if they see any key trends or alternatives there

- What their intentions are going forward and for the heat pump market, and if they have capacity
- What they see as the benefits and challenges to enter this market, and if they understand how to enter this market e.g. next steps and certification processes
- What they would need to know or be supported with to enter the market

Overall, in Phase 1 the project successfully engaged with six firms who represent group 2.

Further industry engagement is a key element of Phase 2, and its supply chain approach is set out in the Findings section below.

Group 3

Desktop research for group 3 was important to map out key organisations that support the supply chain with guidance, training and coordination. There are a large number of such organisations who play an important role either nationally or in specific contexts and localities. This research also considered those who have been undertaking specific activity to increase capacity and resilience for the supply chain including emerging training schemes and skills programmes, to inform some best practice principles for developing the TIME Phase 2 methodology. This group includes:

- Industry and member organisations, such as:
  - UK Heat Pump Association (HPA)
  - Ground Source Heat Pump Association (GSHPA)
  - Heating and Hot Water Industry Council (HHIC)
- Sector certification services, including MCS and pre-qualifications such as water and gas safe regulations.
- Training providers
  - Trades College, including BPEC and Level 3 courses
  - Manufacturer supported courses
  - Greenwich based colleges and courses
  - The London Southbank University LSUB Green Skills Mayor Academy Hub
- Sustainable energy leaders with growing outreach services.

Beyond the desktop research, the team directly engaged with Energiesprong for Work Package 5, considering their approach to delivering homes upgrade and their skill and supplier practices and insights. The team also engaged the LSUB Green Skills Mayor Academy Hub, understanding their insights on local demand for upskilling, best practices in facilitating skills development and their opportunities for linking students with local businesses to mutual benefit. These conversations were complemented with recognition of the Greenwich Council aspirations and emerging strategy for green skills development, in response to TIME and a longer-term pipeline of heat pump, heat network, retrofit and other renewable and energy efficient work for homes across Greenwich.

Within the project team, Heat Geek have the expertise and experience to provide an excellent training and support approach to industry suppliers. The Phase 2 approach has incorporated and built on this to ensure effective delivery with a resilient supply chain including local skills and capability building. However, the full extent of Heat Geek's involvement will be determined in the initial stages of Phase 2. Heat Geek provide a best practice approach for upskilling the heating workforce, through their Heat Geek Academy with online training modules, peer support, industry leading workbook and certification of suppliers as ‘Heat Geeks’ and with further training ‘Heat Geek Mastery’. Heat Geek also support suppliers through the MCS Umbrella Scheme, work pipeline planning and work grant processes.

Kensa have also worked closely with suppliers and provided bespoke training. Kensa provides end-to-end technical support (including training) to build a highly competent, MCS-certified heat pump installer base in the UK, that ensures heat pump installs are of a high quality and ensure savings to consumers. Kensa has trained hundreds of installers and plumbers right from design through to commissioning, and also provides post-commissioning support. This helps build a resilient supply chain that enjoys fitting high-quality heat pump heating systems.

Together, this formed a rich set of insights and best practices to build on for the Phase 2 supply chain approach for effective delivery, upskilling and working practices.

4.5.5 Supply chain mapping

The research and engagement enabled the team to map out the current supply chain in terms of key activities, processes, key work stages and the links between them, and the relevant suppliers and stakeholders at each part of this. This covered the process from parts and equipment supply through upfront work in homes to enable and complement effective heat pump installation, upfront work for infrastructure and groundwork, through to installation and ongoing maintenance and services. This was a useful framework to identify key stakeholders and to assign the stage(s) that are impacted by the identified challenges and barriers. It also provided a baseline to what the TIME project supply chain processes would be, in its developed methodology, such that gaps and needs could be identified by stage and stakeholder. This is a useful cross-team exercise to provide a consistent understanding of the supply chain processes, potential timeline and to be considered alongside the developed consumer journeys.

4.5.6 Challenges to the method

A key challenge to engaging the industry is the low response rate, especially for group 2 as those in traditional heating, plumbing and building services. This was amplified as the engagement was focused during the autumn where there was higher work demand and organisations had less time to participate, especially if they had an inherent lack of interest or incentives to discuss heat pumps. The low response rate is also likely driven the perceived uncertainty in the market (heat pumps do not seem an inevitable focus going forward) and the nature of the workforce, where gas engineers are an ageing workforce. There are often low incentives for organisations to learn about and share views on heat pumps as boiler replacements and services will continue for the foreseeable future (to end of many current careers) and current engineers may be discouraged from doing any further technical training and certification.

To mitigate this, further work could look to incorporate marketing to suppliers and with a clear message that heat pump work will be being delivered in the local area in the near and longer-term future, and to ensure contact with industry suppliers such as small traders is suitable for them in its timing and format. Some of the tasks in the proposed supply chain approach for Phase 2 directly address this challenge.

4.5.7 Replication of the method

The interview questions used for the three industry engagement groups can be replicated elsewhere, where they provide the basis for useful insights to be shared. The experience of interviewing the industry can help to refine this process, for useful follow up questions to explore responses further. Further, the contact approach can be adapted, and questions focused that are most critical where micro and small organisations in the heating space are often pushed for time to take longer interviews.

The identification of industry suppliers to engage can be replicated by following a similar method:

- Use of NOMIS Business Register and Employment Survey (2021 latest data) to understand the scale of the local supplier base and the size of the organisations here.
- Use of local business networks to share information and a call for participation.
- Use of national and sector networks such as the Heat Pump Association to share information and a call for participation.
- Use of online consumer rating channels to identify locally based firms offering different services.

The outline of, and method for, mapping the supply chain and its key processes can also be well replicated elsewhere with some local refinement. This also works well as a live document that can be updated with new information and one which can be used a base to add overlay challenges, processes, gaps, engagement insights and so on.

4.6 WP6 Understanding Grid Impacts and Requirements

Approach to network constraints

The initial plan set out in the Phase 1 proposal for Greenwich TIME was to target 25% of a low voltage network area, the most localised level of the 25% density requirements set out by BEIS. The decision to target a low voltage network area was based on the understanding that the number of homes served by a secondary substation tends to be in the low hundreds; if each substation covered a number of low voltage networks, it would be expected that each low voltage network to cover tens of homes, perhaps into the low hundreds. For the networked GSHPs solution being deployed in the Greenwich TIME project, it would be expected to target 20-100 homes on a single street all of which would be fed by a single supply easily surpassing the 25% requirement. In the future this network could be rolled out like the gas network, with homes connecting as and when they're ready to do so.

The key issue that arose in Phase 1 was the limited data UKPN has on capacity at substations levels below a primary substation, the area (and therefore which homes) are served by a substation, and the definition of a low voltage network area. Capacity data at a primary substation level is freely available on the UKPN website, showing both the area covered by the substation and the percentage headroom. This primary substation data indicated that there was capacity at the primary substation level. The initial plan for the location selection as part of Phase 1 was to avoid network constrained areas as much as possible. However, data at secondary substation level is not as easily available from UKPN as primary substation data and needs to be manually extracted for each secondary substation. UKPN set a limit of 15 secondary substations to be investigated for the project, due to the manual nature of extracting the data for each substation.

To narrow down the long list of secondary substations in Greenwich to 15, DG Cities sought to eliminate sites based on other metrics that would make an area non-ideal for the Greenwich TIME project. These metrics included building types and consumer types. DG Cities additionally used an online tool from UKPN designed to understand the capacity at a site for EV chargers. This tool indicates the likelihood of capacity constraints at secondary substations level and was used to provide an indication of which areas were likely to be constrained and maximise the chances of choosing to investigate substations that did have capacity for further investigation by UKPN.

In addition to the capacity data, the Greenwich TIME project needed to know the number of customers served by each substation and the geographical area served by that substation to ensure the high-density requirement was reached; this data was not available for UKPN. Discussions with the Cambridgeshire-based PACE project, another Stream 1 Heat Pump Ready project, highlighted that they also did not have area data either. Element Energy's networks team are contracted by UKPN for data management. First, it is highlighted explicitly here that no UKPN data was shared with the Greenwich project from the UKPN project as that would be neither acceptable nor replicable. However, the team were able to confirm that the approach taken to understanding the geographical area that a substation serves is based on estimations of which substation the house is nearest to, as opposed to being based on data from the DNO. An example of how this can be mapped is given in the findings section for WP6 in Figure 5.17. This approach to substation mapping was the same as that taken by the Cambridgeshire PACE project. It is therefore important to highlight that the projected areas served by the substation are almost definitely incorrect but remain the best estimate. The nature of the networked GSHP solution means that, despite the absence of information on the areas served by each substation, the Greenwich TIME consortium can be confident that the 25% density requirement will be achieved as all homes in a street are expected to be served by one low voltage feeder from a secondary substation. The issue will be in ensuring an understanding of which low voltage feeder and secondary substation the site is being fed by to understand capacity and mitigation measures.

The final outcome of the interaction with the DNO has been that there are capacity constraints in the Greenwich area, but it is not clear which feeders are constrained. UKPN can only provide more detailed information about the constraints at a site when a formal application is made. In using GSHP systems, a formal application is not required as GSHPs generally have a 'connect and notify' status with regards to informing the DNO of installation, unlike many ASHPs that are 'notify and connect' such that the DNO must be notified before connection.[27] To ensure there are no negative impacts on the local grid, the Greenwich TIME project will continue a two-way information flow between the project and UKPN and consider what the most sensible route may be for future installations. This two-way information flow will further investigate constraints on the network, consider mitigation through the use of flexibility services and to help UKPN to understand likely areas of future heat pump uptake in the long term.

Collaborations

UKPN

The key collaboration for this WP was with UKPN, the DNO for Greenwich. This collaboration was established at the Phase 1 consortium building stage via Element Energy networks team, who work with UKPN. Within Phase 1, the contact with UKPN was with the

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[27] Kensa: Connect & Notify Approvals https://www.kensaheatpumps.com/news-blog/no-more-dno-hassle-says-kensa-heat-pumps-with-connect-notify-approvals/ *accessed October 2022*

innovation team, who in turn communicated with the data team to retrieve the data required for the project. The collaboration for Phase 1 was established initially via a series of meetings to understand who the right person within the UKPN team was to be dealing with this request. In the later stages, the collaboration was mainly handled via emails for data requests and data exchanges.

The Element Energy team had three conversations with different people at UKPN, each meeting required a return to the start on the requirements for the project and the requests on UKPN, which may have been caused by or exaggerated by annual leave in the team as the project began over the summer. Contact with UKPN was established shortly after the kick-off meeting (27th of July) and a first meeting set up on the 8th of August. Two further meetings then took place at roughly two-week intervals; these meetings were still establishing what data was available, what could be requested by the project from UKPN and who these requests needed to be made to/via.

The main set of data was received from UKPN in mid-October, very close to the deadline for Phase 2 submissions in early November. The lag between the initial meetings to set up the data request and the data being received was largely due to the additional exercise that was required of narrowing down the list of sites to 15 substations for investigation, which required bring together other data sources to maximise the likelihood of targeting both stations with capacity and areas of Greenwich that would be likely to take up the offer being made in the project.

The data requested of UKPN for the 15 secondary substations was:

- spare winter capacity, preferably in kW
    - if the summer capacity is easy to add in that would be useful too
- the number of customers served by the substation
    - ideally split by domestic and non-domestic
- the geographical area covered by that substation (i.e. a map/shapefile not a m2)
- any future loads planned on the grid that may affect capacity/number of customers
- any subdivisions of the secondary substation that might align with what BEIS have described as a ‘low voltage network area’
- any other information that is readily available or that you feel might be needed for installations
- Information on potential mitigation measures planned for the area would also be useful.

UKPN then required around 2 weeks to gather the information requested. The information returned was estimations of numbers of customers served by and estimations of the capacity available at each of the substations grouped into red, amber and green capacities as described below:

- Green: estimated that 20% of the nameplate value may be available
- Amber / orange: likely to be between 10% & 20% of the value
- Red: likely to be less than 10% - in most red cases they are at capacity or oversubscribed

UKPN still appeared to have limited confidence in this data and stressed that “the information provided is high level and more clarity will be provided following a formal application”. The future loads and subdivisions of the substation that might align with a low voltage network area were not provide due to the “issue of commercial sensitivity of ongoing or planned projects”. To understand if there were any other avenues for accessing the data required for the project, Jeff Hardy from ICL was able to directly contact the Head of Innovation at UKPN via Jeff's position within the organisation. Going via this additional point of contact, some more data was obtained and UKPN indicated that they have set up an internal process to support the requests of the Greenwich TIME project. This data request and retrieval process could be smoothed by a better understanding from both parties earlier on of what data is needed for the project and what data can be made available by the DNO.

The key contact for the project was in the innovation team, this person was then the link between the Greenwich TIME team and the data team within UKPN. A noted potential issue was that there was never any direct contact between the Greenwich TIME project team and the data team in UKPN. It may have been valuable to have a direct link with the data team, and to establish this link early on, to ensure those in need of the data and those who have the data both understand each other's needs and capabilities.

It became apparent from discussion with organisations within other Stream 1 projects that there were stronger links with the DNO, it is hoped the learnings and best practice from those projects can be brought into the Greenwich TIME methodology to strengthen it for future iterations.

DG Cities

DG Cities were initially not involved in WP6, instead DG Cities were expected to use the outputs from the WP6 in the location selection work on WP2. The request for only 15 secondary substations to be identified meant that DG Cities had to adapt their planned methodology for WP2 and take a role in investigating the grid constraints. The collaboration with DG Cities was handled mainly via the fortnightly consortium calls, weekly surgery sessions and some additional one-to-one calls as required. Data was exchanged, both in csv/excel form and via GIS files to minimise the replication of work between Element Energy and DG Cities and make use of varying levels of GIS skills across the two organisations.

Dr Jeff Hardy (Imperial College)

Jeff Hardy is Deputy Chair of UKPNs Customer Engagement Group. The analytical input and review of models from Jeff was part of WP7, Jeff's key role in WP6 was in accelerating the procurement of data and easing the information flow between the project and UKPN by giving the project multiple channels of communication with UKPN.

Barriers and challenges

The key barrier in this WP was accessing information on the substations, particularly the capacity and area served by secondary substations and the splitting of the network below secondary substation level. It took several phone calls with contacts as UKPN to establish the best person to handle the query, partly due to staff absence and leave across the summer period when this project was starting. UKPN is a data driven organisation and seeks to collect and use the data available on the network to cater for and drive innovation, however, the processes to do that are still being established and therefore the data required for the Greenwich TIME project was not as accessible as would be ideal.

An additional challenge in the project was the terminology from in the Heat Pump Ready guidance of a 'low voltage network area'. The very localised nature of the Greenwich TIME deployments meant that it made sense to target the most localised level of the network for meeting the 25% density requirement. However, the terminology of a low voltage network area was not familiar to UKPN. The question was brought up again in the 20-minute meeting BEIS set up with lead partners in the run up to the Phase 2 submission where BEIS indicated that this may be a terminology used more in rural areas and only by some DNOs. Further investigations within the Element Energy networks team (the Greenwich TIME project was run out of the buildings team) highlighted the existence of low voltage network feeders off secondary substations. These feeders had not come up in conversations with UKPN. It appears likely that these low voltage feeders are synonymous with the low voltage network areas described by BEIS but that UKPN had very limited information on capacity and homes served.

Replication

The approach taken in the Greenwich TIME project has relatively little in the way of barriers to replicability but would benefit from development for future projects, particularly around data sharing with the DNO and quality of data. In discussions with E.ON towards the end of Phase 1, E.ON highlighted that they had a bespoke approach to assessing grid constraints. E.ON did not become part of the Greenwich TIME consortium for Phase 2 but remain interested in the project. Future iterations of the project may be able to benefit from the approach taken by E.ON in the Stream 1 Heat Pump Ready Newcastle project.

4.7 WP7 Performance Monitoring, Data Analysis and Research

This WP contained the analysis and research elements that fed into other work packages. A description is provided below of each of the analysis and research methodologies used.

Total and peak energy demand + understanding of flexibility offered

Hourly electricity demand profiles were generated for each archetype considered in the initial modelling (most common property archetypes in London) using a methodology developed as part of a recent study by Element Energy for Kensa. The method for predicting based on a method detailed in a paper by Watson et. al.[28] Using the method outlined in Figure 4.4, daily heat demand profiles were generated based on the external daily temperatures and the heat demands for each archetype taken from the NEED database.[14] The weather data used for the calculations came from the Met Office CEDA archive, which stores hourly weather observation data for locations across the UK.[29] For the Element Energy study for Kensa, weather data was taken from representative average year (2015) and 1-in-20 cold year (2010) to understand the peak demand on the grid from heat pumps in an average years and a peak year. The work done previous by Element Energy was adapted to use weather data from London (Kew Gardens was the nearest site with complete data) and updating the heat demand data for the archetypes to the values for the relevant house types in London.

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[28] S.D. Watson, K.J. Lomas, R.A. Buswell, “Decarbonising domestic heating: What is the peak GB demand?”, *Energy Policy*, **2019**, https://doi.org/10.1016/j.enpol.2018.11.001.
[29] Met Office CEDA Archive https://data.ceda.ac.uk/badc/ukmo-midas-open/data/uk-hourly-weather-obs/

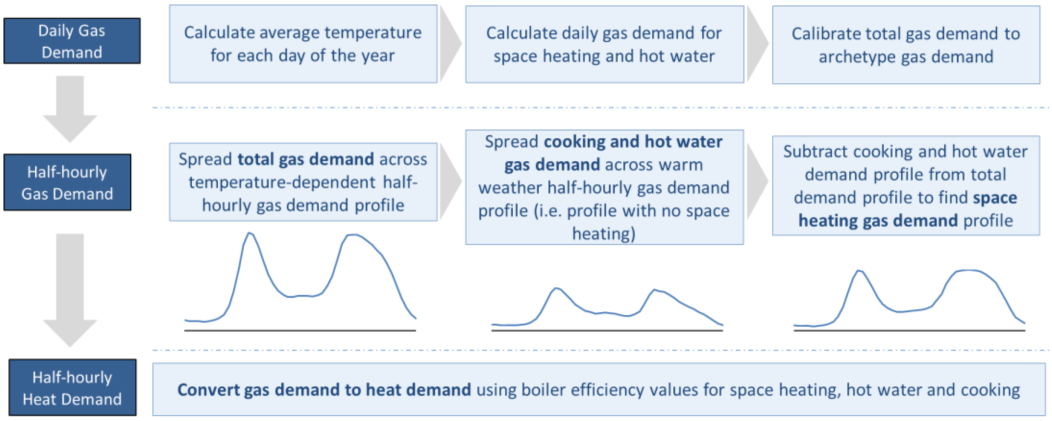

Figure 4.4: Diagram showing the method used to generate half hourly heat demand profiles.

These heat demand profiles were then converted to electricity demands by dividing by the hourly COP predicted for ASHPs and GSHPs, based on hourly temperature and humidity. The values for hourly external temperature and humidity were inputted to a model, again developed in the Element Energy/Kensa study, to calculate the COP of an ASHP and GSHP system on an hourly basis. The ASHP calculations were based on manufacturers data showing COP at various temperatures, while the GSHP data was based on work modelling provided by Genius Energy Labs during the previous study.

The combination of hourly heat demand data and hourly COPs allowed for hourly electricity demands to be calculated, comparing the additional peak demand on the grid from ASHP and GSHP heating systems. The hourly demands were also summed across the year to understand the difference in total heat demand from ASHP and GSHP systems.

Impact on fuel bills

This process has been described within the information provided on the technoeconomic modelling in WP1 and is not repeated here.

Carbon emission reductions

Once the energy demands of the GSHP systems were calculated, the corresponding emissions could be calculated and compared to those from a gas boiler (and ASHP). The carbon intensity of the fuels used was taken from the BEIS Green Book.[30] The emission intensities were compared for both a single year (first installation year of 2023) and cumulatively to 2050.

Monitoring strategy for installations and consumer journey

As part of the planning for deployment in Phase 2, and the design of the consumer journey, it was considered how to monitor and improve continuously throughout Phase 2 roll out. The stage gate structure of Phase 2 allows for natural breaks in the deployment process for reflection on what went well and what didn't (as summarised in **Error! Reference source not found.**).

Table 8-2 in section 8 states the method statement for ensuring assurance, monitoring and consumer protection at every stage of the process, and indeed for the lifetime of the heat

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[30] BEIS Green Book https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal *accessed July 2022*

pump. Quality plans will be developed at each stage gate, aligning with MCS Domestic Heat Pump Best Practice Guide and through MCS-qualified installers at the minimum.

The methodology for (WP4 Developing the Consumer Engagement Strategy) describes how the consumer journey will be monitored.

Establish the key learnings from the project

At each fortnightly meeting, partners were asked for insights, and at the weekly surgery session, more ad hoc findings and questions were raised. Element Energy, as both the coordinator and main analytical party were able to bring together many of the general qualitative and quantitative learnings. The key findings and learnings are captured in this report.

The inclusion of an objective research party in Dr Jeff Hardy was beneficial in establishing the key learnings from the project, ensuring objective questions were asked and answered at consortium meetings. This role of an advisory partner within the main delivery group had value particularly where the project team were focussed on how Phase 2 could be achieved, to ensure the project was being considered holistically. Similarly, the inclusion of Nationwide Building Society offered an objective viewpoint on both the consumer engagement and offer, as well as the regulatory considerations.

A particularly valuable tool for compiling ideas and learnings for the consumer offer and journey was the Miro board managed by OVO (discussed in more detail in WP3 Developing the Customer Offering). OVO encouraged partners to add questions and comments on the various stages of the consumer journey, then compiled these questions and assigned them to partners to find and provide answers.

4.8 WP8 Trial Support & Learning via Interaction with Stream 3

In terms of methodology, there is very little to report on for the Stream 3 interactions. Element Energy attended the Stream 3 sessions and reported back to the consortium. Meetings with the full consortium were put in directly after each Stream 3 event to report items of interest back to the full consortium straight after each workshop. If the information from the Stream 3 event was particularly relevant or only relevant to some parties, the partners were told in advance if their attendance would be particularly useful or not required.

4.9 WP9 Finalisation of Phase 2 Plan

Prior to receiving the Phase 2 application guidance from BEIS, a stop-go check was put on the agenda for one of the fortnightly consortium team meetings. Each partner was asked if they were keen to go ahead with Phase 2 with the roles that had been scoped out during the feasibility study and for any concerns to be raised.

On receiving the Phase 2 application guidance from BEIS, Element Energy set out a plan for completing the Phase 2 application including:

- Highlighting all the documents required
- Setting a timeline
- Highlighting the scoring mechanisms used by BEIS
- Assigning partners to different sections within the proposal
- General notes from Element Energy on the information in guidance document.

Each partner then fed into their assigned sections of the report, commenting where they required input from other partners. Element Energy noted where input was required from other partners and followed with partners to ensure the input was added.

The other sections for completion, e.g. the cost to consumer form, letters of support, were assigned to relevant partners then reviewed by Element Energy.

4.10 WP10 Project Management

In Phase 1 Element Energy filled the project management role for the Greenwich TIME project. As noted above, Element Energy will not continue in this role for Phase 2 and it will be taken on instead by Kensa. However, many aspects of the successful project management of Phase 1 are likely to be carried forward into Phase 2.

Formal project interaction elements in Phase 1 were:

- *Fortnightly formal consortium meetings.* These were used to highlight the expectations early. In early stages these allowed for more unstructured conversation to build ideas, but took on a formalised structure to make sure all partners talked and stated what was need from others.
- *Weekly surgery session.* A weekly meeting with a flexible agenda to address issues arising over the preceding week. This was initially put in diaries as a placeholder but the full hour was almost always used for ad hoc discussion, getting all partner feedback on specific outputs, and troubleshooting.
- *Debrief on Stream 3 calls.* Near-immediate updates were provided and facilitated quick feedback to BEIS.
- *In-person meetings.* A small number of strategically timed in person meetings were organised (e.g. kick-off meeting, Phase 1 – Phase 2 transition meeting). In-person meetings are very useful for bringing partners together and gaining consensus at key stages within the project.

5 Findings from Work Packages

This section summarises the findings for work packages in Iteration 2.

5.1 WP1 Project Scoping

5.1.1 Project vision

The in-person project meeting organised after the kick-off meeting with BEIS was focussed on agreeing a project vision or 'guiding star' to align everyone's understanding of what was hoped to be achieved with the Greenwich TIME project and what the key barriers were understood to be. This was revisited over the course of the project to stay aligned.

"The Greenwich TIME projects aims to remove the barriers to heat pump uptake via a packaged offering that instils trust, reduces complexity, and provides continuity for the consumer.

The barriers are currently understood to be:

- perceptions of heat pumps in general, it will be considered how the offering can avoid common mistakes in branding and messaging
- extolling the virtues of communal systems, i.e. "you are not in this alone";

- reducing complexity in what the consumer is offered, i.e. "we will bring clean heat to your door, please make your home ready for it." There is no need to talk about the Boiler Upgrade Scheme, ground vs air source, heat networks etc., just keep it simple as would be a gas connection;
- who is making the offering - a package from trusted organisations working together lends confidence to the offering and adds to the "community" aspect ("working together to deliver for the community")."

5.1.2 Initial technoeconomic modelling

There were two key outcomes of the consortium discussions around the initial technoeconomic modelling:

- The key levers in the overall cost were identified as the
    - cost of in house works
    - cost of the groundworks
    - IRR on the groundworks financing
    - heat demand of home
- The ratio of gas to electricity prices had a strong impact on whether the offer was likely to be cheaper than, similar to or more expensive than the gas boiler counterfactual
- Mechanisms such as low interest financing for the in-house works had a minimal impact on the offer but the length of time the financing could be offered over had a larger impact.

The early visibility of the consumer offer provided by the initial technoeconomic model highlighted that it was very unlikely the financial offer being made would guarantee fuel bill savings for customers; fuel bill savings could not be used as the key motivator for consumers. The consortium decided to focus efforts on mechanisms for ensuring the consumer offer had annual bills at most similar to that of a gas boiler to ensure the switch to a heat pump would not increase fuel bills, such as maximising the number of people within a street who sign up, incorporating light retrofit measures and ensuring time-of-use tariffs (peak/off-peak only in current energy climate) were available to customers.

The cross-consortium discussion resulting from the insights in the initial technoeconomic modelling, put together by Element Energy, was the first and most potent example within the Greenwich TIME project of the parties coming together to share information and insights. Kensa were able to provide the standard costs and insight on how those costs would change with house types and the number of customers signed up. OVO were able to use their customer research, verified by Nationwide, to highlight which customer archetypes had motivations beyond financial motivations, such as reducing emissions. These insights then fed into the customer engagement strategy (WP4 – Developing the Consumer Engagement Strategy) being developed by DG Cities and set out key parameters for the location selection, also led by DG Cities.

A point that could have led to the falling apart of the project, the understanding that the team would not be going out with a relatively simple sell of 'this green heating solution will save you money' became the point that forged the project partners into a project team. Once the consortium as a whole understood and accepted this outcome, the lack of significant financial motivation in the consumer offer affected the direction of the project in several ways:

- It determined the type of consumer that was most likely to take up the offer in the absence of annual operating costs savings, i.e., the 'able-to-pay consumer groups – this fed directly into the location selection methodology (section 4.2.2)
- It focused the thinking of the consortium onto the other benefits that would appeal in the consumer offer (e.g., environmental benefits, community-mindedness, potential for a combined heating and cooling system). This in turn affected the types of questions asked in the initial consumer engagement (section 5.4).

5.1.3 Detailed technoeconomic modelling

As summarised in the methodology section (WP1 Project Scoping), the more detailed technoeconomic model included:

1. A **simple time of use tariff** (off-peak/on-peak only) analysis

A simple off-peak/peak time of use tariff was developed to apply to current and future electricity costs. The daytime costs used were those corresponding to the energy price cap costs at the time of analysis (34p/kWh electricity) and the night-time prices were set based on the ratio of day and night prices in the previous period (giving 11p/kWh), supplied by OVO. However, it is worth noting that the night-time price was subject to significant uncertainty at the time of analysis due to uncertainties in energy prices in general.

The proportion of electricity used at night was determined from previous studies, as described in the methodology section (WP1 Project Scoping). This assumption of the energy split may also lead to additional inaccuracies in the savings to be made from a time of use tariff.

In Phase 1, it was not possible to determine with very much certainty how much the savings from a time of use tariff could be due to the energy price volatility during the development of the consumer offer in Phase 1. Working more closely with OVO, or another energy supplier in future to determine the savings from different tariffs would be a useful progression from this project. However, this will be more feasible once energy prices are more stable and variable time of use tariffs become a safer offer for consumers.

2. Inclusion of **light retrofit measures**, loft insulation and draughtproofing, that are low cost and low disruption but have a significant impact on the heat demand of the home

The inclusion of light retrofit measures during GSHP installation mean that, at current fuel prices, the ongoing operational costs of the GSHP (including standing charges) could be lower than the gas boiler (Figure B). However, if these light energy efficiency measures are applied to a home with a gas boiler, this would also lead to savings, and would bring the costs of heating a home with a gas boiler below that of the GSHP again. Essentially, if all else is equal, the operating costs of a GSHP (when factoring in the standing charge to help bring the upfront cost down) are not guaranteed to be lower than that of a gas boiler. However, when Kensa installs a GSHP, they consider installing light energy efficiency measures where cost-effective to do so, in homes where their heat pumps are installed. Therefore, this was deemed a key part of the consumer offer versus the business-as-usual case of (for most residents) keeping a gas boiler and not implementing energy efficiency measures.

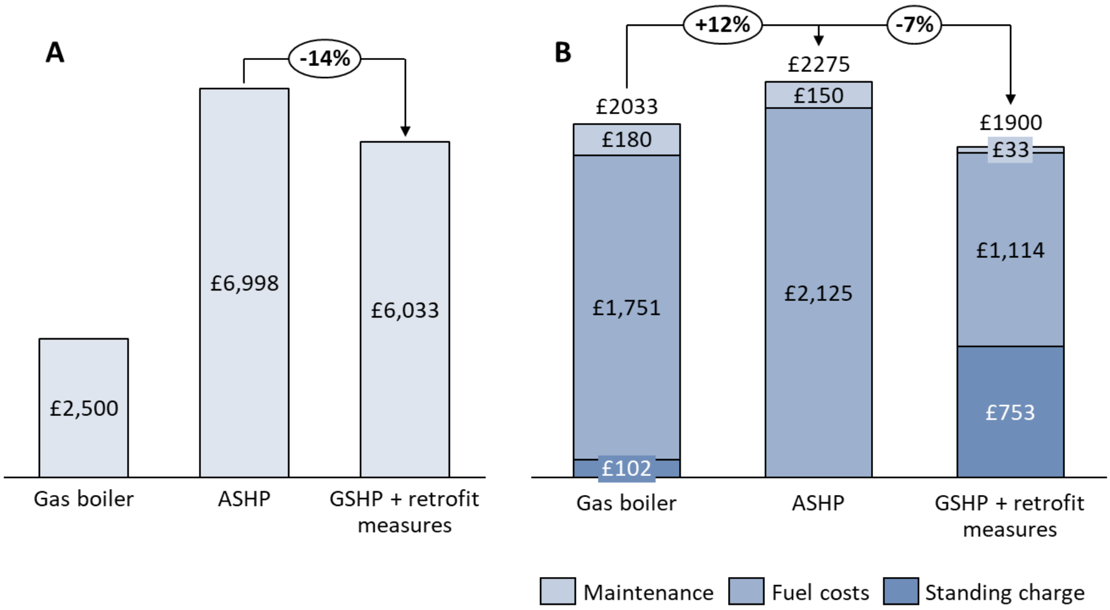


Figure 5.1. A. Upfront costs associated with buying heating systems via a one-off payment. For ASHP and GSHP the BUS grant of £5k and £6k respectively has been taken into account**. B.** Operational annual costs (in 2023) of running and maintaining heating systems.

The technoeconomic model allows for rapid adjustment of various parameters, including:

- which retrofit measures are applied and which heating technologies they are applied to,
- the typical cost of these measures, and
- the typical heat demand reduction from the measures.

Generally, with energy prices as high, and as uncertain as they are, this again highlights the need to prioritise support for energy efficiency measures, especially where consumers are vulnerable and not able to pay for heat pumps. Energy efficiency measures reduce energy consumption and therefore fuel bills, but for fuel poor or less able to pay consumer groups, the higher cost of running a heat pump makes the consumer offer unattractive.

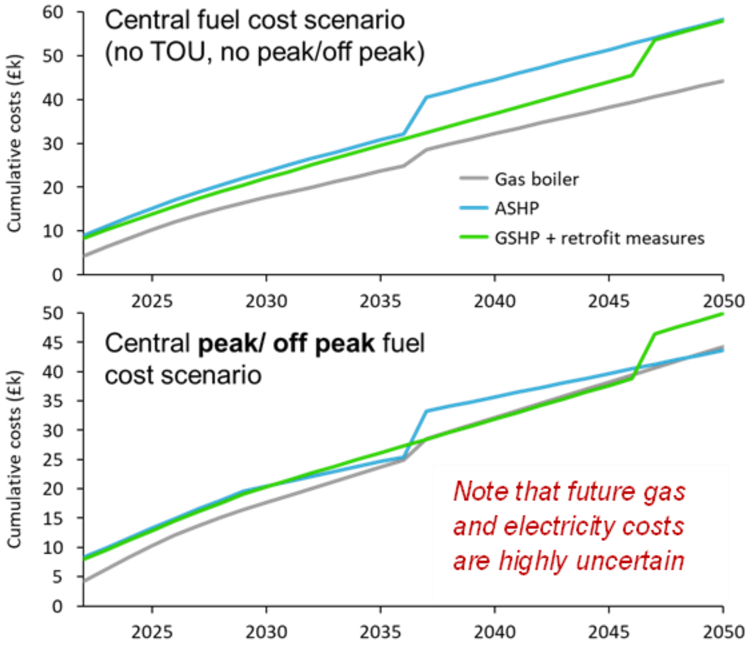
3. Inclusion of a **future fuel cost sensitivity calculation** where the user can set basic assumptions around future energy costs

Future gas and electricity prices are the greatest source of uncertainty within the technoeconomic model, and this led to consortium members feeling very uncomfortable with presenting future price projections to potential customers. The technoeconomic model allows for simple modifications to be made to fuel price scenarios as described in the methodology section. However, with ongoing fuel price uncertainty, it is difficult to draw conclusions about which scenario is most likely. Hopefully the fuel price sensitivity tool will remain useful for the consortium members to explore the effects of fuel prices on the consumer offer as Greenwich TIME moves towards potential deployment phases over the next two years.

The increase in gas and electricity prices in 2022 changed the annual fuel bill picture in favour of heat pumps as gas prices had a proportionally larger increase than electricity, which can be attributed in part to the temporary removal of green levies from gas and electricity prices under measures that were implemented as part of the energy price guarantee[31]. However, this may be a temporary effect as it is not clear whether the government plans to implement lasting changes to gas and electricity prices such that electricity prices are not linked so closely to the price of gas, and so that electricity prices decrease to make low-carbon electric heating options a more attractive offer.

4. Inclusion of a sheet that **projected costs out to 2050 and cumulative costs**, whilst also comparing ground source heat pump costs to air source heat pumps, a gas boiler and other electric options (electric boiler and storage heaters).

As noted above, projecting costs beyond the next year or so is fraught with uncertainty. However, the technoeconomic model provides the option to project costs out to 2050 and therefore to understand the cumulative costs of the GSHP offer compared to other heating solutions (Figure 5.1).



Note that future gas and electricity costs are highly uncertain

Figure 5.2. Cumulative costs of a GSHP, ASHP and gas boiler. Retrofit measures are only applied to the GSHP option. Upper figure shows costs if an economy-7 type tariff is applied, lower figure shows costs if no time of use tariff is applied.

This sheet also provides options to compare heat pumps and a gas boiler to electric options, clearly demonstrating that the cost to achieve the same level of comfort with either an electric boiler of electric storage heater is much higher than that for a heat pump or gas boiler (e.g., Figure 5.2).

The technoeconomic model provided very useful to quickly assess the impact of various factors on the cost of the consumer offer, both in terms of the upfront cost, as well as ongoing costs such as the fuel costs and standing charge for the round source heat pump. It also allowed for quick assessment of which levers could be pulled to make the consumer offer more attractive financially. An example of this was exploring the impact of a lower IRR on standing charge payment when the possibility of grant funding from the Council for some of the investment required to install the shared groundworks.

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[31] UK Government press release: Government announces Energy Price Guarantee for families and businesses while urgently taking action to reform broken energy market https://www.gov.uk/government/news/government-announces-energy-price-guarantee-for-families-and-businesses-while-urgently-taking-action-to-reform-broken-energy-market *published 8th September 2022*

The model also allowed for development of figures that could be used for consumer engagement. An example of this is Figure 5.3, which was adapted from a figure used to demonstrate cost savings associated with the zero emissions boiler from tepeo.[32] This figure allows consumers to place themselves on a graph if they know either their annual energy bill cost, or their annual energy consumption.

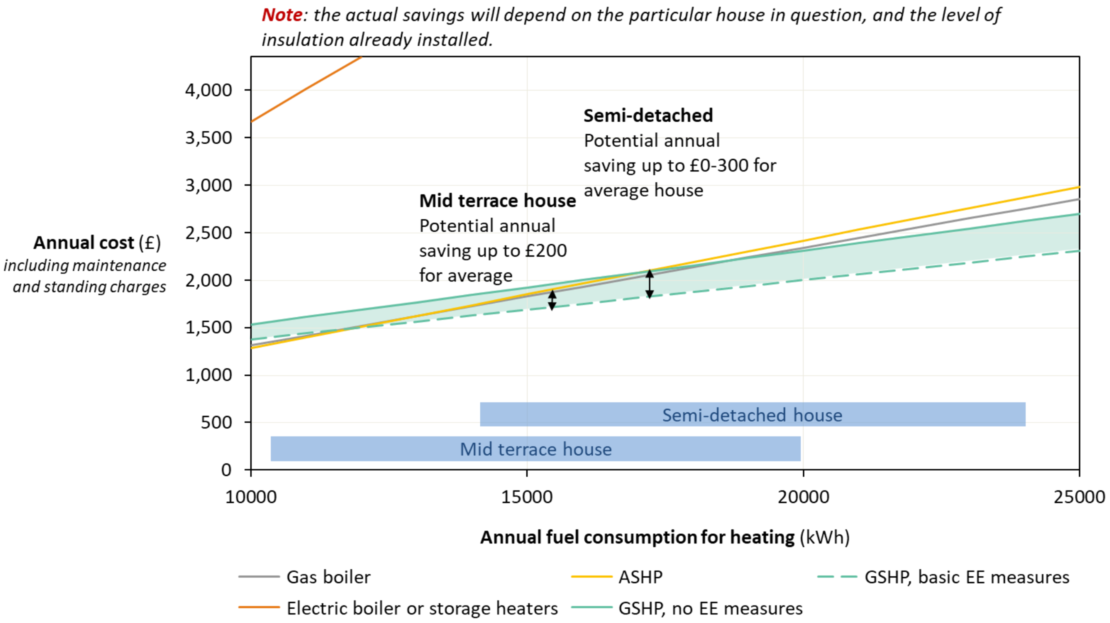

Figure 5.3. Figure developed for consumer engagement to allow consumers to make a rough assessment of the difference in their annual fuel bill they could expect by switching to a GSHP. Precise values are indicative only and will depend on specific features of the house in question.

5.2 WP2 Location Selection Outcomes

The section summarises the outcomes of the location selection methodology summarised in WP2 Location Selection & Methodology Development.

Consideration analysis outcomes

The outcomes of the location selection process described in the methodology section (WP2 Location Selection & Methodology Development), resulted in an initial list of potential sites, which were primarily determined by their presence of low-density terraced housing (initially observed through google maps) mixed ages. This resulted in a list of 10 sites, which were refined to five sites that were then mapped in GIS at an LSOA level. Various LSOAs in an area were combined to achieve a minimum 4,000 household population density (that meets the criteria summarised in the methodology section for WP2 Location Selection & Methodology Development), giving an opportunity for a minimum 1,000 households to connect to a heat pump (in line with the BEIS requirements). The mapped sites were overlaid with data to reflect the primary drivers: building type (age and tenure), heating fuel source, social housing presence and grid constraints. This process resulted in a series of potential sites, listed in the following tables.

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[32] Tepeo: cost and carbon https://tepeo.com/costandcarbon *accessed September 2022*

Table 5-1. Site 1: Elverson Road

Consideration		Site information	Criteria met
Primary consideration	Minimum site size (household population)	Total households: 6,104 (11.6% (709) in fuel poverty). The site performs better in fuel poverty compared to Greenwich average (12.9%).	Yes
	Building type	1.Property age: ● 28% pre-1901 ● 10% pre-1954 ● 22% pre-1982 build ● 32% 1999-2015 build 2.Property type: ● 4,730 flat properties ● 1,450 terraced homes ● 150 semi-detached ● 120 detached ● 0 bungalow (room numbers also available) 3.Property tenure: ● 28% (42%) owner occupied, 20% (30%) social rental, ● 18% (27%) private rental ● 32% unknown *percentages in brackets reflect the share of tenure data inclusive of the unknowns	No - Majority of homes are flat properties, which could be suitable for a district heat network, this is not in line with the BEIS funding requirement.
	Heating main fuel source	65% of the EPC properties are using gas as main heating source.	No - 85% of homes need to be on gas grid.
	Social housing presence	7 social housing estates.	Yes
	Grid constraints	8 HV substations within the site do not have grid capacity.	No - due to lack of grid capacity at the HV level.

Table 5-2. Site 2 - Thamesmead

Consideration		Site information	Criteria met
Primary considerations	Minimum site size (household population)	Total households: 6,996 (8.9% (629) in fuel poverty) The site performs better in fuel poverty compared to Greenwich average (12.9%).	Yes
	Building type, density	1.Property age: ● 0% pre-1972 ● 33% are pre-1982 ● 45% are 1999-2009 build 2.Property type: ● 3,000 flat properties ● 3,000 terraced homes ● 350 semi detached ● 180 detached ● 10 bungalow (room numbers also available) 3.Property tenure: ● 33% owner occupied ● 40% social rental ● 20% private rental ● 4% unknown	No - The property type data from the London Datastore indicates that many residents live in flats. This may indicate that the site is suitable for district heating, which is not in-line with this BEIS funding opportunity. The data also indicates that majority of properties are rental properties, which is not reflective of the Greenwich and UK averages. The data also indicates that the majority of homes are built from 1999 onwards, which again, is not reflective of the Greenwich and UK average.
	Heating main fuel source	92% of the EPC properties are using gas as main heating source	Yes
	Social housing	No social housing estates within site, but 1 large estate (Abbey Wood) is located to the South of the site.	Yes
	Grid constraints	3 HV substations do not have grid capacity within the site.	Requires further analysis.

Table 5-3. Site 3: Abbey Wood/ Plumstead

Consideration		Characteristic information	Criteria met
Primary consideration	Minimum site size (household population)	Total households: 8,466 (16.4% (1,394) in fuel poverty) The site performs worse in fuel poverty compared to Greenwich average (12.9%).	No - due to high fuel poverty
	Building type, density	1.Property age: ● 15% pre-1900 ● 31% are pre-1939 ● 46% are pre-1982 build 2.Property type: ● 2,620 flat properties ● 4,860 terraced homes ● 440 semi detached ● 20 detached ● 90 bungalow (room numbers also available) 3.Property tenure: ● 42% owner occupied ● 28% social rental ● 26% private rental ● 4% unknown	Yes
	Heating main fuel source	95% of the EPC properties are using gas as main heating source	Yes
	Social housing	3 social housing estates.	Yes
	Grid constraints	2 HV substations do not have grid capacity within the site.	Requires further analysis.

Table 5-4. Site 4: Charlton

Consideration		Characteristic information	Criteria met
Primary consideration	Minimum site size (household population)	**Total households**: 5,802 (10% (582) in fuel poverty) The site performs better in fuel poverty compared to Greenwich average (12.9%).	**Yes**
	Building type, density	1.Property age: ● 30% pre-1900 ● 18% are pre-1939 ● 27% are pre-1972 ● 15% pre-1999 build - slightly older than Greenwich as a whole 2.Property type for 5,660 homes: ● 3,350 flat properties; 1,540 terraced homes; 470 semi-detached; 290 detached; 20 bungalow (*room numbers also available*) 3.Property tenure: ● 44 (50)% owner occupied ● 24% social rental ● 21% private rental ● 8% unknown *percentages in brackets reflect the share of tenure data inclusive of the unknowns.	No **-**The property type data from the London Datastore indicates that many residents live in flats. This may indicate that the site is suitable for district heating, which is not in-line with this BEIS funding opportunity. Given that the interaction between non-flat properties and owner occupied was a lower share, indicating that the proportion of houses that are owner occupied is low.
	Heating main fuel source	83% of the EPC properties are using gas as main heating source.	Yes
	Social housing	6 social housing estates.	Yes
	Grid constraints	4 HV substations do not have grid capacity within the site.	Requires further analysis

Table 5-5. Site 5: Eltham

Consideration		Characteristic information	Criteria met
Primary consideration	Minimum site size (household population)	**Total households: 8,425;** 968 in fuel poverty (11%) The site performs better in fuel poverty compared to Greenwich average (12.9%).	Yes
	Building type, density	1.Property age: ● 25% pre-1918 ● 47% are pre-1939 ● 23% are pre-1982 ● 4% to 2015 2.Property type: of the 8,140 recorded households: ● 2,600 flat properties ● 2,840 terraced homes ● 2,260 semi detached ● 240 detached ● 100 bungalow (room numbers also available) 3.Property tenure: ● 59% (65%) owner occupied ● 16% (18%) social rental ● 16% (18%) private rental ● 10% unknown (%without unknowns) *percentages in brackets reflect the share of tenure data inclusive of the unknowns.	Yes - high proportion of owner-occupied dwellings and mix of age type date, both in line with Greenwich and UK averages. Good proportion of non-flat properties.
	Heating main fuel source	88% of the EPC households are using gas as main heating source.	Yes
	Social housing	7 social housing estates.	Yes
	Grid constraints	2 HV substations do not have grid capacity within the site.	Requires further analysis

Narrowing the shortlist sites and refining the final site (Step 3 and 4)

The above long list of sites were then shortlisted to Eltham. The other remaining sites were excluded from further analysis as they did not meet one or more of the primary considerations. For instance, both Thamesmead and Charlton were both excluded as they did not have property age, tenure and or type that is reflective of Greenwich and the UK, preventing the deployment of the ground source heat pump solution in such a site from being replicated across the UK. Thamesmead was also excluded as it has some of the highest levels of income deprivation in Greenwich, making the demographic less likely to be willing to uptake the high upfront and ongoing costs expected for the ground source heat pump scheme (as highlighted in the consumer personas for heat pump uptake).

With this in mind, Eltham was selected as the final site for the proposed ground source heat pump network scheme. The Eltham site was further refined to capture a smaller household population, focussing on the sub-areas (LSOAs) with good grid capacity and without the combine of poor EPC and high-income deprivation.

Collaboration

The process of selecting a potential suitable site in Greenwich for the ground source heat pump scheme involved input and feedback from project partners and stakeholders with the expertise and knowhow for specific site characteristics and factors for uptake. The input of different partners was also articulated in the method process diagram above, Figure 4.1 These collaborations with DG Cities as the lead for the work package were:

- Kensa is the Ground Source Heat Pump manufacturer on this project. For this exercise, they identified the initial high-level sites through a google map scan. Kensa advised that site selection should have preference for terraced housing and areas with mixed age types, as this is replicable for the UK.
- Element Energy is the leading environmental consultant on this project. For this exercise they provided oversight and guidance for site suitability and selection. Element Energy also oversaw the collaboration between the different partners, through their wider project management role.
- Ovo Energy is the leading renewable energy provider on this project. For this exercise they developed the consumer personas, which at a high-level, indicate which groups would be more likely to uptake heat pumps.
- UKPN is the electricity distribution network provider, and on this project they provided advice relating to grid capacity and constraints.

Barriers and challenges

The following barriers and or key challenges arose during the process of identifying a suitable site. The solutions to these challenges are also explained.

- **Grid capacity** - during the process of identifying a suitable site, it was unclear whether a potential site would have grid capacity or not. HV substation capacity was identified through publicly available data and mapped in GIS. LV substation capacity was not available online. UKPN was sought for information, but their assessment was limited to the assessment of 15 substations. Each site had substantially more than 15 substations, and as such, only sites that met other criteria and appeared to have majority HV substation capacity were considered. It is noted that Kensa's ground-source heat pumps, given the lower grid impact than air-source heat pumps, are classified by the ENA as 'connect and notify' rather than 'notify and connect'.

- **Site suitability (fuel poverty)** - due to the high costs associated with purchasing a heat pump, and paying for its operational fees, it is challenging to the make the offer marketable for those suffering from fuel poverty (i.e. low incomes and poor energy efficiency). Those that will be able to pay for the scheme are more likely to be those with higher incomes. At the next stage of the project, and once the scheme is deployed in a certain area, additional public sector funding could be used to ensure that those in fuel poverty can also access the benefits of the scheme.

Replication

A key component of this the suitability of the ground source heat pump scheme is that is can be deployed in areas with characteristics that are typical across the UK: predominantly terraced housed, mixed age types, on a mains gas grid, and poor EPC rating (average D).

The process applied to select a site that meets these above characteristics can be replicated anywhere - through the use of publicly available data, and inputs from applicable DNOs, energy providers and heat pump manufacturers/experts.

5.3 WP3 Developing the Customer Offering

Financial offering to consumers

In Phase 1, two consumer offers were developed, that consumers can choose from in Phase 2:

1. pay ~£6000 upfront and see several £100 per year savings (estimated)
2. pay zero upfront, with a 5-year loan covering the £6000, which means you see a few £100 a year savings after 5 years.

Costs were derived from Kensa's engineers and design teams, based on experience deploying 1000s of heat pumps across the country, however factoring in the cost reductions expected to be achieved through the coordinated methodology described below.

The Greenwich TIME methodology demonstrates a blueprint for high density roll out of heat pumps across the UK that can serve properties that would otherwise be unable to convert to heat pumps. TIME will see installation of shared ground array infrastructure in the public highway, allowing high density housing, in particular terraced housing, to benefit from ground source heat pumps even if they have no available space for boreholes or poor access for drill rigs.

Shared ground array infrastructure in the public realm could replace the existing gas network, with customers connecting to the system when their boiler breaks. This represents a cost saving to the consumer in the ability to use their current boiler until the end of its useful life, rather than early decommissioning.

By spreading the capital cost of the infrastructure across a 40-year term, linked to the property, the barrier of the upfront cost to the consumer reduced. Ground array infrastructure has an expected lifespan of ~100 years[33], whilst owner-occupiers in the UK stay, on

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[33] PIPA: Life Expectancy for Plastic Pipes https://www.pipa.com.au/wp-content/uploads/2018/09/tn013.pdf *accessed 23 December 2022*

average, just 16 years in a property[34]. With the typically low cost of natural gas (2022 energy price crisis aside) and gas boilers and no on-gas domestic boiler ban in sight, the low carbon benefits of ground source heat pump installation are not accurately reflected in house prices and so the original investor will not see a return on sale of the home. This is a deterrent when homeowners do not consider the property their 'forever home'. By linking the capital cost to the property, rather than the individual, this cost is passed to the new occupant. On average, it would be expected each service agreement to be financed by three households across its term.

Placing boreholes in public roads and highways is more complex and therefore expensive than individual boreholes within the curtilage of a property. Planning applications are required, permission to work in the highway must be sought from the local authority, traffic management must be considered, and remedial works must be to highways authority specification. Furthermore, in England, rights to the subsoil beneath the highway are presumed to belong to the owners of the houses adjoining it, unless the land has been registered (new build). Boreholes cannot therefore be installed without third party agreement, in this project that means that boreholes could only be installed outside properties that have signed contracts.

With supportive heat network legislation, the time and resource required to install shared ground array infrastructure in the highway would be reduced. Through heat network zoning, local authorities could designate areas that where heat networks would be deemed permitted development and where the Crown could assign heat rights to network developers (as is within their power in relation to mineral rights).

Cost reductions expected to be achieved:

- *Networked ground-source heat pumps (30% cost saving):* By deploying the boreholes, pipes and trenches in the road and doing this in bulk, rather than having each house source their own boreholes (with associated drilling costs, mobilisation etc which can be shared when networked), a 30% cost savings is expected, as evidence by an independent study conducted by Element Energy for Kensa[35]
- *Bulk purchasing (10% cost saving):* expect to lower unit costs of the heat pump, installs etc by 10%. This model is replicable for 'group purchasing', where neighbours get together to convert at once.
- *Reduction of heat pump size through cost-effective insulation (£1000 per household):* Through cost-effective insulation measures (loft, air tightness, room controls), it is possible to reduce the heat pump size required to be deployed into a property, which saves on costs.
- *Diversity factors (21% cost saving):* By having many households on one array, total borehole depth can be reduced. The rationale is that as households won't all be using their peak heat at the exact same time, the total peak heat load isn't [individual peak heat load x number of properties], but less. For example, the effect of 50 homes clustered on an array allows for a saving of 21% (£6000 per property).
- *Lower trenching per household (£4300 per household saving):* By targeting streets with 80% uptake, the cost of trenching is shared among more houses, lowering cost per household. If for example a street had 40% sign up, the same trenching would need to be laid across the street but split the cost among half the number of households than in the 80% uptake case. With trenching costs for a mid-terraced

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[34] UK Gov: English Housing Survey 2020-21 https://www.gov.uk/government/statistics/english-housing-survey-2020-to-2021-headline-report *published December 2021*

[35] Element Energy for Kensa: Low carbon heat study https://www.kensaheatpumps.com/wp-content/uploads/2022/10/Element-Energy-Low-Carbon-Heat-Study.pdf *published August 2022*

home at £5000 per household, a £4300 saving is observed vs a 40% uptake case, all through high-density deployment.

- *Neighbour-to-neighbour uptake (£200k saving on survey costs):* By making clear to potential customers that their whole cluster is more likely to get chosen and for all of them to see lower costs if their neighbours also sign up, reductions are available in the individual cost of marketing and chance of drop-out post-survey, which lowers overall costs of deployment. With this, it is expected to reduce survey amount from 1326 to 830, which at BEIS' recommended £400 per survey is ~£200k saving, which consumers therefore don't pay and see lower cost offers.
- *Heat pump tariffs (estimated ~20% running cost saving):* Through having collaboration with OVO in Phase 1, and them developing a heat pump tariff methodology based on past heat pump tariffs done, customers can be pointed to heat pump tariffs that are expected to reduce their bills by ~20% based on Octopus Agile tariffs at the time of writing. This saving is of course highly dependent on wholesale price dynamics and available tariffs at the time.
- *Open book sub-contracting (estimated 20% saving in install costs):* plumbing costs are currently very high across the UK. Kensa has previously experienced further inflation of sub-contracting costs when delivering subsidised, time critical projects. Due to the stage of the market and the large area that Kensa covers, it is not yet financially viable to directly employ installers. As an interim measure, Kensa will offer chosen contractors the opportunity to work on the project with open book accounting and agreed margins. To maintain pace and quality, the margin will be variable dependent on pre-set KPIs. The increased security to installers in being able to recover all costs without the need to quote for individual households will increase pace across the project and reduces the cost element seen associated with the unknowns in private retrofit. Based on a live current project, it is expected that this will reduce installer cost by an average of 20%.

Where project will source any additional funding:

- *Utility-style private investment:* Kensa Utilities has an existing range of financial partners interested in funding ground array infrastructure. They see this as an investment opportunity in an entirely new utility class – a green infrastructure asset with CPI-linked standing charge dividend-style returns. Kensa has received 5 solid indicative offers from 5 different financial institutions (ranging from pension funds to strategic investors to high-street banks) with a strong interest in funding Kensa Utilities' networked roll out. The most common question Kensa Utilities gets is "can you do more and faster", really showing that private investment is ready to pour into the mass decarbonisation of UK homes. Kensa Utilities has confidence it can call on any one of these numerous offers to supply the finance required to deliver the infrastructure rollout in the 2023-24 timeframes by the project. Given existing NDAs in place and an ongoing process to secure this funding, it is not possible as part of the application to share the exact names but supply a letter of support on financing with some further information.
- *Example bank loans (in 'zero upfront cost offer'):* While the project itself will not offer these, as ensuring consumer choice is a priority, multiple consumer loan options will be offered (such as 5-year home upgrade loans, green mortgage loans). Consumers will be pointed to where they can source these and at what rates.

Consumer journey

As part of the customer end to end journey mapping a number of key questions arose around each of the key stages of the consumer journey. Barriers and challenges also were identified as part of this process, many of which it has not been possible to answer but also many that would need further investigation and research in Phase 2.

OVO's previous internal user research provides great insight into the key barriers for Heat pump adoption.

Some of the key high-level findings include:

- Customers understand Carbon reduction issues but only if simple terminology is used
- Although customers think about energy consumption, very few have specifically measured their carbon footprint
- There is some interest in reducing carbon footprint but for most customers it is not a priority
- Even after explaining the impact of the home on their carbon footprint, it is still not seen as a priority
- This lack of engagement is likely to be partly driven by few consumers feeling that they are causing 'a problem' relative to the rest of the population
- Lack of engagement is also caused by a perception that getting to a low Carbon footprint will not be easy and potentially expensive
- Talking about wider impacts of carbon reduction is more impactful than talking about carbon reduction itself; forests, wildlife and oceans are all relevant
- There is interest in energy saving tools but this may be driven more by cost reduction than carbon impact
- Green incentives appear popular with customers and could play a role in driving supplier choice in a competitive situation

Creating the customer journey also presented some key findings:

- A more widely known company, such as OVO Energy, would be best placed to own and present the heat pump offer as people are more likely to trust a company that they already know. This was an idea that was supported by DG Cities survey and door-knocking results.
- A financial offering is a key part of being able to manage the capital investment required to join a ground source heat pump network. Without a financial partner that can offer support in the form of a loan, most people would find the upfront costs too high.
- Energy suppliers can have a significant role in wide scale adoption by providing specific Time of Use or 'Type of use' tariffs to help with the ongoing running costs of the heat pump. This would also further the argument of a heat pump being a cost-effective long term investment.
- The current customer journey is complex and requires each partner's role within the customer journey be clearly defined to ensure a smooth sign up process.
- From mapping out the journey, the complexity around the process and journey for a ground source heat pump network was very apparent. With multiple stakeholders involved as the customer goes through the journey it was identified and determined by the stakeholders in the consortium that there would need to be one organisation who owned customer contact and care. All partners agreed that it would make most sense for the partner owning the consumer offer to also own the customer contact. Having one streamlined point of contact for customers allows consistency and will demonstrate a less complex journey to consumers.
- It is important to try and simplify the journey as much as possible so as not to deter customers from signing up to the scheme.
- The organisation that will own the customer contact will need to have enough full time employees (full time equivalent) to support the project and the number of

customers expected to sign up. They will also require training around the products and services however the customer support team will be there to triage issues, questions, complaints to the relevant consortium partners.

- There will need to be secure data sharing mechanisms and processes in place between stakeholders when sharing customer data/ personal information. This needs to all be in adherence with GDPR.
- The organisation that will own the customer contact will require a customer relationship management (CRM) system such as Pipedrive to manage all contact and to help track the customer's process through the end-to-end journey. The CRM will require an operational customer service blueprint to be built which maps out the status transition of how a customer will progress through from new enquiry, all the way through to sign-up and installation.
- Avoiding using the word 'trial' is also important. The Ground Source Heat network is not a trial but a long-term renewable heating solution for residential homes. Although it is an innovation project, customers must be given full transparency that this is a long term and enduring solution that cannot be reverted. Using 'trial' terminology has legal implications particularly around consumer terms and conditions.
- The owner of the consumer offer must ensure that they have the correct FCA permissions in place in order to talk about or refer customers to funding options.

5.4 WP4 Developing the Consumer Engagement Strategy

Through the consumer research, the team gathered insights regarding consumer attitudes and perceptions towards the proposed product and service, as well as intelligence to influence the methods that can be deployed in Phase 2 to drive engagement, and to increase uptake and acceptance of the technology.

The main insights from the feasibility study (survey and door knocking) are presented below:

1. *Tenure and dwelling type*

107 residents completed the survey, of these 55% do not own their home. 72% of respondents live in houses, and only 38% of these are homeowners.

2. *Limited knowledge and awareness*

58% of survey respondents do not have previous knowledge of heat pumps, and only 16.8% of respondents are aware of the Boiler Upgrade Scheme.

Respondents believe that having more information on how a heat pump works, and how it would work within their property, is the most important non-financial incentive for them purchasing a GSHP. They also expressed that they need time to see how heat pumps work and to be convinced of their benefits, before they can invest. This was reflected during semi-structured interviews.

> *"Surely the mixture of flats and houses on the road would make this very difficult, how could we share energy equitably?" Door-knocking respondent.*

3. *Cost barriers*

On average, respondents believe that a government grant covering the costs of a heat pump would have the greatest influence on their purchase of a heat pump. 79% of 106 respondents, even those with higher monthly income, indicated that they would not install a heat pump if it required an initial investment of £3,000, let alone a higher investment as shown in Figure 5.4.

> *"How long would it take before I broke even and made a saving?"*
> *Door-knocking respondent.*

> *"It sounds like too much money" Door-knocking respondent.*

Furthermore, 80% of 98 respondents were unlikely to increase their mortgage to cover the upfront costs of a heat pump (Figure 5.6), and were even less likely to take a loan (Figure 5.5) with 91% stating unlikely or very unlikely:

> *"I would never have a bank loan, especially not in the economy at the moment" Door-knocking respondent.*

> *"I wouldn't want a loan as I no longer have any mortgages or loans"*
> *Door-knocking respondent.*

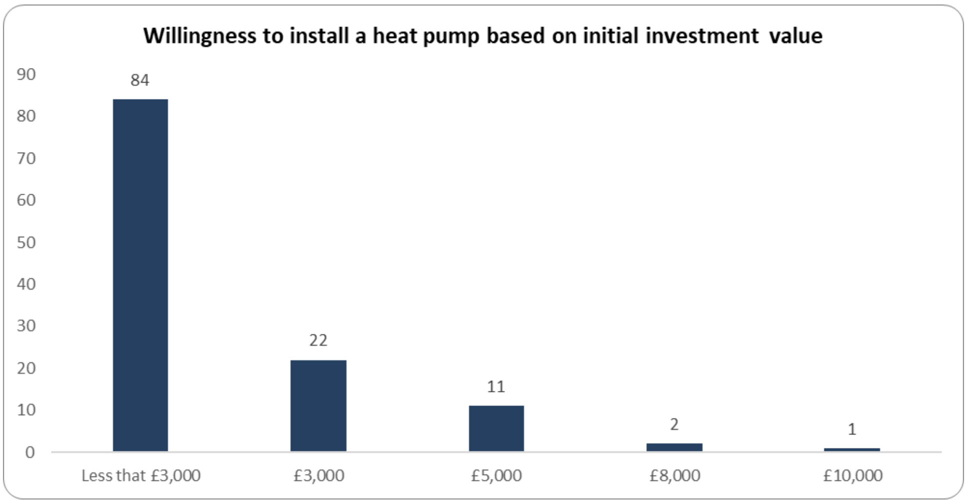


Figure 5.4 Willingness to install a heat pump uptake based on initial investment value

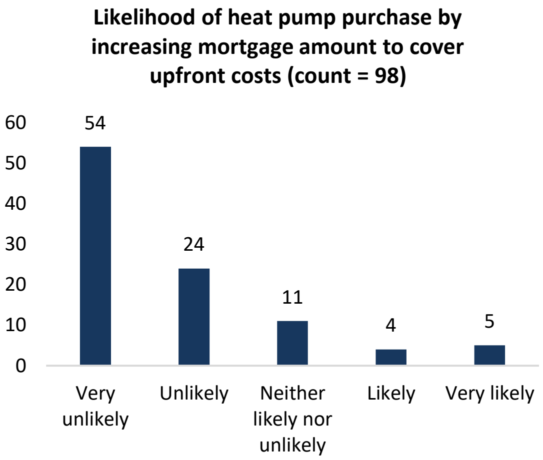


Figure 5.6 Likelihood of heat pump uptake by increasing mortgage

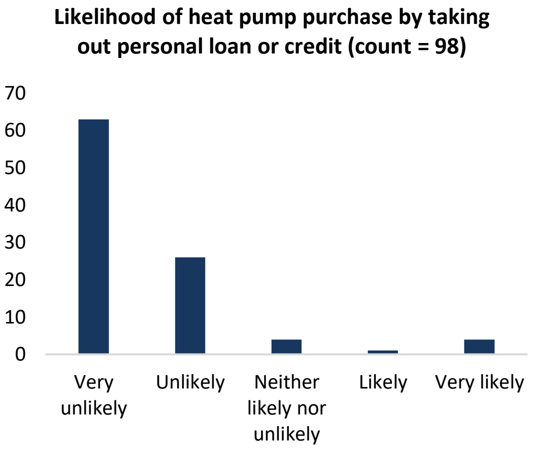


Figure 5.5 Likelihood of heat pump uptake by taking out personal loan

Feedback on the payment options

For both payment options, a portion of respondents (29% for pay-in-part, refer to Figure 5.7) and (16% for loan refer to Figure 5.8) were undecided (neither likely nor unlikely) about the options, as presented in Figure 5. respectively. This indicates that there is an opportunity to increase uptake of the technology by addressing some of the barriers to its uptake (e.g. lack of knowledge, costs). Through the door knocking interviews, it was evident that residents require more information on the payment options (how they are defined) and would expect cost savings:

> *"I would only consider getting a heat pump if it saved money- I would need to see evidence of this from elsewhere in order to trust that this is the case" Door knocking respondent.*
>
> *"I would be up for anything if it saved some money" Door knocking respondent.*

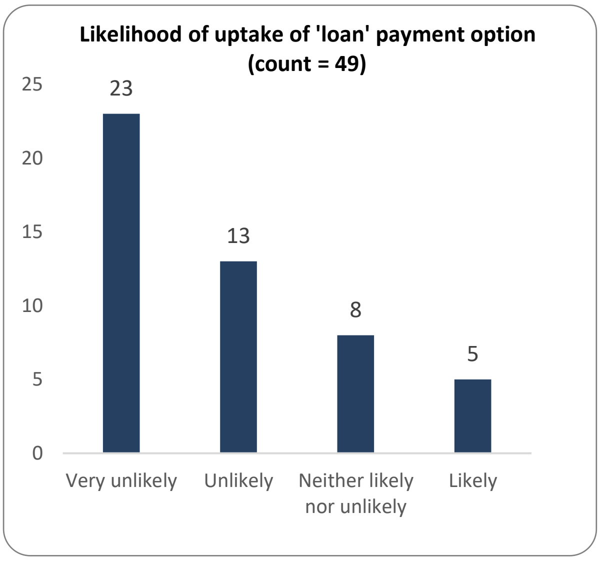


Figure 5.8 Likelihood of uptake of loan payment financing model

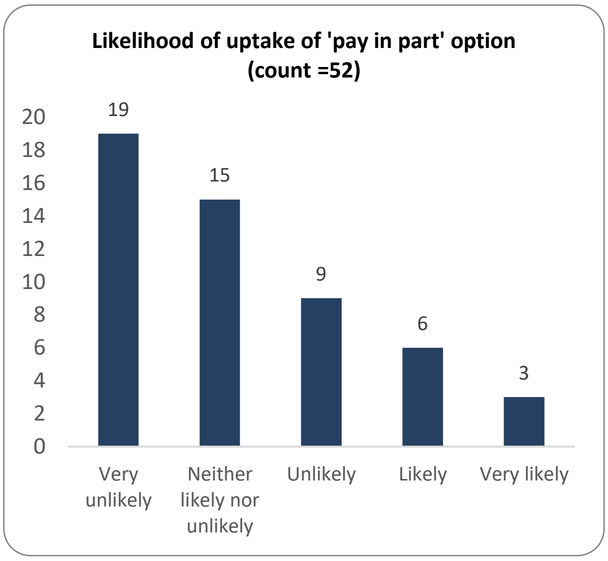


Figure 5.7 Likelihood of uptake of pay in part financing model

Future heat pump uptake

As shown in Figure 5.9, 51% of respondents reported that they would get a heat pump (in between two and 10+ years). The majority of these respondents have either heard of a heat pump or know a little about it. In the full sample, only three respondents reported they knew a lot about heat pumps, and none of this group responded with one of the options for future heat pump uptake timelines presented on Figure 5.9.

The most commonly reported reasons for not investing right away are: to save money for the works, not being homeowners, the cost barriers and moving home. 10% of the respondents indicated that they require more information on heat pumps, are not convinced of the benefits, or need time to see how they work, before they invest.

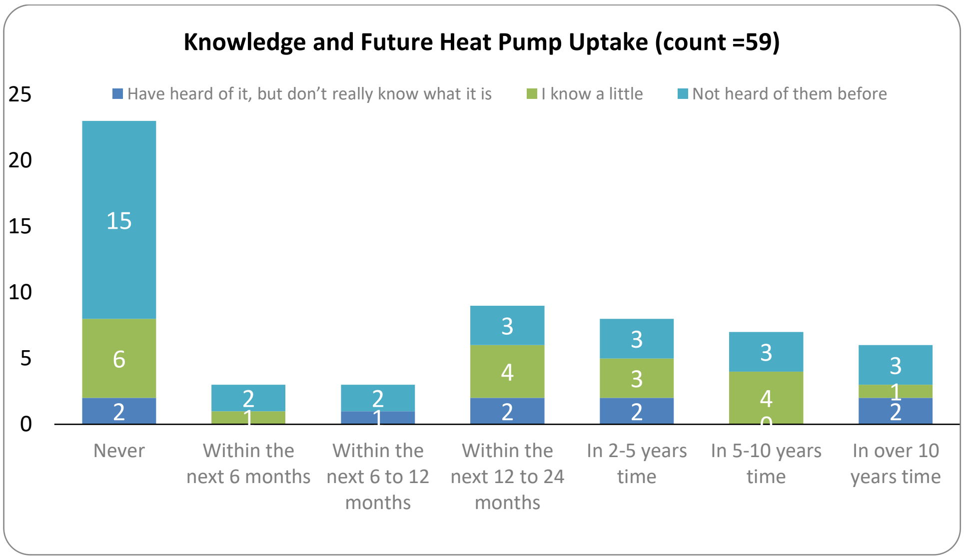


Figure 5.9 Existing knowledge of heat pumps and future uptake

Trust to oversee and run the scheme

As shown in Figures 5.10 and 5.11, majority of respondents indicated that they would trust the Council to oversee the scheme and to also act as the main point of contact for enquiries about installations.

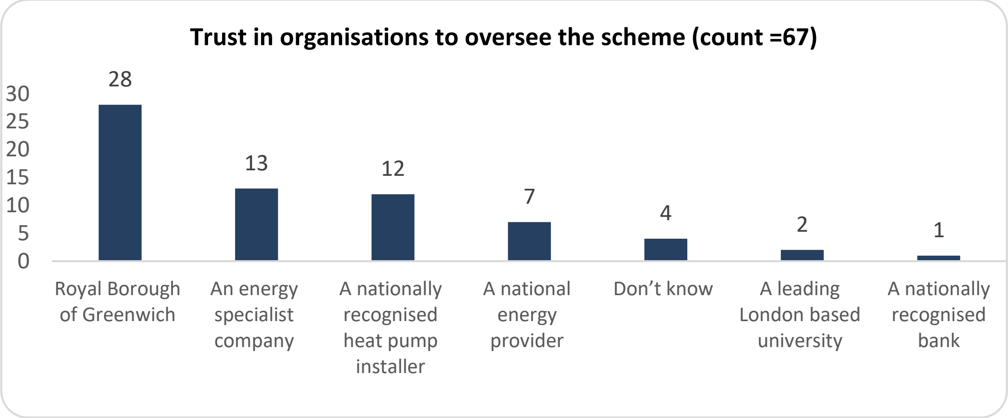
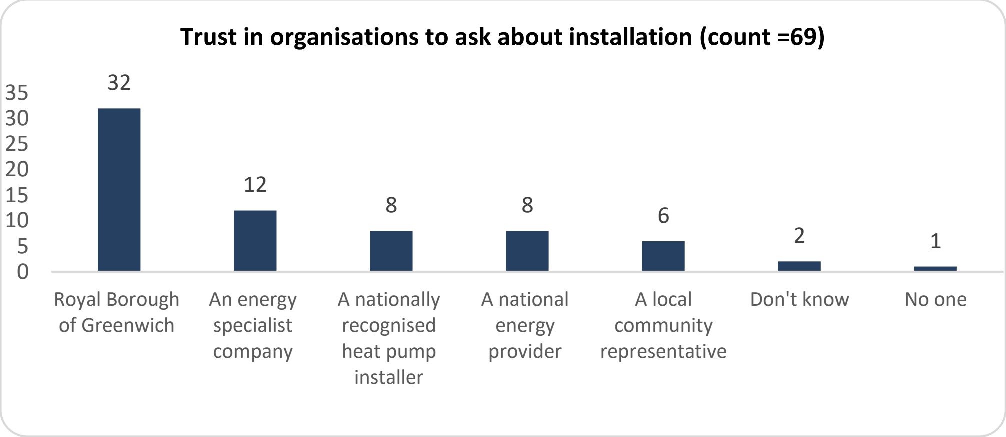


Figure 5.10 Trust in organisations to oversee the Greenwich TIME scheme



Royal Borough of Greenwich	32
An energy specialist company	12
A nationally recognised heat pump installer	8
A national energy provider	8
A local community representative	6
Don't know	2
No one	1

Figure 5.11 Trust in organisations to ask about installation during Greenwich TIME

Financial and non-financial incentives:

59 respondents ranked various financial and non-financial incentives on their ability to influence their decision in purchasing a ground source heat pump.

Financial incentives: On average, respondents believe that a government grant covering the costs of a heat pump would have the greatest influence on its uptake. Respondents also indicated that having similar or overall costs compared to their existing system could positively influence their decision in purchasing a heat pump. In contrast, obtaining a loan to purchase a heat pump was given the lowest ranking.

Non-financial incentives: On average, respondents believe that having more information on how a heat pump works and tailored advice on how it would work within their property, is the most important incentive for influencing their decision in purchasing a GSHP:

“Where has it been successful in the past?” Door knocking respondent.

“Why is it better for the environment?” Door knocking respondent.

Energy efficiency measures

As shown in Figure 5.12, of the 107 respondents, 54% had roof and or loft insulation and 66% had triple glazed windows. More impactful energy saving measures such as wall insulation are low. 45% of respondents would consider insulation measures when replacing their boiler. There is an opportunity to capitalise on this information by highlighting the cost saving and energy saving benefits of various insulation measures.

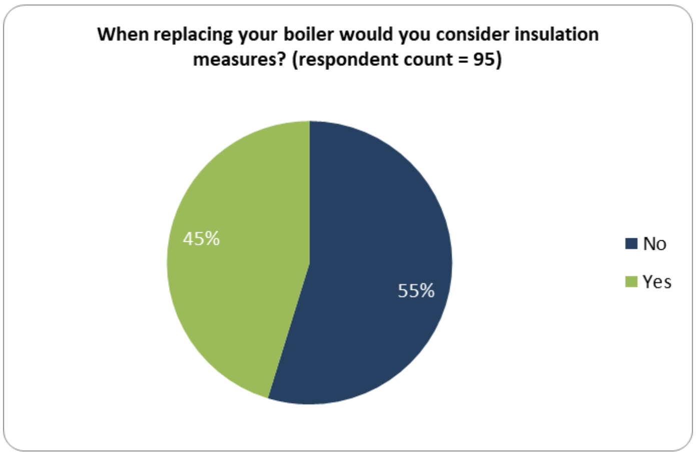
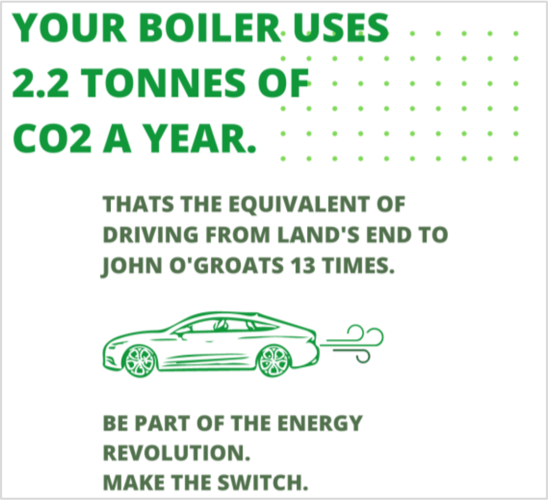


Figure 5.12 Insulation measures when replacing boiler

What messaging resonates with people?

During the door knocking interviews, residents were presented three with adverts promoting the Greenwich TIME offer, shown in Figure 5.13.



YOUR BOILER USES 2.2 TONNES OF CO2 A YEAR.

THATS THE EQUIVALENT OF DRIVING FROM LAND'S END TO JOHN O'GROATS 13 TIMES.

BE PART OF THE ENERGY REVOLUTION.
MAKE THE SWITCH.

Protect your home from rising gas prices.
Make the switch.

Join your neighbours to be part of Greenwich's energy transformation. To find out more click the link below.

Help make Greenwich cleaner, greener and healthier

Give back to Greenwich

We are looking for homeowners to be part of the energy revolution.

dg:cities

Figure 5.13: Three adverts presented to residents as part of the consumer engagement work.

Residents were asked a series of questions with regards to their preferences for each of the above adverts. Through this exercise, advert 2 (Energy Security) appeared to be the most appealing. Residents suggested that resilience and the opportunity to save money were key factors in piquing their interest in the advert:

> *"More likely to click on this one as money saving is the biggest determinant" Door knocking respondent.*

On the contrary, advert 3 (Community Energy) received mixed views from residents:

"Giving back… there are too many ways to give back that aren't purchasing a heat pump" Door knocking respondent."

"I like this one the most, it suggests people have a responsibility for others as well" Advert 1 (Environmental Messaging) was the most controversial amongst residents, in particular to the comparative example used:

> *"Comparing driving and boiler usage doesn't make sense- the comparison doesn't work" Door knocking respondent.*

The consumer engagement feasibility study highlights that there are currently a varied set of barriers to the uptake of heat pumps, mainly relating to lack of knowledge and costs. This is in line with the research outlined in the Ipsos report.

The findings from the feasibility study highlight the need for various actions to be taken as a means to increase consumer recruitment and uptake of the proposed GSHP scheme. These actions are summarised below:

- Increase knowledge sharing and awareness about the Boiler Upgrade Scheme and other heat pump funding opportunities.
- Increase knowledge and build trust by sharing testimonials of communities that have sourced funding to implement their own scheme.
- Increase knowledge sharing and awareness of heat pumps (including cost versus benefits, compared to existing systems).
- Increase information sharing about the proposed energy efficiency measures (particularly insulation) and their benefits, such as long-term fuel bill cost savings.

Considering the points listed above, the findings of the research undertaken during Phase 1 have highlighted that the key innovations necessary to enable GSHP uptake are related to behaviour change and engagement. During Phase 1, consumer appetite was tested for loan options and the alternative cost reduction strategies were surveyed, but it became clear that they do not significantly encourage uptake. They either do very little in reducing costs to consumers or are not what consumers want. Therefore, in Phase 2, the strategy aims to resolve current barriers to uptake, drawing on the research findings from Phase 1.

The approach to mobilisation (Phase 2) is based on the marketing funnel as the approach to reaching consumers at multiple touchpoints along their heat pump journey. The diagram below highlights the phases of the marketing funnel, awareness: making consumers aware of GSHPs and the offer, consideration: providing consumers with more information to help them ascertain that this is the right offer for them, conversion: ensuring the sign up process is as simple as possible, loyalty and advocacy: once they’ve enrolled in the GSHP scheme, making sure customer service is key and then using their experiences as a success story to recruit more GSHP consumers.

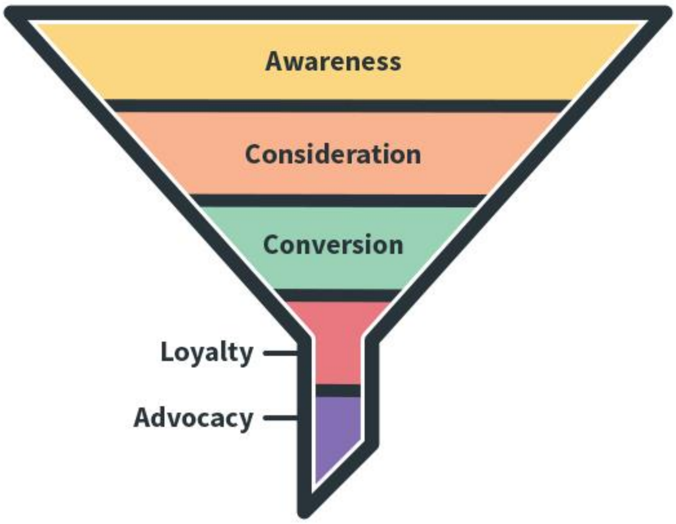


Figure 5.14: The marketing funnel, taken from Sprout Social.

Strategy for consumer engagement in Phase 2

The findings of the research undertaken during Phase 1 have highlighted that the key innovations necessary at this stage to enable GSHP uptake are related to behaviour change and engagement. During Phase 1, consumer appetite for loan options was tested and alternative cost reduction strategies were surveyed, but it became clear that they do not significantly encourage uptake.

The findings from the Phase 1 feasibility study led to the development of the consumer engagement strategy for Phase 2, detailed in the methodology section for WP4 Developing the Consumer Engagement Strategy.

5.5 WP5 Developing the Industry Engagement Strategy

Greenwich TIME will be designed to increase supply chain resilience and capacity. The evidence gathered will be built on during Phase 1 to collaborate and innovate throughout the supply chain, support and engage suppliers, potential suppliers and the wider workforce to deliver the proposed technologies for lower cost and higher quality. The Phase 1 feasibility has mapped the supply chain, its capacity and good practices, and wider market challenges. Seven key objectives have been identified and a set of actions to deliver over the project and, with monitoring of selected KPIs, to deliver Social Value. The approach integrates beneficial outcomes for the supply chain and labour market in the mobilisation and deployment stages of the programme and supports effective delivery of services in line with the social, economic and environmental outcomes as defined in the Public Services (Social Value) Act 2012.

Delivering Social Value

The project will deliver social value and support supply chain resilience by focusing on the following key themes as outlined in the UK Government's Social Value model (2020).

- **Theme 2: Tackling economic inequality** -Support organisations and individuals hardest hit by the pandemic to improve by developing new skills and confidence and enable local businesses in the supply chain to commercialise new capabilities that enable the transition towards a net-zero economy and building resilience. The approaches will support the following key policy outcomes of the Social Value model (1) creating new business, new jobs and new skills; and (2) increasing supply chain resilience.

- **Theme 4: Equal Opportunity** - Generate opportunities for local communities and the supply chain to benefit from high quality technical jobs, and improved job quality. The project will support equal opportunities and access to these roles by utilising methodologies to promote equal opportunities. The approaches will support the following key policy outcomes of the Social Value model: (1) reduce the disability employment gap; and (2) tackle workforce inequality.

Feasibility Stage Findings

Extensive mapping and engagement with supply chain stakeholders was undertaken through a series of semi-structured telephone interviews. Supply chain actors were targeted across diverse sections of the market, including pre-entry/non-entrants, traditional heating and plumbing firms, the local authority, and business networks such as the Heat Pump Association. Key findings include:

- The supply chain requires streamlining and coordination to better support suppliers at different stages, organisational capacities and market maturities, to enable better quality deployment and reduce market barriers for wider market access.
- This coordination is also key for managing the different stages of heat pump deployment and in interaction with effective homes retrofit and upgrade and supporting infrastructure work. This also matters for having more efficient engagement with households and approach to home visits.
- There is uncertainty about the upfront work requirements, in advance of installation, including their time and cost, and limited partnerships.
- There is a lack of demonstration and awareness building of what heat pumps and associated works look like, impacting supplier knowledge and limiting incentives for new trainees.
- There is a lack of trained installers and trained work planners/ designers/ coordinators. This is magnified by:
    1. a lack of high-quality training providers offering relevant courses, leaving engineers without the right incentives to train or the skills or confidence from them; and
    2. an ageing wider heating and domestic trades workforce, where it is not attracting enough new entrants - due to job quality perceptions and technical training (and cost) needs.
    3. Those undertaking heat pump training are overwhelmingly those already in the heating industry, rather than new entrants.
- There can be a lack of consistency from the installation processes through to maintenance, and a lack of service capacity available for the latter.
- Unfavourable payment terms for installers applying for the Boiler Upgrade Scheme grant, leaving them with cash-flow issues as well as large amount of application processes to follow - impacting micro and small to medium enterprises (MSMEs).

Supplier views on the market and its barriers

In the Phase 1 engagement, suppliers reported that a key issue is with sector uncertainty - it is unclear if it is the committed future (which creates a boom) or if there will be a lack of commitment or change of direction from UK government. This inhibits their interest and ability to invest in training, workforce and marketing/ consumer outreach.

Suppliers already face difficulties with workforce recruitment - there is an ageing workforce and a lack of next generation heating engineers. Some issues have been that the market may not seem attractive given work-life balance aspects with driving to and from sites and homes and with needing to go to homes where the occupiers may be vulnerable or difficult to engage with. The sector is not seen as being modern or attractive. This needs some wider coordination and campaigns and possible job quality changes. On the other side, it can pay very well and indeed full-time heat pump engineers can be expected to earn competitive wages and beyond those of gas engineers. Another barrier is the upfront qualifications which are costly for some, which are more technical and then need to be repeated through the career (at which point people may exit the workforce).

Another issue stated is that there is lack of good heat pump and renewable energy knowledge throughout the supply chain which results in the persistence of incorrect information and low incentives in places. Suppliers are aware of training that exists and have had good experiences with different organisations and certification. However, the lack of capacity of courses and of there being in-person and site-specific training is noted. The very technical nature of heat pump work including required calculations and whole house planning before installation is recognised, meaning engineers need to be well trained and of a high-quality – as getting this calculation process right improves system efficiency and performance and helps reduce maintenance needs later on.

Suppliers have also reported issues with receiving faulty batches of parts and equipment due to rushed manufacturing, and with a range of factors causing delays to required inputs and equipment.

Another barrier to the market identified by suppliers is that private residents do not understand the heat pump kit or system and are often reluctant to lose space in their home or have an outdoor unit. Suppliers have also stated that the Boiler Upgrade Scheme is not well constructed and a view that the Domestic Renewable Heat Incentive (DRHI) was more effective in places. It had been recognised by suppliers that some contractors, whilst operating alongside the Boiler Upgrade Scheme, would increase their quotes, resulting in the resident seeing smaller financial benefits from the scheme.

During Phase 1 engagement, suppliers stated the view that there is much work that needs to be done by Government, contractors and manufacturers to encourage the heat pump market to develop. They stated that the Government must provide more supply chain support and refine or update the Boiler Upgrade Scheme. They also identified that there needs to be more and better quality contactors available, which will help reduce costs as the market will be more competitive.

When asked about their expectations of the heat pump market, suppliers had different expectations for different elements of the market. Some suppliers, particularly group 1 suppliers, expect that the heat pump market will see a significant boom within the new build market in the upcoming years due to the 2025 gas boiler ban in newly built homes. Suppliers also stated that they expect the heat pump market to rise in social housing as councils are working towards net-zero and decarbonisation goals. However, suppliers expect that the private market for residents will not grow as quickly as people do not have the necessary funds available and are also reluctant to make the switch to a heat pump. Group 2 suppliers on the other hand, those not yet in the heat pump market, were mostly unsure whether the market would grow and some felt it would not take off but potentially replaced by hydrogen. Group 1 suppliers also recognised a lack of interest from their consumers for heat pumps the foreseeable future. Regardless of their market growth views, many reported a lack of capacity to adapt to heat pumps given the extent of gas boiler installation and servicing work they had in the pipeline.

These findings and challenges from work package 5 engagement informed the proposed supply chain and industry engagement approach for Phase 2. This includes a set of seven clear objectives, set out in Appendix section 13.7, to ensure collaboration through the supply chain, the building of supply chain resilience and capacity, and supporting newly commercialised and disruptive technologies.

5.5.1 Expected Outputs in Phase 2

- The Monitoring Plan and Evaluation Framework - with supply chain resilience and capacity KPIs and the approach to record, measure and feedback from these through the project.
- Supplier Engagement Strategy, with accompanying materials for the information and awareness building and to support suppliers with training and its registration, procurement and work expectations.
- Labour Market and Green Skills Strategy – with a live Action Plan document that is owned by DG Cities and supported by the Council and key education and training stakeholders.

5.6 WP6 Managing the Impact on the Electricity Network

Data at primary substation level

Capacity data at a primary substation level is freely available on the UKPN website, showing both the area covered by the substation and the percentage headroom. This primary substation data indicated that there was capacity at the primary substation level. This data at primary substation indicated that the target areas in Greenwich were within the primary substation areas of Eltham High Street and Eltham Grid 33 kV. These two primary substations have winter headroom of around 30% and 20% respectively, with the capacity projected to stay in that region for the timeline of the project (Figure 5.15 - primary substation capacities).[36]

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[36] UKPN: Find your grid and primary substation https://ukpowernetworks.opendatasoft.com/pages/gridandprimarydashboard/?refine.sitefunctionallocation=LPN-S000000000729 *accessed September 2022*

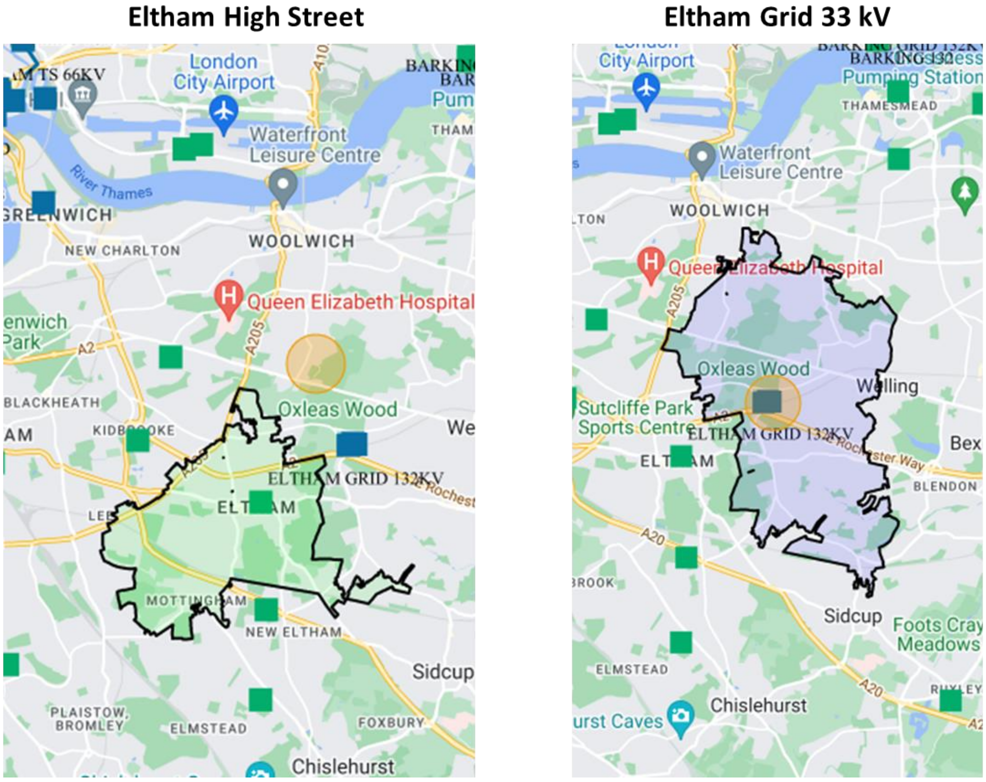

Figure 5.15: Figure showing the area covered by the Eltham High Street and Eltham Grid 33kV primary substations, covering the Eltham area of Greenwich being targeted.[36]

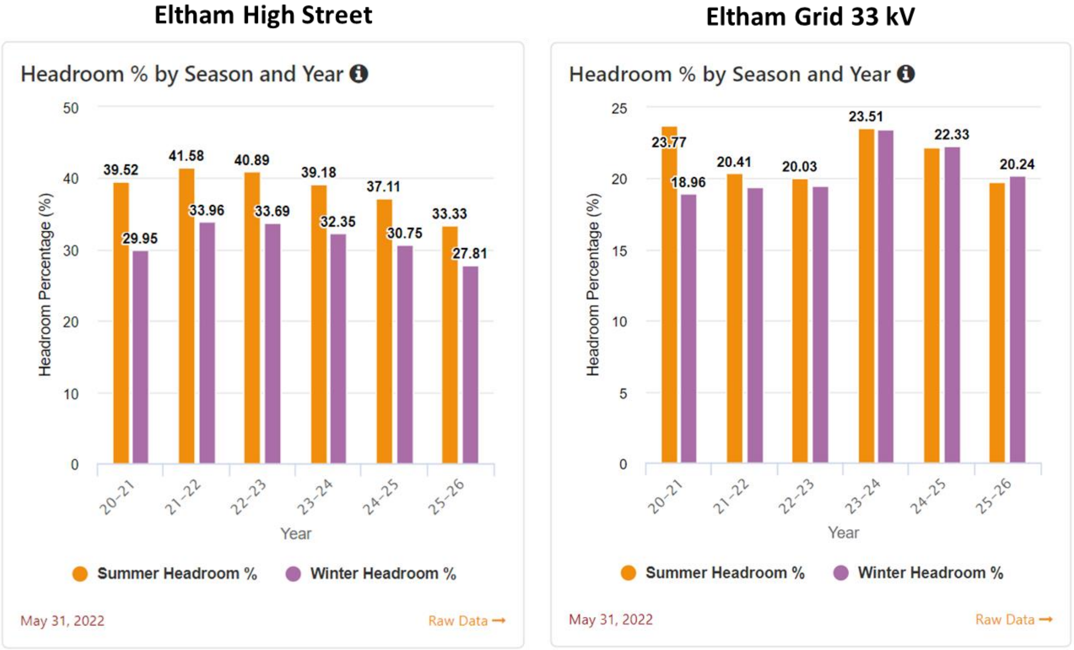

Figure 5.16. Primary substation capacities. Headroom data for the Eltham High Street and Eltham Grid 33kV primary substations that cover the areas of Greenwich being targeted.[36]

Data beyond primary substation level

As mentioned previously, data at secondary substation level is not as easily available from UKPN as primary substation data and needs to be manually extracted for each secondary substation. UKPN set a limit of 15 secondary substations to be investigated for the project, due to the manual nature of extracting the data for each substation. Prior the investigation of the 15 substations, UKPN did provide an initial dataset for all secondary substations in the Eltham area with a heavy caveat that the data was known to contain inaccuracies. Later comparison between the first and second set of data shared by UKPN showed very little correlation between the two datasets indicating that the first dataset is not appropriate for using to understand grid capacity and constraints.

The data provided for capacity at a secondary substation level is shown in Figure 5.17. The areas with red, amber or green shading are those where capacity data was provided, while blue areas are those areas within the selected area for Phase 2 for which data was not requested in the first round of sites. It is likely that some of these areas will need to be assessed by UKPN for potential deployment, particularly those in the northeast of the selected area.

The approach to substation mapping shown in Figure 5.17 was the same as that taken by the Cambridgeshire PACE project (see section 4.6). Again, as mentioned in the methodology section, it is important to highlight that the projected areas served by the substation are not completely accurate but remain the best estimate. The nature of the networked GSHP solution means that, despite the absence of information on the areas served by each substation, the Greenwich TIME consortium can be confident that the 25% density requirement will be hit as all homes in a street are expected to be served by one low voltage feeder from a secondary substation. The issue will be in ensuring an understanding of which low voltage feeder and secondary substation the site is being fed by to understand capacity and mitigation measures.

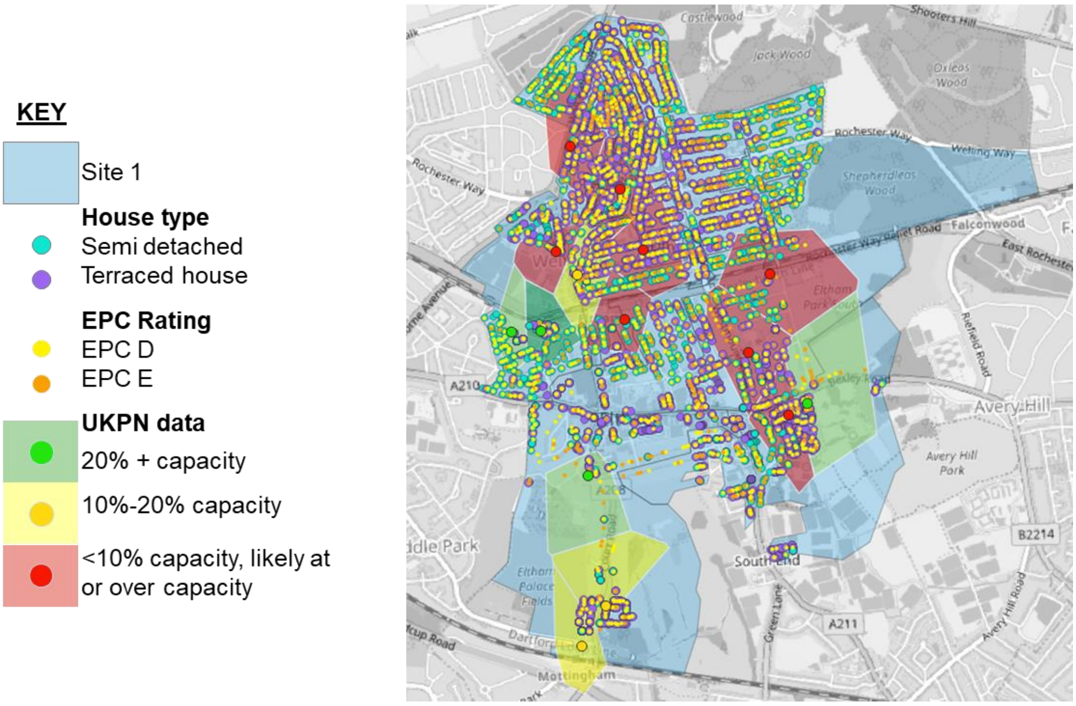

Figure 5.17. Secondary substation capacities mapped to house types and EPC ratings.

The final outcome of the interaction with the DNO has been that there are capacity constraints in the Greenwich area but it is not yet clear which feeders are constrained. UKPN can only provide more detailed information about the constraints at a site when a formal application is made. In using GSHP systems, a formal application is not required as GSHPs have a 'connect and notify' status with regards to informing the DNO of installation, unlike ASHPs that are 'notify and connect' such that the DNO must be notified before connection.[37] To ensure there are no negative impacts on the local grid, the Greenwich TIME project will continue a two-way information flow between the project and UKPN and consider what the most sensible route may be for future installations.

Flexibility

In terms of flexibility offered by networked GSHPs, there are a number of key opportunities:

- Adapting the shape of the demand profile, passively and actively:
    - Passively: The demand profile used to model the peak demand in this study was based on gas demand data from smart meters. Heat pumps (ASHP and GSHP) operate best when run at lower temperatures for longer periods, this mode of operation reduces the peak demand on the grid compared to other technologies such as direct electric heating. It also means that the power supplied to the system could be moderated to be lower during peak hours offering a demand side response mechanism. Encouraging customers to adapt to this flattened demand profile will require consumer education.
    - Actively: the use of time of use tariffs that use financial incentives for occupiers to shift their demand away from the peak

- GSHP specific opportunities
    - GSHPs are more efficient than ASHPs, and this difference is largest when the outside temperature is lowest, coupled with high humidity. These conditions are also when heat demand is at its highest and demand on the grid is at its highest) cold winter evenings. This is not a flexibility argument, simply an advantage for the local grid.

5.7 WP7 Performance Monitoring, Data Analysis and Research

This WP contained the analysis and research elements that fed into other work packages. A description is provided below of each of the analysis and research methodologies used.

Total and peak energy demand

The methodology described in WP7 describes how hourly demand profiles for the target house type were modelled for ASHP and GSHP systems. ASHP systems were modelled as the low carbon counterfactual for networked GSHP systems. Figure 5.18 shows the annual electricity demand (left) and peak electricity demand (right) for the target 3-bed, pre-1919 terraced house. The additional peak demand from a networked GSHP system per home was around 1.4 kW. This value is higher than the 1 kW rule of thumb used for predicting increased demand from heat pumps but the homes being targeted in this project are slightly larger than average homes in well off areas of Greenwich. Figure 5.18 demonstrates the reduction in peak demand offered by GSHP systems over ASHP systems, around 25% with slightly higher savings (27%) in the total annual electricity demand. The reduction in total

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[37] Kensa: Connect & Notify Approvals https://www.kensaheatpumps.com/news-blog/no-more-dno-hassle-says-kensa-heat-pumps-with-connect-notify-approvals/ *accessed October 2022*

demand is higher than the reduction in peak demand due to the contribution of water heating to the total demand, which has been removed from the peak demand as the heat pump systems are assumed to heat water at off peak times.

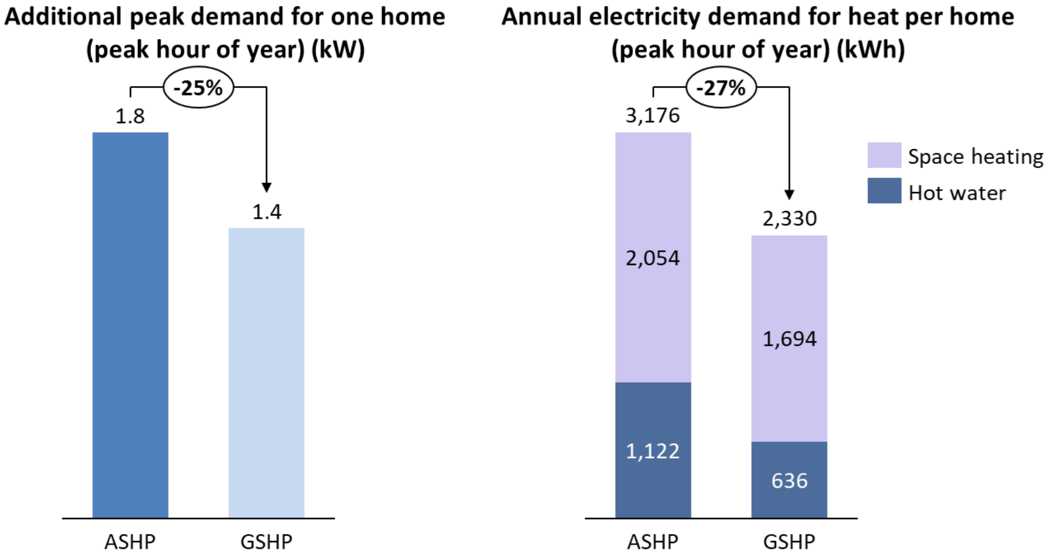
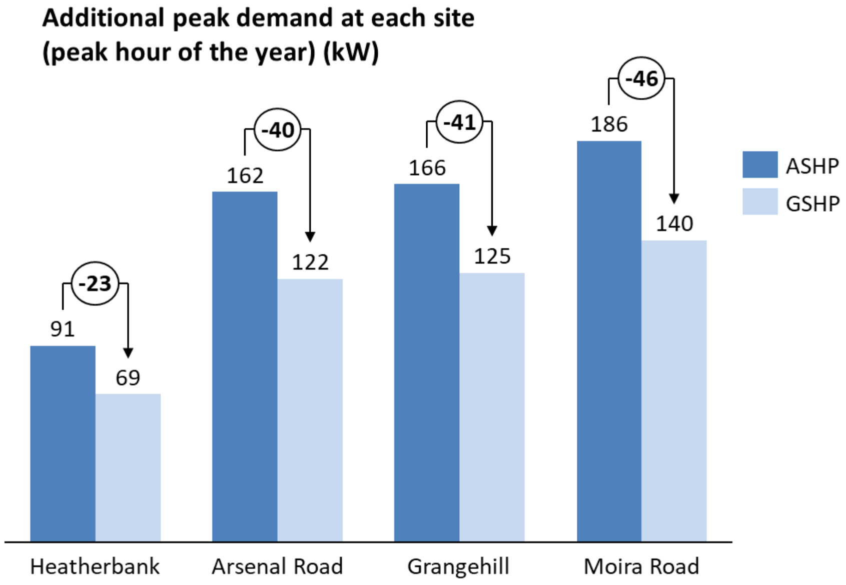


Figure 5.18: Additional demand placed on the grid by installing heat pumps in a 3-bed, pre-1919 terraced home in terms of peak demand (left) and total demand (right)

Based on the number of homes the Greenwich TIME project plans to target, it was possible to predict the additional demand within each substation areas that the project will target. Figure 5.19 shows the additional demand placed on each of the substation areas considered for Phase 2.



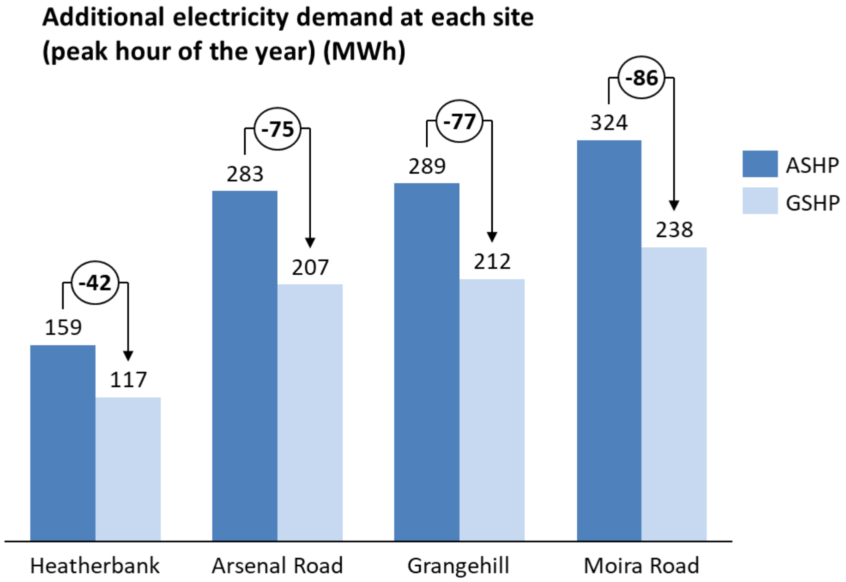


Figure 5.19: Additional demand placed on the grid by installing heat pumps varying numbers of pre-1919 terraced homes at each substation site in terms of peak demand (left) and total demand (right)

Impact on fuel bills

This process has been described within the information provided on the technoeconomic modelling in WP1 and is not repeated here.

Carbon emission reductions

The benefits of heat pump roll out in terms of carbon emissions reductions are clear – even in 2022, switching to a GSHP would lead to a reduction in emissions of ~85% compared to a gas boiler (the most common counterfactual in Greenwich). A 99% reduction is achieved by 2050, but this could be sooner if ambitions for a net-zero electricity grid in the UK by 2035 are realised.

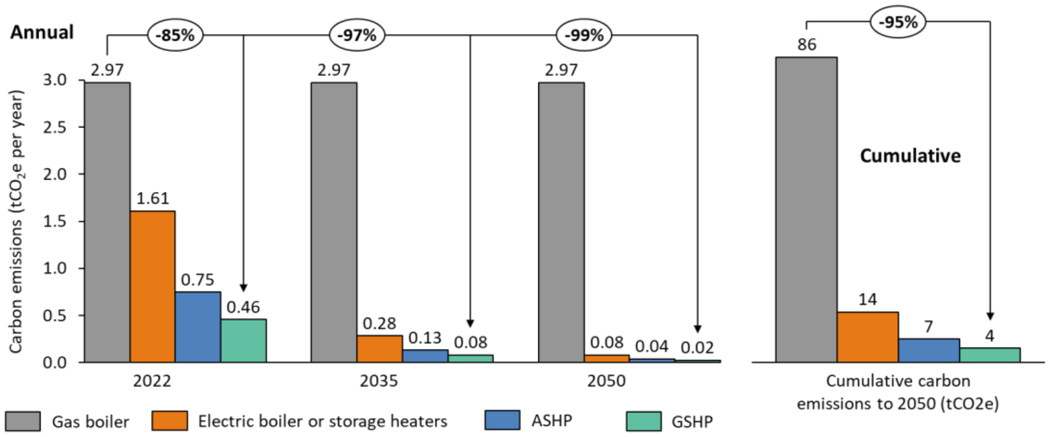


Figure 5.20. Annual emissions (left) and cumulative emissions to 2050 (right) compared for a gas boiler, electric boiler/storage heaters, ASHP and GSHP. Emissions factors are BEIS values.

During the project, an additional analysis was carried out on the emission savings offered by heat pumps in response to a comment in the Ipsos engagement summary:

> *“There was a sense of frustration that heat pumps were the only option being discussed for decarbonising domestic heating; some suggested they would prefer to see support for a system which used other green energy sources such as solar panels.”*

The above statement highlights a lack of understanding about where emissions predominantly come from in homes (i.e., gas boilers) and underlines the need for a wider understanding about the role of low carbon heating in decarbonisation. To do this, an additional comparison was made showing the emissions from gas boilers and heat pumps over time, compared to the emission savings from an average domestic PV system (Figure 5.21).

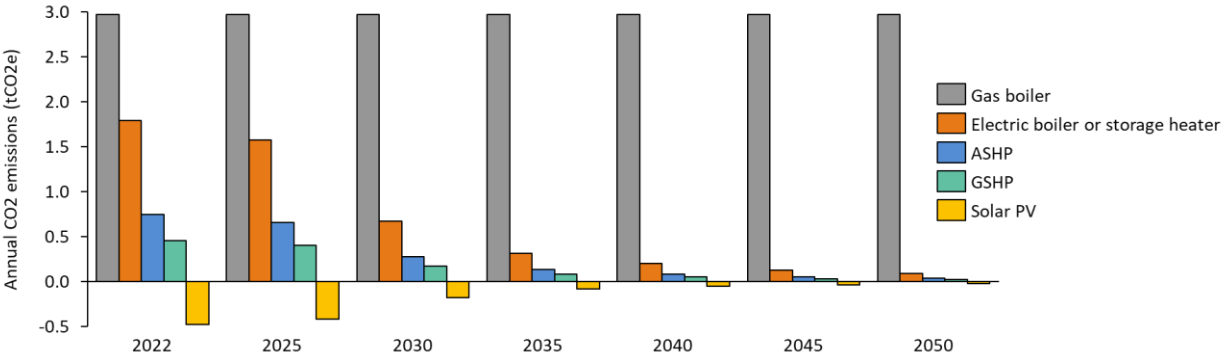


Figure 5.21. Comparison of emissions reduction from various heating systems to emissions savings from solar PV. The values above zero relate to the emissions associated with various heating systems in each of the years shown, with emissions from electric heating options reducing over time as the grid decarbonises. These heating systems have net positive emissions; hence their values are above zero. Below zero, the emissions savings from PV are shown for comparison. These are shown as negative emissions as in isolation these would lead to net negative emissions. The emissions savings over time from PV decrease as the grid decarbonises, i.e., their advantage over the grid decreases.

It is important to emphasise that the emissions savings from PV are much smaller than that from switching from a gas boiler to a heat pump, and that solar PV cannot make homes that are still using fossil fuelled heating net zero ready. Furthermore, as the electricity grid decarbonises over time, the emissions reduction benefit from solar PV decreases. This is clearly demonstrated in Figure 5.21.

Monitoring strategy

As the monitoring strategy has been designed to be deployed in Phase 2, there are not findings yet to report here.

5.8 WP9 Finalisation of the Phase 2 Plan

A Phase 2 application for the Greenwich TIME project was submitted.

5.9 WP10 Project Management

5.9.1 Overview of Project Execution

A key aim of the full methodology developed in the Greenwich TIME project was to develop a methodology that was replicable not only in the sense of location, building type and consumer type, but also in terms of the partners involved in the consortium, i.e. no partner should be critical and irreplaceable as this would limit the capacity for scale up. This aspect of the project replicability has already been tested within the Heat Pump Ready Programme.

As mentioned in the WP9 methodology, the consortium had a stop-go check before beginning the Phase 2 application. OVO had to withdraw at this stage from Phase 2 participation. This decision from OVO was taken at board level as the company has had to rein in extra activities and prioritise supporting customers through the winter during the current energy crisis. OVO organised a meeting with Element Energy as the project coordinator to explain the situation as early as possible after the decision was taken. The consortium as a whole was understanding of the position that OVO were in and appreciated both the transparency the OVO team had given on the decision and OVO team’s input to the project. The OVO team continued to be involved in Phase 1 in consortium discussions and bringing together the Phase 1 deliverables.

OVO stepping back meant that the project was missing a partner leading the consumer journey, this handholding partner that Energy System Catapult had highlighted as integral from their experience on the Electrification of Heat study. Each of the remaining deliver partners (DG Cities, Kensa and Element Energy) investigated options for organisations that could step into OVOs role.

Organisations considered were:

- Direct swap with another energy company
- Organisations that had previously been involved in trials such as Electrification of Heat
- Retrofit organisations that have experience guiding customers through the retrofit journey.

A retrofit organisation called South East London Community Energy co-operative (SELCE) were identified and engaged by DG Cities. There had always been the hope within the project to bring in a local energy organisation to accelerate relationships with the local supply chain, make use of local knowledge and enable the project to benefit from the support of a local party. SELCE were initially focussed on local solar installations but through a desire to reduce fuel poverty, developed a team of retrofit assessors and coordinators. The project plan was adapted to enable SELCE to take on the customer facing and customer handholding role. SELCE are not a large enough organisation to take on the full umbrella role planned for OVO therefore DG Cities and Kensa expanded their roles to fill the gaps left by OVO having to step down.

The central and expanded role of Kensa in the project, plus their experience with large scale deployment projects meant that it made sense for Kensa to take on the lead partner role and for Element Energy to step down. Element Energy's key expertise was in the analytical elements of the project, concentrated in Phase 1, and the coordination of the feasibility study. In future iterations of the project, this role will still be needed, but can be taken on by other partners.

In Phase 2, Kensa will take on the analytical and project management roles. Kensa was involved in much of the technoeconomic modelling – through providing data inputs and for the model and verified many of the calculations independently. Kensa has the requisite skills and knowledge to take the technoeconomic modelling forward for Phase 2. Kensa also has experience in project management of other very similar deployment projects, such as Heat the Streets in Cornwall; Element Energy does not have this same level of detailed experience in heat pump deployment projects.

The decisions around inclusion of new partners, change of roles and stepping down of existing partners were taken across a series of consortium meetings. Most of these were focussed quite intensely across a couple of weeks in early October as the project plan for Phase 2 was adapted. Notably, the project team remained united and continued to function well as a team throughout the challenges and changes.

5.9.2 Method of Project Execution

Element Energy's approach to managing the overall project and consortium partners was to initially require all partners to complete fortnightly summary reports of progress since the previous report was submitted. A fortnightly conference call between all partners was then held in a regular slot such that each partner could present progress, make information or data requests, and lay out next steps.

The format of these fortnightly reports was as follows:

- Progress and next steps
    - Activities in last reporting period
    - Activities planned for next reporting period
- Risks and mitigations table, with following headings:
    - Risk identified in last reporting period
    - Relevant work package(s)
    - Mitigations planned/implemented
    - Date mitigation achieved/expected
- Interactions with partners
    - Data/inputs received from other partners in last reporting period
    - Data/inputs needed in next reporting period
- Outputs and deliverables
    - Outputs/deliverables produced in last reporting period
    - Outputs/deliverables expected in next reporting period

Once the consortium partners had built more of a relationship with each other and scopes of work were better understood, which was roughly 6-8 weeks into the project, the requirement for fortnightly report updates was relaxed as there was an element of trust between partners (and Element Energy as consortium lead) that information was flowing efficiently and appropriately between partners, such that the project was progressing well. Fortnightly meetings were still held at the same time such that requests for information and general updates could be provided by partners where necessary. It was also an opportunity for administration/coordination updates to be provided to all partners, for example if input on finances or other admin documents were required, these could be explained in detail on these calls.

To support further the effective information flows between partners, a weekly “surgery session” was held each week by Element Energy for any partners to join and discuss anything openly with each other. Attendance was not mandatory which helped reduce time being spent unnecessarily by partners not required for specific discussions. An agenda was shared shortly before the call such that different partners were aware of their requirement to attend.

Whilst it is not essential that an organisation specifically like Element Energy lead the management of a consortium, it is essential that individuals (regardless of role/organisation) with experience of consortium management take charge of coordinating partners. Element Energy were responsible for both project management and some of the work package task deliverables; there were therefore two “managers” for the project – one who led specifically on day-to-day management of consortium partners, setting up conference calls, coordination and administration, whilst the other provided support on these elements but was more focused on task delivery, including supporting on work packages not directly responsible for. By defining these roles, the team was able to successfully manage the consortium partners in such a way to allow for progress to be made and deliverables produced without stifling innovation and new ways of thinking from across the consortium.

The approach was to push for conference calls and in-person meetings to be employed as much as time and budget allowed, avoiding mass emails as the primary communication mode. Whilst it was necessary to have consortium-wide email streams at times throughout the project, having a structured approach to engagement between partners (i.e. fortnightly and weekly conference calls, interspersed with in-person meetings at critical points in the project) was important to successful management and ultimate delivery of Phase 1.

6 Recommended Methodology for Coordinating High-Density Heat Pump Deployment

The key elements of the Greenwich TIME methodology for high-density heat pump deployment are summarised here, with more detail found in the individual work package sections described above. The methodology is also summarised visually in a figure in Appendix section 13.8.

6.1 Consortium formation

The key requirements for the consortium were

- **Coordination:** taking on the general project management and, if the project is being delivered by a consortium, coordinating partners
- **Delivery:** responsibility for the installations
- **Consumer journey:** the key contact for consumer throughout the journey
- **Analysis**: responsible for assessing costs, analysing locations and grid impacts
- **Consumer engagement:** responsible for reaching out to customers and bringing them into the project
- **DNO:** requirement for interaction with the local DNO to understand local grid constraints

The above roles can be split and combined between partners in a consortium or delivered by a single large partner (as some energy companies are now doing) with some elements likely to be subcontracted out.

The most important element of the consortium interactions and partnerships within the Greenwich TIME consortium was a strong and shared motivation to see the project come to fruition from all partners, which manifested itself in a willingness to share information and learnings between parties and a determination to overcome barriers. While there are direct economic benefits to continuing to Phase 2 for some partners (e.g. the ability to sell heat pumps for Kensa), and potential economic benefits to others of involvement in future iterations of the project, all partners were driven by a desire to move the UK housing towards net zero. The joint purpose among the consortium and belief in the solution being offered was central to overcoming the challenges faced in the feasibility study. Future projects should ensure all partners have an intrinsic desire to see the project come to fruition.

As described in section 5.9, changes have been made to the consortium members between the Phase 1 study and Phase 2 plans. In Phase 1, research and analysis played a central role as the potential of the project was determined through both qualitative and quantitative methods. Phase 1 benefitted from having an independent organisation (Element Energy) that could draw together disparate strands of the research. In Phase 2, the focus will shift to mobilisation of consumers and deployment, and therefore it is natural that Kensa, as the main delivery partner, will take an even more central role. As a consortium it was decided that it was more likely that future deployment projects would be led by heat pump manufacturers and/or energy suppliers, and therefore Element Energy’s continued involvement was not required.

A specific feature of the Greenwich TIME consortium, which is known to be different to some of the other Stream 1 Phase 1 projects, was that with Kensa as the technology partner, shared group loop ground source heat pumps were chosen as the default technology solution. Another approach could have been to be more technology agnostic, allowing different technology solutions to be chosen according to each dwelling involved in the deployment phase.

The benefits of choosing the technology upfront were that:

- The heat pump manufacturer was engaged in detail from the very start of the project allowing them to:
    - provide accurate costs early on, which was critical to defining the consumer offer clearly
    - lend their extensive expertise to the development of the consumer offer in a highly engaged way
- This simplified the consumer offer, making it easier for the consortium partners to understand and communicate to potential consumers
- This meant that specific house types were targeted that are likely to have similar requirements in terms of the types of energy efficiency retrofits that they require to be heat pump ready. This simplified:
- The installation requirements, and the communication of the consumer offer
- Having one simple consumer offer meant that it was clear which consumer types needed to be targeted as most likely to take up the offer and this further simplified the consumer engagement process.

However, there are risks associated with choosing the technology upfront:

- Networked ground source heat pumps require high uptake in quite a concentrated area (an individual street of adjacent streets) to meet the 25% uptake target set by BEIS.
- The perception of limited consumer choice. However in consumer engagement for phase 2 all options will be laid out for them with independent research and pros/cons to help them make their own choice as to whether they want to sign up or proceed with their own alternative. Kensa and the consortium backs its own solution here, and will want sign up from consumers who choose it.

6.1.1 Consortium management and administration

Data management

Key to ensuring successful delivery of this type of project is ensuring all consortium partners have access to documentation without the need for sharing via email or other more cumbersome web-based systems. The approach was to use Sharepoint as a repository for all shared documents, which is invaluable to the quick dissemination of documents that all partners could have access to and edit. Sensitive data or information can be stored locally by the lead organisation, and only shared with relevant partners via email or an alternative method where needed.

It is important that IT departments of the lead organisation hosting the Sharepoint folder do not have strong limitations on access for external organisations, or can relax them for the purposes of the project. This can be an issue when looking to share documents between partners quickly, i.e. specific people who previously had access are suddenly unable to access the shared folder, resulting in short delays and blockers to project progress whilst IT departments or lead organisation project managers seek to rectify the issue.

Contracts and agreements

Whilst there was discussion of non-disclosure agreements (NDAs) for sensitive data at the start of the project, this was not required as all parties were comfortable sharing their data where needed, and the nature of the project did not require such strong terms to be agreed between all parties. It is however recommended that NDAs be coordinated and signed by the lead organisation at the start of this type of project, as the lack of sensitive data in the project was perhaps unusual rather than the norm.

A consortium agreement was produced and signed by all partners. This can be challenging to coordinate as there will be legal departments from different organisations with requirements and amendments for the agreement. It is recommended that the lead organisation of future projects of this type rely on the UK government's template consortium agreements that are relevant to the consortium formed for any given project as early as possible (ideally before project commencement if possible, such that there is sufficient time for legal departments to review and agree to the terms and make any amendments necessary).

6.2 Consumer offer

The next stage of the feasibility study is to set out the consumer offer. The consumer offer may either define the consumer type, or be defined *by* the consumer type. In the Greenwich TIME case, the consumer offer has set the consumer type. There are benefits and risks to this approach. Broadly the benefits relate to the simplification of the consumer offer and requirements for consumer engagement through appealing to a subset of consumers that are likely to be motivated and persuaded by a similar set of factors. This will allow the consumer mobilisation to be more focused and targeted, and therefore a more efficient use of the consortium's resources. In-depth local engagement was identified as a key component for Phase 2; if this was required to target a wider range of consumers, less time and energy would be put into each consumer type overall. Narrowing down to a particular consumer type does have potential risks. By narrowing down there is less room for error in the consumer mobilisation process, i.e., if you cannot appeal to you consumer type target, there aren't other consumer types to fall back on.

If, say a local authority was heavily involved and keen to target areas of high fuel poverty, the area and consumer type would be the initial parameters and the consumer offer would be developed to ensure cost savings to consumers by seeking funding sources for aspects of the deployment (such as energy efficiency improvements) and seeking low interest loans to ensure the standing charge was kept as low as possible.

6.3 Location selection

The three key inputs into the location selection are likely to be:

- **Consumer type**: largely defined by the consumer offer, key to understand the motivations and identifying metrics of the target consumer type
- **House type**: ensuring the housing density is high enough, ideally flats and terraced housing but streets of semi-detached/detached houses may be possible
- **Local grid capacity**: ideally deploying in areas with headroom in the local grid.

In terms of the house type, the focus here is on the networked GSHP solution and therefore high-density housing. There is no reason that aspects of the methodology developed in the Greenwich TIME project could not be adapted to other technologies, such as individual heat pump technologies. Such solutions would not use the split ownership mechanism, but areas and consumer types could still be targeted and engaged in the same way, with a strong focus on local engagement.

The metrics listed above, consumer type, house type and grid capacity, can be mapped based on publicly available information such as census and EPC. This mapping exercise allows target areas to be identified. The scale of the mapping exercise depends heavily on the aims of any individual project, e.g., a local authority targeting their own social housing stock in a certain area vs looking for target areas across a whole city.

6.4 Consumer surveying

Understanding the awareness and desire for low carbon energy solutions will change from place to place and will change over time as low carbon technologies become more widespread and familiar. The mixture of online surveying and door to door surveying used in the Greenwich TIME project allowed both quantitative and qualitative information to be collected about attitudes to heat pumps themselves, as well as other aspects of the offer such as financing options. The surveying in Greenwich TIME was targeted to reach those in the consumer archetypes being targeted for deployment, as well as in the identified site areas emerging from WP2. The benefit of the door knocking exercise here was that it captured some further qualitative insights than the survey, which needed to be kept to a suitable length for good completion rates. The face-to-face engagement meant people could elaborate on the views or barriers, which would have been identified on the survey, that were most pertinent to them as well as to ask questions and respond to further information that they requested, or which could be shared at the time. This exercise could be time-consuming, particularly for a wider area of targeted consumer archetypes, and as such alternative engagement methods to explore qualitative insights more deeply may be considered such as online Focus Groups or local site-based workshop or drop-in sessions. However, as more surveys and engagement is undertaken and its findings shared for heat pumps, there may be less need for such accompanying engagement for individual projects.

6.5 Setting out the consumer journey

The most important aspects of the consumer journey were found to be the initial awareness and understanding, which is currently low, and the support and handholding throughout the whole consumer journey.

There are aspects of the proposed consumer journey for Greenwich TIME that are likely to be applicable to other similar projects:

- In Greenwich TIME: The initial phase of raising awareness and understanding will take place with a strong local emphasis, largely as a result of the need for very high-density uptake for the networked GSHP solution.
    - **General learnings:** The focus on local events and workshops allows consumers to interact both with the technology and the organisations responsible for delivery, and allows consumers to feel that they are not alone on the journey. These interactions also allow consumers to develop a better understanding of the solution on offer and enable them to build trust in the solution.
- In Greenwich TIME: Once engaged, the consumer journey within will largely be handled by one party, in this case SELCE supported by Kensa, such that the consumer always has a single point of contact. Retrofit assessors will provide detailed assessments of homes and bespoke packages with any recommended measures that are specific to each home.

- **General learnings:** This approach, with individual assessments of each home, is required to ensure that the costs and disruption of any ancillary works is fully understood by all parties prior to contract signing. Providing a single point of contact of the consumer is also likely to be important in all projects to minimise the complexity experienced by the consumer.

7 Areas for Innovation

In the Heat Pump Ready programme, BEIS incentivised process and system innovation opposed to technology and tools innovation (which was funded separately, including through Stream 2 of the Heat Pump Ready programme), but deliberately left definition of what counted as innovation relatively unspecified so as not to set all projects down one course. The innovations sought as part of Heat Pump Ready Stream 1 were around the approach to coordination and high density deployment of heat pumps within a specific location. The key innovations within the Greenwich TIME project that were expected to enable the coordination of high-density heat pump deployment are listed below.

The innovative methodology in the Greenwich TIME project:

- Engenders trust through partnerships between commercial and community enterprises as well as academia by creating a shared vision (WP1) through regular open discussions and information sharing (WP10)
- Provides phased and layered consumer information, starting with area-wide awareness to develop familiarity and, through the customer journey, gradually adding more detail to avoid overloading (and losing) customers (WP4)
- Provides an approach to mobilise heat transition at scale and at pace through targeted, localised street-by-street approach (WP2)
- Overcomes evidenced engagement barriers by taking a local, personal engagement approach, aiming to bring the community along on the journey (WP4)
- Targets consumers by multiple combined chosen aspects i.e., consumer type, building type, funding availability to have the best chance of achieving high-density consumer sign up (WP2, WP3)

7.1 Innovative interactions between partners

Typically, outside of the structure of the innovative Greenwich TIME project, each of the organisations within this project would work in isolation from each other and the coordination and activities described above wouldn't happen. Once demonstrated through TIME, this coordination will be more commonplace, which is why Heat Pump Ready has been so critical. Below summarises some of the key interactions within the Greenwich TIME project.

Setting up of the initial technoeconomic (TE) model

Parties involved: Kensa, Element Energy (Phase 1 only)

Innovative element: In the methodology used here, commercial selling party (Kensa) is subject to objective checks on the offer being put forward prior to being put in front of a consumer.

Kensa's standard method is to use SAP calculations (as standard across the industry) but these calculations have significant flaws, particularly in predicting the energy savings from heat demand measures such as insulation and heating control mechanisms. Element Energy and Kensa refined the calculations used for heat loss and the impact of retrofit measures based on Element Energy's expertise in retrofit consulting.

The advantage of an initially basic technoeconomic model was that all parties could understand and use the model in the early stages of the project, developing the understanding of all parties involved. This meant parties other than Kensa and Element Energy then knew the details of the offer such as

1. The realities of the financial offer and how it compares with a gas boiler
2. The biggest levers and mechanisms for using these (e.g., with the understanding the loan repayment rate has a major impact on the attractiveness of the offer, DG Cities went on to speak to Greenwich Council about low-cost loans)

Consumer archetypes to target

Parties involved: OVO, DG Cities, Heat Geek

Innovative element: The initial TE model highlighted that, within the confines of the BEIS Heat Pump Ready study, the proposed solution was unlikely to be considerably cheaper than a gas boiler and that the target consumer would have to be those whose motivations were not purely financial.

OVO provided the consumer archetypes, Kensa do not have the capacity or access to consumers to do this research themselves. Using the existing archetypes saved doing the research again. DG Cities knew the best way to target these consumer types based on marketing knowledge. Heat Geek were able to validate these archetypes and confirm that these archetypes are indeed the people they are seeing coming to them looking to purchase a heat pump.

Consumer journey

Parties involved: Heat Geek, Kensa, DG Cities, Consumer journey partner (Phase 1: OVO; Phase 2: SELCE)

Innovative element: The consumer journey provides a detailed understanding of consumer motivations, barriers and touchpoints, so that engagement strategies can be developed and barriers alleviated to encourage maximum uptake in clusters.

Supplier engagement

Parties involved: Heat Geek, DG Cities, Greenwich Council, Kensa

Innovation element: Early and specific supplier focused events to raise awareness of the program, allowing local contractors to receive training and upskill to take on installation tasks.

Monitoring, evaluation, and learning

Parties involved: ICL + all partners

Innovative element: Within the consortium ICL acted as an objective partner, working across most work packages and being privy discussions, data, and decisions. This role fulfilled four purposes. First, it provided specific technical knowledge and sense checking to several work packages, including techno-economic and network modelling, customer engagement and customer journey. Second, by working across the project it helped avoid silos that naturally form. Third, it enabled cross fertilisation between work packages, for example between techno-economic modelling and customer engagement. Finally, ICL brought in additional contacts to the project, such as engaging with UKPN at a different level to deepen their interest in the outcome During Phase 1, and moving into Phase 2, it remains key to use the knowledge and learning gained to iterate the processes and also to engage with key stakeholders (Ofgem, BEIS, etc.) to ensure replicability elsewhere.

7.2 Innovations for GSHP uptake

Fuel costs

Early analysis within Phase 1 clearly identified that the financial incentive for GSHP uptake within the Greenwich TIME programme would be limited, and potentially non-existent at worst. The incorporation of light retrofit elements, such as loft insulation and draughtproofing, into the offer meant that the proposed solution was much more likely to save households money on an annual basis and made sense with the kind of homes being targeted, pre-1919 terraced homes. However, the comparative annual costs of the networked GHSP system compared to a gas boiler depend heavily on the ratio of gas and electricity prices. The prices rises seen in 2022 have been much larger proportionally for gas than for electricity, which favours the economic argument for heat pumps. However, relying on this more favourable ratio in the face of such uncertainty about future fuel prices is unwise and cannot be expected to create trust in the financial incentives of switching to heat pumps. Fuel pricing mechanisms like switching green levies from electricity to gas, further decoupling the cost of electricity from the cost of gas (and other fossil fuels) and time of use tariffs can all be used to lock in the favourable ratio of gas to electricity prices, even as prices eventually return to more typical levels.

The uncertainty around future fuel costs meant that careful consumer targeting, and clear communication of the benefits of having a heat pump installed, beyond the financials, was going to be crucial to the customer recruitment strategy.

Consumer engagement and behaviour change

The findings of the research undertaken during Phase 1 have highlighted that the key innovations necessary at this stage to enable GSHP uptake are related to behaviour change and engagement. During Phase 1, tested consumer appetite for loan options was tested and alternative cost reduction strategies were surveyed, but it became clear that they do not significantly encourage uptake.

The approach to Phase 2 is based on the marketing funnel as the consumer journey, the aim is to reach consumers at multiple touchpoints along their heat pump journey. The phases of the marketing funnel (Figure 5.14) are:

- **Awareness**: making consumers aware of GSHPs and the offer
- **Consideration**: providing consumers with more information to help them ascertain that this is the right offer for them
- **Conversion:** ensuring the sign-up process is as simple as possible
- **Loyalty and Advocacy:** once they've enrolled in the GSHP scheme, making sure customer service is key and then using their experiences as a success story to recruit more GSHP consumers.

Such an approach will be required as there is a status quo bias towards gas, and this will be required in each community until the standard for a household is to fit a heat pump, not a gas boiler.

Full details of the consumer engagement approach are provided in WP4 Developing the Consumer Engagement Strategy.

Other innovations for GSHP uptake

A number of other, more specific innovations are being trialled in the Greenwich TIME project as part of the approach to mobilisation and deployment:

- Data collection through an interest register portal to enable filtering out of unsuitable properties, while identifying clusters.
    - What is innovative: While such portals have been used before, on TIME this will collect additional information so that the hassle-factor is marginally higher so that only interested people will sign up to it.
    - Who delivers: DG Cities to build the narrative and portal as part of its WP1.4, with inputs from Kensa Utilities
    - What is achieved: Significant cost savings, both on surveys (as the total number is vastly reduced), as well as on local engagement (as it self-identifies clusters within the area)
- Consistent trust and point of contact through energy champions who accompany the PAS2035 retrofit coordinator and installer
    - What is innovative: Customer fatigue and lack of trust can originate from continuously different people coming into a customer's house, which often leads them to be very sceptical of each individual. By having the energy champion there handholding throughout the process, trust is built, and consumers have someone they can call at any time with questions, helping allay concerns and increasing conversion once into the survey process
    - Who delivers: SELCE via their energy champions
    - What is achieved: Trust and lower dropouts, therefore minimising cost of delivering high density heat pumps. Highly replicable to any community.
- Using neighbours to encourage their neighbours to sign up, driving a "we're in this together" feel, to increase the % density in clusters from trusted voices.
    - What is innovative: This is not the case with individual purchasing decisions and makes it a group purchasing decision. The messenger effect documents that people are more likely to listen to others they know and trust. The incentive of individuals' costs going down if their neighbours sign up to also innovative and new.
    - Who delivers: SELCE identifying leaders in the community who can volunteer and help get their neighbours to sign up
    - What is achieved: Higher density uptake and lower costs (both surveys and engagement) given neighbours may trust neighbours more than the consortium
- Innovation: A coordinated two-visit survey approach that enables a free initial survey with all information consumers need to make a decision, with a £150 fee driving commitment to the second survey to minimise drop out.
    - What is innovative: Minimised consumer fatigue from just two visits, while providing them increasing information to make a decision. This means they shouldn't feel pressured and have the time to make decisions.
    - Who delivers: Kensa Utilities and SELCE, together with local installers
    - What is achieved: A good survey experience for consumers lowering drop out and therefore costs of surveys

8 Approach for Mobilisation and Deployment Following Recommended Methodology

8.1 Mobilisation of customers

Much of the content here is covered in WP4 methodology and findings but is summarised here for completeness.

The recommended engagement strategy aims to reach consumers at multiple touchpoints along their journey, and consists of 2 phases:

1. **mobilisation**: awareness, consideration and
2. **deployment**: conversion, loyalty and advocacy.

For Greenwich TIME, this strategy is cyclical, with activities being repeated to continuously recruit customers throughout the mobilisation and deployment stages in Phase 2.

The customer journey team (to be known as 'Energy Champions' in Greenwich TIME) comprises:

- retrofit-trained coordinators,
- local resident volunteers and
- energy advice specialists.

These Energy Champions will be active throughout the customer journey. Their objective is to guide residents from the beginning i.e., recruitment, to the end i.e., troubleshooting following installation. Their activities will be referred to below as part of each customer journey stage.

Awareness

Research conducted by DG Cities in Phase 1 highlighted that awareness of heat pumps is low (58% of residents had not heard of GSHPs). This, combined with a consumer offer that cannot definitely provide financial savings means that it is recommended that significant resource has been assigned to initial awareness raising activities.

For Phase 2 of Greenwich TIME, these awareness raising activities include:

- Distribution of marketing materials (e.g., leaflets, flyers and social media advertisements), directing people to the Greenwich TIME website and promoting community events.
- Community Heat Learn and Share workshops to raise awareness of GSHPs and build relationships between the local community and TIME stakeholders.
    - These events are innovative because they use co-design techniques to tailor GSHP solutions to residents' needs.
    - These events will include a mock GSHP set up, allowing residents to see the size of the equipment and visualise it installed in their home.
- Energy-saving roadshow schools edition: A series of workshops delivered by SELCE with year 10/11 students to discuss the benefits of renewable heating and energy-saving measures at home and providing information packs to take home to parents.

    - These events utilise the ‘majority illusion’ to overcome the notion that heat pumps are a new or niche technology and establish a local dialogue around heat pumps

- Energy Champion’s Heat Pump Parties: engaging local residents in one of their neighbours’ homes, a method proved to be successful in whole street decarbonisation projects led by SELCE.

Consideration

Once residents have indicated an interest in the scheme, it is important to provide them with more specific information about how the scheme would work in their home and progress them through their journey to signing the contract.

Activities include:

- Distribution of an energy-efficiency newsletter to anyone who has ‘registered their interest’. This provides updates about the project, energy-saving tips and a link to sign up to the scheme.
- GSHP Scheme Demonstrator Site: An opportunity to visit communities in Croydon and Essex where a Kensa GSHP scheme is operating, and later sights in Eltham once constructed.
    - This approach utilises social proof, by introducing prospective TIME consumers to current GSHP users and seeing it in action may help to solidify the decision to purchase and alleviate concerns.

Conversion

The conversion aspect of the consumer journey includes the logging of consumer progression on Kensa’s CRM system, the initial survey, secondary survey and contract signing.

Activities include:

- Greenwich Community Heat Day: a series of events to showcase the scheme's progress to date, support outreach and publicise the project to the press. This will create group cohesion and inspire uptake during the following stage gates.
- Energy champions:
    - Door knocking and leafleting, aimed to secure 5 survey bookings per day during a 3-week period.
    - Conducting primary PAS2035 survey and secondary retrofit survey.
    - Identifying external funding opportunities (e.g. for insulation) where applicable.

Loyalty

Once the contract is signed, engagement continues via the Energy Champions.

Activities include:

- Liaising with contractors to highlight residents' needs.
- Acting as point of contact for residents during install.
- Supporting residents to ensure optimal use of GSHP in the home.
- Collecting resident satisfaction data following installation.

Advocacy:

During the advocacy stage, residents could be asked to offer testimonials to be used in up-coming Greenwich Heat Days.

8.2 High-Density Heat Pump Deployment

This section provides some of the key learnings and recommendations for the actual deployment of heat pumps, drawing on the plans for Greenwich TIME Phase 2 as examples of how this influenced decisions within the Phase 2 plan. Note that the process recommended here is relatively specific to the consumer offer (which targeted 'able-to-pay' consumers) and technology solution (networked ground source heat pumps) and the method may need to be adapted where these elements of the methodology are changed in future projects.

8.2.1 Location selection

Following a data-driven mapping exercise within Greenwich to identify likely suitable areas (WP2 Location selection), Eltham was chosen as the target site for Phase 2 of the Greenwich TIME project. The target areas and details are summarised in Table 8-1.

Table 8-1: Details of target areas for Phase 2 of Greenwich TIME.

Area	Target #	Target Density	% of Homes Most Suitable	Housing Type	Building Type
Heatherbank Substation (200 homes)	50	25%	61%	99% Priv 1% SH 0% ND	73% Terrace House 0% Terrace Flat 0% Flat 24% Semi 3% Detached
Arsenal Road Substation (354 homes)	89	25%	60%	69% Priv 31% SH 0% ND	64% Terrace House 17% Terrace Flat 0% Flat 19% Semi 0% Detached
Grangehill Place Substation (364 homes)	91	25%	46%	91% Priv 9% SH 0% ND	63% Terrace House 16% Terrace Flat 3% Flat 17% Semi 1% Detached
Moira Road Substation (408 homes)	102	25%	55%	73% Priv 27% SH 0% ND	57% Terrace House 22% Terrace Flat 3% Flat 16% Semi 2% Detached
Total	332	25%	55%	81% Priv 19% SH 0% ND	63% Terrace House 16% Terrace Flat 2% Flat 18% Semi 1% Detached

The key questions asked in this process of choosing the **overall area** (~8,000 homes in Eltham) were:

- *Does the site have majority terraced housing?* Networked heat pumps are suitable in up to ~80% of UK homes.[38] However, the higher the density of homes, the lower the cost of the shared infrastructure per property, making terraced houses & flats ideal. Furthermore, terraced houses often do not have an easy alternative form of clean heating: a lack of space for air-source or individual ground-source heat pumps, and insufficient density for high temperature district heating.
- *Does the site have the type of consumers who would be interested in a heat pump offer and could afford to contribute to the upfront costs?* LSOA level demographic data on education and deprivation was used to match populations to two consumer archetypes identified by OVO through their engagement with customers.
- *Does the site have predominantly owner-occupied dwellings?* Identified through EPC data.
- *Does the site have maximum 30% social housing presence?* Identified through data provided by Royal Borough of Greenwich Council.
- *Does the site have grid capacity?* UKPN were engaged with to identify areas with sufficient secondary substation capacity in the target area, and to rule out areas that are overly constrained.

To **further refine and target areas ideal for uptake**, the process below was followed:

- Clusters were identified as fitting the following criteria:
    - *Energy efficiency band:* EPC D or E bands were targeted so that light insulation measures can be incorporated into the solution (i.e., loft, air tightness, room controls, and in some cases cavity wall), such that residents would see a larger annual cost saving as part of the scheme, making the project more attractive. Note that this insulation is *not* required for heat pumps to work, as demonstrated in the Electrification of Heat trial.
    - *Terrace housing or flats:* these are the highest density housing types, so the cost per property for the in-road infrastructure would be lowered.
    - *30 m2 -100 m2 floor area:* these properties are likely to have enough internal space for a Shoebox heat pump and thermal storage unit, but not so big that a larger heat pump is needed.
- Overlap these ideal clusters with secondary substation predicted boundaries, to ensure the 25% density requirement is hit and ensure that there is likely grid capacity for this 25%. Clusters with the highest housing density within secondary substation boundaries were selected.
- From this process, 4 areas have been chosen to target through 4 stage gates, rather than 1 stage gate, to minimise the time between sign-up and receipt of a heat pump. It is critical to minimise this as household situations may change e.g., their boiler breaks so they buy one in a distress purchase and then don't want a heat pump right after, or they move house, have a child etc. Therefore, targeting smaller clusters, getting them signed up faster, then deploying, and moving onto the next one is a way to minimise this drop-out / cool-off risk.

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[38] Regen: Rethinking heat: a utility-based approach for ground source heat pumps https://www.regen.co.uk/publications/rethinking-heat *accessed October 2022*

Within each of these 4 areas, the critical aspect for the deployment strategy is identifying clusters within each of the 4 areas where 80% uptake can be achieved, as this is what the costs are based on. Using Heatherbank as an example, with an estimated 200 homes within the secondary substation boundary - if the 50 homes targeted for 25% density are spread across the whole area, a network for the whole area is needed, but initially only paid for by 25% of households. In future this is exactly the roll-out model (like how the gas network was rolled out): once demonstrated in many areas like Greenwich, when local authorities do heat zoning etc. However, for this project, those 50 households are all needed in very high-density pockets: e.g. on 2 streets of 30 homes each, 24-25 on each street would need to sign up. This is again to share the cost of in-road infrastructure over as many homes *initially*.

8.2.2 Survey methodology

Our innovative survey and consumer engagement methodology is set up to identify and recruit 80% pockets in each of target areas, leading to heat pumps at 25% density in each areas.

Current survey and sales techniques for private household retrofit for heat pumps have a high per-property sales cost, largely from house-by-house targeting and high dropout rates after in-home surveys.

The recommended methodology developed through Phase 1 of Greenwich TIME turns this process on its head through **community-led, time-limited and highly targeted deployment**. Messaging is focussed on a community call-to-arms with fast action required. Emphasis is on the 82% carbon savings, air pollution impact, the benefits of cooling, energy security, and a one-off financing offer. Focus will be placed on the moving as a street, as a community to encourage consumers to make the transition now alongside their peers.

The consumer journey begins with area-wide engagement, critical to ensuring general interest, warming up and driving community-based discussion. With this interest and community call-to-arms enabled, the critical first step in the targeted survey approach is a self-selection portal. Interested households (from community events, leaflet drops, conversations with neighbours, online marketing etc) register their interest in an online portal.

From the initial information provided, streets/clusters can be identified where there is high sign-up[39]. Prior to conducting surveys, to further narrow the clusters and to minimise the number of surveys required, local energy champions[40], who are experts in engaging with everyday consumers regarding energy and climate change, will visit and introduce the project to the homes in such clusters who *haven't* registered interest. This aims to increase the % of homes interested and registered on the portal within a target cluster. The energy champions will also identify neighbours particularly interested to help volunteer by visiting their neighbours to encourage them, building a sense of community and "we're in this together" feeling. Energy champions will coordinate neighbourhood 'heat pump parties' where resident volunteers will invite neighbours to their homes to learn more about the project and further develop community relations. It will also be clearly communicated to

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[39] From Kensa's experience running the Heat the Streets project, this is very likely to yield clustered interest caused by the similar life stage, level of disposable income and ethos of neighbours, as well as neighbour-to-neighbour discussions. In the case of Heat the Streets, 80%+ clusters were already identified through just this registration of interest, which gives strong evidence that an even more powerful initial area-wide engagement approach, facilitated by leading partners such as DG Cities and SELCE, should yield similar outcomes.

[40] In Greenwich TIME this role is fulfilled by SELCE

neighbours that their own costs go down if they get their neighbours to sign up. This is different to individual air-source/ground-source deployment, as it makes it a community network deployment.

With target clusters now identified, the self-selected information can be used to filter out homes that wouldn't be suitable (e.g., due to a lack of space for a heat pump internal/external to the property), which limits survey costs.

Suitable homes in the cluster are then called to organise a **PAS2035 retrofit coordinator first survey**. Here a floor plan, measurements, building information, insulation information and heat loss calculations are done, which fills any gaps from the self-register portal in building information, allowing for reversion after the visit with a targeted quote and draft contract[41].

After the first survey, the **second, more detailed survey** is booked in. The second survey involves an installer visit to take the floor plan from visit 1 and discuss, together with the householder, where the pipes, radiators, heat pump, insulation etc will be. The outcome of this is that the householder, having had time to review the contract and now understanding exactly what it'll look like, can decide then to sign or abort. A 14-day cooling off period allowed following contract signing, to aid consumer protection. A secondary survey abortive cost of £150 is levied, which helps filter out consumers unlikely to proceed after the first survey, helping minimise resource drain and focus interest quickly. This is deducted from the cost-to-consumer at installation.

This highly targeted approach minimises the number of surveys. After visit 1 ~50% drop out is expected, and just 20% drop out after the second visit. The number is higher after visit 1 as then the costs to consumer become targeted and specific, which is what most people need to make their decision.

8.3 Quality Assurance During Deployment

Based on Phase 1 findings, the project focuses on providing people with access to reliable information from third-party sources and highly skilled in-house technical expertise for installation and certification. This ensures high-quality customer interactions at every stage of the project. Having organisations like SELCE on board with specific community engagement skills is a key element of this approach.

Table 8-2 states the method statement for ensuring assurance, monitoring and consumer protection at every stage of the process, and indeed for the lifetime of the heat pump. Quality plans will be developed at each stage gate, aligning with MCS Domestic Heat Pump Best Practice Guide and through MCS-qualified installers at the minimum.

Table 8-2. Assurance, Monitoring and Consumer Protection across design, install & post-installation in Greenwich TIME

Design	
Heat loss calculations	Will be consistent and accurate through use of PAS2035 certified retrofit coordinators, with reports made available after and collaboration/knowledge sharing through weekly standups among retrofit coordinators to ensure consistency in approach.

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[41] In Greenwich TIME Kensa Utilities will supply these, with the energy champion delivering & explaining it (via phone call/email), to preserve that trusted point of contact through the champion.

Heat pump sizing	Insulation being used where possible to reduce the size of heat pump required, but in any case PAS2035 certified retrofit coordinators will be used to ensure right sizing. Available in reports, together with Kensa's market-leading transparency on heat pump performance to aid sizing.
Space heating flow temperature and appropriate emitter sizing	By having energy champions there to explain that lower flow temperatures mean lower bills, and that radiators may not feel as hot. Consultation and consideration for vulnerable customers to ensure they feel comfortable.
Hydronic design	Bespoke training program combining Heat Geek and Kensa to ensure that the full home designs are done appropriately, with handoffs between PAS2035 coordinators and installers, facilitated by CAD drawings to ensure design is deliverable. Thermal imaging reports to be used too, as well as EcoFurb Plan Builder tool with SELCE team.
Integration with heating controls and weather compensation	Weather compensation less effective for GSHP (given ground temperature is a lot more stable than air temperature), and it is the most common technical call with residents thinking heat pumps aren't working (when radiators feel colder). Smart controls integration will be delivered to ensure time of use tariffs can be leveraged.
Understanding of the equipment being installed	Bespoke training to ensure that system designers understand the requirements of equipment, including staff from the manufacturer (Kensa) itself. This will be done with the resident too, walking them through the planned design so they're comfortable with what they sign up to.
Efficient hot water production	PAS2035 designs with Sunamp thermal storage units which have been tested together with Kensa heat pumps and certified to be efficient for hot water.
Integration with other technologies and tariffs	Smart controls and the innate flexibility, together with consumer education to switch to time of use tariffs to save running costs.
Network connection	Engagement early with UKPN, given domestic GSHP 'connect and notify' approach, to ensure that timely network connections can be made.
Consumer contract signing	14-day cooling off period included when signing the contract, to help consumers if they change their mind immediately after. We also give them ample time to review the details of the contract, with an energy champion to walk them through in easy to understand terms. We encourage discussing with their families if we're concerned about their ability to digest the information. The standing charge itself can only change with CPI, itself offering significantly better consumer protection than existing district heating networks.
Consumer handover	
Handover documentation	MCS handover packs will be delivered at install, as well as Kensa 'how to' guides which provide this in simple information, as well as QR codes on the heat pump for links to videos and other easy to digest sources for accessibility and differing needs.
System operation and maintenance	Energy champions to take each resident through this, alongside the abovementioned info packs and videos which explain this in easier-to-digest formats.
Ongoing consumer protection	
Customer support immediately post-install	Energy champions to follow-up visit ~2 weeks after for any queries, feedback, and also for any fixes/support required (e.g. on monitoring equipment).
Manufacturer warranties	Standard 5-year warranty offered from Kensa heat pumps. This can be extended by paying for Kensa's enhanced warranty.
MCS certified contractors guarantee	MCS-certified contractors guarantee to be provided, given MCS-certified installers / Umbrella schemes employed throughout the project.

Renewable Energy Consumer Code of Conduct	Part of installer training and weekly standup meetings to ensure this is complied with.
Maintenance schedules and plans	This will all be included in the contracts and in the visits from the energy champions, ensuring people are aware of (admittedly minimal) maintenance and service requirements, and the costs thereof.
Aftercare package	Packages for Kensa to maintain and replace the heat pump will be made available, alongside enhanced warranties where consumers desire.

8.4 Local Installer Base, Supply Chain and Training Providers

Local Installer Base

Based on Phase 1 research, the local installer base is characterised by a set of MCS-qualified firms who cover London and Kent local areas, whilst the council has also tendered work to heat pump and associated specialists. Many of these installers are more focused on ASHPs to date though state an ability and/ or interest to provide for GSHPs also. Therefore, some of the local installers can provide a group to test the project's early engagement activities and the training approach, feedback from this group will be utilised and they could form some of the 'supplier champion' roles to support the building of a supplier network and information filtering. The local install base also has a key role to play to support the methodology through a range of activities for open day events, on-site work experience and more formal trainee and apprenticeship support.

Our bespoke training program will help ensure that the local supply chain is built up and trained, ready to handle many more heat pump projects.

Supply Chain

Our feasibility assessment engagement activities found a high level of uncertainty from current heating and plumbing companies who do not yet supply heat pumps. The project is critical to provide a clear market signal to such firms for the commitment to heat pump trials and methods to enable high density deployment. On the infrastructure & drilling side, Kensa has existing relationships with borehole drillers in the Southeast. This can be called upon during the project, while also creating certainty on works for local drillers to grow. Kensa saw this with Heat the Streets, where a driller bought a new rig (costing £10,000s) when he knew Heat the Streets was coming to Stithians (without guarantee of winning the contract). The supply chain approach has been designed with this signal role being central, meaning that the supplier engagement activities will be accessible, appealing and timely. The supply chain will support the method by taking part in the training programme, awareness building and demonstrator events, to then provide further capacity to the project, or for wider decarbonisation work in Greenwich, through providing feedback to the project through the M&E tasks. The supply chain will be supported through use of 30-day payment terms, given this has been identified as a challenge in the existing supply chain around payment times, enabling accessibility to more smaller supply chain participants. Pre-tendering supply-chain engagement events will prepare and incentivise firms to enter the training process.

Training Providers

The Council has undertaken work on building a green skills strategy and has seen some small local delivery of apprentices in decarbonisation. The project will build on this and provide an opportunity to engage young people and those suitable for re-training to build understanding of the sector. Suppliers will be incentivised to provide work experience and testing days with local trainees and apprenticeships. Existing training providers that will be called on include Heat Geek for breadth (using online courses to train installers) and Kensa for depth (on the specific technology). This provides a bespoke training package to ensure competence to deliver both this project and future ones, with a more resilient supply chain. This approach is complemented by the labour market and green skills strategy of Greenwich council.

Providing student, trainee and work experience will be supported by local education and training providers, to help spread the project marketing and provide a matching service to project suppliers. For example, the team engaged with the Green Skills Hub at the London South Bank University and identified a potential collaboration here and with other colleges to provide work experience.

8.5 Approach to Network Constraints

The initial plan set out in Phase 1 was to target 25% of a low voltage network area (LVNA), the most localised level of the 25% density requirements set out by BEIS. LVNA is not a term used by UKPN, but there are a number of low voltage feeders off each secondary substation, which each serve 10's of properties. For the networked GSHPs solution being deployed in this project, the target is 20-100 homes on a single street to be fed by a single supply, easily surpassing the 25% requirement. Effectively the density requirements for the networked GSHP solution are higher than those required by BEIS.

A key challenge in Phase 1 was the limited data UKPN has on secondary substation capacity. The initial plan for selecting locations was to avoid network constrained areas, however very limited data was available at secondary substation level (see Reference Figures). UKPN set a limit of 15 secondary substations to be investigated, due to the manual nature of extracting the data for each substation. UKPN did provide a rough initial dataset for all secondary substations in Eltham, however, comparison between the first and second datasets showed very little correlation between the two indicating that the first dataset is not appropriate for use to understand grid capacity.

It was necessary to know the number of customers and the geographical area served by each substation; data not available from UKPN. A method of approximating areas was used that is consistent with the Cambridgeshire-based PACE project and Element Energy's networks team. It is therefore important to highlight that the projected areas served by the substation are likely not 100% correct, but remain the best estimate. The nature of the street-by-street solution in the project gives confidence that the 25% density requirement will be hit on a low voltage feeder from a secondary substation, but further information will be required on the capacity of each feeder.

The project will continue a two-way information flow between the project and UKPN to further investigate constraints on the network, provide mitigation through the use of flexibility services and to help UKPN to understand likely areas of future heat pump uptake.

With regards to learnings for future projects, it may have been valuable to have a direct link with the data team, and to establish this link early on, to ensure those in need of the data and those who have the data both understand each other's needs and capabilities.

It also became apparent from discussion with organisations within other Stream 1 projects that there were stronger links with the DNO; it is hoped the learnings and best practice from those projects can be brought into the Greenwich TIME methodology to strengthen it for future iterations.

8.6 Alignment with Local Authority Heat Pump Deployment Ambitions and Policy

Greenwich Council's landing page for their Carbon Neutral Plan explicitly states that the Council is "preparing a business case to find solutions for private sector housing such as installing ground source heat pump ambient loops" (Greenwich Council: Carbon Neutral Plan). Greenwich Council has a net-zero 2030 target, 20 years ahead of national targets. The Council's Carbon Neutral Plan lays out the actions required to get to net-zero. The key focus areas for buildings are improving energy efficiency and heating system conversion, with an explicit focus on heat pumps. The level of ambition and rapidity of change required for a net-zero 2030 target is highly reliant on the electrification of heat. The evidence base for the Greenwich Carbon Neutral Plan highlights the need for taking part in pilot projects beginning in the early 2020s to meet the 2030 target. The Council recognises the need, not only for the electrification of heat, but the importance of taking part in programmes like Heat Pump Ready and the specific role that networked GSHPs will play in decarbonising high density areas.

9 Costs to Consumers

9.1 Overview

The business model for the Greenwich TIME project aims to overcome a number of key barriers to high density heat pump deployment:

- The high cost of ground source heat pumps, driven by the groundworks, by splitting the upfront costs between in-home works and groundworks
- The potential increased running costs of heat pumps compared to a gas boiler counterfactual by using GSHPs with efficiencies close to 400%
- The degree of infrastructure required for high density heat pumps, especially for GSHPs: by carrying out works on a street-by-street scale the extent of infrastructure required is far less than for individual GSHP systems
- The lack of commercial investment opportunities in low carbon heating: by offering the investment in the groundworks an investment opportunity, the low carbon heating transition becomes of commercial interest, attracting low-cost finance from investments such as pension funds
- The coordination of individuals for the street-by-street solution required to deliver at the scale and pace required for net zero. The alternative, relying on everyone to organise their own surveys, designs, installs etc would hamper the pace and scale of deployment.

The methodology put forward in the Greenwich TIME project requires a number of roles to achieve the aims of high-density heat pump deployment. The costs to fulfil each role may be recouped via sales (i.e. all costs are recouped via the consumer offer) or the service of the organisation(s) may be contracted by an entity such as a local authority with the aim of reducing emissions from domestic heating.

9.2 Greenwich TIME Model Commercial Offering

The commercial offering through Greenwich TIME effectively tackles 3 aspects of cost:

- The shared ground array infrastructure which feeds ambient heat into the heat pumps (i.e., all outside the property)
- The cost of insulation upgrades which enable a larger running cost saving to the resident
- The cost of the heat pump and its installation

Given that the upfront costs of ground-source heat pumps are generally higher than alternative low-carbon heating solutions (ASHPs or other electric heating options), the solution to facilitate uptake is to spread upfront costs into longer-term running costs, thereby reducing the upfront cost barrier. Given the shared ground array is estimated to last 50-100 years, funding needs to come from long-term, patient investors (i.e., not households), and here Kensa Utilities has multiple offers from pension funds, strategic investors and high-street banks extremely keen to fund a CPI-linked green infrastructure asset. The cost of insulation is also a long-lasting benefit, often beyond the tenure of households, so therefore is also included as a Kensa Utilise funded asset. Both the infrastructure and insulation costs are paid back through monthly standing charges over a 40-year period. This means residents pay for just their use of the infrastructure for the time they're there, lowering the overall costs to them. Removing the infrastructure costs already reduces upfront costs by a significant margin, leaving just the heat pump and install costs.

The upfront costs are then covered via three sources where appropriate: [1] The BUS grant amount; [2] additional targeted funding where applicable (e.g., ECO for lower-income homes); [3] home-owner contributions. The two options for home-owner contribution intended to be offered to consumers in Phase 2 of Greenwich TIME are either [A] an upfront lump sum (~£6,000 for the typical 3-bed pre-1919 mid-terrace home common across Greenwich) or [B] paid back over time as a loan.

Compared to a ~£20k-£25k typical of an individual ground-source heat pump install, the innovative coordinated methodology and business model employed through TIME allows for a very attractive commercial offer where just ~£6,000 is residual for customers to cover upfront (Figure 9.1).

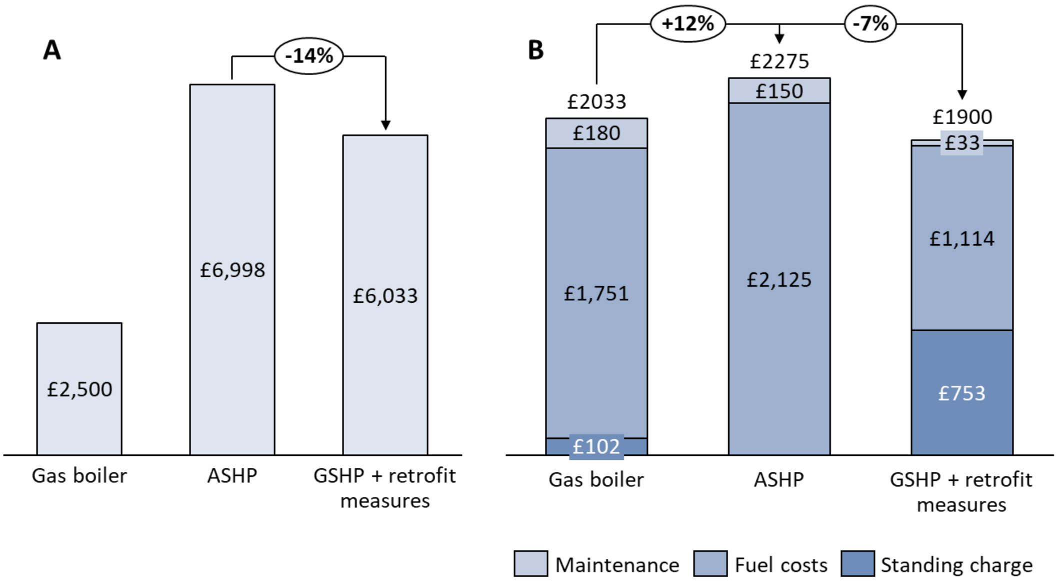

Figure 9.1. A. Upfront costs associated with buying heating systems via a one-off payment. For ASHP and GSHP the BUS grant of £5k and £6k respectively has been taken into account**. B.** Operational annual costs (in 2023) of running and maintaining heating systems. *note that this figure is a repeat of Figure 5.1.*

The offer proposed in Phase 2 of the Greenwich TIME project compares favourably to alternative low-carbon heating solutions, as demonstrated by Figure 9.1. Here costs are compared to an air-source heat pump (ASHP), with Element Energy's modelled install cost of ~£12k (in line with costs seen on BEIS' Boiler Upgrade Scheme (BUS)[42]). With the £5k BUS, this means that an ASHP costs ~£7k, £1k more expensive than the TIME offer.

Looking at running costs, with a COP of 3.5 on ground-source at the post-insulation 13,000 kWh/yr, compared to gas & ASHP at the pre-insulation 17,000 kWh/yr (ASHP at COP 2.4, aligned to Element Energy values used for the UK Climate Change Committee's Sixth Carbon Budget[43]), a ~£1,000 reduction is seen on bills vs ASHP given GSHP's efficiency. This creates headroom for the standing charge, meaning consumers pay both less upfront and ongoing vs ASHP, making this an attractive commercial offering. Nesta

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[42] UK Government Official Statistics Boiler Upgrade Scheme statistics: September 2022, https://www.gov.uk/government/collections/boiler-upgrade-scheme-statistics *accessed October 2022*

[43] Climate Change Committee: Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget (Element Energy) https://www.theccc.org.uk/publication/development-of-trajectories-for-residential-heat-decarbonisation-to-inform-the-sixth-carbon-budget-element-energy/ *published April 2021*

studies show 32% of people will be willing to pay up to £6k for a heat pump, and given the focus in TIME on higher ability to pay customers, this gives confidence in the desire of the offer.**Error! Bookmark not defined.** GSHPs running costs can be brought down by a further ~20% through use of time of use tariffs, based on Octopus' Agile tariff.[44]

9.3 Funding of Future Projects

Through the Greenwich TIME project providing a blueprint for high-density on-gas homes, there are a number of savings expected to be available for future rollouts:

- Attracting investment from private organisations, largely financial institutions, who are expressing ongoing interest in funding the green infrastructure assets (ground arrays) deployed through TIME and networked heat pump solutions at large. This will reduce the cost of finance from the current modelled 6% down to 3-4%, from discussions Kensa has had with some of the UK's largest pension funds.
- Trained installer bases requiring less upfront support, and having more confidence in pricing jobs (as opposed to adding a risk premium given the uncertainty of what's required in a home, an observation Kensa has made in the field)
- Economies of scale on heat pump manufacturing costs, with British manufacturers scaling up to serve a larger market
- Time of Use Tariffs to become more common and optimised for heat pumps, as discussed in Phase 1 with OVO but not taken forward currently due to the current energy crisis
- Wider public awareness and comfort with heat pumps ("look what they did in Greenwich") lowering sales and marketing costs required to receive sign-up
- Innovative solutions for conducting surveys more cheaply (e.g., 3D in-home scanners from a phone/tablet)

All of these cost reductions create significant headroom for the cost to consumer to absorb some of the costs which through TIME are BEIS-funded:

- Surveys and in-home design
- Marketing and customer engagement
- Coordinating party (Phase 1: Element Energy)
- Consumer journey parties (e.g., DG Cities, SELCE)

These costs could be added to the upfront cost, or added to the standing charge levied on customers, or split across both options. This split will depend on the customer archetypes present in any location deployed in, and the local conditions.

Instead of the cost to consumers absorbing this, there's a high likelihood that local authorities going forward will take a larger role in the coordination and uptake of regional heat decarbonisation approaches. Given Zoning Coordinator powers being granted through the Energy Bill[45], and their net zero by 2030 targets, Greenwich Council and others already understand that meeting decarbonisation targets will require investment from the Council. It

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[44] Octopus Energy: How much could you save with a heat hump? *accessed October 2022*). https://octopus.energy/blog/heat-pump-running-costs/

[45] UK Government: Heat network zoning *accessed October 2022* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1024216/heat-network-zoning-consultation.pdf

may be that the coordination and some of the consumer recruitment could be led by the Council themselves, collaborating with local community energy organisations with the option to bring in external parties to support on aspects or stages of the project. For instance, Element Energy was recently brought in as a paid project coordinator by the Greater London Authority to support the final stages BEIS Home Response project, providing a similar role to coordination aspect of Element Energy's role in Phase 1 of Greenwich TIME. This 6-month work was paid £28k for the coordination of the final stages, around 3% of the project budget. A more consumer-led option would be for a local community organisation take on the coordination and consumer recruitment elements, possibly using the consumer journey platforms available via organisations such as E.ON, Scottish Power or Home Energy Scotland. Being non-professional organisations, community energy organisations would not need to generate a profit on these projects but, as with local authorities, they may need to pull in support from other organisations as subcontractors.

Therefore, the funding made available for Greenwich TIME is critical in delivering a methodology that won't all need to be replicated for future rollouts, while pushing forward the industry to help it deliver cost savings to absorb some of the costs which are currently BEIS/public funded. It must be noted however that this methodology is not a final product and that it will need ongoing development to optimise and adapt to different places, consumers and economic environments.

The likely organisation(s) responsible for future rollout are broad, as the methodology can be adopted by many, but will likely include utility companies like Kensa Utilities or E.ON, but may also be filled at a regional level led by local authorities. This flexibility gives confidence in its replicability.

The challenge however remains that the counterfactual ~85% of UK households compare against is gas, where gas is relatively cheap vs electricity compared to other countries (10.3p/kWh gas vs 34p/kWh electricity in the UK, compared to 23c/kWh gas vs 30c/kWh electricity in the Netherlands).

9.4 Reducing the Cost of Heat Pump Deployment

Widespread adoption of heat pumps beyond public funding will require several policy levers, many of which are being considered. Some of these are listed and described below:

1. Reducing the Ratio of Gas to Electricity Prices

Guaranteeing that any heat pump system will be cheaper to run in the long term than a gas boiler system is very difficult in the current volatile economic climate, but the reverse is also true: claiming a gas system will be cheaper long term is equally uncertain. The Greenwich TIME project has created a solution that has the best chance of reducing bills for the kind of homes being targeted by including come light retrofit measures in the offer to reduce heat demand, supporting consumers to explore further retrofit options via SELCE, deploying a high efficiency heat pump solution with high quality installers, and potential for additional savings via time-of-use tariffs. These are measures that are within a household's control, however, there are measures that are beyond the control of individual households, the most obvious being the transition of green levies from gas to electricity. This transition would reduce electricity costs be around 5 p/kWh, resulting in annual savings of around £150[46].

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[46] ClimateXChange: Review of gas and electricity levies and their impact on low-carbon heating uptake https://www.climatexchange.org.uk/research/projects/review-of-gas-and-electricity-levies-and-their-impact-on-low-carbon-heating-uptake/ *published September 2021*

The energy required to run a GSHP is broadly similar to that used for lighting and appliances and the savings for a standard house are expected to be balanced across increased gas prices and reduced electricity prices, a corresponding £150 increase would be expected in the gas counterfactual heating bill. These bill savings combined would have a combined benefit of £300 for GSHPs compared to a gas boiler.

2. *Heat Pump Prices Decreasing with Increased Certainty*

While TIME will demonstrate a blueprint for high-density heat pump roll out and increase confidence of the sector, seeing some cost declines, real cost declines will come from longer-term Government signals of certainty. Finalising a date for banning gas boiler replacements in existing homes, and indeed confirming the Future Homes Standard, would aid this confidence and see many UK-based manufacturers scale up production, reducing costs through economies of scale. It is hoped that TIME adds to this certainty that heat pumps can deliver.

3. *Lower Cost Ground Array Finance*

Once the networked GSHP model for owner-occupied homes becomes more mature, it is expected that the IRR required for investors to be interested would decrease. In this project it is modelled at 6%, but is expected to get to 3%-4%, per conversations Kensa has had with potential funders. Reducing the IRR to 3%-4% would reduce the standing charge for homes by 25%-35% and is a significant lever in the consumer offer for pulling the annual costs further below that of a gas boiler. Local authorities could also look to co-invest, as local authorities are able to secure a loan from the Treasury at much lower cost PWLB rates. BEIS could also significantly support and accelerate this by making UKIB loans easier and more accessible to shared ground array infrastructure, and perhaps lending its balance sheet for such infrastructure financing.

4. *Statutory Utility Rights*

While present in the Energy Security Bill, these rights to work in the road, and indeed deploy boreholes in and below the public roads, will reduce planning delays, costs and uncertainty, which will lower the ultimate costs to consumers.

5. *Zero Interest Loans for Home Upgrades*

During Greenwich TIME the use of commercial 5-year loan rates for in house works was investigated, the Government has in the past offered zero interest green loans, and reversion to these could reduce the ‘zero upfront cost’ offer by several £100/yr, making heat pump adoption more competitive. The use of such financing is not expected to be used in Phase 2 of Greenwich TIME but is expected to play a part in future iterations of the project.

6. *Proliferation of Time of Use Tariffs*

Encouraging and mandating time of use tariffs will also see several £100/yr savings on bills, given the flexibility that heat pumps offer. This is especially apparent with GSHPs, as at night (when load shifting is common), the ground temperature is stable whereas the air temperature (for ASHPs) drops off.

7. *Incorporating Waste Heat*

An additional consideration not explicitly explored in the Greenwich TIME project is the opportunity for incorporating waste heat into the networked GSHP system. This waste heat would be used boost the temperature of the system, resulting in higher COPs. Depending on various factors, such as the magnitude and consistency of the waste heat source, the waste heat may simply be used to boost the temperatures and improve the COP of the system or used to allow less ground infrastructure to be put in thereby reducing the installation costs. The website reuseheat.eu lists over 7,000 sites in the UK with waste heat potential[47], around two thirds of which are food retail sites that would not be able to serve a large district heating network but could top up a local networked GSHP system.

All of these changes could see the TIME offer become significantly more competitive, offering many £100s a year of savings, and encourage a significant amount of private investment to enter into heat pump deployment.

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[47] Recovery of Urban Excess Heat | ReUseHeat Project | Fact Sheet | H2020 | CORDIS | European Commission (europa.eu)

10 Long Term Sustainability

10.1 Financial sustainability

Rolled out at to its maximum extent, Greenwich TIME Phase 2 will install heat pumps in 332 homes. A business case for Kensa to deliver this was identified during Phase 1, with BEIS supporting Phase 2 with ~£4.7m of funding. This correlates to a funded cost of ~£14.2k per home, around 25% lower than the £19.5k per heat pump associated with the Electrification of Heat trial.[48]

For long-term sustainability of the business case, and the opportunity to replicate this method of mass heat pump roll-out again (either in Greenwich or an equivalent location elsewhere in the country), this funded cost will need to be provided from an alternative source. There are three options to achieve this:

1. Spread this cost across the households installing the heat pumps, recovered by increasing the fixed annual standing charge paid by customers connecting to the shared ground loop system(s). This would increase the fixed standing charge by £100s per home.
2. Secure funding from an alternative source, such as central government or the local authority (be it the Royal Borough of Greenwich or otherwise).
3. The additional cost is absorbed by the private sector delivery/operations company (in this instance, Kensa), provided that the business case can tolerate the increased investment required.

Option 1 avoids the need to secure funding from a government source, which may not be readily available in regions of the UK where the methodology is applicable. However, given the high upfront costs associated with heat pump installation, coupled with relatively small or marginal fuel cost savings for households, increasing the annual cost of heat pumps may discourage uptake by counteracting annual cost benefits for households.

Option 2 presents the reverse of option 1, in which households are expected to be more interested in purchasing a heat pump due to more affordable annual costs, but with the proviso that securing this level of funding from government sources may be challenging in different regions of the UK. Similarly with option 1, some of the funded cost.

Option 3 would require further analysis of the business case developed during Phase 1. Some of the ~£14.2k per household funded cost would likely be incurred regardless of the number of households purchasing a heat pump, thus with economies of scale there could be an opportunity for the cost to be.

With all of the above three options, some of the ~£14.2k per household funded cost would likely be incurred independently of the number of households purchasing a heat pump (i.e. a fixed project cost to the delivery company), thus with economies of scale there could be an opportunity for the cost to be spread across a larger number of homes, allowing for a reduced cost of delivery for the household, the government source or the private sector delivery company.

In practice, a combination of all three options would likely be the appropriate approach to replicating this heat pump roll-out methodology, i.e., some funding from government, the

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[48] Energy System Catapult: Electrification of heat UK demonstration project https://es.catapult.org.uk/project/electrification-of-heat-demonstration/ *accessed October 2022*

private sector absorbing some cost into its business case, and the household paying a small amount extra per year in fixed charges.

There may however be a case for the support to come directly from a government source in the form of grant funding. Many local authorities have set net zero targets by the end of the decade (including the Royal Borough of Greenwich) or sooner, and as such must make significant investments in rolling out low-carbon technologies. Many net-zero strategies for local authorities identify heat pumps as key components in achieving their aims. Unless all homeowners are expected to pay fully for their own heat pumps (and associated costs) to achieve the net zero aims stipulated by the authority, then investments to enable widespread deployment via the methodology described here could represent a cost-saving in achieving net-zero aims.

10.2 Replicability

The innovative methodology developed in the Greenwich TIME project has been designed expressly to be replicable across most of the UK's urban and semi-urban regions, targeting one of the most common house types: terraced, pre-1919, solid brick homes. The networked infrastructure acts as utility network to replace the gas network, with a network feeding input energy to individual in-home white boxes (in this case heat pumps, not gas boilers). With the gas network covering ~85% of UK homes, this is the reach, which is supported by studies into the applicability of the technology by others.[38] Therefore, replicability is at the core of this project.

The conditions present for the methodology here in Greenwich are:

1. **Suitable housing types for networked heat pumps**: primarily terraced streets and flats. For terraced housing there's generally no space for individual air-source or individual ground-source heat pumps, heat density is too low for high-temperature district heating, and hydrogen is unlikely – therefore networked ground source heat pumps are the only viable solution. For flats, challenges with alternatives are there too.
2. **Council interest in supporting the decarbonisation of heating in communities**: Greenwich Council (like ~80% of UK local authorities) have a net zero target by 2030
3. **Installer base available for upskilling & training**: Plumbers, gas engineers and heat pump engineers present to go through the training program to install networked ground-source heat pumps
4. **Limited consumer awareness of heat pumps**: Our surveys show limited awareness of heat pumps and how they work, and what the benefits are, requiring the detailed consumer engagement approach in a community-led way to drive trust in the process
5. **Grid integration coordination**: Coordination needed with the local DNO to ensure grid capacity and/or upgrades required to ensure heat pumps can be delivered in the area
6. **The need for solution coordination**: It would be extremely inefficient to have different parts of Eltham go with the four different generally accepted solution types (individual air-source heat pumps, high-temperature district heating, networked ground source heat pumps, hydrogen) as you'd need 4 sets of infrastructure built. Coordination is needed in identifying the best solution for the area and deploying it at scale, street by street.

These conditions are present across the majority of urban and semi-urban areas of the UK, accounting for 75% or 19.2 million UK households:

Replicability of suitable housing types for networked heat pumps

Terraced housing is the most common UK housing type present, accounting for 6.9m houses. In addition, there are 6.1m flats, together accounting for ~50% of the UK's housing stock. Kensa has deployed in 1,000s of tower block flats already (Enfield, Croydon, Gentoo etc) with a similar methodology of shared ground arrays. Given BEIS' Electrification of Heat trial focussed more on detached and semi-detached houses, this methodology offers a blueprint to tackle the other major housing types.

It is also planned to deploy in some semi-detached houses in Greenwich, and with expected cost declines and demonstration of the model here in Greenwich, networked heat pumps can also expect to cover many of the UK's 6.2m semi-detached houses. Altogether here 75% of the UK's homes are likely very suitable for this innovative methodology.[49]

The focus in Greenwich has been on EPC D and E homes (which make up 43% and 18% of England and Wales homes respectively), given that some simple and cost-effective insulation measures can help achieve savings below that of the gas boiler counterfactual. These are also perceived to be 'hard to decarbonise' homes. However, the methodology works just as well for any EPC, where insulation upgrades may not be done.

Replicability of council interest in supporting the decarbonisation of heating in communities

80% of UK local authorities & councils have declared net zero by 2030 or sooner, and in many cases heat from buildings is the largest source of emissions to tackle. A methodology that requires them to aid coordination but drives in purely private investment to deliver it is likely very attractive for them.

Replicability of installer base available for upskilling & training

Plumbers, gas engineers and heat pump engineers present across the country, many seeking upskilling to transition from gas onto heat pumps.

Replicability of limited consumer awareness of heat pumps

Nationwide surveys show limited awareness of heat pumps is present across the country, and indeed the surveys conducted by the Energy Systems Trust as part of Heat Pump Ready Stream 1 show a low willingness to transition away from gas across all Heat Pump Ready regions. In order to make the UK 'heat pump ready', awareness is required. The innovative methodology starts with awareness and education through fun, community-led workshops and activities. It targets schools to encourage family discussions on it. It targets neighbourhoods to encourage neighbour discussions. This all helps demystify heat pumps and make it a group transition, whilst making clear the benefits of lower carbon, energy security, cooling, pathway to significantly lower prices, home value uplift etc. It is believed this approach is replicable and necessary anywhere in the country.

Replicability of grid integration coordination

Coordination needed with the local DNO to ensure grid capacity and/or upgrades required to ensure heat pumps can be delivered in the area is present across the country, with all DNOs dealing with the dual challenges of EV and heat pump uptake. Our methodology of

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[49] UK Government Official Statistics: Council Tax: stock of properties 2020, Table CTSOP3.0 https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2020 , *accessed October 2022*

area-by-area rollout facilitates their planning of upgrades and makes this process easier, and unlikely that DNOs will delay rollout, which may occur if uptake is done sporadically in regions.

Replicability of the need for solution coordination

The same argument of not building four sets of infrastructure to serve four possible solutions is valid across the country, and is reflected in the Government's approach to zoning, where certain zones are specified for one solution to be deployed. With many of the conditions comparable as in Greenwich, the innovative methodology has been purposefully designed to be replicable, which is estimated to be the case for 75-80% of UK households (per housing type and council interest).

A study conducted by Leeds University highlighted that there is currently a gap in technologies tackling the 'middle' density of UK housing: houses that are denser than detached homes, but not dense enough for high-temperature district heating networks. This gap happens to represent 50%+ of UK homes, covering terraced housing and flats, as illustrated in Figure 10.1.

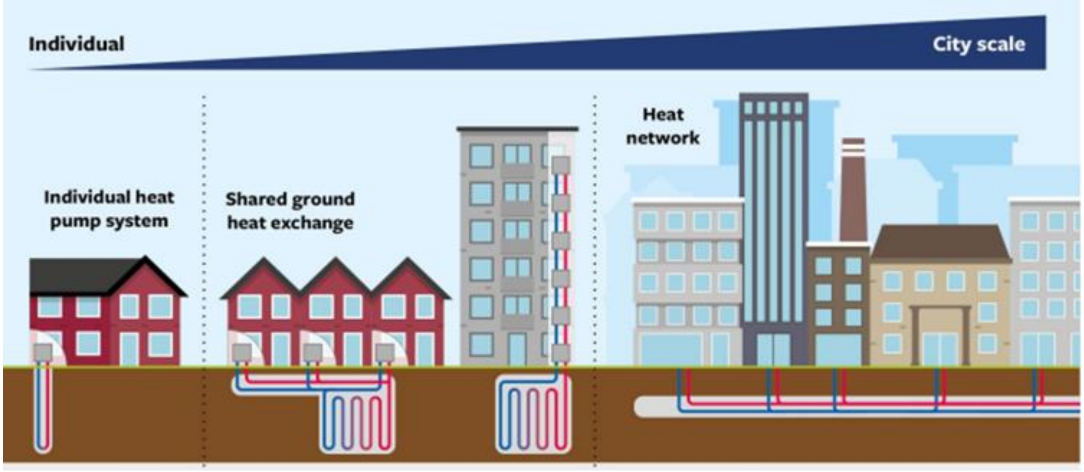

Figure 10.1: Illustration of the gap in low carbon heating deployment between individual and heat network scale systems, where networked GSHP systems are ideally suited.

In terms of the number that could be deployed by 2028 using this innovative methodology, it is looked at top-down. The Government's target is 600,000 heat pumps deployed by 2028 (including newbuild heat pumps). The CCC's Balanced Pathway assumes 624,000 retrofit heat pumps required (excluding newbuild) in achieving net zero, offering a starting point for understanding deployment numbers. 75% of the UK housing stock is suitable, and near-term the most suitable segment for the methodology includes 50% of the UK housing stock (terraced housing and flats), and therefore the estimate is that 312,000 heat pumps can be deployed by 2028 using this innovative methodology, with likely a greater share of the UK housing stock addressable by this methodology after this date.

This is naturally a significant step up from the current proposed target through Heat Pump Ready, but it highlights the significant scale deployment that will be required over the coming few years, where tipping points will need to be exploited in a similar fashion as to electric vehicles.

Take the UK's 10 major cities, what this could represent is shown in Table 10-1. The methodology naturally extends to many more than just the UK's top 10 cities, but this is just to illustrate for scale. In each of them mostly largely terraced streets and flats where networked heat pumps are likely the favoured solution, and the coordinated methodology developed through this project will be required to roll it out.

Table 10-1. Projected heat pump deployment numbers based on different methodologies[50]

Area	Number of Households	More conservative assumption in line with local authority targets	HPs per area assumed proportional to number of households based on suitable homes
		Number of HPs by 2028	% of Housing Stock Decarbonised
London	1,586,350	120,665	8%
Birmingham	448,570	34,120	8%
Leeds	357,750	27,212	8%
Glasgow	328,229	24,967	8%
Sheffield	252,500	19,206	8%
Edinburgh	239,364	18,207	8%
Manchester	234,290	17,821	8%
Liverpool	232,100	17,655	8%
Bradford	219,140	16,669	8%
Bristol	203,490	15,478	8%

A number of factors that would help accelerate industry towards this deployment are:

- Zoning policy: Councils granted the powers to designate zones as ideal for certain heating solutions (which in many cases it is believed will be the methodology solution of networked heat pumps), extending upon 'heat network zoning'. Each heating solution requires infrastructure deployment (grid upgrades for ASHP, shared ground arrays for networked heat pumps, district heating networks for district heating), and therefore going piecemeal risks deploying multiple sets of infrastructure, which would be highly inefficient for the transition.
- Local authorities or central Government low-cost financing of the groundworks, allowing for lowering of the standing charge even further so that the financial case is even more attractive for consumers to take up
- Further low-cost loans for in-home upgrades for consumers being developed in other parts of NZIP[51] and through the Green Homes Finance Accelerator[52] (e.g., green mortgages)
- Rebalancing the relative prices of electricity and gas to allow renewable energy to be delivered more cheaply, and aid the economic case for heat pumps vs gas (as is done with fuel duty for diesel vs electricity for EVs)

Industry is however ready to deliver at this scale and this innovative methodology largely relies on private investment in infrastructure and in-home upgrades.

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[50] Source: Table CTSOP3.0 https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2020

[51] Net Zero Innovation Portfolio - GOV.UK (www.gov.uk)

[52] Apply for the Green Home Finance Accelerator - GOV.UK (www.gov.uk)

Taking a more conservative approach, it is assumed each of these areas would wait to see 1-2 of Greenwich TIME's Phase 2b stage gates completed before being 100% confident in replicating the methodology in their locality. Engagement would of course start sooner in 2023/24, so deployment in each area would begin in late 2024. Kensa's experience from Heat the Streets is that once it started to be deployed in Stithians, councils up and down the country were reaching out to Kensa asking Kensa to "do the Heat the Streets model for us". The interest seen from other councils drives confidence Greenwich's deployment will generate further interest and accelerate deployment, especially given each council's necessity to achieve their net zero goals. It is envisaged that future will follow a similar 'stage gate' approach, starting with a few 100 homes in the first instance before ramping up to 10,000. In order to be on track for their net zero goals by 2030, councils cannot afford to go any slower. The outcome from this 'wait and see' approach in replicating the innovative methodology is that 110,000 heat pumps are deployed by 2028 (breakdown given in Table 10-1).

The methodology naturally applies to many more than the UK's top 10 cities, used above for illustration. As previously mentioned, with 50% of the UK's 26m housing stock very suited to this innovative methodology (and 75% total suited to it), the limitation on the numbers deployed is ultimately due to some of the accelerants described previously.

11 Recommendations

11.1 Recommendations on coordinated methodology

This section highlights some of the key recommendations from the coordinated methodology for Greenwich TIME. While there might be other methodologies that are equally effective, each of the recommendations below covers a key theme that is likely to be present in all heat pump deployment projects occurring over at least the next few years.

For Greenwich TIME, direct involvement of a heat pump manufacturer was very valuable to

- provide oversight for installation process
- provide accurate financial inputs for modelling and defining the consumer offer (having the manufacturer involved meant that this could be defined early on)

If a heat pump supplier is not directly involved in the consortium and developing the consumer offer and journey, a technical body that can have oversight of the installation processes and required training and ensure high quality installations (such as Heat Geek) should be engaged as part of the project instead. Ensuring high quality installations will be critical to the success of the project and how it is viewed externally, as well as to facilitate the effective development of a resilient and high-quality local supply chain and skills.

Working with local organisations that already have experience of engaging with the community in the selected areas is also critical and is likely to remain so until awareness and acceptance of heat pumps is much higher. The local Council was highlighted as a key trusted organisation by Greenwich residents, so involvement and endorsement by the local Council is likely to be an important component of these projects more generally, although this may vary depending on how the local Council is viewed in different areas. For Greenwich TIME, the connection to the Council was provided by an organisation with very strong links to the Council and experience working with local communities (DG Cities), however in other projects the Council could be involved more directly on the community engagement and delivery side. A Local Council is also likely to play an important role in supporting the development of local skills and a resilient supply chain to deliver the work and help deliver Social Value. This is based on their wider plans, strategies, and pipeline of work, and to build on current procurement and skills programmes for more effective outcomes. For deployment, the valuable input of SELCE has also been brought to the consortium to provide the experience and expertise in working closely with communities and households through different user journeys for sustainable behaviours and low carbon energy uptake. Having such an organisation as part of a consortium is beneficial and SELCE also offer expertise in the home survey and retrofit side of the deployment journey, to enable a holistic and effective process with consumers.

For Phase 1, the involvement of an independent organisation (Element Energy) to coordinate the early feasibility analysis played a key role in consortium-building by making sure that all voices were heard early on, and that all partners were ‘on the same page’ with regards to what could be achieved and what the desired outcome was. While it was recognised that Element Energy’s participation was not needed for deployment phases (see section 5.9) a similar role for an organisation without commercial interests may remain useful in other projects in the future.

11.2 Recommendations for achieving high density heat pump deployment

Greenwich TIME aims to drive heat pump uptake within the ‘able-to-pay’ consumer group and those who are motivated to reduce emissions as, even with the BUS grant, the upfront costs of a heat pump are more than double what consumers typically expect to pay for a gas boiler. Furthermore, while the ongoing costs of a GSHP (fuel costs, standing charge and maintenance) can be less than that of a gas boiler, this relies on cost-effective energy efficiency measures such as loft insulation, draft-proofing and temperature controls. The actual savings experienced by each individual home will be different and a saving against a gas boiler cannot be guaranteed in all cases.

Therefore, in the specific context and current conditions of the Greenwich TIME offer, consumer uptake must be driven in part by non-financial factors. In Greenwich TIME these were identified to be:

- A clear understanding of consumer types for targeting (an example of consumer types for targeting is given in Appendix 13.3)
- Active and continuous consumer engagement to:
    - tackle low awareness and understanding of heat pumps
    - emphasise the carbon emission savings and other benefits from heat pumps such as reduced maintenance compared to a gas boiler
    - drive uptake on a community level, where higher levels of participation reduce the costs for all involved
    - emphasise the smooth consumer journey residents will experience, and how this would compare to having to do this on their own
- An informed, resilient and upskilled supply chain ready to install heat pumps at scale.

Moving away from the specific context of Greenwich TIME, key factors identified for increasing the uptake of heat pumps in future are:

- Pricing and policy to support heat pump uptake much more widely
    - For ongoing costs: Rebalancing the relative prices of electricity and gas to allow renewable energy to be delivered more cheaply, and aid the economic case for heat pumps vs gas (as is done with fuel duty for diesel vs electricity for EVs)
    - For upfront costs this includes lower-cost financing for both the ground array and the in-home upgrades (e.g. zero interest loans from the Government to cover these over time)
    - Statutory utility rights for shared ground array utility companies
- Zoning policy: Moving from ‘heat network zoning’ to ‘heat zoning’, with councils granted the powers to designate zones as ideal for certain heating solutions (which in many cases it is believed will be the methodology solution of networked heat pumps, given the % suitability demonstrated earlier).
- A wider education piece on the impact of low carbon heating on emissions and the broader benefits (including cost if and when there is a strong case for this)
    - This aspect was highlighted in the Ipsos research, where participants questioned why they hadn’t heard more in the media or why more effort had not been made to educate the public.
- More case studies of homes with heat pumps

    - This was highlighted as a key action in the recent report by Richard Carmichael of Imperial College London, “Accelerating the transition to heat pumps” as a mechanism for improving consumer confidence.[53]
    - Consumer engagement also identified a lack of knowledge for how heat pumps work as well as how they are installed and then operate and look within homes similar to an individual’s own home.
- Incorporating networked GSHP systems into a whole house retrofit approach potentially using the localised focus/methodology used in Greenwich TIME
    - Coupling this approach with green finance offers and engaging mortgage lenders (who have decarbonisation targets to meet on their own financed portfolios). An alliance of mortgage providers may be useful here to ensure there is no dependency on a single mortgage provided to carry the solution, or any associated risk.

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[53] Ricard Carmichael, “Accelerating the transition to heat pumps: measuring real world performance and enabling peer-to-peer learning” https://www.imperial.ac.uk/energy-futures-lab/reports/briefing-papers/paper-10/ *published 2022*

12 Conclusion

Greenwich TIME brings an innovative approach to consumer targeting and engagement that can be successful in driving high density heat pump uptake. However, fundamental, primarily financial barriers and limitations for heat pump deployment remain significant.

Greenwich TIME provides an innovative approach to high density heat pump deployment by:

- Bringing together partners who would usually work in isolation, but that have each made crucial contributions towards an informed and successful consumer offer
- Geographically targeting mobilisation and deployment to areas with consumer types that have been identified as suitable for a shared ground loop ground source heat pump and likely to take up the consumer offer by the project partners
- Using a bespoke consumer engagement plan and consistent consumer journey partner (handholding organisation) to promote confidence in the scheme, and to simplify and demystify the process of installing a heat pump
- Aligning the project with supply chain upskilling and resilience.

12.1 The coordinated methodology

In Greenwich TIME, it was found that the involvement of several key parties was highly beneficial to the outcomes of the project:

- Direct involvement of the heat pump manufacturer led to a highly informed project in terms of both the technical requirements and the financial considerations of the project. While this may not always be the case, it was also found that the heat pump manufacturer was a highly motivated and engaged partner in the project that played a crucial role in driving the project forward.
- Involvement of local organisations was also important for the early stages of consumer engagement in the feasibility study, and to provide a more in depth understanding of local community considerations and potential drivers for heat pump uptake.
- Due to the highly clustered approach required for the networked ground source heat pump solution, where high uptake needs to be achieved at the level of individual streets, it was also important to be targeted. This meant there was also an important role to play for an organisation that had the ability to produce and map consumer personas, or already had these available (as was the case with OVO in Phase 1). Consumer profiling is likely to remain important to projects such as these, especially while the financial offer is not definitively cheaper than the alternatives, and heat pump awareness remains low. However, it may not have quite as important a role where heat pump deployment is more dispersed than the networked solution, as it would be for example when air source heat pumps.
- In Greenwich TIME, the local organisations worked with also provided the direct link to the Council, which emerged as a highly trusted organisation in the local area. This highlights the importance of Council involvement in future projects of this kind, noting however that the level of trust in the Council compared to other organisations will vary from area to area.
- As detailed in outcomes from WP6 (Understanding Grid Impacts and Requirements), engaging with the DNO to understand where heat pumps could be deployed under current grid capacity constraints presented challenges. Access to secondary substation capacity data was not as straightforward as had been hoped.

Therefore, in future projects it will remain important to engage early on, as well as continuously throughout the process, with the local DNO to determine what data is available. As more of this type of project are carried out on existing homes, it is likely that DNOs understanding of the impacts will also improve and this component of these projects will become easier to gather data for.

12.2 Feasibility for Phase 2

The feasibility of the consumer mobilisation and heat pump deployment plan for Phase 2 relies on the efficacy of the consumer engagement plan. Critical components of this will be:

- Engendering trust with consumers
- Educating consumers on the benefits of heat pumps
- Consumers choosing to take up the offer despite it not providing assured financial savings. This will rely on the basis of the home equity value uplift, the benefit of cooling provision, the large carbon footprint reduction and the energy security benefits.

Into the installation stage, the following are identified to be likely factors for success:

- Having well-coordinated interaction between home retrofit updates and heat pump deployment, to support the consumer journey and heat pump effectiveness
- Reducing the number of visits to each household as part of the deployment and ensuring high satisfaction rates with the work and in meeting time and cost expectations
- Capturing and reporting on early success for the wider community and potential consumers, supporting continued uptake by other residents. A clear monitoring and evaluation approach is part of this, with relevant and measurable KPIs.

The success of Phase 2 also relies on the seamlessness of the consumer journey, with the experience of early adopters potentially affecting the success of the later deployment phases.

12.3 Barriers remaining

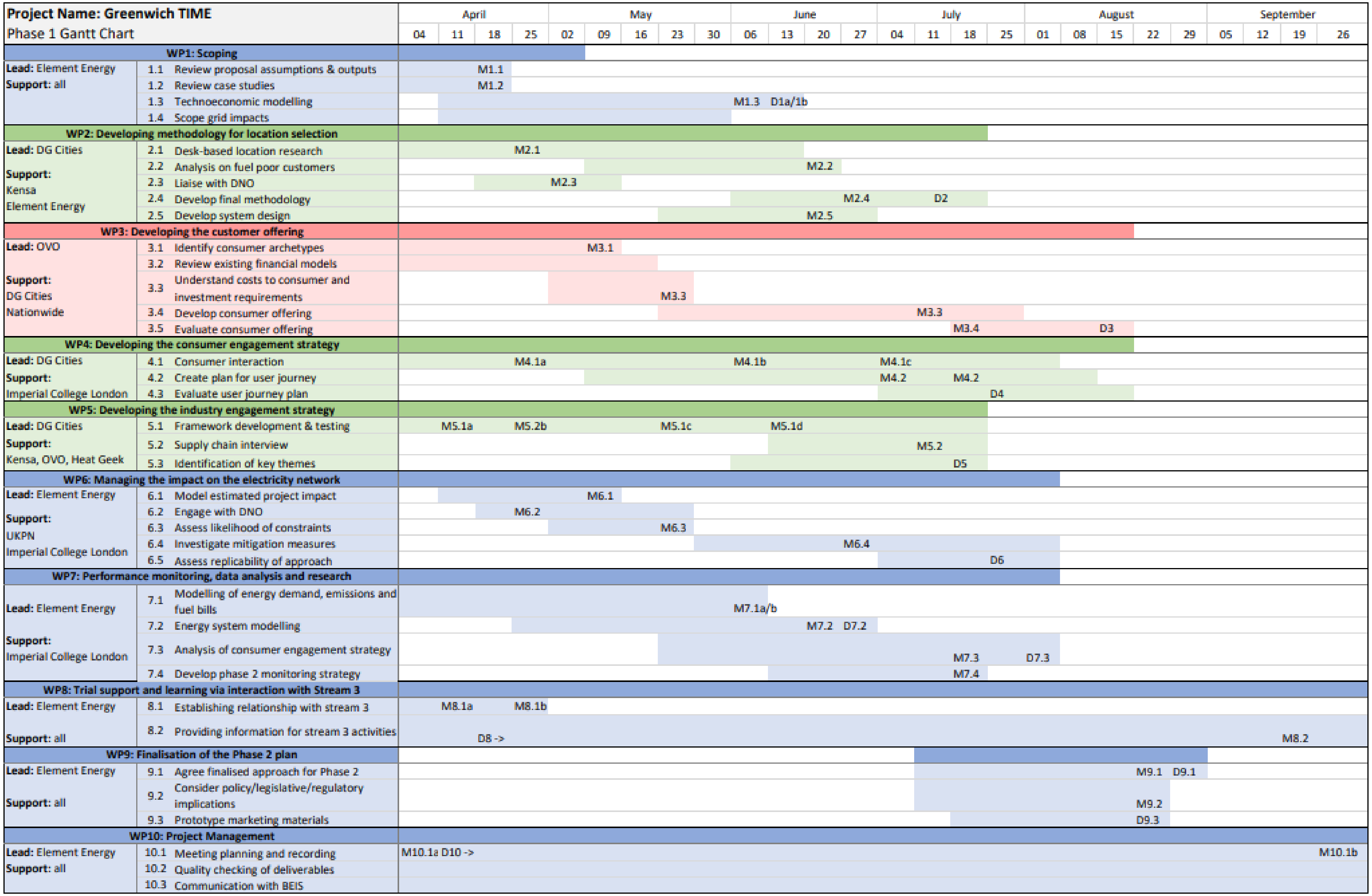
Should Greenwich TIME be successful, it will play a key role in driving consumer and investor confidence in such schemes, however further action is needed to tackle the main barriers to heat pump uptake. Below are some general observations of changes that would facilitate higher heat pump uptake. While these are general in nature, they represented significant barriers within the Greenwich TIME project that had a large impact on the direction of the project in terms of the types of consumers that could be targeted and the way in which consumers will need to be engaged in Phase 2. These issues are likely to continue to present challenges to projects of this nature and therefore place limitations on their scope.

- All else being equal (i.e., no difference in the energy efficiency measures applied), running costs remain higher than those of a gas boiler when the standing charge is included. If this remains the case, installing heat pumps will be unattractive to a large proportion of consumers. Options to reduce these costs come in both the fuel cost and standing charge aspects. Industry is working hard on reducing these costs.
- Equally, while upfront costs of heat pumps remain significantly higher than that of boilers, heat pumps will remain inaccessible to much of the population without further funding support. In cases without guaranteed annual savings, the decision to move to a heat pump can become difficult for customers to justify..

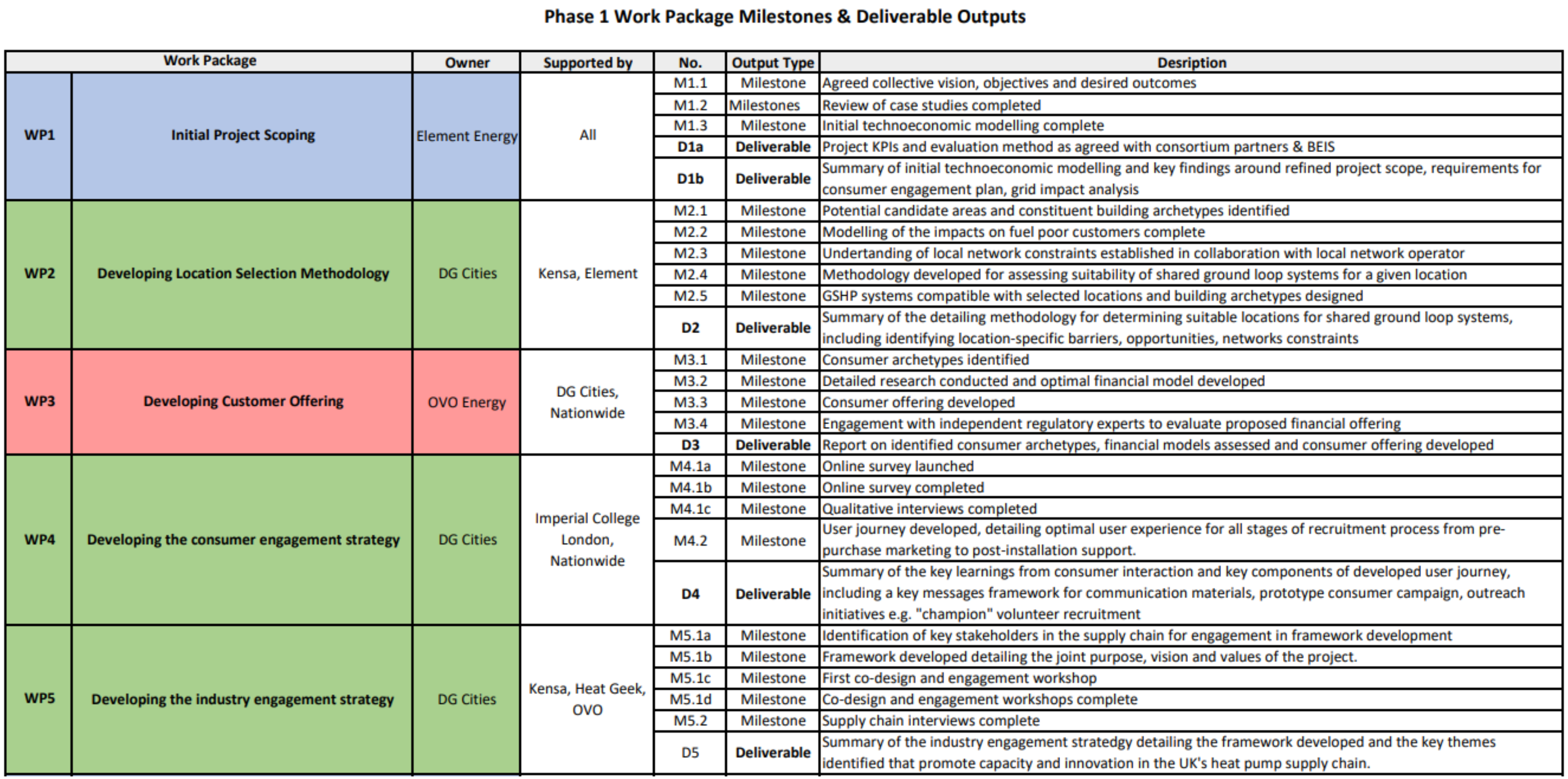
- Even within the consumer groups targeted in Phase 1, who were identified as likely to be early adopters, awareness and understanding of heat pumps was low, and apprehension about installation was high. Broader communications around the benefits of heat pumps would be useful (e.g., a Government campaign to inform potential consumers could be useful at an appropriate time).
- Grid constraints are more likely to be driven by new developments (e.g., new homes or commercial developments), EV uptake, and other large electricity demands. Over time, the requirement for grid reinforcements will increase. Future focussed projections must be used when sizing grid upgrades, and the cost of oversizing grid infrastructure weighed up against the cost of having to upgrade again purely due to network constraints.

13 Appendices

13.1 Phase 1 Gantt, and work package milestones and deliverables



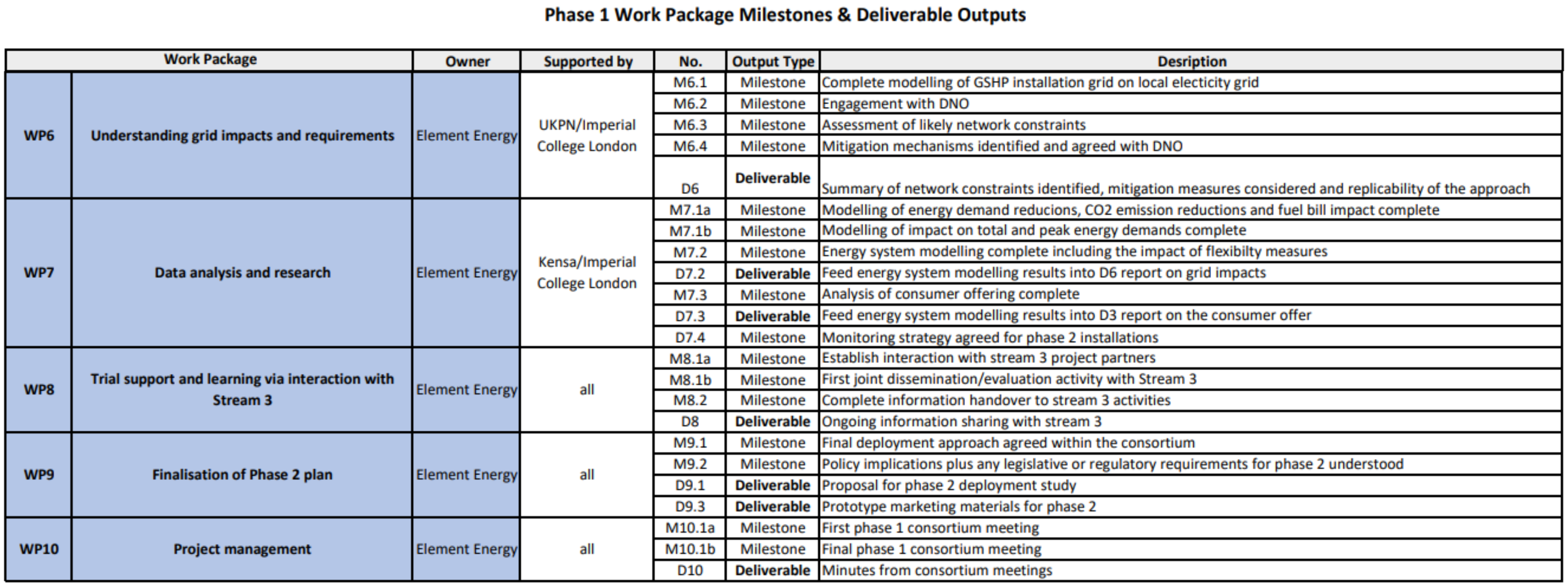
Project Name: Greenwich TIME			April				May					June				July				August					September			
Phase 1 Gantt Chart			04	11	18	25	02	09	16	23	30	06	13	20	27	04	11	18	25	01	08	15	22	29	05	12	19	26
WP1: Scoping																												
Lead: Element Energy **Support:** all	1.1	Review proposal assumptions & outputs			M1.1																							
	1.2	Review case studies			M1.2																							
	1.3	Technoeconomic modelling										M1.3	D1a/1b															
	1.4	Scope grid impacts																										
WP2: Developing methodology for location selection																												
Lead: DG Cities **Support:** Kensa Element Energy	2.1	Desk-based location research				M2.1																						
	2.2	Analysis on fuel poor customers												M2.2														
	2.3	Liaise with DNO					M2.3																					
	2.4	Develop final methodology													M2.4		D2											
	2.5	Develop system design												M2.5														
WP3: Developing the customer offering																												
Lead: OVO **Support:** DG Cities Nationwide	3.1	Identify consumer archetypes						M3.1																				
	3.2	Review existing financial models																										
	3.3	Understand costs to consumer and investment requirements								M3.3																		
	3.4	Develop consumer offering															M3.3											
	3.5	Evaluate consumer offering																M3.4				D3						
WP4: Developing the consumer engagement strategy																												
Lead: DG Cities **Support:** Imperial College London	4.1	Consumer interaction				M4.1a						M4.1b				M4.1c												
	4.2	Create plan for user journey														M4.2		M4.2										
	4.3	Evaluate user journey plan																	D4									
WP5: Developing the industry engagement strategy																												
Lead: DG Cities **Support:** Kensa, OVO, Heat Geek	5.1	Framework development & testing		M5.1a		M5.2b				M5.1c			M5.1d															
	5.2	Supply chain interview															M5.2											
	5.3	Identification of key themes																D5										
WP6: Managing the impact on the electricity network																												
Lead: Element Energy **Support:** UKPN Imperial College London	6.1	Model estimated project impact						M6.1																				
	6.2	Engage with DNO				M6.2																						
	6.3	Assess likelihood of constraints								M6.3																		
	6.4	Investigate mitigation measures													M6.4													
	6.5	Assess replicability of approach																	D6									
WP7: Performance monitoring, data analysis and research																												
Lead: Element Energy **Support:** Imperial College London	7.1	Modelling of energy demand, emissions and fuel bills										M7.1a/b																
	7.2	Energy system modelling												M7.2	D7.2													
	7.3	Analysis of consumer engagement strategy																M7.3		D7.3								
	7.4	Develop phase 2 monitoring strategy																M7.4										
WP8: Trial support and learning via interaction with Stream 3																												
Lead: Element Energy **Support:** all	8.1	Establishing relationship with stream 3		M8.1a		M8.1b																						
	8.2	Providing information for stream 3 activities			D8 ->																						M8.2	
WP9: Finalisation of the Phase 2 plan																												
Lead: Element Energy **Support:** all	9.1	Agree finalised approach for Phase 2																				M9.1	D9.1					
	9.2	Consider policy/legislative/regulatory implications																				M9.2						
	9.3	Prototype marketing materials																				D9.3						
WP10: Project Management																												
Lead: Element Energy **Support:** all	10.1	Meeting planning and recording	M10.1a D10 ->																									M10.1b
	10.2	Quality checking of deliverables																										
	10.3	Communication with BEIS																										



Phase 1 Work Package Milestones & Deliverable Outputs

Work Package		Owner	Supported by	No.	Output Type	Desription
WP1	**Initial Project Scoping**	Element Energy	All	M1.1	Milestone	Agreed collective vision, objectives and desired outcomes
				M1.2	Milestones	Review of case studies completed
				M1.3	Milestone	Initial technoeconomic modelling complete
				D1a	**Deliverable**	Project KPIs and evaluation method as agreed with consortium partners & BEIS
				D1b	**Deliverable**	Summary of initial technoeconomic modelling and key findings around refined project scope, requirements for consumer engagement plan, grid impact analysis
WP2	**Developing Location Selection Methodology**	DG Cities	Kensa, Element	M2.1	Milestone	Potential candidate areas and constituent building archetypes identified
				M2.2	Milestone	Modelling of the impacts on fuel poor customers complete
				M2.3	Milestone	Undertanding of local network constraints established in collaboration with local network operator
				M2.4	Milestone	Methodology developed for assessing suitability of shared ground loop systems for a given location
				M2.5	Milestone	GSHP systems compatible with selected locations and building archetypes designed
				D2	**Deliverable**	Summary of the detailing methodology for determining suitable locations for shared ground loop systems, including identifying location-specific barriers, opportunities, networks constraints
WP3	**Developing Customer Offering**	OVO Energy	DG Cities, Nationwide	M3.1	Milestone	Consumer archetypes identified
				M3.2	Milestone	Detailed research conducted and optimal financial model developed
				M3.3	Milestone	Consumer offering developed
				M3.4	Milestone	Engagement with independent regulatory experts to evaluate proposed financial offering
				D3	**Deliverable**	Report on identified consumer archetypes, financial models assessed and consumer offering developed
WP4	**Developing the consumer engagement strategy**	DG Cities	Imperial College London, Nationwide	M4.1a	Milestone	Online survey launched
				M4.1b	Milestone	Online survey completed
				M4.1c	Milestone	Qualitative interviews completed
				M4.2	Milestone	User journey developed, detailing optimal user experience for all stages of recruitment process from pre-purchase marketing to post-installation support.
				D4	**Deliverable**	Summary of the key learnings from consumer interaction and key components of developed user journey, including a key messages framework for communication materials, prototype consumer campaign, outreach initiatives e.g. "champion" volunteer recruitment
WP5	**Developing the industry engagement strategy**	DG Cities	Kensa, Heat Geek, OVO	M5.1a	Milestone	Identification of key stakeholders in the supply chain for engagement in framework development
				M5.1b	Milestone	Framework developed detailing the joint purpose, vision and values of the project.
				M5.1c	Milestone	First co-design and engagement workshop
				M5.1d	Milestone	Co-design and engagement workshops complete
				M5.2	Milestone	Supply chain interviews complete
				D5	**Deliverable**	Summary of the industry engagement stratedgy detailing the framework developed and the key themes identified that promote capacity and innovation in the UK's heat pump supply chain.

Figure 13.1. Summary of Work Package milestones and deliverables (1/2).

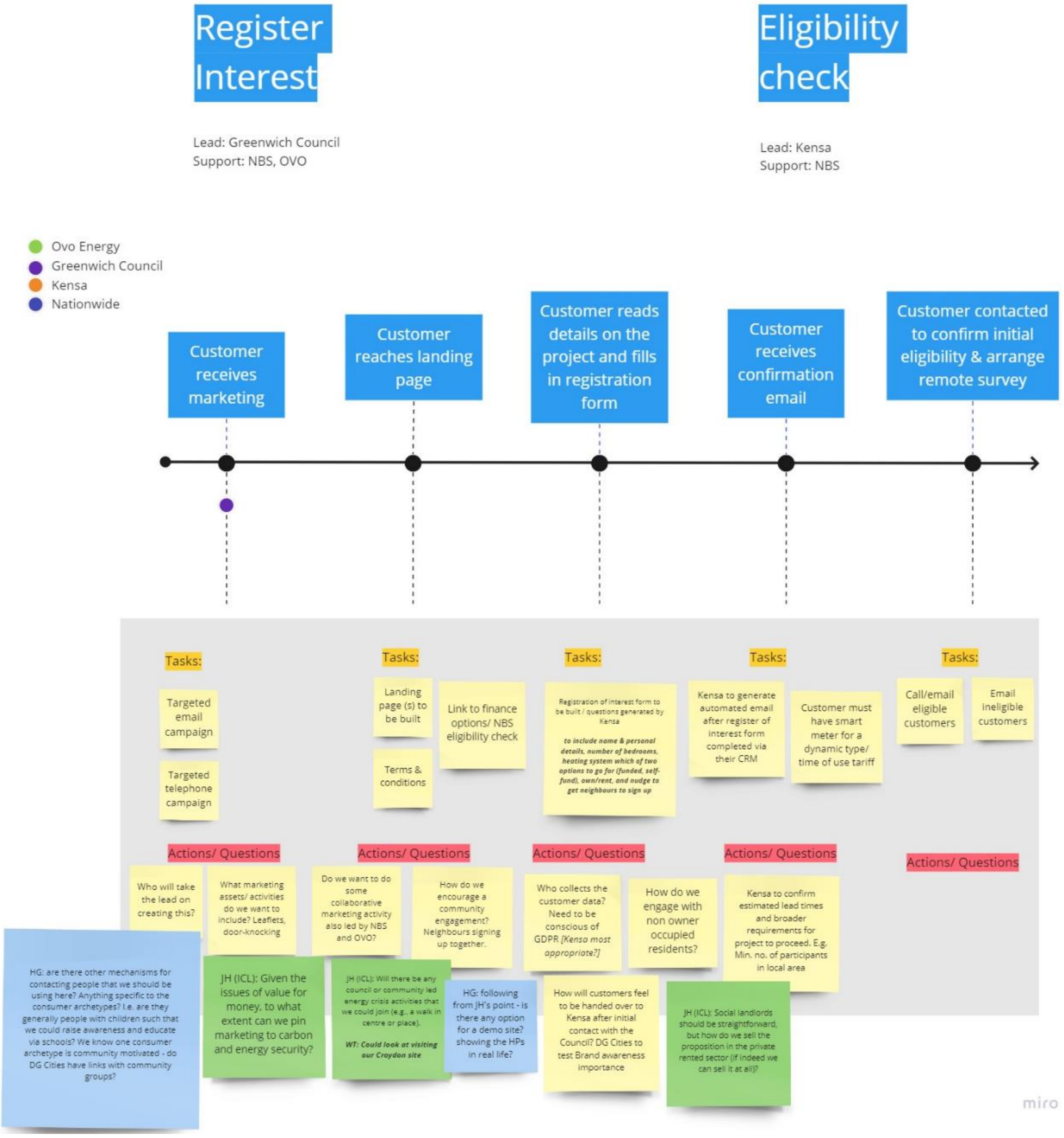


Phase 1 Work Package Milestones & Deliverable Outputs

Work Package		Owner	Supported by	No.	Output Type	Desription
WP6	**Understanding grid impacts and requirements**	Element Energy	UKPN/Imperial College London	M6.1	Milestone	Complete modelling of GSHP installation grid on local electicity grid
				M6.2	Milestone	Engagement with DNO
				M6.3	Milestone	Assessment of likely network constraints
				M6.4	Milestone	Mitigation mechanisms identified and agreed with DNO
				D6	**Deliverable**	Summary of network constraints identified, mitigation measures considered and replicability of the approach
WP7	**Data analysis and research**	Element Energy	Kensa/Imperial College London	M7.1a	Milestone	Modelling of energy demand reducions, CO2 emission reductions and fuel bill impact complete
				M7.1b	Milestone	Modelling of impact on total and peak energy demands complete
				M7.2	Milestone	Energy system modelling complete including the impact of flexibilty measures
				D7.2	**Deliverable**	Feed energy system modelling results into D6 report on grid impacts
				M7.3	Milestone	Analysis of consumer offering complete
				D7.3	**Deliverable**	Feed energy system modelling results into D3 report on the consumer offer
				D7.4	Milestone	Monitoring strategy agreed for phase 2 installations
WP8	**Trial support and learning via interaction with Stream 3**	Element Energy	all	M8.1a	Milestone	Establish interaction with stream 3 project partners
				M8.1b	Milestone	First joint dissemination/evaluation activity with Stream 3
				M8.2	Milestone	Complete information handover to stream 3 activities
				D8	**Deliverable**	Ongoing information sharing with stream 3
WP9	**Finalisation of Phase 2 plan**	Element Energy	all	M9.1	Milestone	Final deployment approach agreed within the consortium
				M9.2	Milestone	Policy implications plus any legislative or regulatory requirements for phase 2 understood
				D9.1	**Deliverable**	Proposal for phase 2 deployment study
				D9.3	**Deliverable**	Prototype marketing materials for phase 2
WP10	**Project management**	Element Energy	all	M10.1a	Milestone	First phase 1 consortium meeting
				M10.1b	Milestone	Final phase 1 consortium meeting
				D10	**Deliverable**	Minutes from consortium meetings

Figure 13.2. Summary of Work Package milestones and deliverables (2/2).

13.2 Miro boards used to develop consumer journey



Register Interest

Lead: Greenwich Council
Support: NBS, OVO

Eligibility check

Lead: Kensa
Support: NBS

● Ovo Energy
● Greenwich Council
● Kensa
● Nationwide

Customer receives marketing

Tasks:

Targeted email campaign

Targeted telephone campaign

Actions/ Questions

Who will take the lead on creating this?

What marketing assets/ activities do we want to include? Leaflets, door-knocking

HG: are there other mechanisms for contacting people that we should be using here? Anything specific to the consumer archetypes? I.e. are they generally people with children such that we could raise awareness and educate via schools? We know one consumer archetype is community motivated - do DG Cities have links with community groups?

JH (ICL): Given the issues of value for money, to what extent can we pin marketing to carbon and energy security?

Customer reaches landing page

Tasks:

Landing page (s) to be built

Terms & conditions

Link to finance options/ NBS eligibility check

Actions/ Questions

Do we want to do some collaborative marketing activity also led by NBS and OVO?

How do we encourage a community engagement? Neighbours signing up together.

JH (ICL): Will there be any council or community led energy crisis activities that we could join (e.g., a walk in centre or place).

WT: Could look at visiting our Croydon site

HG: following from JH's point - is there any option for a demo site? showing the HPs in real life?

Customer reads details on the project and fills in registration form

Tasks:

Registration of interest form to be built / questions generated by Kensa

to include name & personal details, number of bedrooms, heating system which of two options to go for (funded, self-fund), own/rent, and nudge to get neighbours to sign up

Actions/ Questions

Who collects the customer data? Need to be conscious of GDPR *[Kensa most appropriate?]*

How do we engage with non owner occupied residents?

How will customers feel to be handed over to Kensa after initial contact with the Council? DG Cities to test Brand awareness importance

JH (ICL): Social landlords should be straightforward, but how do we sell the proposition in the private rented sector (if indeed we can sell it at all)?

Customer receives confirmation email

Tasks:

Kensa to generate automated email after register of interest form completed via their CRM

Customer must have smart meter for a dynamic type/ time of use tariff

Actions/ Questions

Kensa to confirm estimated lead times and broader requirements for project to proceed. E.g. Min. no. of participants in local area

Customer contacted to confirm initial eligibility & arrange remote survey

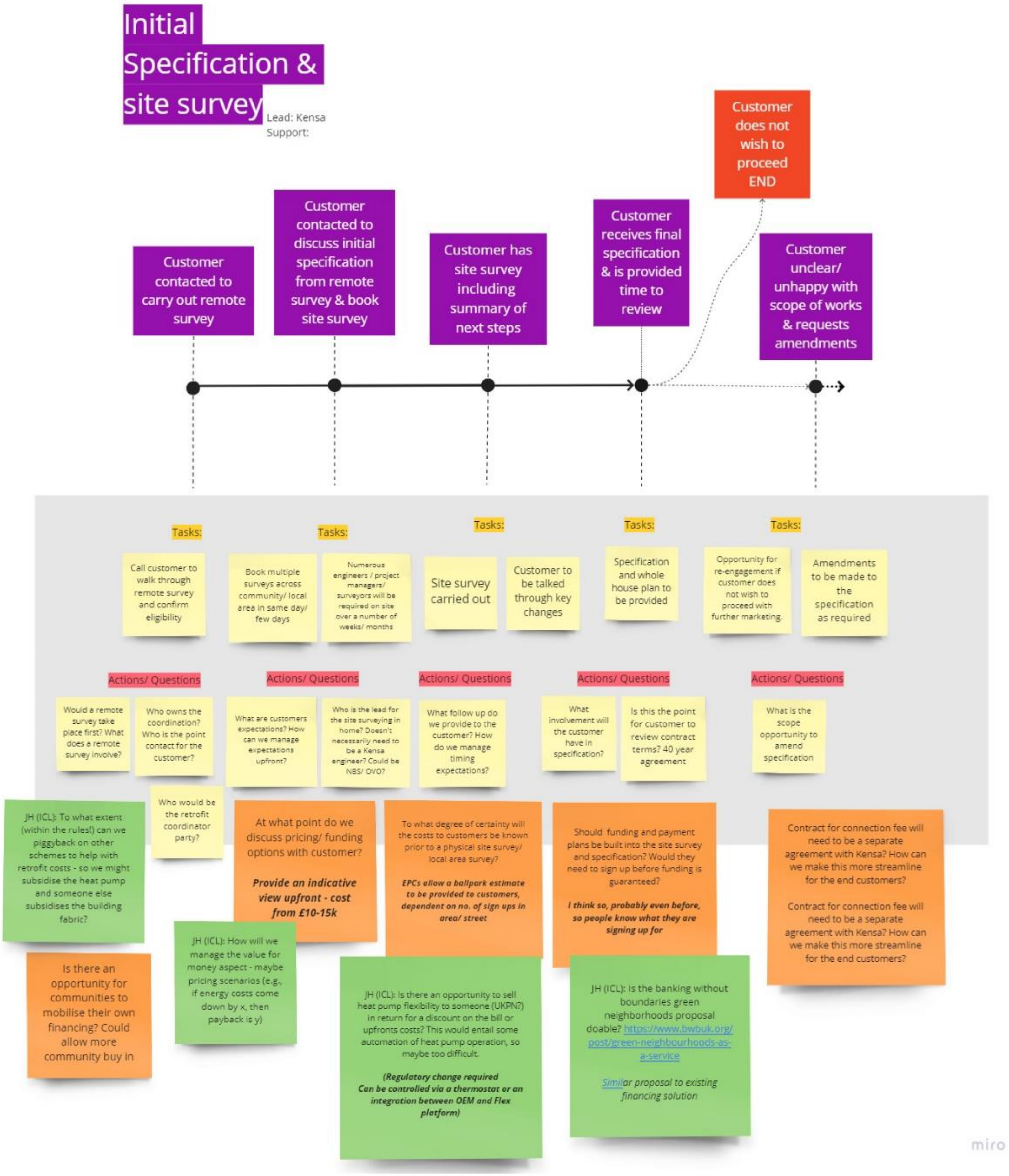
Tasks:

Call/email eligible customers

Email ineligible customers

Actions/ Questions

Figure 13.3. Miro board used to develop consumer journey (1/5).



Initial Specification & site survey

Lead: Kensa
Support:

Customer contacted to carry out remote survey

Customer contacted to discuss initial specification from remote survey & book site survey

Customer has site survey including summary of next steps

Customer receives final specification & is provided time to review

Customer does not wish to proceed END

Customer unclear/ unhappy with scope of works & requests amendments

Tasks:

Call customer to walk through remote survey and confirm eligibility

Tasks:

Book multiple surveys across community/ local area in same day/ few days

Numerous engineers / project managers/ surveyors will be required on site over a number of weeks/ months

Tasks:

Site survey carried out

Customer to be talked through key changes

Tasks:

Specification and whole house plan to be provided

Tasks:

Opportunity for re-engagement if customer does not wish to proceed with further marketing.

Amendments to be made to the specification as required

Actions/ Questions

Would a remote survey take place first? What does a remote survey involve?

Who owns the coordination? Who is the point contact for the customer?

Who would be the retrofit coordinator party?

Actions/ Questions

What are customers expectations? How can we manage expectations upfront?

Who is the lead for the site surveying in home? Doesn't necessarily need to be a Kensa engineer? Could be NBS/ OVO?

Actions/ Questions

What follow up do we provide to the customer? How do we manage timing expectations?

Actions/ Questions

What involvement will the customer have in specification?

Is this the point for customer to review contract terms? 40 year agreement

Actions/ Questions

What is the scope opportunity to amend specification

JH (ICL): To what extent (within the rules!) can we piggyback on other schemes to help with retrofit costs - so we might subsidise the heat pump and someone else subsidises the building fabric?

Is there an opportunity for communities to mobilise their own financing? Could allow more community buy in

At what point do we discuss pricing/ funding options with customer?

Provide an indicative view upfront - cost from £10-15k

JH (ICL): How will we manage the value for money aspect - maybe pricing scenarios (e.g., if energy costs come down by x, then payback is y)

To what degree of certainty will the costs to customers be known prior to a physical site survey/ local area survey?

EPCs allow a ballpark estimate to be provided to customers, dependent on no. of sign ups in area/ street

JH (ICL): Is there an opportunity to sell heat pump flexibility to someone (UKPN?) in return for a discount on the bill or upfronts costs? This would entail some automation of heat pump operation, so maybe too difficult.

(Regulatory change required
Can be controlled via a thermostat or an integration between OEM and Flex platform)

Should funding and payment plans be built into the site survey and specification? Would they need to sign up before funding is guaranteed?

I think so, probably even before, so people know what they are signing up for

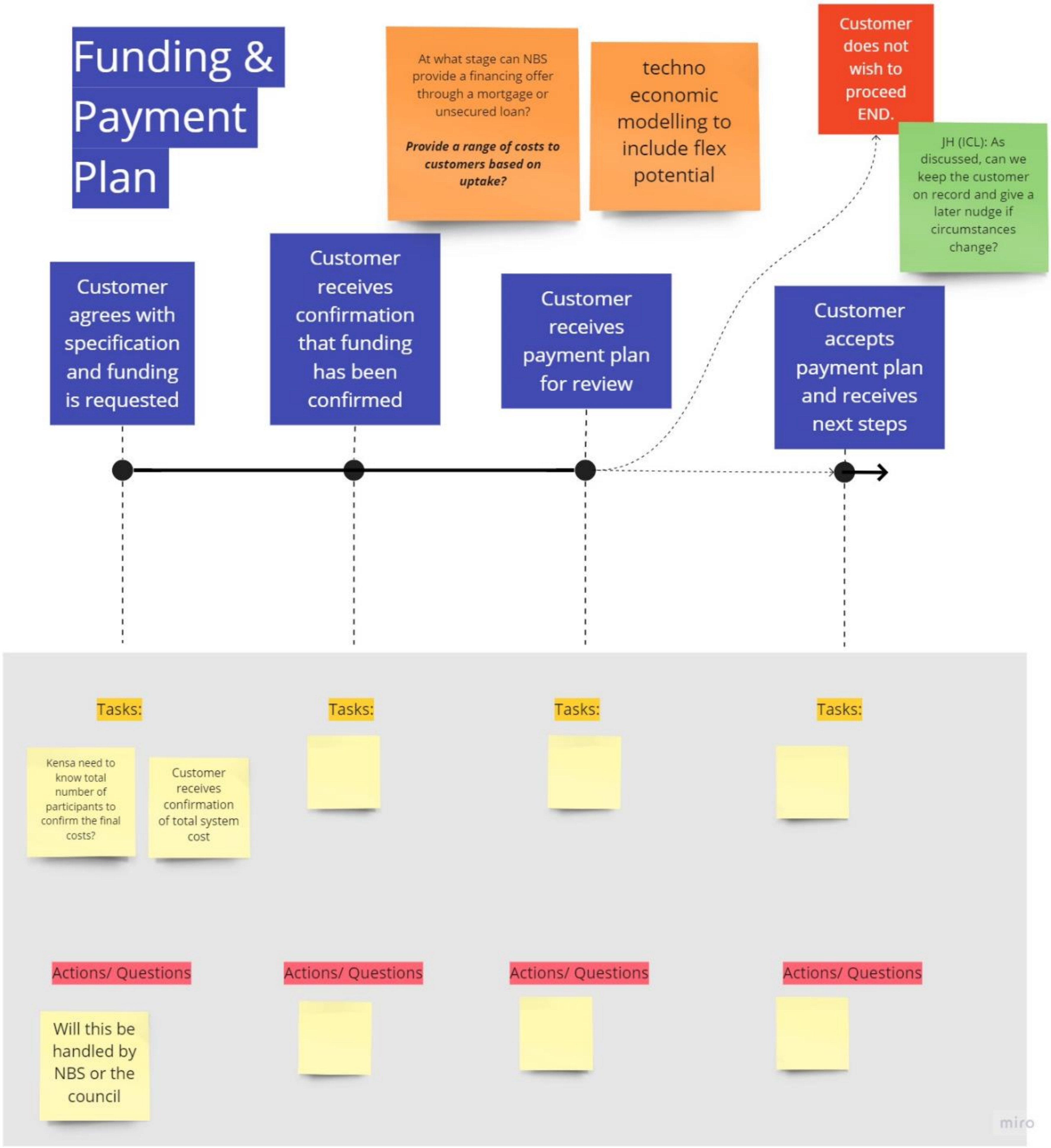
JH (ICL): Is the banking without boundaries green neighborhoods proposal doable? https://www.bwbuk.org/post/green-neighbourhoods-as-a-service

Similar proposal to existing financing solution

Contract for connection fee will need to be a separate agreement with Kensa? How can we make this more streamline for the end customers?

Contract for connection fee will need to be a separate agreement with Kensa? How can we make this more streamline for the end customers?

Figure 13.4. Miro board used to develop consumer journey (2/5).



Funding & Payment Plan

At what stage can NBS provide a financing offer through a mortgage or unsecured loan?

Provide a range of costs to customers based on uptake?

techno economic modelling to include flex potential

Customer does not wish to proceed END.

JH (ICL): As discussed, can we keep the customer on record and give a later nudge if circumstances change?

Customer agrees with specification and funding is requested

Customer receives confirmation that funding has been confirmed

Customer receives payment plan for review

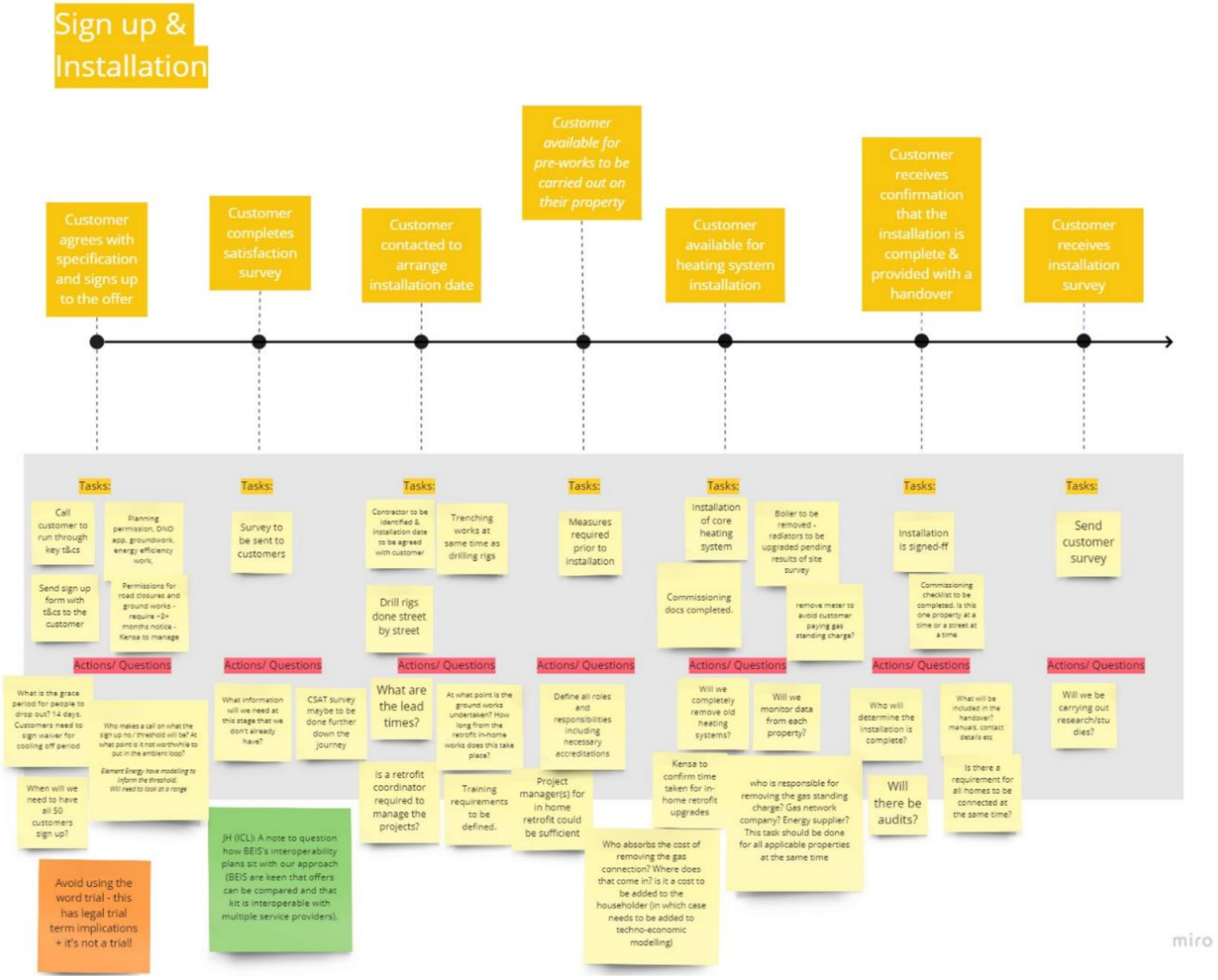
Customer accepts payment plan and receives next steps

Kensa need to know total number of participants to confirm the final costs?

Customer receives confirmation of total system cost

Will this be handled by NBS or the council

Figure 13.5. Miro board used to develop consumer journey (3/5).



Sign up & Installation

Customer agrees with specification and signs up to the offer

Tasks:
- Call customer to run through key t&cs
- Planning permission, DNO app, groundwork, energy efficiency work.
- Send sign up form with t&cs to the customer
- Permissions for road closures and ground works - require ~3+ months notice - Kensa to manage

Actions/ Questions:
- What is the grace period for people to drop out? 14 days. Customers need to sign waiver for cooling off period
- Who makes a call on what the sign up no./ threshold will be? At what point is it not worthwhile to put in the ambient loop? *Element Energy have modelling to inform the threshold. Will need to look at a range*
- When will we need to have all 50 customers sign up?
- Avoid using the word trial - this has legal trial term implications + it's not a trial!

Customer completes satisfaction survey

Tasks:
- Survey to be sent to customers

Actions/ Questions:
- What information will we need at this stage that we don't already have?
- CSAT survey maybe to be done further down the journey
- JH (ICL): A note to question how BEIS's interoperability plans sit with our approach (BEIS are keen that offers can be compared and that kit is interoperable with multiple service providers).

Customer contacted to arrange installation date

Tasks:
- Contractor to be identified & installation date to be agreed with customer
- Trenching works at same time as drilling rigs
- Drill rigs done street by street

Actions/ Questions:
- What are the lead times?
- At what point is the ground works undertaken? How long from the retrofit in-home works does this take place?
- Is a retrofit coordinator required to manage the projects?
- Training requirements to be defined.

Customer available for pre-works to be carried out on their property

Tasks:
- Measures required prior to installation

Actions/ Questions:
- Define all roles and responsibilities including necessary accreditations
- Project manager(s) for in home retrofit could be sufficient

Customer available for heating system installation

Tasks:
- Installation of core heating system
- Boiler to be removed - radiators to be upgraded pending results of site survey
- Commissioning docs completed.
- remove meter to avoid customer paying gas standing charge?

Actions/ Questions:
- Will we completely remove old heating systems?
- Will we monitor data from each property?
- Kensa to confirm time taken for in-home retrofit upgrades
- who is responsible for removing the gas standing charge? Gas network company? Energy supplier? This task should be done for all applicable properties at the same time
- Who absorbs the cost of removing the gas connection? Where does that come in? is it a cost to be added to the householder (in which case needs to be added to techno-economic modelling)

Customer receives confirmation that the installation is complete & provided with a handover

Tasks:
- Installation is signed-ff
- Commissioning checklist to be completed. Is this one property at a time or a street at a time

Actions/ Questions:
- Who will determine the installation is complete?
- What will be included in the handover? manuals, contact details etc
- Will there be audits?
- Is there a requirement for all homes to be connected at the same time?

Customer receives installation survey

Tasks:
- Send customer survey

Actions/ Questions:
- Will we be carrying out research/studies?

Figure 13.6. Miro board used to develop consumer journey (4/5).

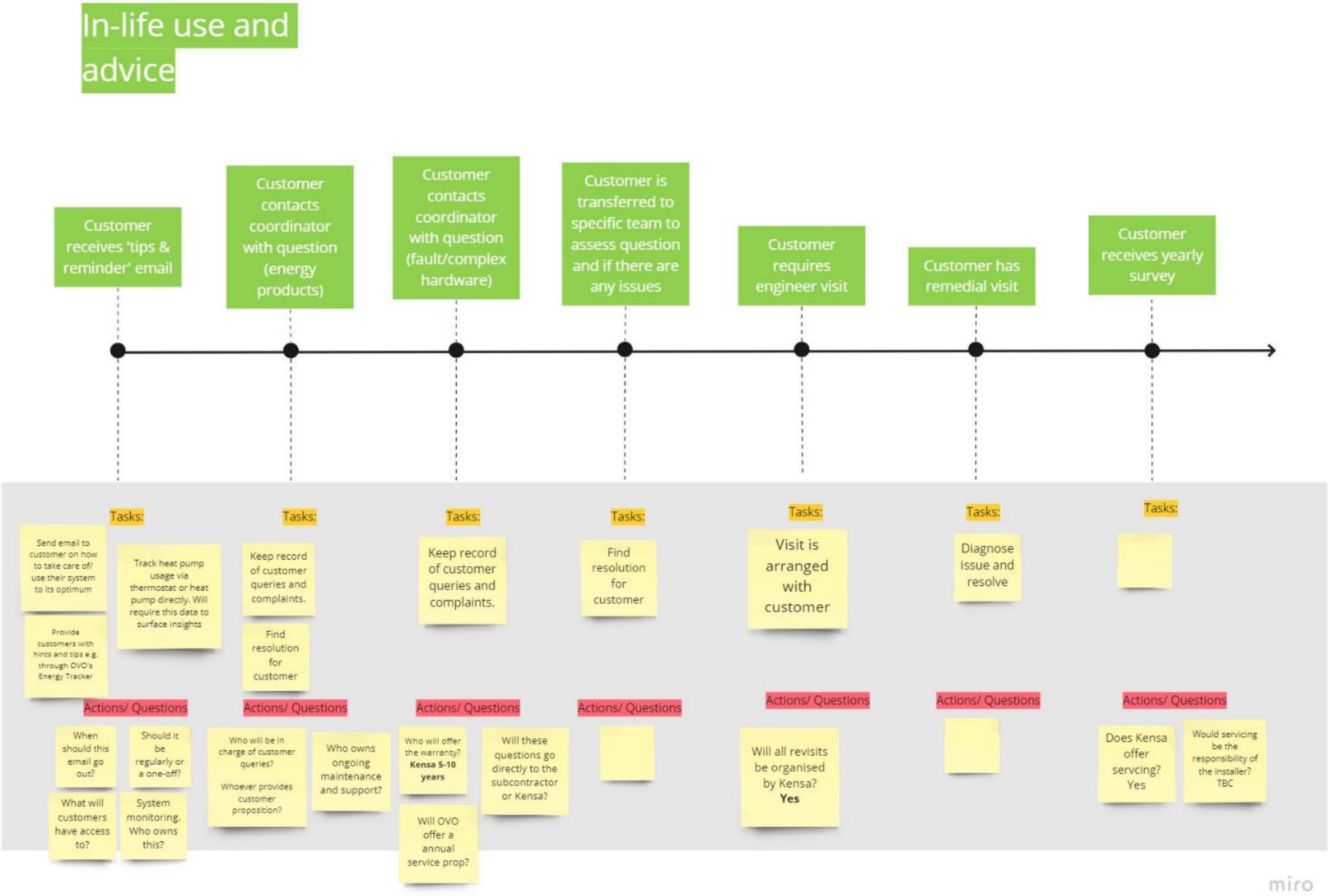
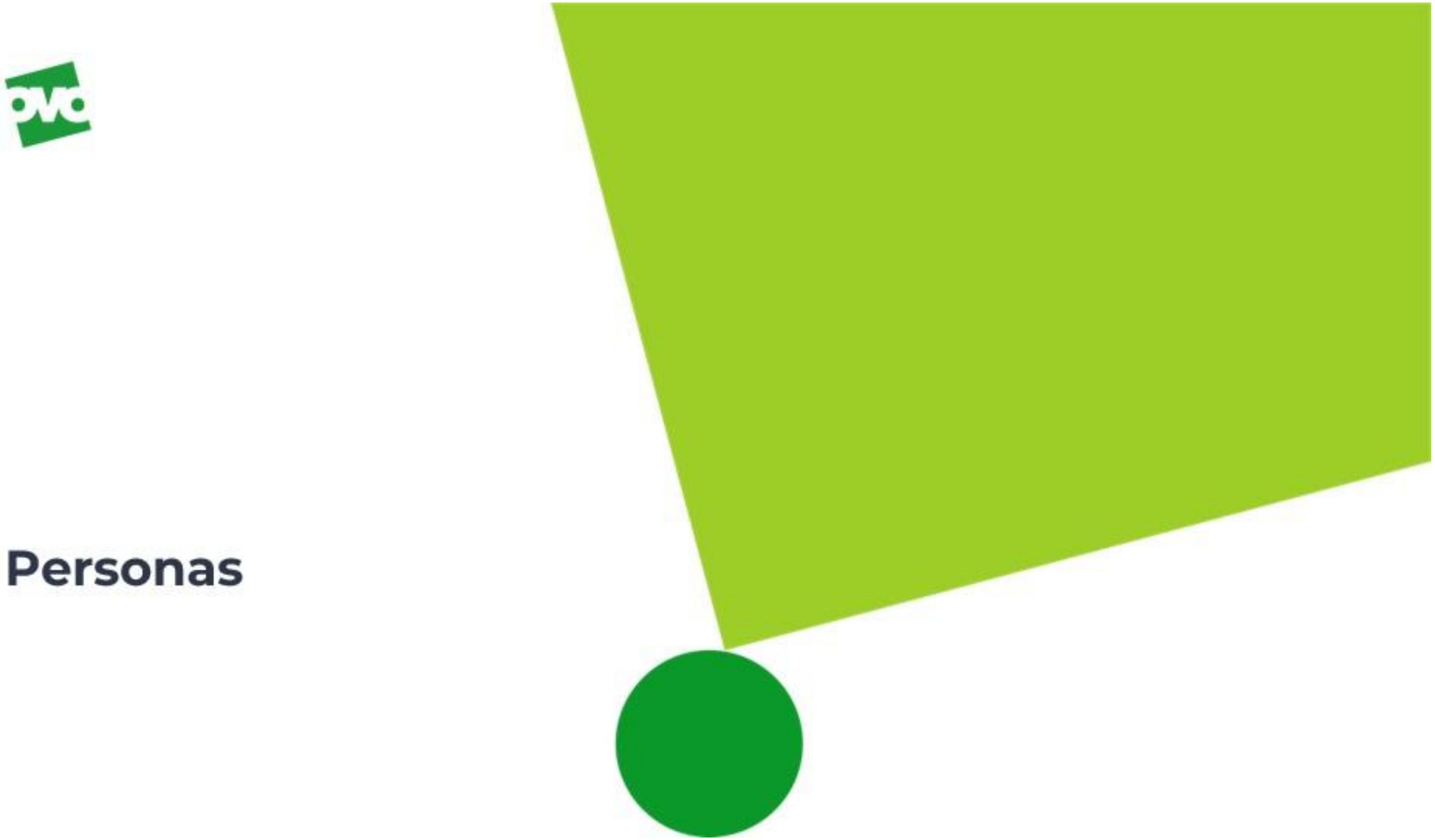
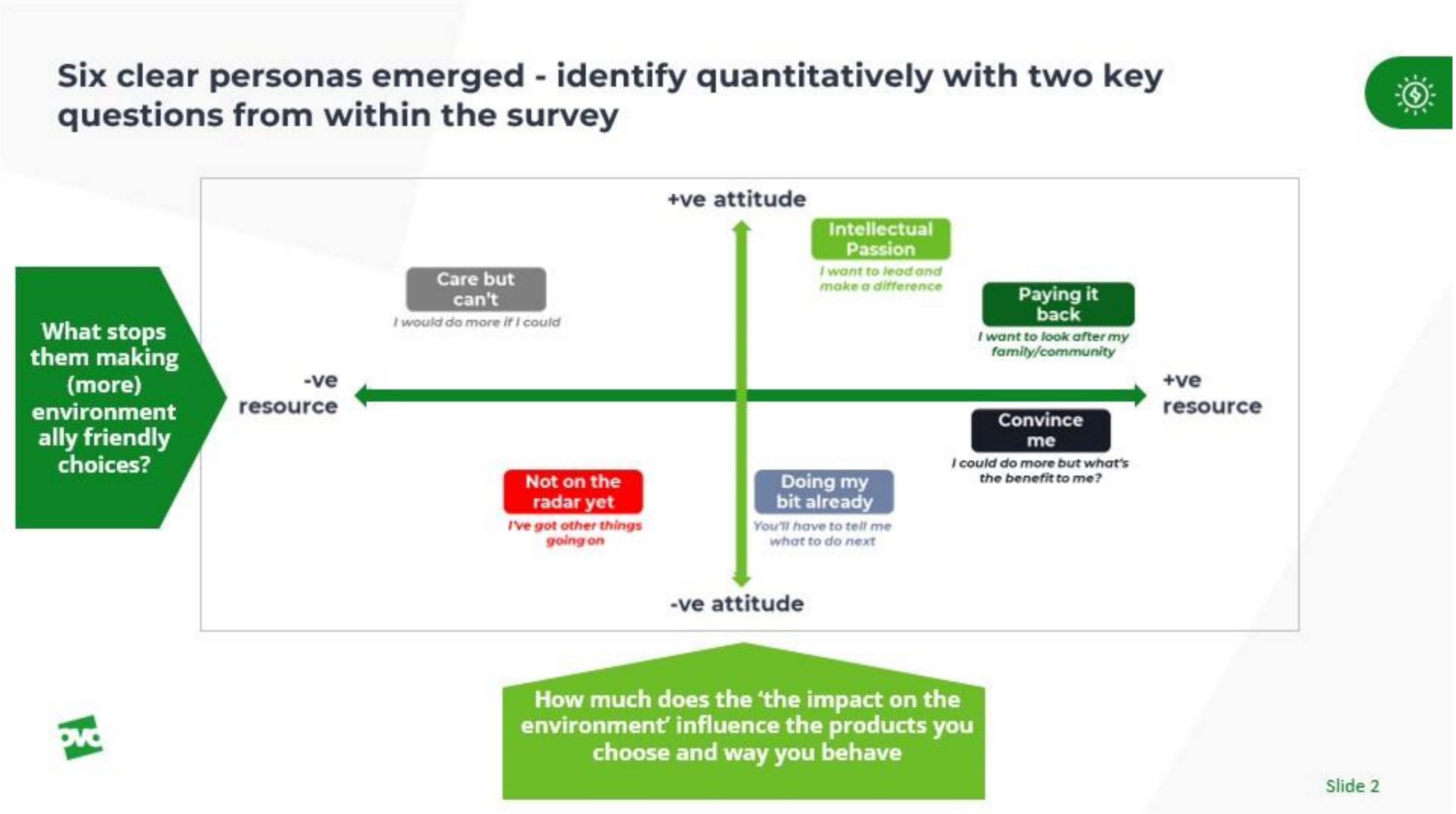


Figure 13.7. Miro board used to develop consumer journey (5/5).

13.3 OVO consumer personas



Personas



Six clear personas emerged - identify quantitatively with two key questions from within the survey

What stops them making (more) environment ally friendly choices?

+ve attitude

-ve attitude

-ve resource

+ve resource

Intellectual Passion
I want to lead and make a difference

Care but can't
I would do more if I could

Paying it back
I want to look after my family/community

Convince me
I could do more but what's the benefit to me?

Not on the radar yet
I've got other things going on

Doing my bit already
You'll have to tell me what to do next

How much does the 'the impact on the environment' influence the products you choose and way you behave

Slide 2

INTELLECTUAL PASSION

Target #1 | 6% of the market

'Intellectual Passion' are consumers who are committed to the cause and making a change

I want to lead and make a difference

It's an issue close to my heart – I'm worried that this clock is ticking. For me, it is a passion and something that drives what I do day to day

PROFILE

- Early/ mid career
- Mixture of ages but generally working age
- 49% have HHI of £40k+ (vs avge. 35%)
- 45% have kids under 16 (vs. avge. 35%)

WHERE THEY ARE NOW

- Already using specialist green products and making efforts where they can
- E.g. Hybrid cars (12% own EV vs. 7% avge.), specialist energy tariffs (29% on renewable tariff vs avge. 18%)

WHAT THEY NEED

- Guidance on what to do next
- Access to new products and information about environmentally friendly choices
- To be made aware of new options available to them

HOW TO COMMUNICATE TO THEM

- 'Macro' messaging – empowering them to lead important social change
- Communicate as 'educated equals' – shared vision and goals
- 37% are picking up info on green issues via social media (vs avge. 24%)

WHAT HAS RESONATED?

- Strong interest in all **tools** on offer, but App, Home Visit and Quarterly email are most relevant
- All tested **incentives** are popular, but those focusing on seagrass and protected habitat particularly strong
- Global Warming strongly seen as most important issue we are facing

PAYING IT BACK

Target #2

18% of the market

'Paying it Back' want to make good use of their resources to benefit family and community

I want to look after my family/community

I'm worried the immediate future for those closest to me and around me.
I want to use what I've built over time wisely to help others

PROFILE

- Older (53% are 50+ vs avge. 44%)
- 44% have HHI of £40k+ (vs avge. 35%)
- Family, local community-oriented
- Top of a multigenerational family
- Have capital but want to spend it wisely

WHERE THEY ARE NOW

- Doing all of the basics plus investing in cost effective green friendly equipment (e.g. solar panels)
- Making green friendly choices but wisely and with thought (not wasting their hard earned capital)

WHAT THEY NEED

- Sensible product choices that have clear local benefits to those around them
- Prepared to invest but only if there is a clear tangible benefit in the short/medium term to themselves, family or community

HOW TO COMMUNICATE TO THEM

- Local and community focus (not macro, global or intangible)
- Focus on the positive impact on the people and environment closest to them
- Pragmatic – give green credentials but also explain why this is a 'prudent' choice

WHAT HAS RESONATED?

- Reasonable Interest in all **tools** on offer, but slightly more focus on physical tools e.g. lightbulbs, insulation, appliances
- All tested **incentives** are popular, but those focusing on seagrass and protected habitat particularly strong
- Importance of issues in line with population (top 3 of global warming, deforestation and single use plastics)

CARE BUT CAN'T (PHYSICAL)

Target #3

14% of the market

'Care but Can't' (Physical) consumers have a positive attitude but have constraints that stop them doing more

I do what I can, and I would do more if I could. I want to find ways to help

I worry for the future of my children but my hands are tied

PROFILE

- Broadly reflective of the UK profile as a whole

WHERE THEY ARE NOW

- Undertaking a lot of behaviours, particularly strong on using bags for life, using public transport and switching off devices
- Above average engagement with renewable tariffs, as less price sensitive than Care but can't (Physical)

WHAT THEY NEED

- Access to environmentally friendly choices that can be implemented in ANY home
- Support / advice for choices that may be more complex

HOW TO COMMUNICATE TO THEM

- Be supportive and inclusive – do not make them feel guilty for things that are beyond their control
- Reward them for their emotional investment

WHAT HAS RESONATED?

- Lightbulbs and appliance (which can be used in ANY home) are the most popular **tools** we tested.
- **Incentives**, generally resonate with this group; environmental activities (seagrass planting,, protected habitats) just as popular as items for their home (lightbulbs, thermostat)
- Importance of global warming and use of earth's resources more important to this group than the average consumer

Slide 5

CARE BUT CAN'T (TIME/MONEY)

Target #4 | 18% of the market

'Care but Can't' (Time/Money) consumers have a positive attitude but have other demands on their time and money

I do what I can, and I would do more if I could. I want to find ways to help

I worry for the future of my children but my hands are tied

PROFILE

- Younger families
- 40% are under 40 (vs avge. 35%)
- 44% have kids under 16 (vs avge. 35%)

WHERE THEY ARE NOW

- Doing everything that they can afford
- All of the basics plus more ethical behaviour where there is little negative financial impact (e.g. smart purchasing, reusable nappies etc)
- They will invest time in greener choices but cannot invest money

WHAT THEY NEED

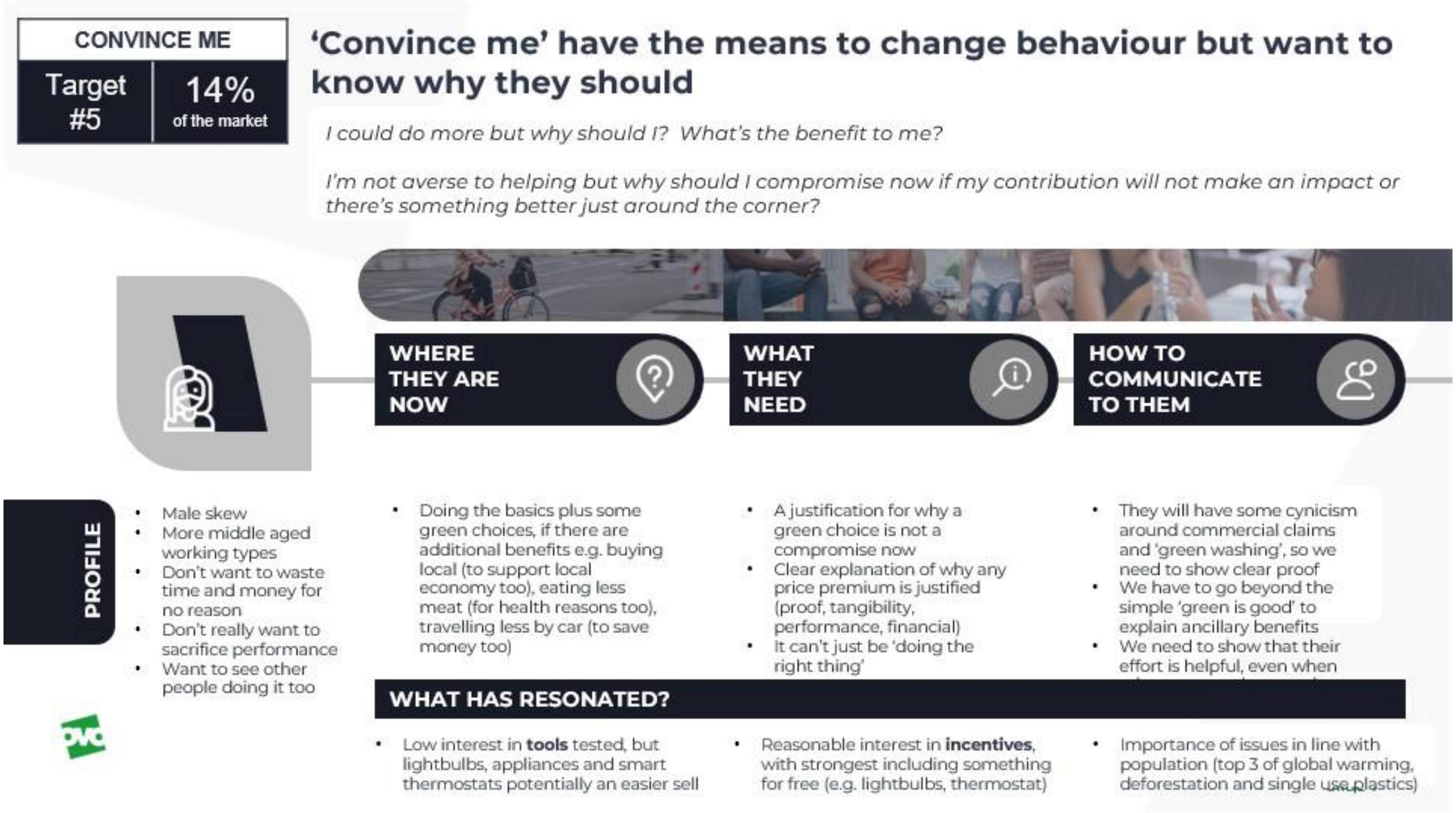
- Access to more environmentally friendly choices without financial penalty
- Support and grants to help them make the right choice

HOW TO COMMUNICATE TO THEM

- Be supportive and inclusive – do not make them feel guilty for not investing financially. Recognise that family commitments will take priority
- Reward them for their emotional investment – show them how they can help without financial penalty

WHAT HAS RESONATED?

- Reasonable interest in **tools** on offer; smart meters and thermostats as well as lightbulbs and appliances all have potential
- **Incentives**, generally resonate with this group, the strongest including something for free (e.g. lightbulbs, thermostat)
- Importance of issues in line with population (top 3 of global warming, deforestation and single use plastics)



CONVINCE ME

Target #5

14% of the market

'Convince me' have the means to change behaviour but want to know why they should

I could do more but why should I? What's the benefit to me?

I'm not averse to helping but why should I compromise now if my contribution will not make an impact or there's something better just around the corner?

PROFILE

- Male skew
- More middle aged working types
- Don't want to waste time and money for no reason
- Don't really want to sacrifice performance
- Want to see other people doing it too

WHERE THEY ARE NOW

- Doing the basics plus some green choices, if there are additional benefits e.g. buying local (to support local economy too), eating less meat (for health reasons too), travelling less by car (to save money too)

WHAT THEY NEED

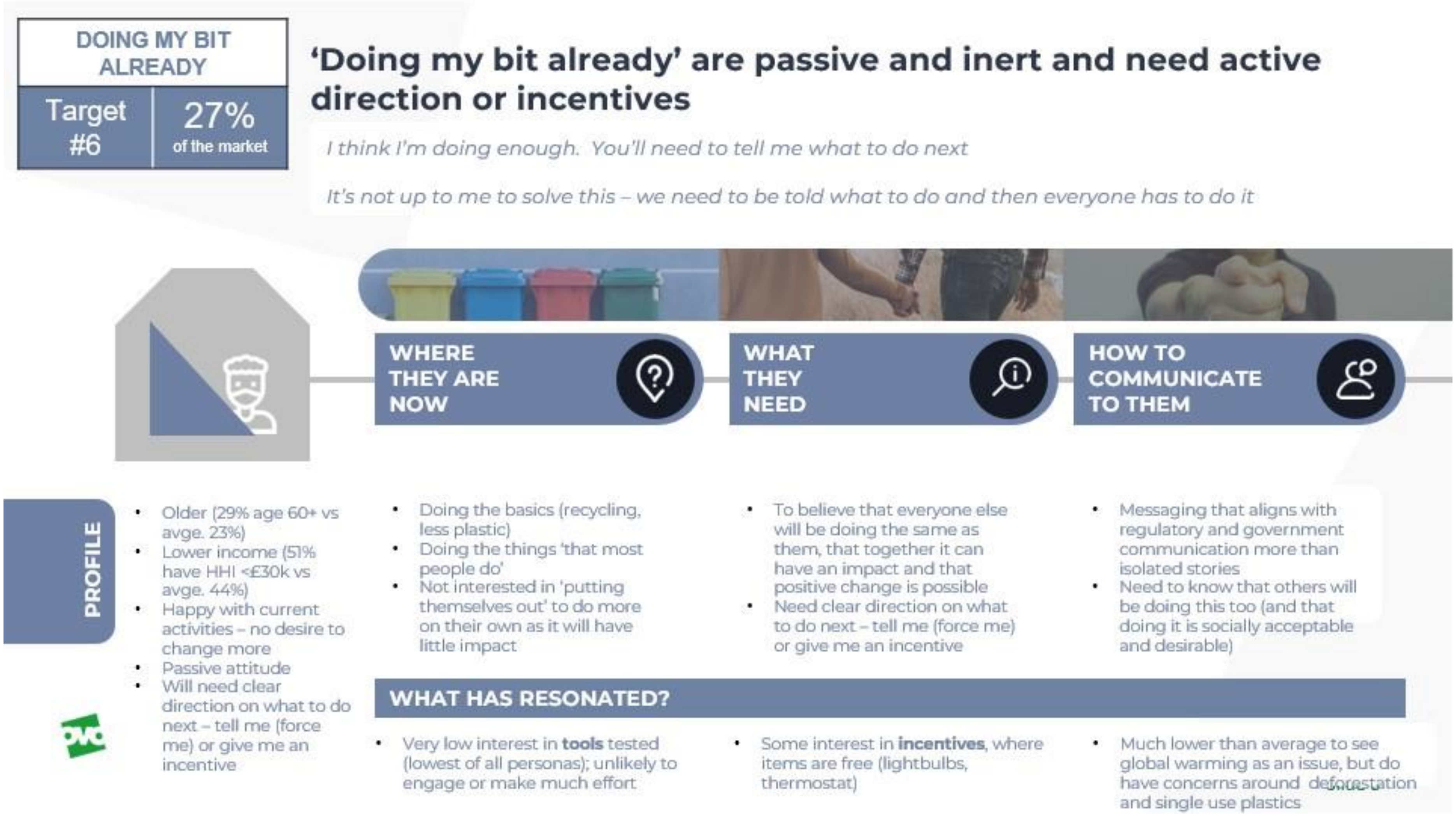
- A justification for why a green choice is not a compromise now
- Clear explanation of why any price premium is justified (proof, tangibility, performance, financial)
- It can't just be 'doing the right thing'

HOW TO COMMUNICATE TO THEM

- They will have some cynicism around commercial claims and 'green washing', so we need to show clear proof
- We have to go beyond the simple 'green is good' to explain ancillary benefits
- We need to show that their effort is helpful, even when

WHAT HAS RESONATED?

- Low interest in **tools** tested, but lightbulbs, appliances and smart thermostats potentially an easier sell
- Reasonable interest in **incentives**, with strongest including something for free (e.g. lightbulbs, thermostat)
- Importance of issues in line with population (top 3 of global warming, deforestation and single use plastics)



DOING MY BIT ALREADY

Target #6

27% of the market

‘Doing my bit already’ are passive and inert and need active direction or incentives

I think I’m doing enough. You’ll need to tell me what to do next

It’s not up to me to solve this – we need to be told what to do and then everyone has to do it

PROFILE

- Older (29% age 60+ vs avge. 23%)
- Lower income (51% have HHI <£30k vs avge. 44%)
- Happy with current activities – no desire to change more
- Passive attitude
- Will need clear direction on what to do next – tell me (force me) or give me an incentive

WHERE THEY ARE NOW

- Doing the basics (recycling, less plastic)
- Doing the things ‘that most people do’
- Not interested in ‘putting themselves out’ to do more on their own as it will have little impact

WHAT THEY NEED

- To believe that everyone else will be doing the same as them, that together it can have an impact and that positive change is possible
- Need clear direction on what to do next – tell me (force me) or give me an incentive

HOW TO COMMUNICATE TO THEM

- Messaging that aligns with regulatory and government communication more than isolated stories
- Need to know that others will be doing this too (and that doing it is socially acceptable and desirable)

WHAT HAS RESONATED?

- Very low interest in **tools** tested (lowest of all personas); unlikely to engage or make much effort
- Some interest in **incentives**, where items are free (lightbulbs, thermostat)
- Much lower than average to see global warming as an issue, but do have concerns around deforestation and single use plastics

NOT ON THE RADAR

Target #7

3% of the market

'Not on the radar' have other personal priorities and are not actively engaging with carbon reduction

I've not really thought about it – I've got so many other things going on

I know the issues exist but I've got other things to think about and to be honest I don't really think I make that much difference

PROFILE

- Younger - 47% are under 40 (vs avge. 35%)
- Limited budget – want to spend on things for me
- 42% have HHI <£20k (vs avge. 23%)

WHERE THEY ARE NOW

- Only doing what they are required to do (and not really considering it as a green choice – just a typical behaviour)
- Green issues not really a consideration
- 52% cite 'cheapest price' as important in energy supplier choice (vs avge. 30%)

WHAT THEY NEED

- They would not consider that they need anything – they are not missing anything as they are not engaged
- They would need a significant shock or change in circumstances or lifestyle before they change opinion

HOW TO COMMUNICATE TO THEM

- They will not respond to green only messaging – so we may reach them indirectly through traditional buying channels (cost comparison)
- We need to show green as a 'normal' behaviour or choice, such that it does not feel like an effort or something they need to think about

WHAT HAS RESONATED?

- Low interest in **tools** tested, but stronger interest in the more tech / innovation areas e.g. smart meters, solar panels, ground/air heat pumps
- Some interest in **incentives**, with tech again having an influence; thermostat controlled from phone and prize draw for EV, the most popular among this group
- Importance of issues largely in line with population as a whole, but threat to wildlife habitats over-indexes for this group

Slide 9

13.4 Heat Pump Ready Tariff Design

13.4.1 About this report

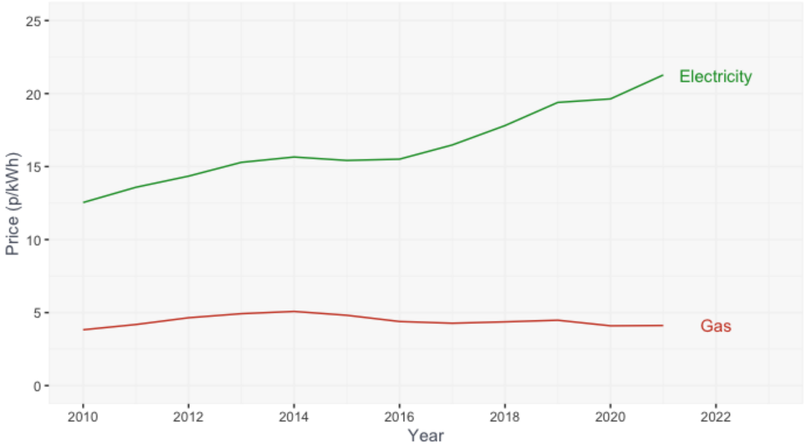
The BEIS Heat Pump Ready Programme has been set up to support the development of innovative solutions across the heat pump sector. The Greenwich TIME project is within Stream 1 of the Heat Pump Ready Programme, which is focussed on solutions for high-density heat pump deployment. As part of the Greenwich TIME project OVO is responsible for developing the consumer offer, a key part of this being a suitable energy tariff that will minimise the running costs of a ground source heat network system to the end customer.

As part of the Heat Pump Ready Project, this document provides the basis of a methodology to develop a tariff to support a ground loop system. This methodology may be developed as part of the Phase 2 of the work to develop a consumer tariff proposition, where the framework will be tested and validated.

13.4.2 Motivation for this work

A key part of building a viable heat pump proposition is ensuring that the heating systems are cost-effective in operation when compared to their equivalent alternative. Within the UK this comparison is predominantly made against a gas boiler, which as of 2020, provided heating to 86% of homes[54].

Figure 1 shows historical domestic gas and electricity prices from 2010 until 2021. In 2021, electricity prices were 5 times more expensive per gas. Although the events of the recent energy crisis have changed this balance, the nature of how electricity markets work in the UK mean electricity prices have closely tracked gas increase. Based on the latest October price cap, the price will be fixed at the next two years at 36p/kWh for electricity, and 10p/kWh for gas, which is a price differential of 3.6.



Source: Annual domestic energy bills, BEIS (Tables 2.2.1 and 2.3.1) CPIH Index 00, ONS

Figure 1: *Average cost per kWh for a typical for a typical dual fuel customer*

With heat pumps normally operating with a Coefficient of performance between 3 and 4.5, the financial payback of a heat pump on a traditional tariff can be low on a traditional tariff. However, this work aims to explore alternative tariff arrangements that may be able to provide a more cost-effective return on investment.

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[54] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1055629/Energy_Report_2019-20.pdf

13.4.3 Context on Tariffs

There has been extensive research and reporting into the benefits of Time of Use tariffs[55]. Such tariffs are seen as an important part of the decarbonisation of heat. This section aims to provide a brief overview of their development and potential opportunities for their application.

The majority of electricity tariffs on the market currently offer a fixed cost of electricity for the end consumer. However, in reality the cost of supplying this electricity fluctuates significantly throughout the day and year. Figure 2 provides an example procurement price curve, where electricity costs are typically at their lowest during the overnight period between 10pm and 6am (though there is significant variation day to day), and they exhibit a significant peak between 4pm and 8pm during working days.

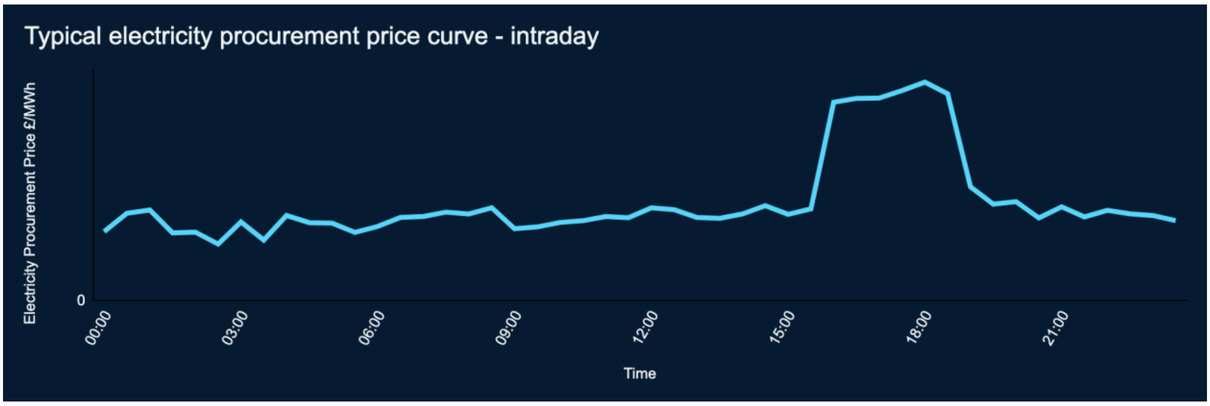

Figure 2: *typical electricity procurement price curve for 24 hours*

Economy 7 was established in the 1970s as a **Time of Use** (ToU) tariff, offering reduced price night rates between 12 30 and 7 30am, which provided a cost incentive for people to change their usage behaviour. These tariffs were particularly suited for properties with electric storage heaters that were capable of shifting their load to off-peak.

While these ToU tariffs originally required specialist metering arrangements, the rollout of smart meters has enabled the availability of ToU tariff for a broader proportion of the population, as billing can be done in half-hourly intervals. This has combined with the rollout of electric vehicles has renewed interest in such tariffs, which has led many energy companies to launch off-peak tariffs specifically targeting electric vehicle charging.

In addition to the more traditional ToU tariffs with fixed windows of consumption, it has also allowed the development of more **dynamic ToU** that more accurately reflect the constantly changing prices within the energy market. Notably, Octopus Agile[56] changes the price every half-hour time period. Figure 3 shows an example of days: it can generally be seen that there is still a clear evening peak pricing event, but with a range of off-peak pricing depending on the day. However, there are challenges with such tariffs though due to the high volatility of prices and the exposure to customers if prices do increase within a time period.

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[55] As an example see https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/The%20Value%20of%20TOU%20Tariffs%20in%20GB%20-%20Volume%20I.pdf

[56] https://octopus.energy/agile/

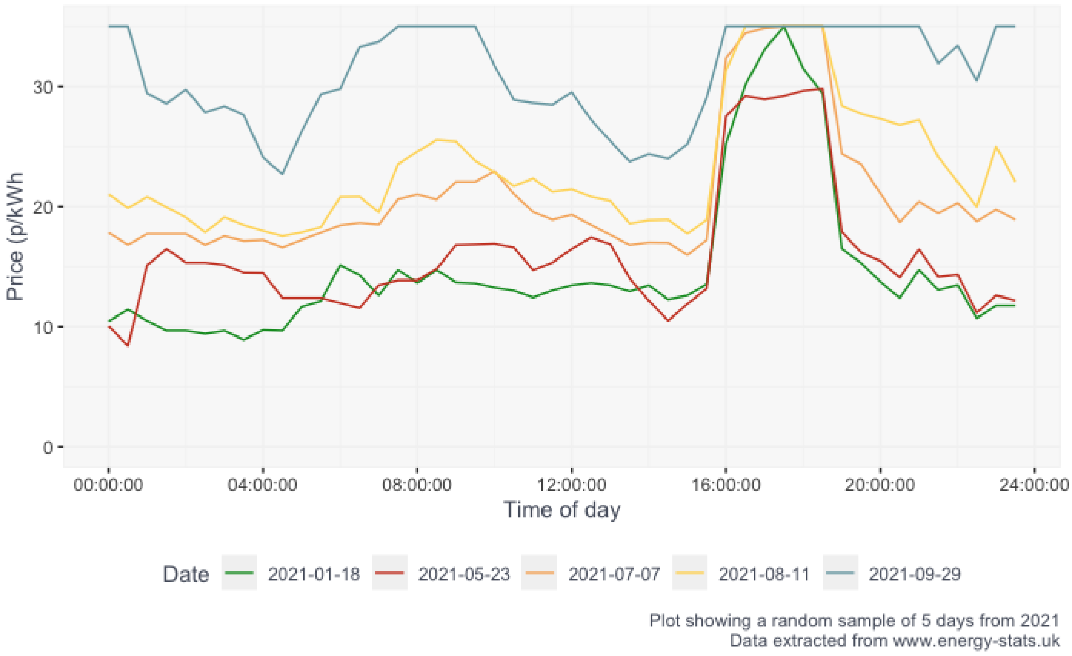


Figure 3: example pricing of Octopus Agile Tariff

Finally, there have been developments on **Type of Use** tariffs in recent years. While these follow the principles of Time of Use tariffs, the customer still only pays a single electricity rate, yet the energy supplier has a means of directly controlling whether a device is on or off, and is therefore able to shift the device to a cheaper time of day and provide a financial saving to the customer. This has so far only been commercially available when applied to electric vehicles, with examples being OVO Drive + Anytime and Intelligent Octopus.

OVO also launched a Heat Pump tariff as part of the Greater Manchester Local Energy Market innovation project. This was a limited trial only available to customers living in Greater Manchester with a Daikin Heat pump. An integration between Daikin and Kaluza's intelligent platform was required to enable this Type of Use tariff. The trial is now closed and this tariff is no longer available however the technical capabilities exist across OVO and Kaluza to replicate this with other heat pump OEMs.

These developments provide important context for a development of a tariff specifically designed at ground source heat arrays. While ToU tariffs originally started to support electric heating, the majority of interest for the last 10 years has been focussed on the shift to electric vehicles.

Ultimately, the aim of most time of use tariffs is to shift load to times of day when electricity costs are lower. In order to capitalise on this, loads that can be deferred must be available. By comparison, deferring the load of a heating device like a heat pump is significantly more complex than an electric car, but in principle follows the same opportunity.

13.4.4 Methodology

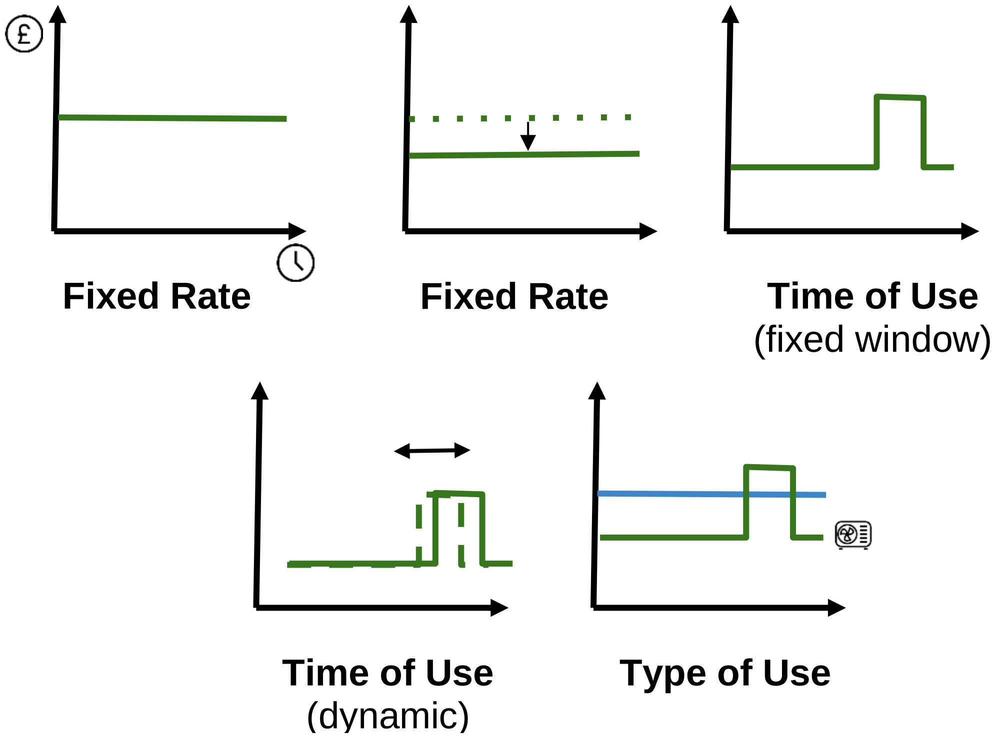
Our overall objective is to develop a tariff that **minimises the running cost of the heat pumps** being designed within the Greenwich TIME project. This will be based around several different scenarios, but shifting load from peak to off-peak times is a fundamental strategy within this work. This analysis will be based on a combination of analysis of typical load profiles, along with simulation of the potential value that could be derived from load shifting, using data informed from operational systems. Several tariff arrangements will be explored, as discussed further below.

Although this work focuses specifically on the Greenwich TIME project, this methodology aims to be generalisable to similar systems within other contexts.

13.4.5 Tariffs to Explore

For baselining and comparing results, all analysis will be compared against a gas boiler being used for heating. Against this scenario, the following tariffs are compared:

1. **Fixed price tariff:** this will act as the baseline of the electricity tariffs. Assume that the heat pump is run against the current tariff structure.
2. **Fixed rate (reduced unit rate):** analyse the expected load profile of the heat pumps and identify whether the load profile would enable any cost savings to be provided in the tariff.
3. **Time of Use Tariff (fixed window):** explore the system performance with a traditional time of use tariff, where a discounted rate of energy is provided for a number of hours per day.
4. **Time of Use Tariff (dynamic):** scenarios where the price changes occur but the time window is not fixed.
5. **Type of use tariff:** two separate electricity rates, one for the house, and one for the heat pump. A lower rate is offered to the heat pump in exchange for greater control over the asset.



The hypothesis to explore is that the ground source heat pump systems present the opportunity to shift their demand to less expensive time periods, thus allowing a discounted tariff to be provided to the consumer.

Where possible, the aim of this study is to develop a financially viable tariff structure, one that is sustainable both from the customer and energy companies' perspective. As a result, the option of purely subsidising the cost of electricity to reduce the unit cost does not fall within the scope of this methodology.

13.4.6 Components of Methodology

In order to assess the tariff suitability for, the methodology needs to view the separate components which influence the tariff structure and form an understanding of the design characteristics. As shown in Figure 4, three main components need to be assessed in order to understand the suitability of a tariff: 1) the thermal performance of a building 2) design parameters of the heat network and heat pumps and 3) local grid constraints. These are detailed more within the following subsections.

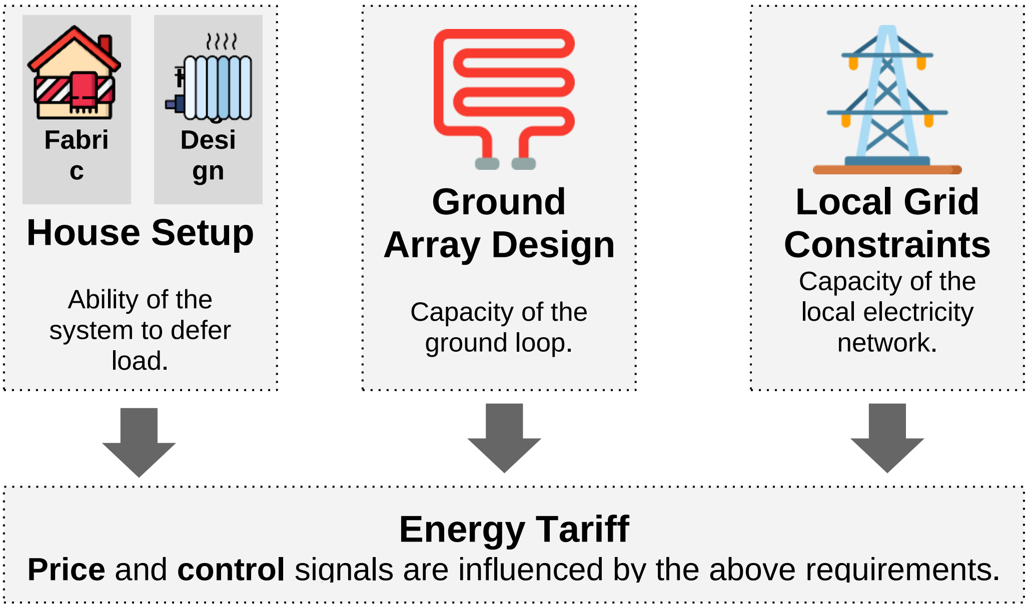


Figure 4: Components of methodology

13.4.7 House Setup

To assess the potential of tariffs, there is a need to understand both the thermal performance of the home along with the setup of a typical heating design system. By understanding both, it is possible to explore simulations of performance to assess the suitability of the tariff.

13.4.7.1 Thermal Fabric

Load shifting a heat pump fundamentally relies on the potential to turn the heat pump off for a period of time without impacting the thermal comfort of the property. An understanding is therefore needed of the thermal performance of a typical home used within these projects to assess how the buildings will perform during such periods.

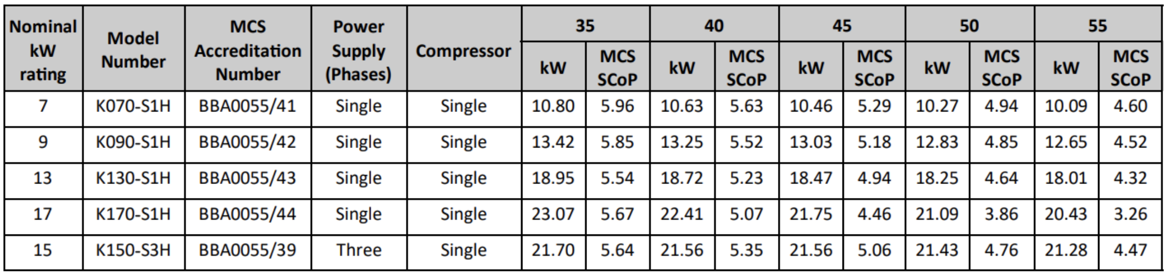
Where possible, the desire is to utilise existing data from field trials conducted by Kensa and OVO. Such analysis has already indicated at a high level that retrofit properties are capable of seeing 2-4 hours depending on the building type and insulation, while new builds are expected to achieve longer.

For this study, the majority of houses are small 1-bedroom or studio flats spread over 2 floors and insulated bungalows, with an average EPC rating of D. A minimum **2 hour shifting period has been determined** as suitable for this type of housing stock.

13.4.7.2 Heating System Design

This study focuses particularly on Ground Source Heat Pumps. While there are similarities between these and Air Source Heat Pumps (ASHP), there are key differentiations between the two which impact the assessment of a tariff[57]. Namely, the Coefficient of Performance for an ASHP is dependent on ambient temperatures, which exhibit greater fluctuations across both seasonal and daily time periods.

Performance data will be used for the technology proposed within the trial. The SCOP for the shoebox 6 is 3.84, but this is dependent on the design flow temperature of the system. As the systems will be set up to weather compensate, it is important to assess COP at an increased temporal granularity, as a minimum looking at the monthly averages. This is important for tariff pricing as it is often peak winter load which can lead to extreme pricing events, so the aim is to be able to accurately assess the electricity demand.



Nominal kW rating	Model Number	MCS Accreditation Number	Power Supply (Phases)	Compressor	35		40		45		50		55	
					kW	MCS SCoP	kW	MCS SCoP	kW	MCS SCoP	kW	MCS SCoP	kW	MCS SCoP
7	K070-S1H	BBA0055/41	Single	Single	10.80	5.96	10.63	5.63	10.46	5.29	10.27	4.94	10.09	4.60
9	K090-S1H	BBA0055/42	Single	Single	13.42	5.85	13.25	5.52	13.03	5.18	12.83	4.85	12.65	4.52
13	K130-S1H	BBA0055/43	Single	Single	18.95	5.54	18.72	5.23	18.47	4.94	18.25	4.64	18.01	4.32
17	K170-S1H	BBA0055/44	Single	Single	23.07	5.67	22.41	5.07	21.75	4.46	21.09	3.86	20.43	3.26
15	K150-S3H	BBA0055/39	Three	Single	21.70	5.64	21.56	5.35	21.56	5.06	21.43	4.76	21.28	4.47

Figure 5: performance data for the Kensa Shoebox heat pumps with an inlet temperature of 10 degrees Celsius. Source Kensa

A second important consideration is the configuration of the system. Two archetypes have been proposed within this work:

1. **No thermal store:** any load shifting has to be handled purely by the thermal performance of the building. There will be changes in temperature within the occupied space.
2. **Included thermal store:** the heat pump has a means to store heat within a thermal store so that heat can still be provided to the property even if the heat pump is not running.

The length of time a thermal store can bridge is a function of the stored energy, the design heat loss of the property, and the current weather conditions. Early performance data from Kensa indicates that systems with a thermal store are able to shift 6 to 8 hours of temperature, although these values have not been validated during a winter period and therefore should be treated with caution.

13.4.8 Heat Network Design

The ground loop is designed to a 10-degree temperature, assumed all year. This will be used to calculate efficiency of systems throughout the year.

The Ground loop systems proposed in this project share a ground array. The efficiency of such a system will therefore be marginally impacted by the running of each individual heat pump, which in effect marginally reduces the temperature of the shared array. However, the

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[57] OVO have completed past studies which look particularly at ASHPs. These findings will be useful for guidance, but caution will be required in applying these past findings.

flow temperatures provided are provided at the worst-case scenario, and therefore results will be marginally conservative.

Finally, there is no limitation on the ability to get heat from the network. This means that there is no restriction preventing all heat pumps running at the same time. This is an important consideration within the tariff design.

13.4.9 Local Grid Constraints

For the purpose of this study, it is being assumed that grid constraints are not an issue, as the capacity of the local substation is being used as part of the site selection.

It is proposed that grid constraints remain a consideration within the ongoing discussion. For example, designing a tariff for example provided a fixed time window of short duration (i.e. 2 hours off peak at the same time of day) could encourage all heat pumps to run at the same time which might lead to excess load.

13.4.10 Data Requirements

Analysis wants to be conducted at a household level, to develop an understanding of how representative a tariff would be for a mix of customers. For each household of interest:

- **Address**, to enable the use of other datasets like Energy Performance Certificates
- The peak heat loss of the property of the property as defined by a detailed heat loss survey
- **Size of the heat pump installed**
- **Thermal storage size** (If installed)
- **Peak charge and discharge rate** of thermal stores (if lower than the heat pump's limits)

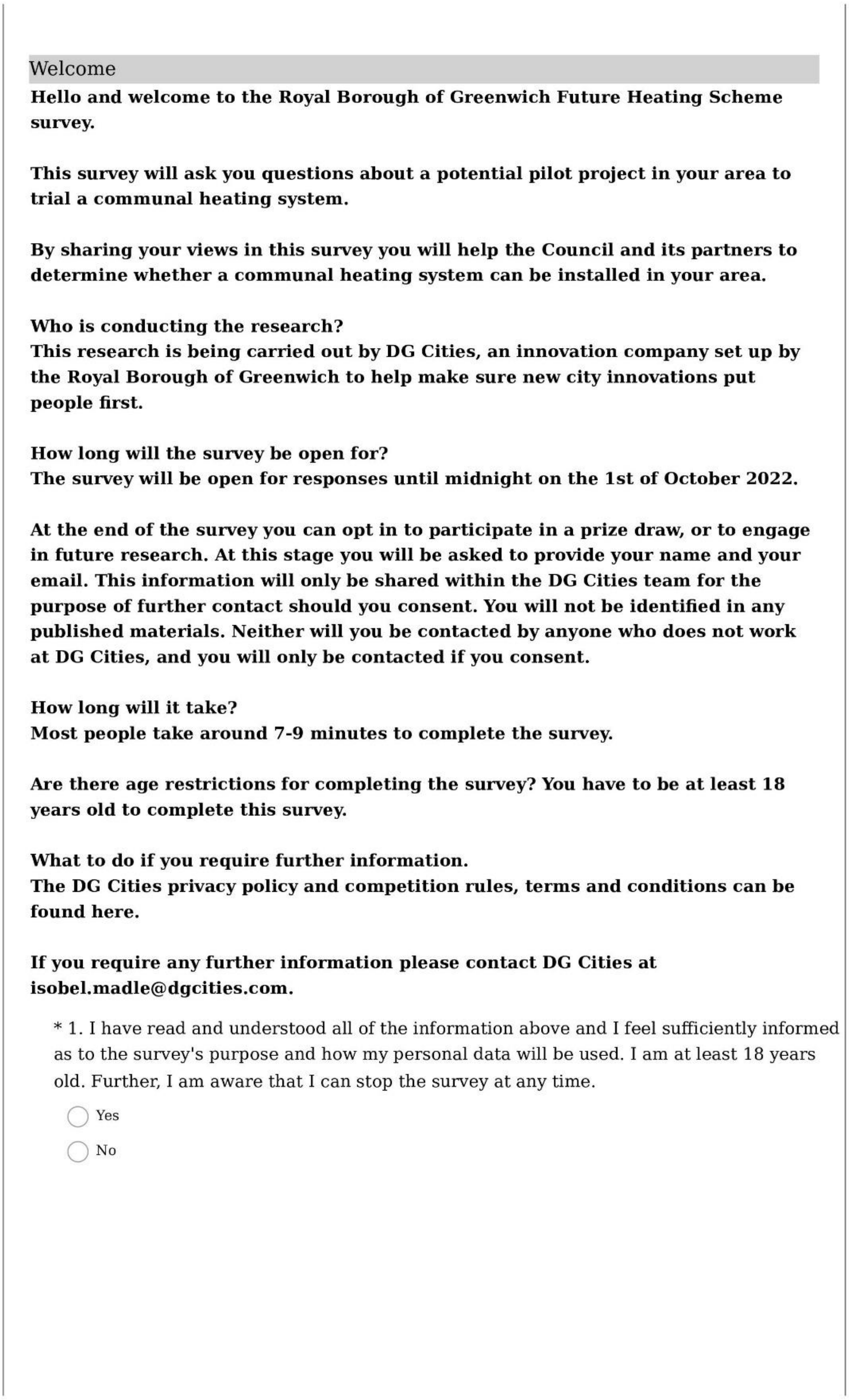
For baseline tariffs, there would be a benefit from having:

- **Power consumption of the heat pump.** This would ideally be half-hourly energy consumption data, spanning a period of time. As a minimum would want 6 months of data including winter and or Autumn/Spring

For assessing tariffs and simulations:

- **Any temperature data of internal temperatures**. This would allow some assessment of the load shifting capability of each home
- **Detailed monitoring data where possible.** If full logging of the heat pumps is available, knowing flow and return temperatures etc will be useful for building more sophisticated simulations to assess optimal tariffs.

13.5 Survey



Welcome

Hello and welcome to the Royal Borough of Greenwich Future Heating Scheme survey.

This survey will ask you questions about a potential pilot project in your area to trial a communal heating system.

By sharing your views in this survey you will help the Council and its partners to determine whether a communal heating system can be installed in your area.

Who is conducting the research?
This research is being carried out by DG Cities, an innovation company set up by the Royal Borough of Greenwich to help make sure new city innovations put people first.

How long will the survey be open for?
The survey will be open for responses until midnight on the 1st of October 2022.

At the end of the survey you can opt in to participate in a prize draw, or to engage in future research. At this stage you will be asked to provide your name and your email. This information will only be shared within the DG Cities team for the purpose of further contact should you consent. You will not be identified in any published materials. Neither will you be contacted by anyone who does not work at DG Cities, and you will only be contacted if you consent.

How long will it take?
Most people take around 7-9 minutes to complete the survey.

Are there age restrictions for completing the survey? You have to be at least 18 years old to complete this survey.

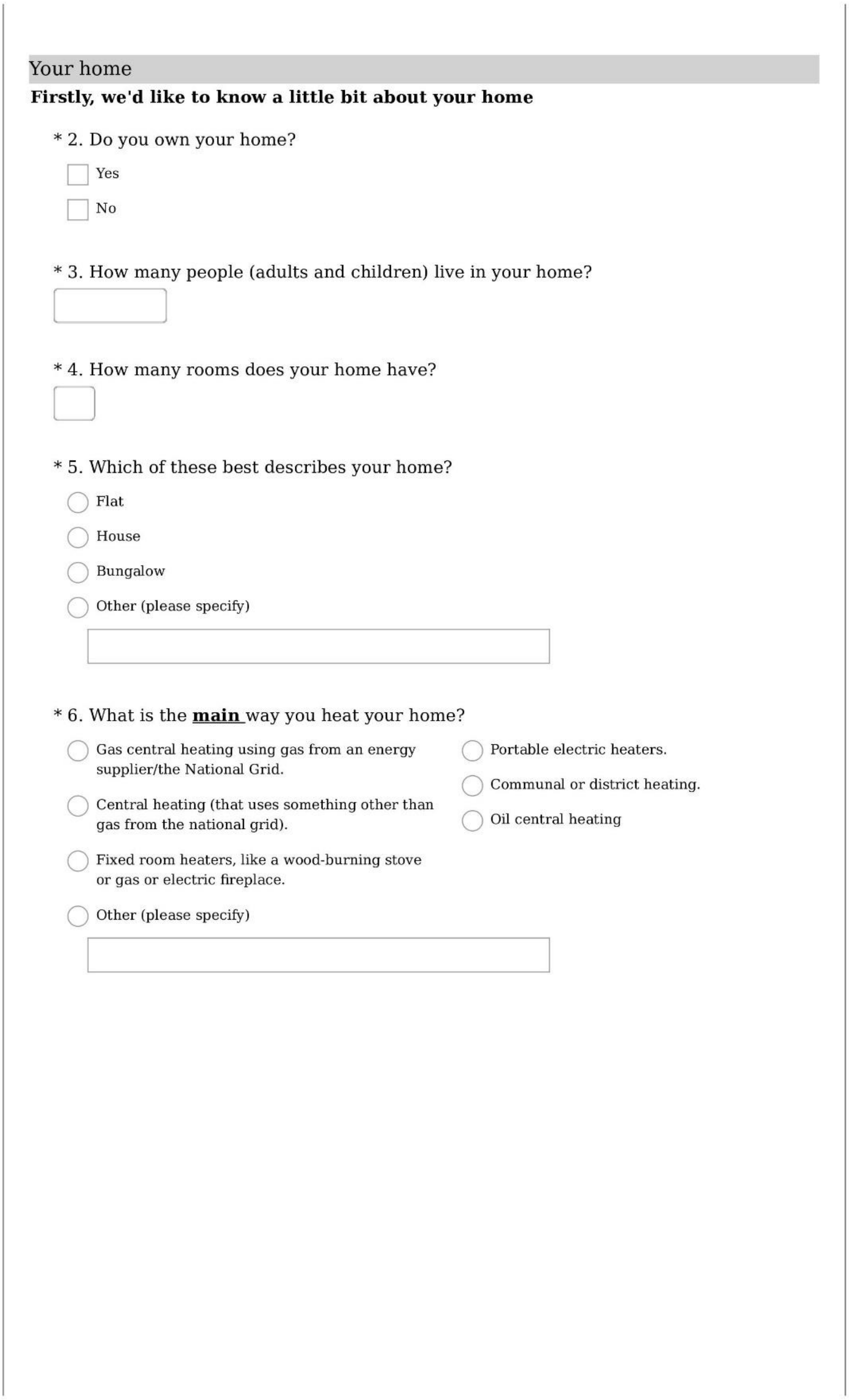
What to do if you require further information.
The DG Cities privacy policy and competition rules, terms and conditions can be found here.

If you require any further information please contact DG Cities at isobel.madle@dgcities.com.

* 1. I have read and understood all of the information above and I feel sufficiently informed as to the survey's purpose and how my personal data will be used. I am at least 18 years old. Further, I am aware that I can stop the survey at any time.

○ Yes

○ No



Your home

Firstly, we'd like to know a little bit about your home

* 2. Do you own your home?

☐ Yes

☐ No

* 3. How many people (adults and children) live in your home?

* 4. How many rooms does your home have?

* 5. Which of these best describes your home?

○ Flat

○ House

○ Bungalow

○ Other (please specify)

* 6. What is the **main** way you heat your home?

○ Gas central heating using gas from an energy supplier/the National Grid.

○ Central heating (that uses something other than gas from the national grid).

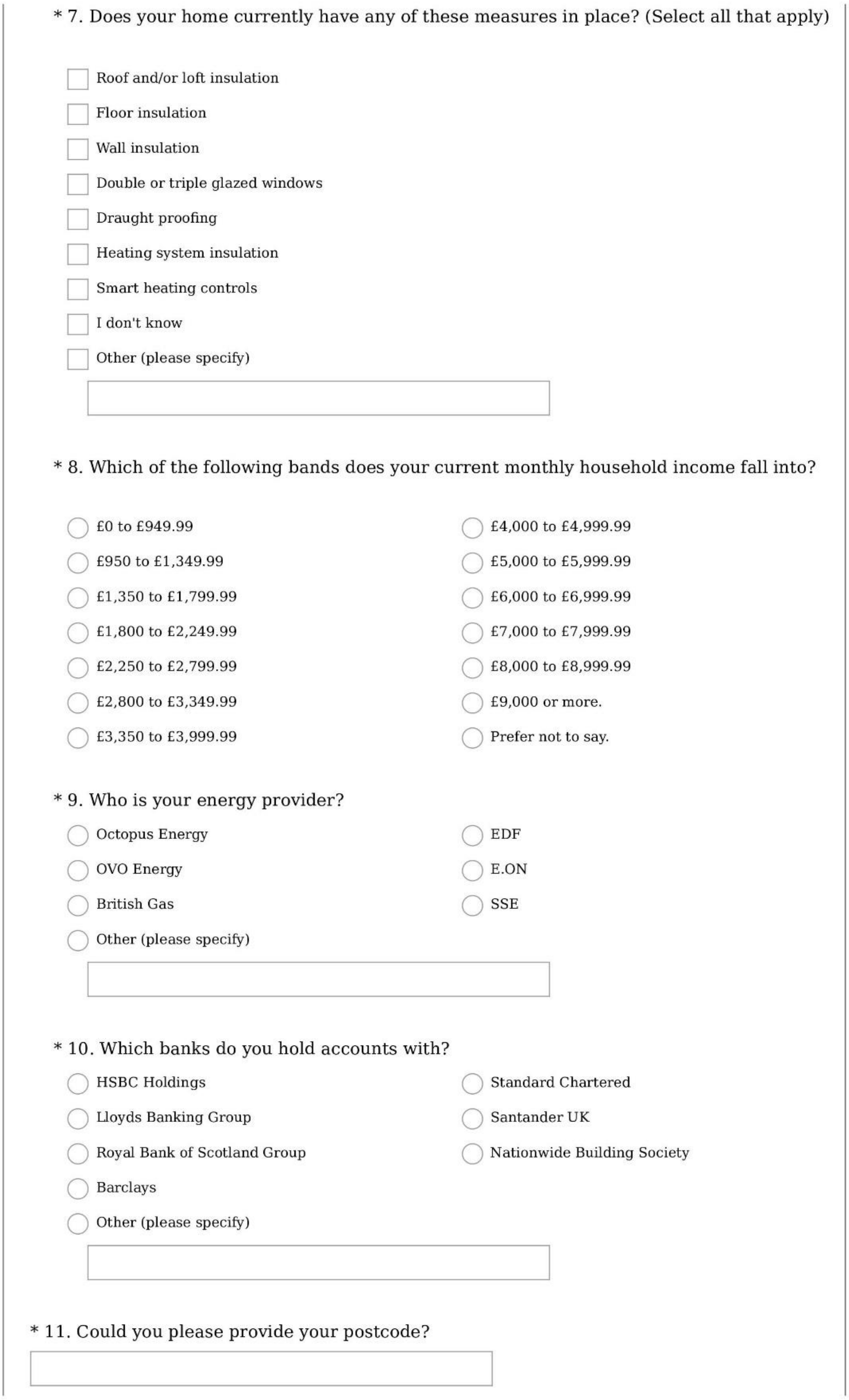
○ Fixed room heaters, like a wood-burning stove or gas or electric fireplace.

○ Other (please specify)

○ Portable electric heaters.

○ Communal or district heating.

○ Oil central heating



* 7. Does your home currently have any of these measures in place? (Select all that apply)

☐ Roof and/or loft insulation
☐ Floor insulation
☐ Wall insulation
☐ Double or triple glazed windows
☐ Draught proofing
☐ Heating system insulation
☐ Smart heating controls
☐ I don't know
☐ Other (please specify)

* 8. Which of the following bands does your current monthly household income fall into?

○ £0 to £949.99
○ £950 to £1,349.99
○ £1,350 to £1,799.99
○ £1,800 to £2,249.99
○ £2,250 to £2,799.99
○ £2,800 to £3,349.99
○ £3,350 to £3,999.99
○ £4,000 to £4,999.99
○ £5,000 to £5,999.99
○ £6,000 to £6,999.99
○ £7,000 to £7,999.99
○ £8,000 to £8,999.99
○ £9,000 or more.
○ Prefer not to say.

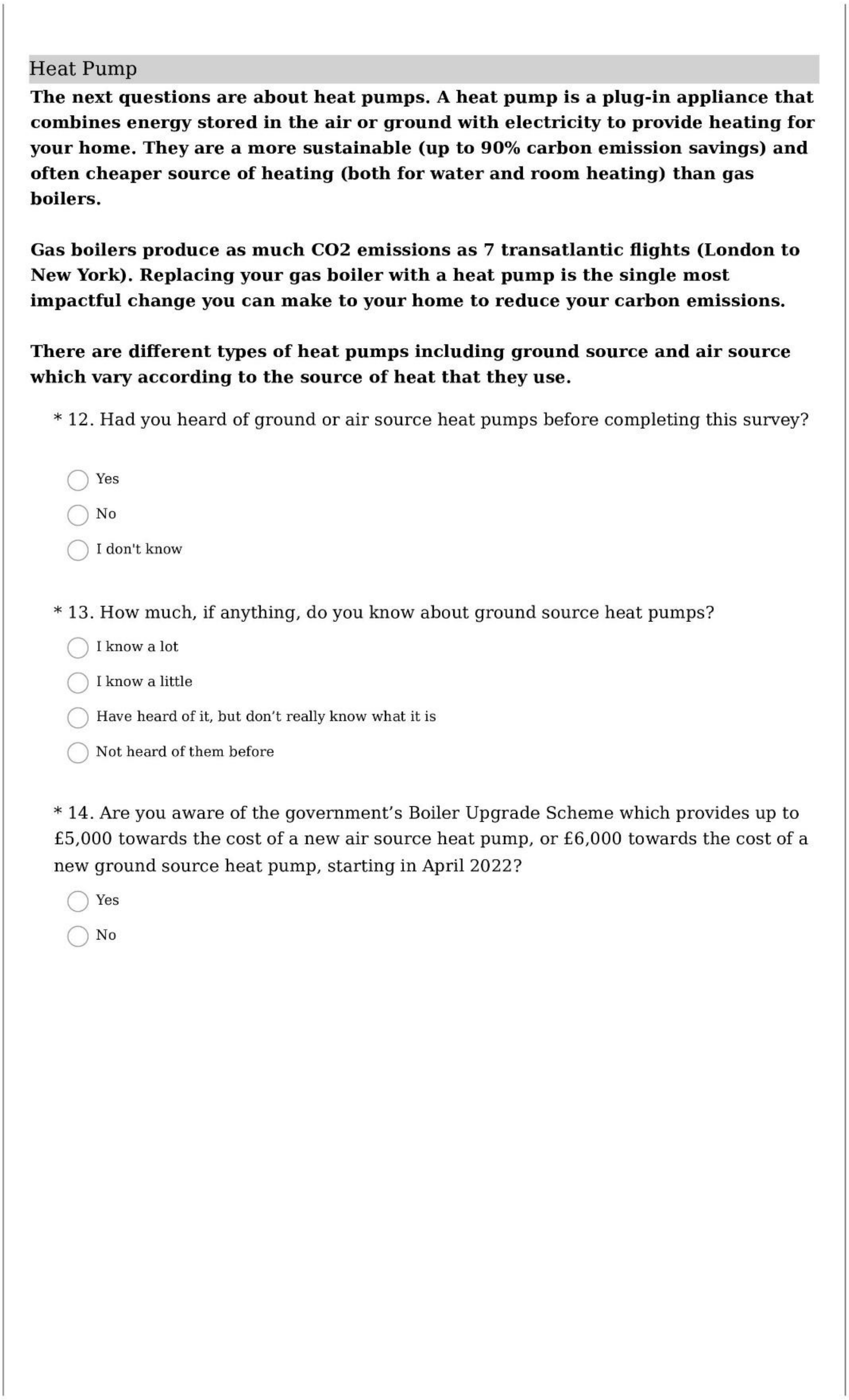
* 9. Who is your energy provider?

○ Octopus Energy
○ OVO Energy
○ British Gas
○ Other (please specify)
○ EDF
○ E.ON
○ SSE

* 10. Which banks do you hold accounts with?

○ HSBC Holdings
○ Lloyds Banking Group
○ Royal Bank of Scotland Group
○ Barclays
○ Other (please specify)
○ Standard Chartered
○ Santander UK
○ Nationwide Building Society

* 11. Could you please provide your postcode?



Heat Pump

The next questions are about heat pumps. A heat pump is a plug-in appliance that combines energy stored in the air or ground with electricity to provide heating for your home. They are a more sustainable (up to 90% carbon emission savings) and often cheaper source of heating (both for water and room heating) than gas boilers.

Gas boilers produce as much CO2 emissions as 7 transatlantic flights (London to New York). Replacing your gas boiler with a heat pump is the single most impactful change you can make to your home to reduce your carbon emissions.

There are different types of heat pumps including ground source and air source which vary according to the source of heat that they use.

* 12. Had you heard of ground or air source heat pumps before completing this survey?

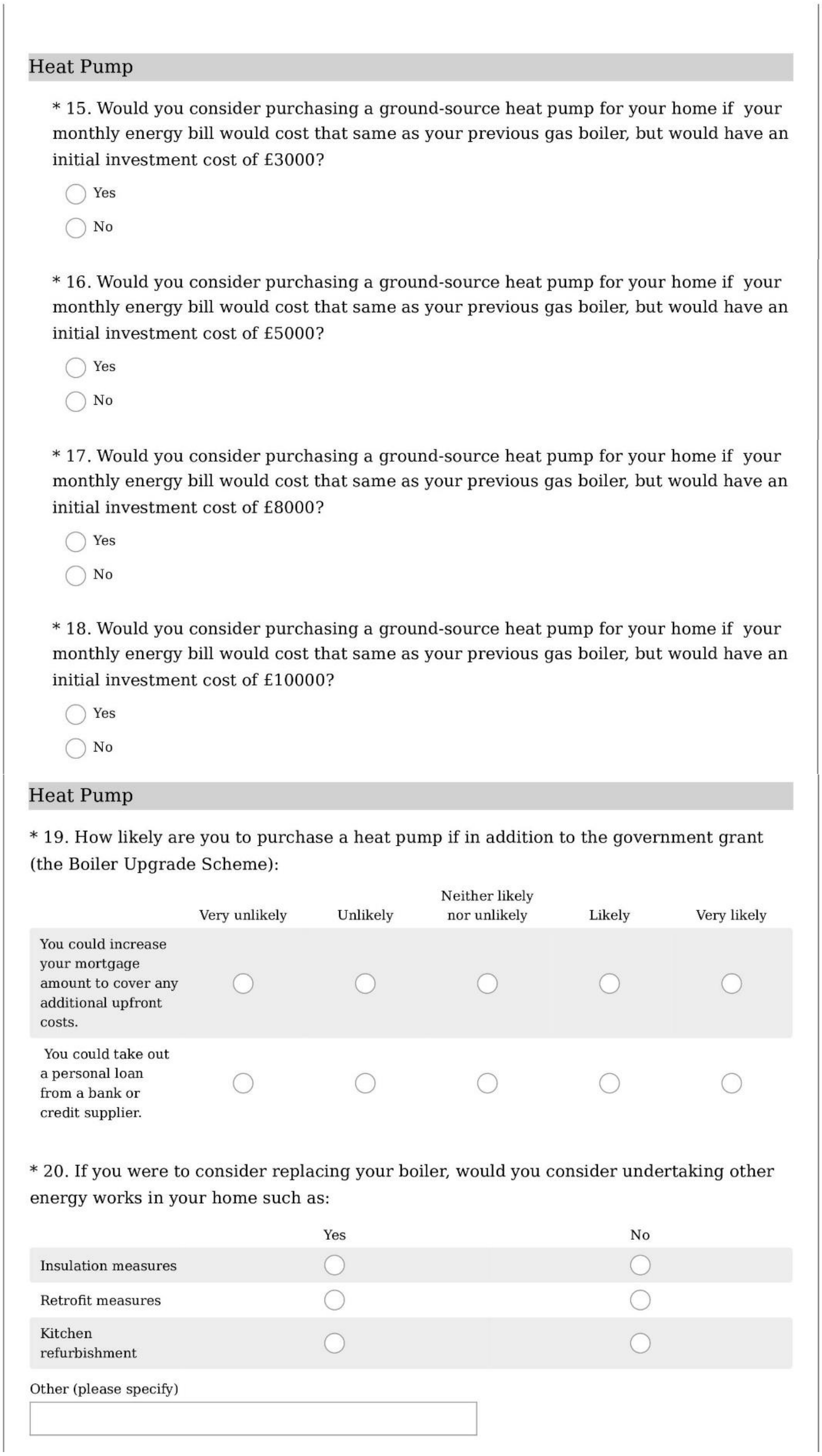
○ Yes
○ No
○ I don't know

* 13. How much, if anything, do you know about ground source heat pumps?

○ I know a lot
○ I know a little
○ Have heard of it, but don’t really know what it is
○ Not heard of them before

* 14. Are you aware of the government’s Boiler Upgrade Scheme which provides up to £5,000 towards the cost of a new air source heat pump, or £6,000 towards the cost of a new ground source heat pump, starting in April 2022?

○ Yes
○ No



Heat Pump

* 15. Would you consider purchasing a ground-source heat pump for your home if your monthly energy bill would cost that same as your previous gas boiler, but would have an initial investment cost of £3000?

○ Yes
○ No

* 16. Would you consider purchasing a ground-source heat pump for your home if your monthly energy bill would cost that same as your previous gas boiler, but would have an initial investment cost of £5000?

○ Yes
○ No

* 17. Would you consider purchasing a ground-source heat pump for your home if your monthly energy bill would cost that same as your previous gas boiler, but would have an initial investment cost of £8000?

○ Yes
○ No

* 18. Would you consider purchasing a ground-source heat pump for your home if your monthly energy bill would cost that same as your previous gas boiler, but would have an initial investment cost of £10000?

○ Yes
○ No

Heat Pump

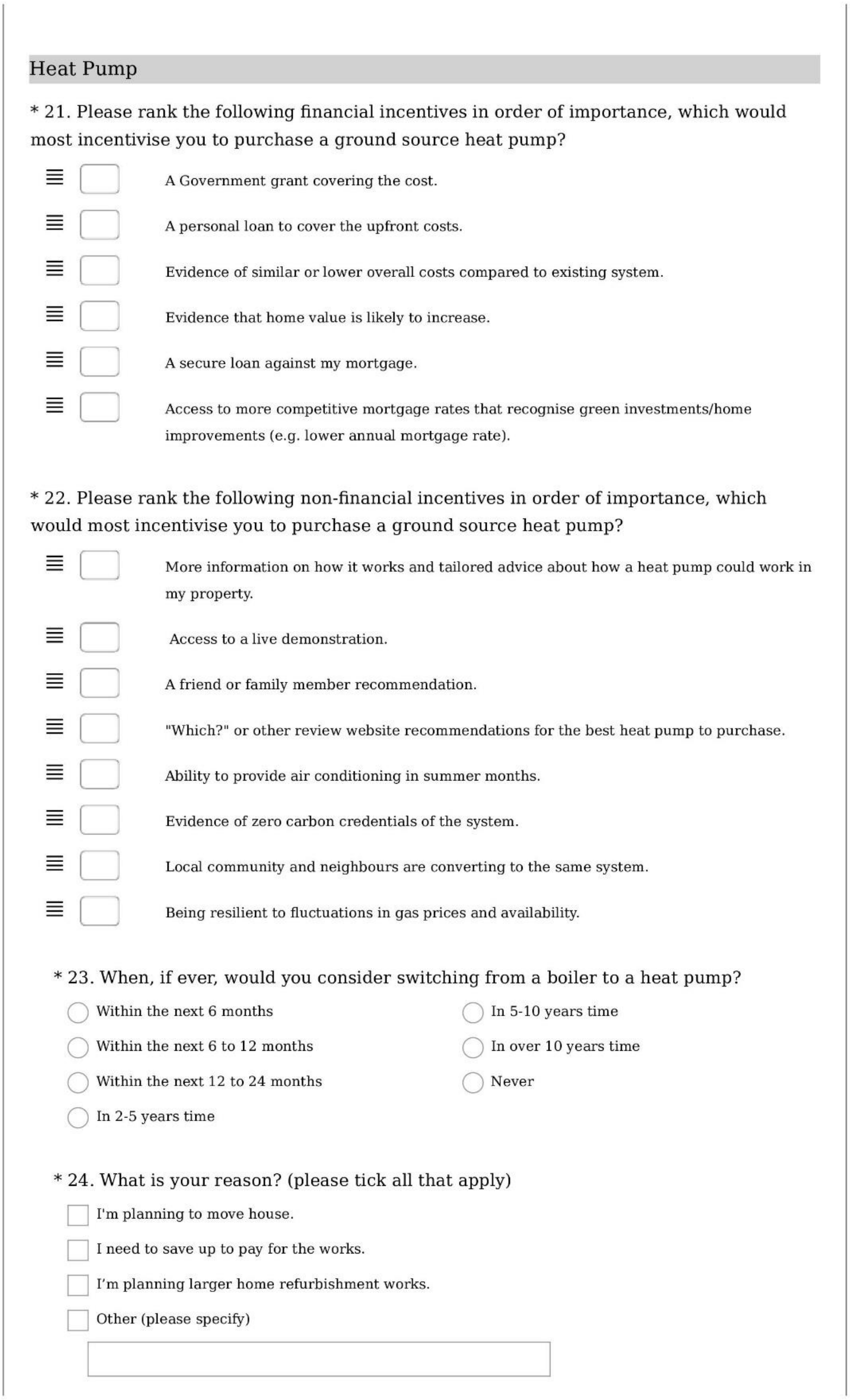
* 19. How likely are you to purchase a heat pump if in addition to the government grant (the Boiler Upgrade Scheme):

	Very unlikely	Unlikely	Neither likely nor unlikely	Likely	Very likely
You could increase your mortgage amount to cover any additional upfront costs.	○	○	○	○	○
You could take out a personal loan from a bank or credit supplier.	○	○	○	○	○

* 20. If you were to consider replacing your boiler, would you consider undertaking other energy works in your home such as:

	Yes	No
Insulation measures	○	○
Retrofit measures	○	○
Kitchen refurbishment	○	○

Other (please specify)



Heat Pump

* 21. Please rank the following financial incentives in order of importance, which would most incentivise you to purchase a ground source heat pump?

≣ ☐ A Government grant covering the cost.
≣ ☐ A personal loan to cover the upfront costs.
≣ ☐ Evidence of similar or lower overall costs compared to existing system.
≣ ☐ Evidence that home value is likely to increase.
≣ ☐ A secure loan against my mortgage.
≣ ☐ Access to more competitive mortgage rates that recognise green investments/home improvements (e.g. lower annual mortgage rate).

* 22. Please rank the following non-financial incentives in order of importance, which would most incentivise you to purchase a ground source heat pump?

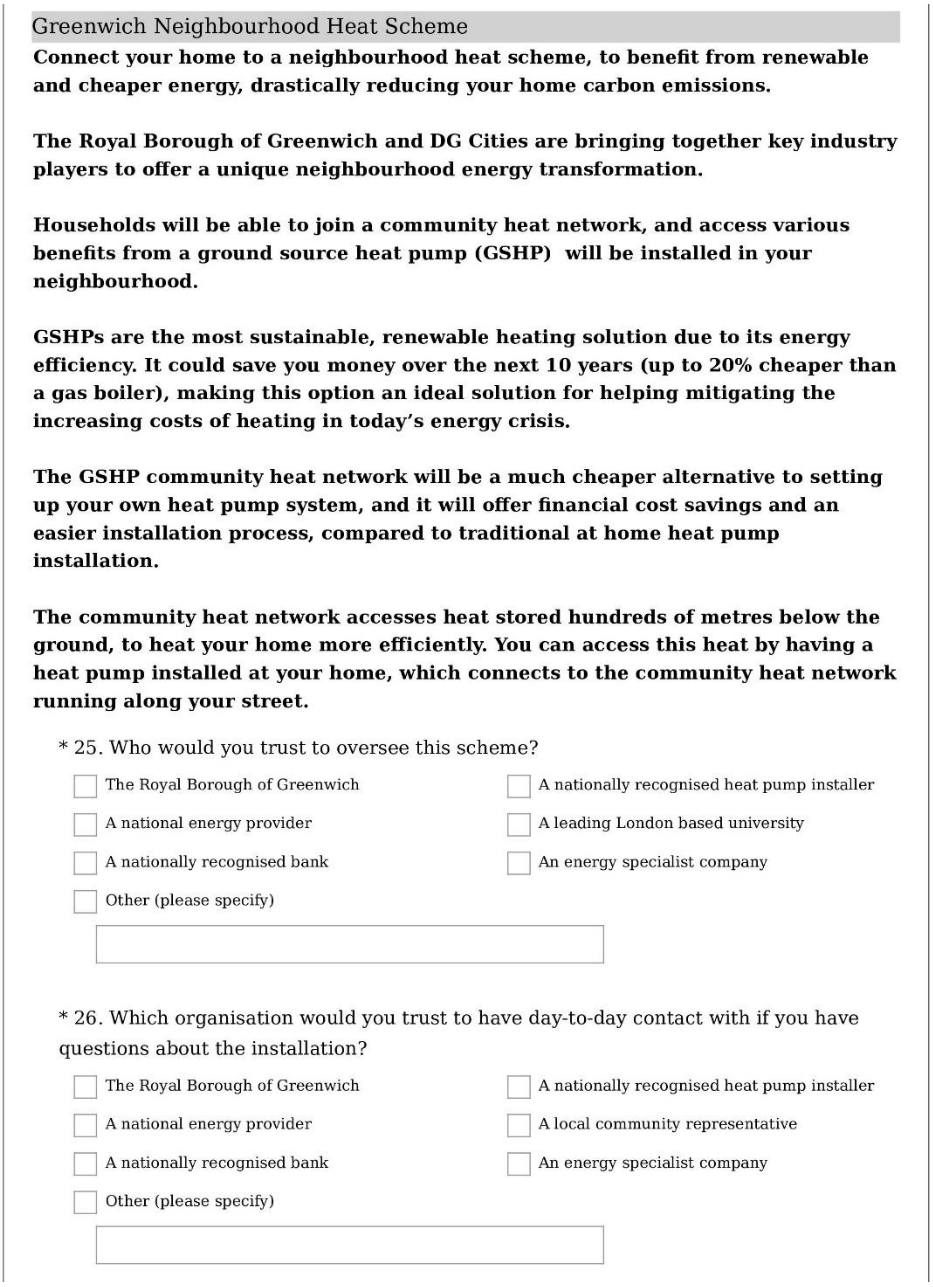
≣ ☐ More information on how it works and tailored advice about how a heat pump could work in my property.
≣ ☐ Access to a live demonstration.
≣ ☐ A friend or family member recommendation.
≣ ☐ "Which?" or other review website recommendations for the best heat pump to purchase.
≣ ☐ Ability to provide air conditioning in summer months.
≣ ☐ Evidence of zero carbon credentials of the system.
≣ ☐ Local community and neighbours are converting to the same system.
≣ ☐ Being resilient to fluctuations in gas prices and availability.

* 23. When, if ever, would you consider switching from a boiler to a heat pump?

○ Within the next 6 months
○ Within the next 6 to 12 months
○ Within the next 12 to 24 months
○ In 2-5 years time
○ In 5-10 years time
○ In over 10 years time
○ Never

* 24. What is your reason? (please tick all that apply)

☐ I'm planning to move house.
☐ I need to save up to pay for the works.
☐ I'm planning larger home refurbishment works.
☐ Other (please specify)



Greenwich Neighbourhood Heat Scheme

Connect your home to a neighbourhood heat scheme, to benefit from renewable and cheaper energy, drastically reducing your home carbon emissions.

The Royal Borough of Greenwich and DG Cities are bringing together key industry players to offer a unique neighbourhood energy transformation.

Households will be able to join a community heat network, and access various benefits from a ground source heat pump (GSHP) will be installed in your neighbourhood.

GSHPs are the most sustainable, renewable heating solution due to its energy efficiency. It could save you money over the next 10 years (up to 20% cheaper than a gas boiler), making this option an ideal solution for helping mitigating the increasing costs of heating in today's energy crisis.

The GSHP community heat network will be a much cheaper alternative to setting up your own heat pump system, and it will offer financial cost savings and an easier installation process, compared to traditional at home heat pump installation.

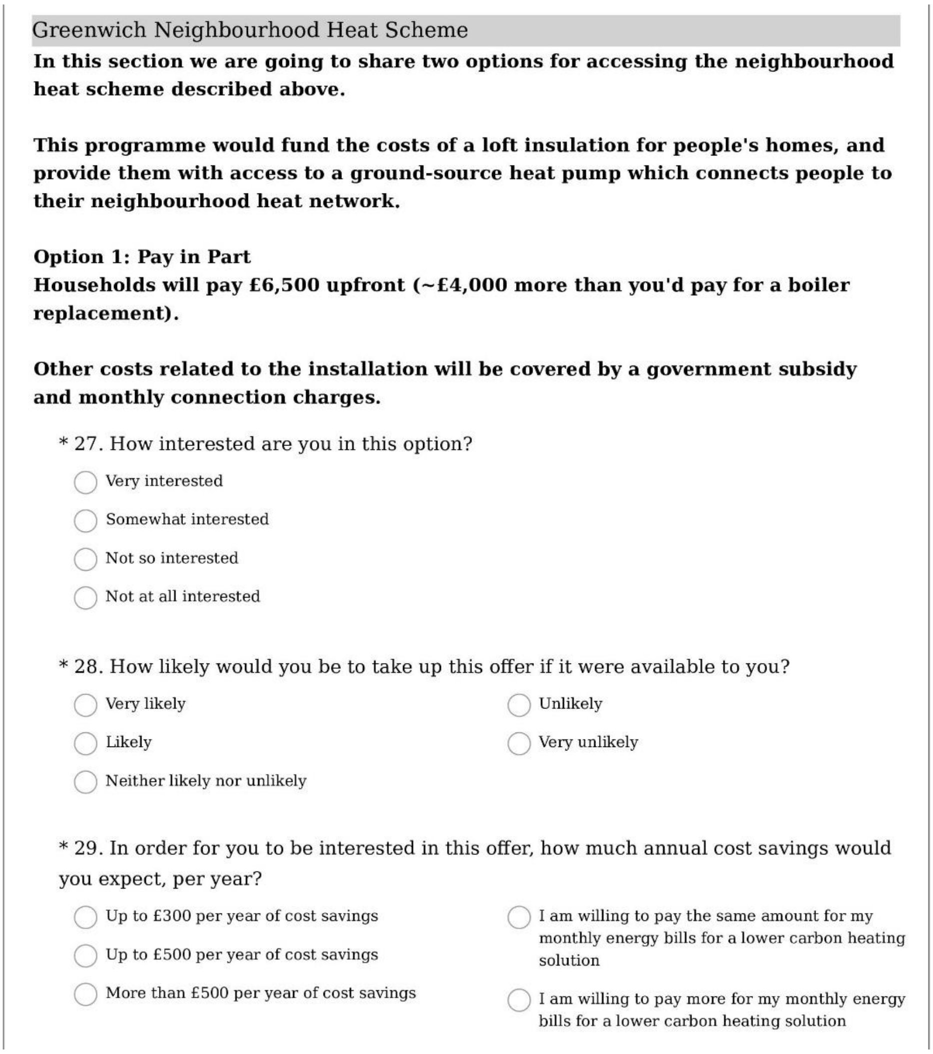
The community heat network accesses heat stored hundreds of metres below the ground, to heat your home more efficiently. You can access this heat by having a heat pump installed at your home, which connects to the community heat network running along your street.

* 25. Who would you trust to oversee this scheme?

☐ The Royal Borough of Greenwich
☐ A national energy provider
☐ A nationally recognised bank
☐ Other (please specify)
☐ A nationally recognised heat pump installer
☐ A leading London based university
☐ An energy specialist company

* 26. Which organisation would you trust to have day-to-day contact with if you have questions about the installation?

☐ The Royal Borough of Greenwich
☐ A national energy provider
☐ A nationally recognised bank
☐ Other (please specify)
☐ A nationally recognised heat pump installer
☐ A local community representative
☐ An energy specialist company



Greenwich Neighbourhood Heat Scheme

In this section we are going to share two options for accessing the neighbourhood heat scheme described above.

This programme would fund the costs of a loft insulation for people's homes, and provide them with access to a ground-source heat pump which connects people to their neighbourhood heat network.

Option 1: Pay in Part
Households will pay £6,500 upfront (~£4,000 more than you'd pay for a boiler replacement).

Other costs related to the installation will be covered by a government subsidy and monthly connection charges.

* 27. How interested are you in this option?

○ Very interested

○ Somewhat interested

○ Not so interested

○ Not at all interested

* 28. How likely would you be to take up this offer if it were available to you?

○ Very likely

○ Likely

○ Neither likely nor unlikely

○ Unlikely

○ Very unlikely

* 29. In order for you to be interested in this offer, how much annual cost savings would you expect, per year?

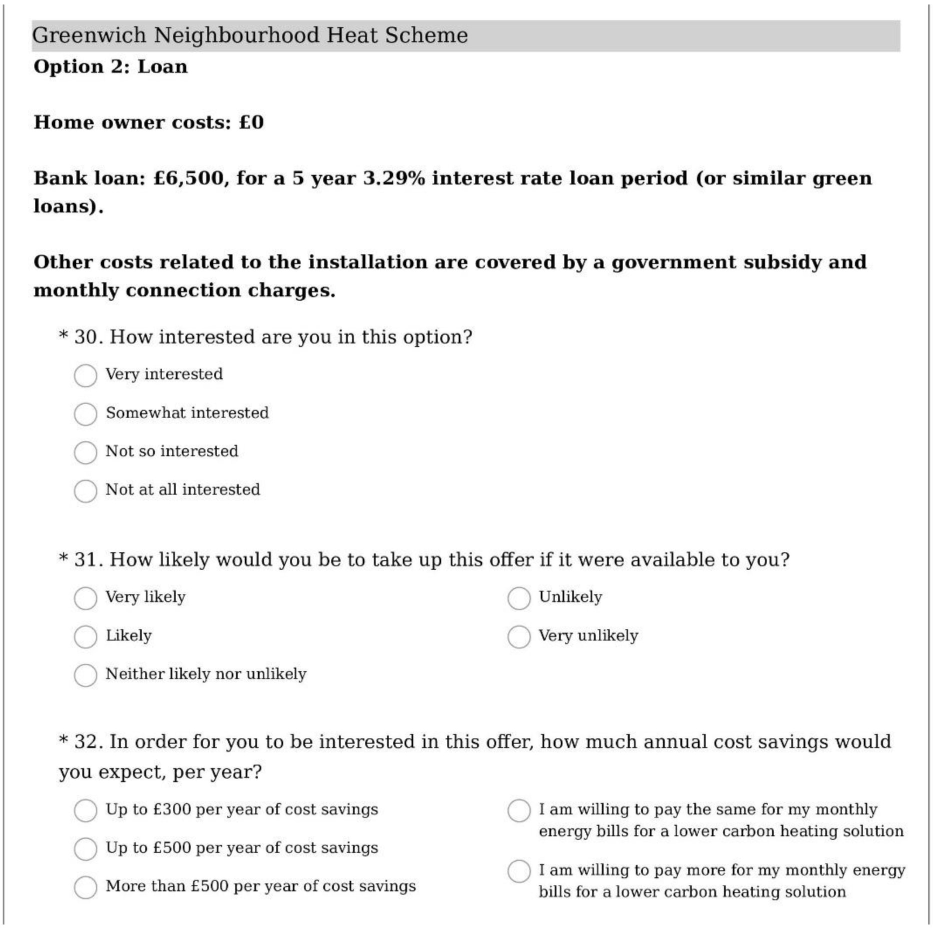
○ Up to £300 per year of cost savings

○ Up to £500 per year of cost savings

○ More than £500 per year of cost savings

○ I am willing to pay the same amount for my monthly energy bills for a lower carbon heating solution

○ I am willing to pay more for my monthly energy bills for a lower carbon heating solution



Greenwich Neighbourhood Heat Scheme

Option 2: Loan

Home owner costs: £0

Bank loan: £6,500, for a 5 year 3.29% interest rate loan period (or similar green loans).

Other costs related to the installation are covered by a government subsidy and monthly connection charges.

* 30. How interested are you in this option?

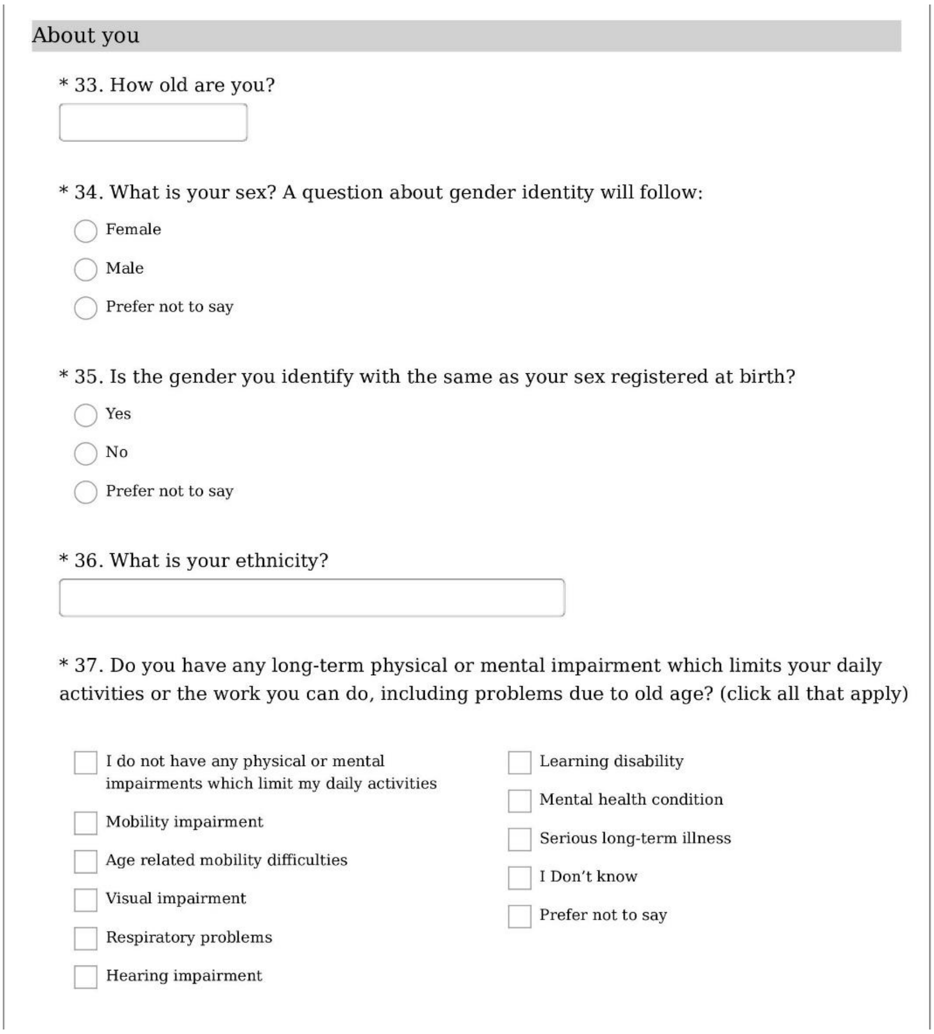
○ Very interested
○ Somewhat interested
○ Not so interested
○ Not at all interested

* 31. How likely would you be to take up this offer if it were available to you?

○ Very likely
○ Likely
○ Neither likely nor unlikely
○ Unlikely
○ Very unlikely

* 32. In order for you to be interested in this offer, how much annual cost savings would you expect, per year?

○ Up to £300 per year of cost savings
○ Up to £500 per year of cost savings
○ More than £500 per year of cost savings
○ I am willing to pay the same for my monthly energy bills for a lower carbon heating solution
○ I am willing to pay more for my monthly energy bills for a lower carbon heating solution



About you

* 33. How old are you?

* 34. What is your sex? A question about gender identity will follow:

○ Female
○ Male
○ Prefer not to say

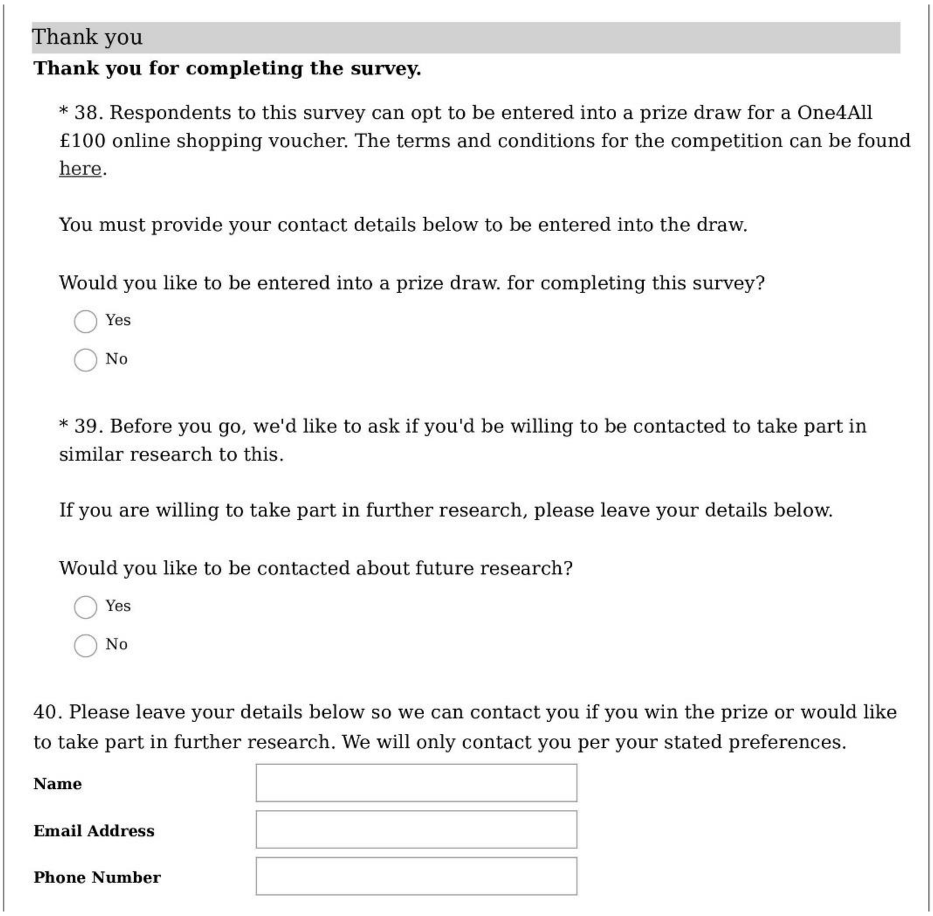
* 35. Is the gender you identify with the same as your sex registered at birth?

○ Yes
○ No
○ Prefer not to say

* 36. What is your ethnicity?

* 37. Do you have any long-term physical or mental impairment which limits your daily activities or the work you can do, including problems due to old age? (click all that apply)

☐ I do not have any physical or mental impairments which limit my daily activities
☐ Mobility impairment
☐ Age related mobility difficulties
☐ Visual impairment
☐ Respiratory problems
☐ Hearing impairment
☐ Learning disability
☐ Mental health condition
☐ Serious long-term illness
☐ I Don’t know
☐ Prefer not to say



Thank you

Thank you for completing the survey.

* 38. Respondents to this survey can opt to be entered into a prize draw for a One4All £100 online shopping voucher. The terms and conditions for the competition can be found here.

You must provide your contact details below to be entered into the draw.

Would you like to be entered into a prize draw. for completing this survey?

○ Yes

○ No

* 39. Before you go, we'd like to ask if you'd be willing to be contacted to take part in similar research to this.

If you are willing to take part in further research, please leave your details below.

Would you like to be contacted about future research?

○ Yes

○ No

40. Please leave your details below so we can contact you if you win the prize or would like to take part in further research. We will only contact you per your stated preferences.

Name ☐

Email Address ☐

Phone Number ☐

13.6 Door-knocking interview guidance/script

Door knocking plan:

Aim of door knocking: To get in-depth opinions about the offers developed and the messaging created.

<u>Plan</u>

- **Dates**:6th October
- **Pairings**: Hiba & Ash, Isobel & Sam
- **Meeting point:** North Greenwich @9am, and head from there (45 min bus ride to first street)
- **Location (streets, area)**:
  Location 1 (near Eltham Station):
    - Dunvegan Rd, Westmount Rd, Greenvale Rd
    - Earlshall Rd, Elibank R, Craigton Rd
    - Grangehill Rd, Dumbreck Rd, Westmount Rd
    -

Location 2 near the above

- Moira Rd, Rochester Way
- Admiral Seymour Rd, Rochester Way
- Prince Rupert Road, Rochester Way
- Congreve Rd, Rochester Way

Location 3, near above

- Prince Ruper Rd, Brome Rd, Lovelace Grn
- Congreve Rd, Lovelace Grn

Location 4, near above

- Kidbrook Ln, Elmbrook Gardens

Location 5,

- Sherard Rd, Pullman Pl, Tattersall Cl
- Sherard Rd, Everest Rd, Lassa Rd
- Sherard Rd, Well Hall Rd
- Prince John Rd, Sherard Rd, Lilburne Rd, Lilburne Gardens
- Sherard Rd, Carnecke Gardens, Eltham Hill, Yolande Gardens, Prince John Rd,
- Sherard Rd, Lassa Rd, Well Hall Rd,

Location 6

- Strongbow Rd, Strongbow Cr
- Dobell Rd, Strongbow Rd

Location 7

- Kings Orchard, Wythfield Rd
- Wythfield Rd, Court Yard, Tilt Yard Approach
- Court Yard, North Park

    - Court Yard, Middle Park Ave

- **Time**:
    - Morning: 10am until 12pm
    - Lunch: 12pm to 1:30pm
    - Afternoon: 2pm to 4pm
- **Materials to bring**: office tablet with necessary content on it or items on paper,

Overview text

Introduction

- Hi, I'm X and this is X. We are researchers working on a project for the Council. Do you have a moment to help with some research?
- We work for DG Cities, a research company, and we are speaking to people in your neighbourhood about a new energy scheme we are hoping to pilot. We are speaking with local people to understand what they think about the project idea.
- Do you have a moment to help with our research (smile!) It'll take about 5 mins, 10 max.

Intro to scheme

The Royal Borough of Greenwich and DG Cities are bringing together a group of companies including a nationwide bank and national energy company to develop a community heat network in Eltham. The group of companies will install a new heat system and households will be able to access heat from this network through a heat pump unit installed within their home.

We are speaking to people about what they think of this idea. The likelihood of this development will depend on the level of interest from residents in the area and government support as part of this proposal. We're here today to understand what you think and whether you'd be interested in such a service in the future.

Firstly, can you tell us a bit about you?

- What type of heating do your currently have?
- Do you own your home, or are you renting it?

Benefits of a heat pump

Have you heard of a ground source heat pump before? Yes/No

A ground source heat pump network consists of a series of pipes that would be dug into the ground under the street and would extract energy from the ground to provide heating into your home.

The community heat network accesses heat stored 150 to 300 meters below the

ground, to heat your home more efficiently. The network accesses heat through pipes installed below the ground. You can access this heat by having a heat pump plug-in unit installed at your home. This unit combines electricity from the grid and energy from the ground to provide heating for your home, water and also cooling for your home in the summer.

GSHPs are the most sustainable, renewable heating solution due to its energy efficiency. It could save you money over the next 10 years (up to 20% cheaper than a gas boiler), making this option an ideal solution for helping to mitigate the increasing costs of heating in today's energy crisis.

The GSHP community heat network will be a much cheaper alternative to setting up your own heat pump system, and it will offer financial cost savings and an easier installation process, compared to traditional at home heat pump installation.

Testing:

Initial feedback

- What are your first impressions of the idea?
- What do you like/dislike about it?
- What do you think about the idea of a shared Heat network between you and your neighbours?
- What did you think of the "green energy" credentials compared to gas?
- How important is it that you save money? Would you pay more if you had more reliable and cleaner energy?

- **If renting:** would you like your landlord to consider this type of heating service?

Payment options

If own property, if not then skip section

I'd like to now share some information about the costs to get your feedback:

(Present a printout of the table below for them to hold - and talk through the costs)

	Option 1	Option 2
Upfront costs to you: This cost covers part of the total costs (£12,500) required for installing the heat pump and connecting it to the network.	£6,500 (~£4,000 more than you would pay for a boiler replacement)	£0

Bank loan This cost covers part of the total costs (£12,500) required for installing the heat pump and connecting it to the network.	0	£6,500 (for a 5-year period, 3.29% interest rate loan period - or similar green bank loans)
Government subsidy This cost covers part of the total costs (£12,500) required for installing the heat pump and connecting it to the network.	£6,000	£6,000
Monthly connection charges (paid by resident) This would cover the costs for energy efficiency measures (offered as part of this scheme) and fees to access the ground source heat pump network	£750 annually (for 40 years) £625 annually (for 40 years, without energy efficiency measures)	£750 annually (for 40 years) £625 annually (for 40 years, without energy efficiency measures)
Loft insulation: Loft insulation will help the heat pump work more efficiently and keep your home warmer for longer.	£0	£0

This programme would fund the costs of some basic insulation measures such as loft insulation and draft-proofing for people's homes and provide them with access to a ground-source heat pump which connects people to their neighbourhood heat network.

Questions:

- Which option would you prefer?
- If you wouldn’t pick these options - why not? (ask follow up questions)

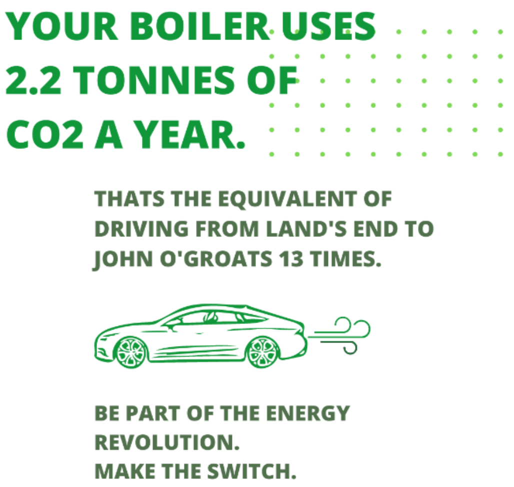
  - ○ Would you take up this scheme, and pay more monthly bills than your gas bills, for a lower carbon heating solution?
  - ○ Or, would you take up this scheme, and have the same monthly bills, as it is a lower carbon emitting solution?
  - ○ Would you take up this scheme if you were to get up to:
    - Up to £300 per year of cost savings
    - Up to £500 per year of cost savings
    - More than £500 per year of cost savings

__Environmental Messaging__

Now I'd like to get your feedback on some adverts we've developed.

Please take a moment to look at the first advert:

__Ad 1__



YOUR BOILER USES 2.2 TONNES OF CO2 A YEAR.

THATS THE EQUIVALENT OF DRIVING FROM LAND'S END TO JOHN O'GROATS 13 TIMES.

BE PART OF THE ENERGY REVOLUTION.
MAKE THE SWITCH.

- What are your initial reactions to this ad?
- If you saw this message, would you click on it to find out more?
  - No - why not?
  - No - what would make you want to click on it more?
- How does it make you feel about alternative energy solutions, like heat pumps?
- **If renting** Would you be likely to share this advert with your landlord?

Now I'd like to share another ad with you and hear your thoughts:

Ad 2

- What are your initial reactions to this ad?
- If you saw this message, would you click on it to find out more?
  - No - why not?
  - No - what would make you want to click on it more?
- How does it make you feel about alternative energy solutions, like heat pumps?
- **If renting** Would you be likely to share this advert with your landlord?

Thank you, now one last Ad.

Ad 3

- What are your initial reactions to this ad?
- How does it make you feel?
- If you saw this message, would you click on it to find out more?
    - No - why not?
    - No - what would make you want to click on it more?
- How does it make you feel about alternative energy solutions, like heat pumps?
- **If renting** Would you be likely to share this advert with your landlord?

Final section

Thanks so much for your help, do have any final thoughts you'd like to share?

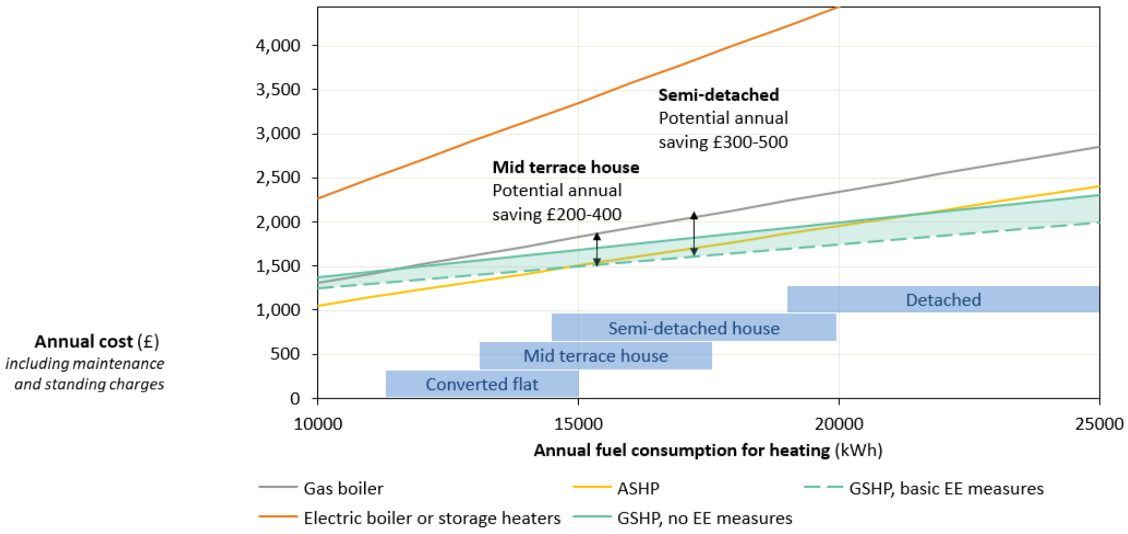
Thanks for your time today.

Additional information to support cost testing options (not to be read out)

Annual operational costs with variable tariff (at price cap for gas/electricity, during peak and off-peak hours)

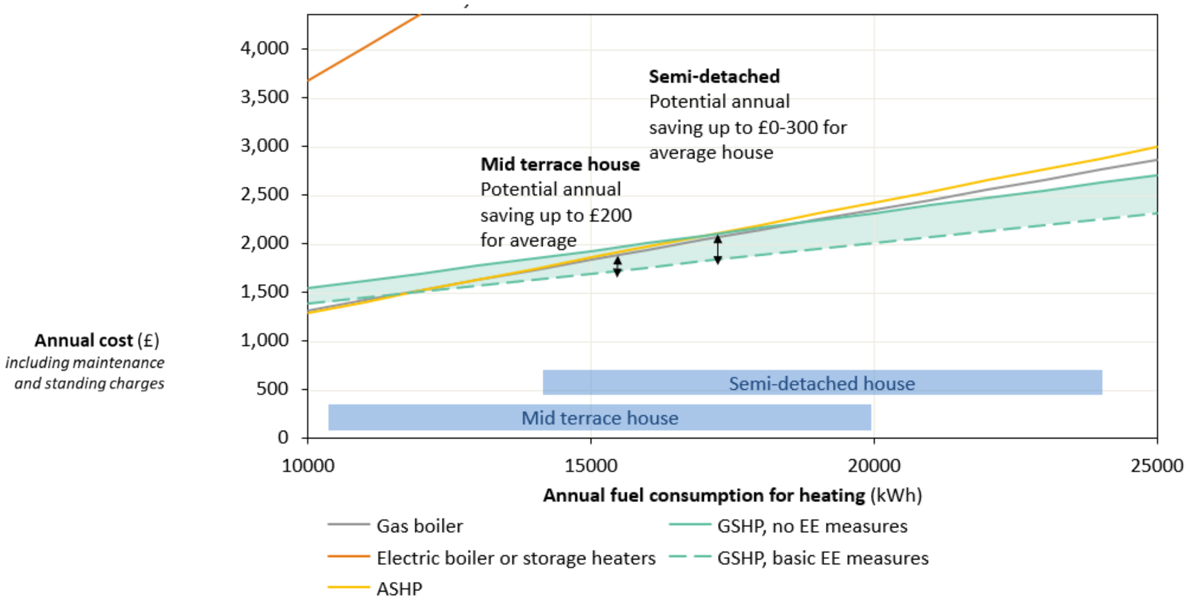
- All prices are based on the current price cap for gas and electricity (10.3p/kWh gas; 34 p/kWh electricity during the day, and 11p/kWh at night)

- Energy efficiency (EE) describes the insulation levels of the home. Basic EE measures included here: draft-proofing, heating controls and loft insulation (relevant for a very poorly insulated home with an EPC of E).



Note: *the actual savings will depend on the particular house in question, and the level of insulation already installed.*

Annual operational costs (Less savings can be achieved with a fixed tariff (at price cap)



- Technology efficiency used in the above cost is presented below. Lower efficiencies may result in higher costs.
  - Gas boiler: 80%
  - Electric boiler or storage heaters: 100%
  - Air source heat pump: 240%
  - Ground source heat pump: 350%

- Heat pump design assumes a fairly standard heat pump setup of 50 degree flow temperature. This tends to be the highest temperature people will install them at. If the flow temperature is lower, the energy consumption will reduce.

- Energy efficiency (EE) measures are only applied on the GSHP option as this is the package being offered in Heat Pump Ready. However, applying measures to gas boilers and ASHPs would also lead to cost savings, which are not shown in the figure.

- The EE measures applied in above costing are based on a poorly insulated home, i.e. EPC E. The actual impact of EE measures (and the associated costs) will depend on the condition of the fabric of the home on a case by case basis.

- For GSHP, the costs include the ~£750 annual standing charge to access the shared ground array deployed as part of the program, which should mean you pay the same/less than you would upfront for an air-source heat pump.

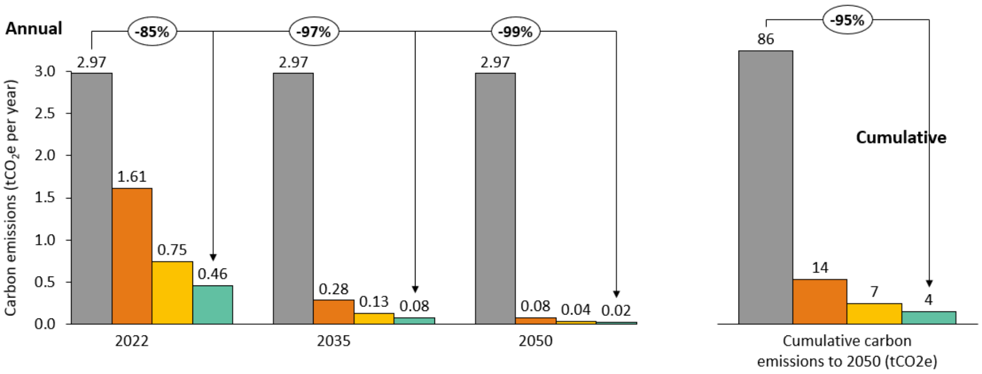
- Costs of the systems themselves are not included here.

- The fuel unit costs correspond to the price cap values from the Energy Price Guarantee, which runs from October 2022 for 2 years. Beyond this point fuel costs are highly uncertain and are therefore not shown here.

- For the electric storage heater option, it is assumed that the consumer would try to meet the same heat demand as with a gas boiler. This may not be realistic as storage heaters may be used in a more ad hoc manner, heating only the rooms where the inhabitants spend most of their time. Therefore, the figure shows what the costs would be if you tried to achieve the same level of comfort with electric (non-heat pump) heating.

Emissions reduction with GSHP

- GSHP has the lowest emissions compared to gas boiler and air source heat pump.
- Emissions from ground source heat pumps will continue to decline over the years, as the carbon intensity of the grid declines.



FAQs

Why would I want a heat pump?

- It is the most impactful way to reduce your homes carbon footprint
- It could reduce your bills over time
- You have extra energy security, because your energy is stored underneath your home, rather than imported from abroad
- The Government has introduced plans to ban the purchase of new gas boilers from 2035, eventually we will all need to switch to alternative energy sources. Heat pumps are the most efficient.

What is the running cost of a ground source heat pump?

- It depends on your home. For very energy efficient homes, a heat pump wouldn't cost more to run than a standard gas heating system.
- The loft insulation provided as part of this scheme can improve the energy efficiency of your home.

Are heat pumps noisy?

- Heat pumps are not louder than a traditional boiler.
- A potential benefit of GSHP over ASHP is that GSHP is quieter (same as a boiler) whereas ASHP has an outside unit that is large and does generate some noise (although they are getting quieter all the time)

Are there any maintenance costs and requirements to heat pumps?

- Unlike with a gas boiler, with a heat pump, the recommendation is that the heat pump is serviced every 3-5 years, costing around £60-£100 a visit (not included in the offer).

How long will it take to install my heat pump?

- A week to install.

How good are heat pumps in cold weather?

- Heat pumps can work in very cold conditions. They are used all over the world, in much colder climates than the UK.
- When temps really drop, heat pumps might not be as efficient. On the whole, heat pumps are at least 3x more efficient than a gas boiler. Heat pump efficiency is measured using coefficient of performance (CoP) - this is calculated by comparing the amount of input to the amount of output. If an air source heat pump uses one kW of electricity 3kW of heat, then the CoP is 3. The higher the CoP, the better the heat pump.
- As the temperature underground stays pretty much constant throughout the year, the efficiency is pretty much the same (350%) year-round, where ASHP will drop to much lower efficiencies (100-200%) when it's cold outside.

How big will the heat pump in my home be?

With insulation measures we aim to fit our 'Shoebox' heat pump, which is around the size of a microwave, which we fit in airing cupboards, under the stairs, or wherever is suitable in your property (shoebox unit marked in red circle in below image).

What infrastructure works will my home need in order for the heat pump to work?

We'll remove your boiler and insert the ground-source heat pump, and a thermal storage unit (Seen in the photo above) and hook it up to your existing hot water system. There may be a few rooms where we need to upgrade the radiators, so that the heat pump can run more efficiently and at lower running cost, which we include in our deal. Lastly, a few hours of trenching to connect your house to the infrastructure in the road just outside.

More FAQs

https://www.kensautilities.com/faq/

13.7 WP5 Approach and KPIs for Phase 2

The feasibility findings supported development of an approach for Phase 2 to support supply chain collaboration, capacity and resilience building, and a set of KPIs designed to measure progress towards developing a supply chain that is fit for purpose both for Greenwich TIME and a longer-term pipeline of decarbonisation work in the local area.

The findings of the feasibility informed a set of seven objectives for industry engagement and development of the supply chain, which frame the approach. These are:

- Objective 1: Provide demonstration and training touchpoints - building a supplier community and a shared learning approach
- Objective 2: Provide bespoke and accessible installer training, which also provides a consistent and effective base for future work in Greenwich
- Objective 3: A clear qualification approach for local trusted suppliers, with procurement stage support
- Objective 4: To improve workforce recruitment with a clear 'job quality transition' and green up-skilling strategy
- Objective 5: A streamlined process for installers through the home information, documentation, grant access and work quality assurance
- Objective 6: Effectively communicate and manage the work pipeline process
- Objective 7: Provide an effective process of retrofit and heat loss home surveys

This sets out the key approach actions that were determined to be valuable in meeting the challenges and needs of the supply chain, as findings of this work package.

1. The number of suppliers and staff who complete the TIME training programme, by firm type (size, local base), reflecting the creation of new suppliers**.**
2. The number/ share of contract opportunities and value that is awarded to Greenwich or South East London based firms. By firm size (micro, small, medium, large enterprises).
3. The number of new FTEs created in the supply chain, set out by key role (ground works, retrofit coordination, work design, work installation, consumer engagement), and record where these are in the local area.
4. Number of local apprentices and/ or trainees engaged in the TIME project, with their: a) number and type of work experience days, b) their overall work duration, c) their post-project outcomes - their continued workforce engagement.
5. **The** Number of suppliers engaged at the project's Supply Chain Engagement Days; and the share of suppliers who were engaged were satisfied with the delivery.
6. Percentage of all companies in the supply chain under the contract to have implemented the 6 standards in the Mental Health at Work commitment.
7. Percentage of all companies in the supply chain under the contract to have implemented the Good Work Plan standard.
8. Percentage of home completions that meet: a guaranteed site delivery timescale; minimisation of disruption by best means; and provision of heat throughout to full heat pump transition.
9. The share of suppliers that provide a rating of satisfactory or good for the project's training, engagement and coordination.

13.7.1 Approach area 1: Collaboration throughout the supply chain

The specific actions the project will take to collaborate throughout the supply chain, and ensure a fair and responsible approach to working with supply chain partners throughout their mobilisation and deployment stage relate to supply chain objectives:

- Objective 1: Provide demonstration and training touchpoints - building a supplier community and a shared learning approach
- Objective 2: Provide bespoke and accessible installer training, which also provides a consistent and effective base for future work in Greenwich
- Objective 3: A clear qualification approach for local trusted suppliers, with procurement stage support

The overall actions are as follows:

Supply Chain Engagement and Support Activities:

To engage, recruit and upskill suppliers, 3 initial Supply Chain Engagement Days will be delivered with local organisations, which will be complemented through additional networking activity. The supply chain engagement days will consist of engagement with local suppliers and support development of increased understanding of opportunities, technical skills, and increased confidence in heat pumps. The engagement events will support suppliers with pre-procurement readiness, accessing the project training programme, providing matching to local education providers (London South Bank University Green Skills Hub, Greenwich colleges) for potential trainees and network building. DG Cities, SELCE and Kensa will deliver a further 3 engagement events later in the project for suppliers to share ongoing learnings. The Eltham project base will be used to host ongoing engagement for new suppliers to register their interest and intent to become project qualified through training and procurement preparation.

Bespoke Supplier Training:

Bespoke supplier training will be delivered as a mixed training package that combines three key elements:

1. Heat Geek’s online expert-led training modules and new modules that reflect the specifics of the Greenwich TIME project
2. Kensa led on the ground training with their Installer Development Team and with site visits available to previously delivered and demonstrator homes in Croydon/other locations; and
3. The Eltham demonstrator and project base of knowledge, equipment and events that cover supplier procurement, training and quality assurance activities, using the same base as that provided for consumer and community exhibition, demonstration and information.

The innovation in this approach is that homeowners will not have to seek out local installers, those installers will be brought to the project, vetted and trained by industry experts. This will also help to increase consumer trust in heat pump installers in the local area. In addition, the project acts as a ‘carrot’ for installers and the local supply chain to upskill themselves and invest, given the volume of work to come. This will benefit future installs which will be higher quality and lower cost. Kensa saw this on the Heat the Streets project, where drilling contractors invested in new and improved rigs when they saw the project moving towards deployment. Further, the disaggregation of the groundworks and in-home works significantly increases access to the space for the supply chain.

Developing Fair Procurement Qualification and An Open-Book Working Approach With Installers:

Training and procurement preparation forms the first stage of certifying suppliers by selecting those who meet pre-qualification criteria invited to tender for the work. Qualification terms for 'local trusted / TIME approved' suppliers' certification and procurement short-listing will be developed in Phase 2. Kensa will work 'open book' with suppliers on pricing, with a pre-agreed margin to be charged on works, with incentives for reducing the works per home. In Kensa's experience this ensures consumers and installers both receive a fair deal. It will be ensured in Phase 2 that the process is accessible to all business types and sizes, ensuring inclusive procurement.

MCS Umbrella Schemes for Access:

A barrier to many installers entering the market is the time and cost associated with MCS-accreditation. Both Kensa and Heat Geek offer MCS Umbrella schemes, assisting with the process. This widens the accessibility of the supply chain to working on this project and gives them the experience to thereafter pursue MCS accreditation and thereby strengthen the supply chain.

13.7.2 Approach area 2: Supply chain resilience and capacity

The specific actions the project will take to influence staff, suppliers, customers and communities through the delivery of the contract to support resilience and capacity in the supply chain are related to the supply chain objectives:

- Objective 1: Provide demonstration and training touchpoints - building a supplier community and a shared learning approach
- Objective 3: A clear qualification approach for local trusted suppliers, with procurement stage support
- Objective 4: To improve workforce recruitment with a clear 'job quality transition' and green up-skilling strategy
- Objective 5: A streamlined process for installers through the home information, documentation, grant access and work quality assurance
- Objective 6: Effectively communicate and manage the work pipeline process

The actions are as follows:

Labour market and green skills strategy development and implementation:

The Council is developing a vision and approach in collaboration with local colleges who are providing apprenticeships; the approach presented here will build on this. A coordinated information and marketing campaign will focus on the identified barriers to provide an appealing offer to build interest in the project. The TIME project provides an opportunity to engage young people and those suitable for re-training to build understanding of the sector and diversity of opportunities. Suppliers will be incentivised, as proportional contract performance requirements, to provide work experience, schools engagement, open days, local trainees and/or formal apprenticeship placements. The approach will be designed to ensure inclusive access and meet the project KPIs. This includes inclusive access to the market and job opportunities and activity participation, covering disabled workforce access and participation of individuals from groups including BAME, women and older ages.

Utilise the Eltham Project Base and GSHP Demonstration:

Residents will have the opportunity to visit a local project base that will host equipment demonstrations, information and events, and a community in Croydon, where a Kensa GSHP scheme is operating as the main source of heating for 40 residents. This will also support the potential supply chain and workforce by acting as a physical presence to signal the project's intentions, and highlight the role of heat pumps in Greenwich going forward. In time, the project will have local demonstrator homes for new suppliers or workforce entrants to interact with.

Supplier Good Work Plan Pledge:

Local businesses in the supply chain will be influenced to improve their workforce practices by ensuring that suppliers sign-up to reporting their action and commitment towards the Good Work Plan and are recruiting and training from diverse backgrounds. This will be done during the supplier recruitment and sign-up phases of the project by ensuring that contracts and terms, and monitoring processes provide evidence of Good Work practices. In addition, this includes commitment to the 6 standards of the Mental Health at Work.

Effective Coordination of Work Planning and Delivery:

All suppliers and potential suppliers will receive timely communications detailing requirements for the programme of works (location, resource requirements, road closures, interruption to utilities). Open communication, clear targets, milestones and delivery expectations are a clear part of this. The TIME deployment method will be refined to ensure a smaller number of and more effective home visits for mobilisation and deployment following initial engagement and information building activities, and past initial online registration.

13.7.3 Approach area 3: Supporting newly commercialised and disruptive technologies

The specific actions which the project will take to support newly commercialised and disruptive technologies throughout the supply chain to deliver lower cost and/or high-quality goods and services are related to the supply chain objectives:

- Objective 2: Provide bespoke and accessible installer training, which also provides a consistent and effective base for future work in Greenwich
- Objective 5: A streamlined process for installers through the home information, documentation, grant access and work quality assurance
- Objective 7: Provide effective retrofit and heat loss home surveys

The actions are as follows:

Supplier Clarity and Effective Engagement with Consumers

Our consumer engagement staff will join all visits by both retrofit coordinators and installers, so that customers can ask questions they have while allowing the coordinators/installers the time and space to conduct their work to high quality. This continued point of contact through consumer engagement staff for residents also assists with gaining access to the property, making the job easier for coordinators & installers. Kensa has used this model effectively in the form of a Customer Liaison Officer on the Heat the Streets project. This will also be supported with suppliers having been locally certified and being supported with the MCS Umbrella Scheme and with consistent project branding.

Quality Assurance and Good Work Examples

Supplier champions' can be selected through the project to share lessons with the wider supplier community, also supporting the wider Greenwich pipeline beyond TIME. The lessons will be shared at supplier events around September 2023 and beyond, enabling more suppliers to get comfortable with investing & making the transition into networked ground-source heating instals. A checklist process will be developed and followed for suppliers, to ensure timelines are updated and followed effectively to allow for a more streamlined process.

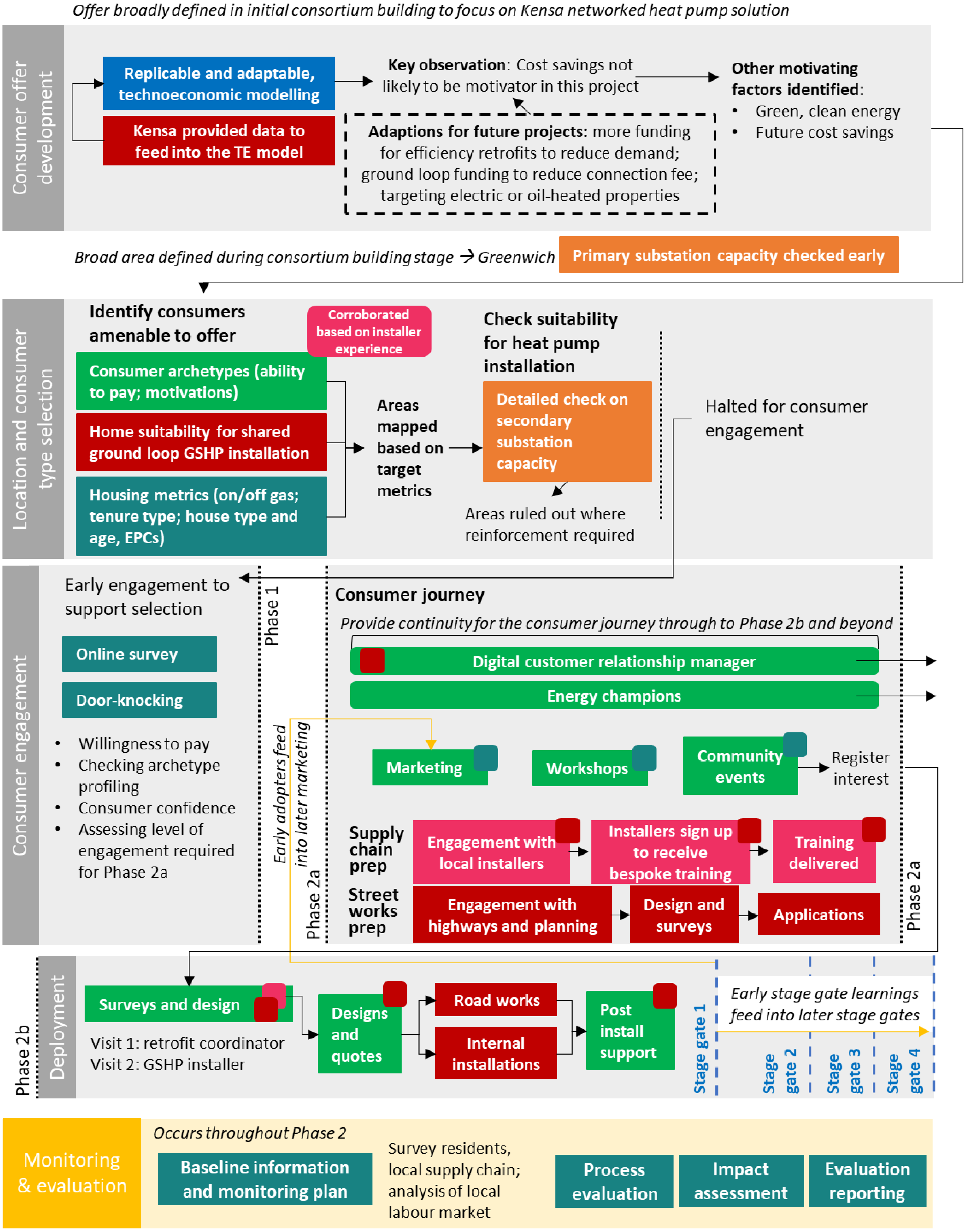
Online Supplier Portal Innovation

A checklist process will be developed and followed for suppliers, to ensure timelines are updated and followed effectively to allow for a more streamlined process. Live data and online format for work scheduling, notes and updates, with flow maps and notifications to be explored. This would also enable past job learning to be utilised to continue to improve future work delivery. This will be used to communicate timescale and operations to consumers.

Governance and Delivery

Delivery of the above objectives with the proposed Work Package 4: Monitoring and Evaluation will be ensured. The KPIs will be monitored throughout, supporting project learning and feedback at stage gate points for the project partners and suppliers with focused engagement and feedback.

13.8 Process flow diagram



Offer broadly defined in initial consortium building to focus on Kensa networked heat pump solution

Consumer offer development

Replicable and adaptable, technoeconomic modelling

Kensa provided data to feed into the TE model

Key observation: Cost savings not likely to be motivator in this project

Other motivating factors identified:
- Green, clean energy
- Future cost savings

Adaptions for future projects: more funding for efficiency retrofits to reduce demand; ground loop funding to reduce connection fee; targeting electric or oil-heated properties

Broad area defined during consortium building stage → Greenwich

Primary substation capacity checked early

Location and consumer type selection

Identify consumers amenable to offer

Corroborated based on installer experience

Consumer archetypes (ability to pay; motivations)

Home suitability for shared ground loop GSHP installation

Housing metrics (on/off gas; tenure type; house type and age, EPCs)

Areas mapped based on target metrics

Check suitability for heat pump installation

Detailed check on secondary substation capacity

Areas ruled out where reinforcement required

Halted for consumer engagement

Consumer engagement

Early engagement to support selection

Online survey

Door-knocking

- Willingness to pay
- Checking archetype profiling
- Consumer confidence
- Assessing level of engagement required for Phase 2a

Phase 1

Early adopters feed into later marketing

Phase 2a

Consumer journey

Provide continuity for the consumer journey through to Phase 2b and beyond

Digital customer relationship manager

Energy champions

Marketing

Workshops

Community events

Register interest

Supply chain prep

Engagement with local installers

Installers sign up to receive bespoke training

Training delivered

Street works prep

Engagement with highways and planning

Design and surveys

Applications

Phase 2a

Phase 2b

Deployment

Surveys and design

Visit 1: retrofit coordinator
Visit 2: GSHP installer

Designs and quotes

Road works

Internal installations

Post install support

Stage gate 1

Early stage gate learnings feed into later stage gates

Stage gate 2

Stage gate 3

Stage gate 4

Monitoring & evaluation

Occurs throughout Phase 2

Baseline information and monitoring plan

Survey residents, local supply chain; analysis of local labour market

Process evaluation

Impact assessment

Evaluation reporting

Project participants

K	Technology partner (Kensa)	UKPN	DNO (UK Power Networks)
DG	Consumer engagement partner (DG Cities)	HG	Supply chain expert (Heat Geek)
O/S	Consumer journey partner (Phase 1 OVO, Phase 2 SELCE)	EE/K	Project coordinator / analyst (Phase 1 Element Energy; Phase 2 Kensa)

■ Colour of larger rectangles indicates who main responsibility lies with

■ Small rounded square indicates verified / corroborated / supported by another party

→ Yellow arrow indicates feedback from monitoring and evaluation