Bristol Heat Pump Ready

Phase 1 Report

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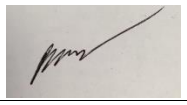
signature	
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Glossary

Term	Definition
BCC	Bristol City Council
BH	Buro Happold
BHPR	Bristol Heat Pump Ready
BTS	Build Test Solutions
CSE	Centre for Sustainable Energy
DNO	Distribution Network Operator
HPRS	Heat Pump Ready Survey
HPR	Heat Pump Ready
HTC	Heat Transfer Coefficient
NGED	National Grid Electricity Distribution
SCoP	Seasonal Coefficient of Performance
SusWoT	Sustainable Westbury-on-Trym
TGR	The Green Register

1 Executive Summary

Bristol Heat Pump Ready (BHPR) is a methodology and business model that focusses on scaled deployment of clustered heat pumps in the city of Bristol. The methodology is fully transferrable to any other UK city and could significantly accelerate the deployment of heat pumps nationally.

Despite a government aspiration of deploying 600,000 heat pumps per year by 2028, current installations are significantly lower with only 5,300 air source heat pumps installed under the boiler upgrade scheme in its first 7 months of operation [ref: Boiler Upgrade Scheme statistics: November 2022 - GOV.UK (www.gov.uk)]. An alternative approach is required that will radically change this situation.

BHPR seeks to address this by turning the tables on current market practices which rely on the consumer to engage with the supply chain and make decisions on what could be perceived an expensive investment, based on limited information.

Instead, a targeted approach will be taken to identify and engage with heat pump ready consumers, offering them a full package of information, supplier agnostic surveying, and a trusted quality stamp that provides confidence in supplier selection and installations.

This approach has been developed in Phase 1 of the BEIS Heat Pump Ready Programme and was led by Buro Happold, supported through sub contracts by Bristol City Council, Centre for Sustainable Energy and The Green Register. The work completed in Phase 1:

- Analysed over 8,500 homes in the Westbury-on-Trym area of Bristol. Following the analysis three electricity distribution network clusters, totalling 209 homes, have been selected for targeted deployment in trialling of the methodology. There are currently around 290 heat pumps retrofit into homes in the City of Bristol, so this represents a significant portion of current city deployment.
- Developed a Heat Pump Ready survey process, with the advice of industry experts, to improve the collection and analysis of data to support quality heat pump system design. Through collaboration with a Stream 2 project, a simple version of this survey process was trialled on five homes in and around Westbury-on-Trym.
- Built strong connections with the local community sustainability group, Sustainable Westbury-on-Trym, and worked with them to understand the needs of the community with respect to a local heat pump scheme. This insight was then incorporated into a customer journey process map.
- Designed a model for a supplier hub that will bring together trusted installers and surveyors and connect them with relevant training.
- Developed a self-sustainable business model which would be funded through consumer surveys and installations. The model leverages volume of deployment and economies of scale to deliver value to the consumer and supply chain whilst covering the overheads of the BHPR scheme.
- Combined the outputs of the above activities into a proposal for the BHPR service model.

Key findings were:

- Of the 8,551 dwellings in Westbury-on-Trym, 859 properties were identified as being ready to install a heat pump with no fabric upgrades required and 3,613 properties require a small amount of undisruptive fabric upgrades before a heat pump can be installed.
- A measured approach to heat loss calculation is the only truly accurate way to ensure appropriate system sizing and design. Households want high quality surveys to have their system designed based on robust data and are willing to pay up to £500 for the multi-faceted survey which compares favourably with current market prices for less accurate heat loss surveys averaging £350.
- In order to engage consumers, BHPR needs to offer independent impartial advice, an accurate home survey, standardised pricing and performance evaluation. Engagement needs to take a community-led, bespoke place-based approach. It is also important that BHPR builds trust in tradespeople. It was found that residents with solar PV saw this as a gateway technology to heat pumps.
- There is a scarcity of heat pump installers in the local area, indicating that developing training and skills is a priority to grow the supply chain in tandem with customer demand; in particular, opportunities exist to diversify the skills of existing plumbers and heating engineers. A robust competence framework is needed, with meaningful assurances for consumers. Knowledge-sharing and mentoring within the supply chain helps to increase skills and keep standards high – this can be facilitated by an independently-run 'hub' style operational model.
- Current published data sets do not permit the development of an accurate low voltage electricity map with individual property connections. Therefore, approximations have had to be used for the properties assigned to individual substations for the purposes of planning in Phase 1, using 'polygon' data available.

Key areas of innovation to be taken forward in subsequent phases, building on the findings of Phase 1 include:

- Establishing a consumer portal designed around the BHPR service model to provide information and access to supply chain for consumers
- Utilising the latest in digital twin planning techniques to reduce overheads of finding and working with heat pump ready consumers
- A new method of surveying incorporating building heat performance modelling to improve quality of heat pump installations
- A supplier certification and quality scheme to enhance trust in installers.

Consumer value is derived from easy access to information for decision making and informed selection of installers based on a quality stamp.

Recommendations for deployment post Phase 1 include focussing on the targeted cluster areas identified as well as continuing to refine this methodology and the associated business model to test our assumptions, gather learning and refine the process.

Currently the business model assumes notional numbers but appears to be self-sustainable needing just over 300 heat pump installations per year in any given suburb area of the city targeted. This will be reviewed during subsequent phases of trialling the methodology to refine the numbers and costs as actually realised thereby resulting in an accurate model for deployment when commercialised.

A tool kit will also be developed under subsequent activities which will enable other UK cities to adopt the BHPR process for deployment thereby accelerating the national uptake of heat pumps in cities.

2 Introduction

Bristol Heat Pump Ready is a project led by Buro Happold alongside sub-contractors Bristol City Council, Centre for Sustainable Energy and The Green Register to develop a UK wide approach to stimulated mass uptake of heat pumps and deliver on our national carbon targets but with a local focus. This is in line with HM Government, Department for Business, Energy & Industrial Strategy's innovation project Heat Pump Ready.

The City of Bristol is a leader in UK climate action, being announced in 2018 as the first Local Authority to declare a climate emergency and have a goal to reach carbon neutrality by 2030. Building on this momentum this project focuses on working with local communities and the local supply chain to develop a cohesive approach that will ensure consumers are fully supported in the transition to low carbon heat.

The Bristol Heat Pump Ready methodology has been designed and pilot tested during the Phase 1 feasibility stage in collaboration with the project partners and a large network of advisors to tailor an innovative and collaborative approach to consumer engagement and deployment of heat pumps in an urban environment.

Our feasibility work was centred around four key aspects:

- Understanding the community and garnering a strong interest in heat pumps by firstly assessing the heat pump readiness of city neighbourhoods through the latest in digital twin planning, leveraging existing strong community focal points, engaging with organisations representing the diversity of residents in the area and demonstrating the benefits of home retrofit.
- Ensuring households have a really great experience – choosing a heat pump must be an attractive and viable solution for them, they need to better understand their property, their system must be designed to very high quality, they must have easy access to support and it must be a smooth process. This was achieved by understanding householder needs and using this as a basis for developing the offer, improving the assessment of property characteristics and installation design which will lead to the development of easy to access information for the householder, and coordinating the supply chain to reduce the length of the process and lower costs.
- Generating a cohort of skilled local installers by using a variety of training methods and identifying those installers with a keen interest in quality heat pump design, making them ambassadors for their trade.
- Minimising the impact of heat pumps on the electricity network through better heat pump sizing, flexible system design. Understanding how to work with National Grid Electricity Distribution to develop approaches to better network planning and policy which will reduce consumer costs.

2.1 Organisations

2.1.1 Work Package Leads

The following organisations led one or multiple work packages in line with the HPR Phase 1 approach. Further details on the work packages can be found later in the report under "Summary of Work packages".

Buro Happold bring their expertise in project management, data systems, digital twin planning and business model development. They also bring previous project experience in developing innovative approaches to community led planning and increasing uptake of heat pumps including innovation projects such as the UKPN NIA funded CommuniHeat.

Buro Happold has over 40 years of experience in urban development with a firm pledge to only be involved in projects with clear decarbonisation goals. Recent portfolio of work and experience includes being one of the first 3 organisations in the UK to deploy commercial Local Area Energy Plans (LAEPs) to understand how to decarbonise our cities and local authority regions – supporting the Energy Systems Catapult in Greater Manchester and leading in Staffordshire. We helped form and are a leading partner in the innovative CommuniHeat project which works directly with community energy companies using the latest in digital engineering to develop an approach to decarbonising off gas grid rural communities.

Buro Happold offer the delivery of the digital engineering and analysis aspects of the project, further details are provided in Section 4 of the report.

Bristol City Council are leading the way in decarbonising UK cities having been voted the UK's leading Smart City in 2018 and creating innovative initiatives like Bristol City Leap to rapidly scale energy responses to the climate emergency.

Two teams from Bristol City Council are involved in this project;

- City Innovation Team, with skills in research and development of innovative technologies and approaches;
- Sustainable City and Climate Change Service, who connect the work of the council to decarbonisation policy and strategy.

The City Innovation Team is a diverse team of in-house innovation advisors with a broad base of expertise that includes smart technologies, data, user-centred design, social innovation, and community engagement. Recent energy project delivery includes the Horizons 2020 funded Twinergy. The team is working with partners across Europe to deliver digital twinning of buildings, demand side response optimisation, new renewable energy and battery storage installations and co-design across different work packages.

The Sustainable City and Climate Change Service works in collaboration with other teams and city partners to initiate successful climate initiatives, for example the award of European Green Capital in 2015, the declaration and response of the council and city to the climate emergency, and the development of a strong and diverse sustainability ecosystem in the city.

Bristol City lead the local authority input and delivery of the assessment of heat pump readiness within homes, further details are provided in Section 4 of the report.

The Centre for Sustainable Energy (CSE) has an extensive project portfolio and experience in consumer engagement, energy efficiency, policy design and fabric retrofit offerings.

Based in Bristol, CSE delivers expertise and experience around energy retrofit. CSE's Futureproof project is a major programme helping homeowners and builders in the West of England to carry out energy saving retrofits with confidence. Originally funded by BEIS (£799,428 2018-21), it tested different approaches for increasing energy efficiency improvements amongst able-to-pay owner-occupiers. CSE now operates this service on a paid for basis. In 2021, CSE started the Retrofit support programme (2021-23, Funded by Energy Redress, £163,519) and scaling up (UK Community Renewal Fund, WECA, 2021-22, £134,290) which aims to scale up the low-carbon housing retrofit market and local supply chain.

CSE deliver the community engagement and recruitment aspects of the project, further details are provided in Section 4 of the report.

The Green Register specialises in developing a network of quality suppliers as well as running courses to upskill; having run over 500 events with more than 3,000 different people attending training since it was formed in 2000. Their focus on the development of multi-skilled offerings in the industry is also key to some of the service offerings we are proposing.

The Green Register (TGR) offers over two decades' experience in sustainable construction training, building a significant network, knowledge base and expertise over this time. Working in partnership with CSE on the West of England-based Futureproof project, funded by BEIS in 2018-2021, The Green Register has developed and delivered a highly targeted training programme to SME contractors in the region which encompasses the whole-house approach to retrofit, including low-carbon technologies such as heat pumps.

During 2020, TGR won funding to the value of £349,696 under the Green Homes Grant Skills Training Competition to develop and run an innovative training and accreditation scheme, the Futureproof Skills & Certification Programme, 'a one-stop-shop' which encompassed specially developed retrofit training by TGR, along with PAS2030 and Trustmark certification to enable SME contractors to access government-funded retrofit works at a subsidised rate.

TGR deliver the supply chain elements of the project focusing on growth and quality assurance, further details are provided in Section 4 of the report.

2.1.2 Advisory Panel

The advisory panel included a large number of industry leading expert organisations and individuals who contributed to the methodology and subsequent planned development activities which provided significant value to the project team as well as back to HM Government under Phase 1.

National Grid Electricity Distribution (formerly Western Power Distribution) – the local DNO for the area assisting with providing electricity network data and enabling discussion around network analysis and future connection of heat pumps at scale.

Veritherm – a leader in heat transfer coefficient (HTC) measurement surveys adding value to the project in developing a more accurate method to understanding building fabric and heat loss, subsequently aiding better heat pump and system design. Veritherm attended workshops to support the design of the heat pump ready home survey approach and supplier hub design.

Build Test Solutions – also a leader in HTC measurement, however offering a different technology and approach to the Veritherm method. Working closely with Veritherm, BTS also offer significant value to advising on more accurate industry methods to surveying properties. Build Test Solutions attended workshops to support the design of the heat pump ready home survey approach and supplier hub design.

Energy Tracers – delivering innovative approaches to thermography to enhance the consumer journey and deliver high quality information to aid various levels of retrofit advice to consumers. Insights to what constitutes good thermal imaging information is key to the success of this element of consumer/property survey. Energy Tracers attended workshops to support the design of the heat pump ready home survey approach and supplier hub design.

C Brookes Heating and Plumbing – representing the heat pump installer sector of the supply chain, C Brookes are highly regarded in regards to the design and installation of heat pumps having achieved excellent performance across their installations. They added value to understanding current approaches to property surveying, system design and what aspects of consumer interests are currently delivered. This aided the project team to enhance the current approach and deliver a more innovative methodology. They attended workshops to support the design of the heat pump ready home survey approach and supplier hub design.

Pump Plumbing and Heating – representing the gas boiler sector and in the process of entering the heat pump installer sector, Pump offer valuable insights to current processes and advice on how installers could integrate themselves as part of a wider methodology to deliver to consumers. They attended workshops to support the design of the heat pump ready home survey approach and supplier hub design.

University of Bristol – with experience in delivering consumer engagement workshops, they worked alongside CSE to deliver specific targeted consumer engagement workshops following on from CSE's engagement and provided advice on engagement approaches and capturing the outcomes from the workshops.

Centre for Sustainable Energy (Retrofit Coordinator and Assessor) – offering essential insights to current retrofit assessment approaches for consumers and property owners. They aided conversation to develop and further enhance the methodology to provide a more coherent and consumer friendly pack of information. They attended workshops to support the design of the heat pump ready home survey approach. **Sustainable Westbury-on-Trym** – assisting CSE with on the ground consumer engagement and recruitment utilising existing local knowledge and leveraging pre-existing relationships with the local community. They offered an open door into the community to enable more efficient engagement.

Bristol Energy Network – co-hosting local community engagement workshops with the University of Bristol bringing further local knowledge and energy advice to the community and participants.

BetaTeach – a renowned industry expert with a wealth of knowledge in the heating and education sector, working across all three streams of the HPR programme, BetaTeach sat in various workshops offering knowledge and information across many parts of the developing methodology.

EcoDC – an experienced professional in high quality sustainable and Passive House construction methods, they offered expertise to the real-life approaches and challenges to sustainable construction methods. Enabling the project to incorporate any valuable information to our methodology to enhance the consumer experience and deliver more efficient systems. They attended workshops to support the design of the supplier hub design.

PHC Renewables – a local product supplier acting as a third party between manufacturers and installers to provide value in volume discounts. PHC also deliver heat pump training in line with various manufacturers helping to support the growth of the local supply chain. They attended workshops to support the design of the heat pump ready home survey approach and supplier hub design.

3 Aims & Objectives

The overall aim of BHPR is to develop and implement an approach that delivers a step change in the uptake of heat pumps across the city. In line with this BHPR has itself set a number of objectives and corresponding outcomes listed below in Table 3—1.

Table 3—1 Objectives and outcomes

Objectives	Outcomes
Design an approach that would significantly increase the number of heat pumps in Bristol at a rate of uptake far in excess of current levels as a result of deploying BHPR	• Identifying clusters of homes most suitable for heat pumps in the target area • Understanding how retrofit improvements could sit alongside the installation of heat pumps
Develop an overall approach that is sustainable in increasing customer confidence and willingness resulting in the accelerated uptake of heat pumps	• Increased confidence amongst the local target population around installing heat pumps • Residents share their positive experiences through local 'open doors' events
Explore the use of digital planning in deploying at city scale taking into account buildings, heat systems performance, network data and demographic information	• Enhanced information to target particular properties for heat pump installation maximising enquiry to installation success rates
Design innovative approaches to data collection and analysis including better buildings performance data to inform the planning process and customer journey	• An approach created where heat pumps are correctly sized which results in potentially reduced energy usage in homes compared to standard approaches and reduced impact to the electricity network • Approach designed where homes are able to identify and remedy insulation and draft proofing measures required to maximise heat pump efficiency
Design the customer journey and more attractive service propositions that are deliverable through the supply chain and can be supported by community groups	• Approach designed where customers have an excellent journey to installing a heat pump • Finance options investigated for customers to access to fund the installation • Understanding of how strengths of local community groups are harnessed to deliver the project
Design innovative approaches to learning and upskilling of supply chain	• Understand how social value can be maximised locally by upskilling workforce • Approaches designed where installers are able to provide the highest quality installations • Approaches designed where installers are able to access a regular flow of local work • Approaches designed where confidence in workmanship is enhanced amongst customers
Explore and develop approaches that include commercial and finance models that are deployable and will accelerate uptake	• Approaches designed where lowest possible lifetime costs are delivered to customers • Approaches designed where more people are able to afford to install a heat pump • Approaches designed which encourages more prosumers in the local energy system
Develop interfaces to the DNO and underpin the above stages with intelligent use of network data	• Better understanding of local network constraints to enable targeting of recruitment

3.1 Challenges and Barriers

The following summarises the barriers and challenges to scaleable and accelerated deployment of heat pumps into the city which have been identified as part of Phase 1.

- The current process is a reactive approach, relying on consumers to engage with the industry and own full responsibility for information gathering and decision making
- The system/product offering is often not considered standard or well-known and requires consumer investigation and acceptance
- Perceptions by some of poor quality and low efficiency based on experience voiced by other consumers over social media and word of mouth
- Lack of information available on system options, choices and expectations as well as guidance for consumers on how to engage
- Limits on supply chain capacity meaning the supply chain can only respond to consumer requests and not be proactive
- Inconsistencies in supply chain approaches to delivery leading to cost and performance variations to consumers
- Lack of grid capacity where there is interest which may delay installations
- Cost to consumers and perception of costs meaning consumers consider heat pumps to be an expensive option
- Inaccurate methods used to size heat pumps resulting in systems being significantly over or undersized
- No consideration of actual building performance when sizing heat systems which can lead to inefficient operations and wrong sizing.

3.1.1 Approach to Addressing the Challenges

The following approach was formulated as a result of initial Phase 1 activities in developing a concept approach and leveraging existing local knowledge and knowhow.

3.1.1.1 Building Consumer Trust and Driving Demand

Trust is a considerable barrier to the uptake of energy efficiency measures and low carbon technologies. The sales market is dominated by installers whose claims are often at odds with the messaging from reference websites i.e., Energy Saving Trust, Money Saving Expert and CSE's own advice materials.

Relatively savvy consumers are quick to understand some of the wider the issues associated with heat pump installations and poor performance, which in turn undermines their ability to take action to implement a low carbon heating technology.

By using community energy advisory groups such as CSE and SusWoT, an independent and unbiased flow of advice can be offered that has no vested interest in explicit sales. These organisations are embedded local community-led organisations, bringing together the skills of these organisations helps build trust to drive a greater uptake of heat pumps. This was a central hypothesis of our planned approach which proved to be correct when we completed the feasibility study.

3.1.1.2 Network Constraints

Our pilot planning process has identified clusters where 25% uptake does not appear to be of concern based on capacity and ruled out areas where constraints may be apparent. By appraising clusters based on alignment between network capacity and building readiness to accept heat pumps, we can begin to exploit existing capacity to accelerate uptake.

This approach relies on existing published DNO data on headroom and proximity of homes. However, there is considerable value in enhancing this approach, which is proposed in this methodology. By obtaining more granular data on property assignments to circuits, we are able to then better anticipate the actual demand on feeders and subsequently distribution substations.

This approach also includes appraising those homes which have driveways suitable for vehicles and therefore EV charging. This can be factored into the forecasted load of the homes to further consider what headroom is available for heat pumps.

This methodology offers the capability for two-way transfer of information between the DNO and the digital spatial and visualisation platform (digital twin) so that information can be seen on where target areas for heat pump clusters are but also where consumers are expressing interest. It is considered that this will assist the DNO in better forecasting the uptake on its network and the ability to prepare infrastructure upgrades where required. Information can also be accommodated from the DNO on where its ED2 asset plans to upgrade infrastructure align with the deployment strategy thus not only using current DNO capacity data but also forecasted capacity data.

Further innovation is possible though close collaboration with the DNO to explore how diversity assumptions can be tailored based on heat systems deployed. Currently NGED's standards are that no diversity shall be applied to heat pumps, which results in a significant increase in capacity requirement on the network to be maintained in line with government targets of heat pump uptake.

There is no national standard as such with other UK DNOs factoring in some levels of diversity into their standards. Evidence from other projects suggests there are opportunities to better appraise this aspect and work closely with NGED to inform them on this standard, as well as work with the industry which can provide solutions to delivering diversity.

Any improvement in diversity, in conjunction with optimising heat pump sizing, could have a significant and positive effect on network capacity requirements going forward. This would make the difference between homes being able to have heat pumps in the near-term vs not.

Actual heat system and building performance data will also be used to more accurately size and forecast power demand and performance, which may adjust the planning assumptions and include for more heat pump installations on the network for a given capacity.

3.1.1.3 Alignment to LA policy

The City of Bristol is a leader in UK climate action. In 2018, Bristol was the first Local Authority to declare a climate emergency and has a goal to reach carbon neutrality by 2030. To achieve this goal the city council collaborated with public, private, voluntary and third sector partners to co-design the One City Climate Strategy providing the city with strategic, shared approach to decarbonisation.

Initial modelling for the climate strategy evidence base ('Bristol net zero by 2030: The evidence base') identified heat pumps as the preferred solution for 94,000 buildings.

According to the MCS database, there are currently around 500 heat pumps in the City of Bristol, around 200 of which are shared loop ground source heat pump systems in new build, which do not share the challenges of retrofitting heat pumps into existing buildings.

Implementing the Bristol Heat Pump Ready methodology will enable Bristol to significantly accelerate heat pump uptake in the city in line with its decarbonisation goals along with being a suitable demonstrator for other local authorities and organisations to deploy this approach to meet their own targets.

4 Summary of Work Packages

4.1 Work Package Overview

Figure 4—1 outlines the work packages and their headings along with the organisation taking the lead on delivery. Below each work package is an indication of where there are interdependencies between various packages, highlighting where close monitoring and communication is required to ensure effective and efficient delivery.

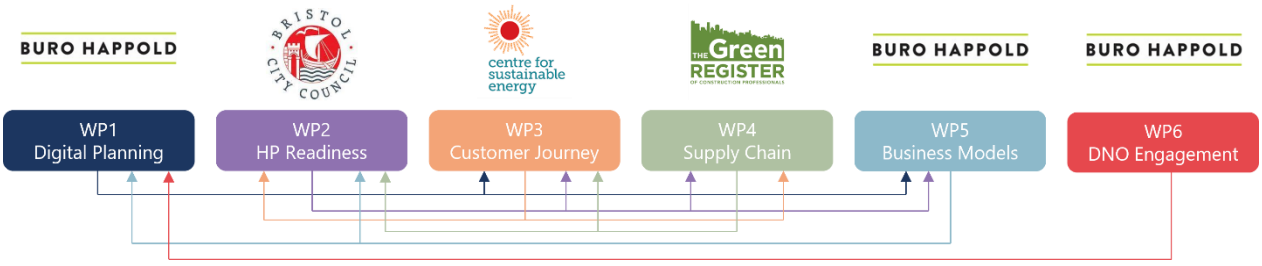


Figure 4—1 Work Package Headings and Interdependencies

4.2 Work Package 1: Digital Planning – Buro Happold

4.2.1 Summary

Utilising the very latest in digital twin technology to determine a city scale application that can be used to strategically target heat pump ready consumers. Combining multiple layers and the stacking of datasets and relevant information relating to building archetypes, projected heat system performance, electricity network capacity and demographics to provide a visual system accessible by multiple users (local authority, consumers, community groups) to inform planning and target areas for deployment. This stage is considered critical in identifying heat pump ready homes as appraising the considerable housing stock without such an approach would be extremely resource intensive with low yields of success. The incredible amount of data needed to do this means the latest in visualisation techniques should be applied to be able to quickly decipher and interpret information and develop insights. The coordination and planning this promotes drives a level of collaboration that is currently not normal in the industry where multiple stakeholders from different sectors come together and plan for scaled roll out. The planning process then underpins the resulting deployment strategy allowing targeted deployment of finite resource.

4.2.2 Key Tasks

- Collection and validation of required datasets and stakeholder information
- Manipulation and management of data to enable stacking
- Analysis of various sets of layered data to inform the following:
    - Dwelling suitability for targeted engagement
    - DNO network appraisal and compliance with BEIS density KPI's

4.2.3 Deliverables

- Visualised results of dwelling suitability filtering analysis to enable Work Package 3 Community Engagement
    - Maps of cluster areas indicating outlining "Green" and "Amber" properties – refer to Section 6
- Visualised results of DNO network capacity and substation clusters to understand the constraints and restrictions on installing heat pumps at scale

4.3 Work package 2: Heat Pump Readiness – Bristol City Council (BCC)

4.3.1 Summary

BCC coordinated the development of an innovative approach to collecting and analysing data and information (supported by an advisory panel), which will better determine the optimisation of heating systems and level of fabric retrofitting required, whilst increasing customer confidence. This is a key component to the concept that a more accurate appraisal of homes is needed to better size heat systems determine fabric performance and requirements and therefore more accurately determine system costs for the consumer.

The approach involved utilising a buildings physics approach using the latest in analytics to accurately predict building and heat system performance, optimise efficiency measures, building retrofits and heat system sizing. The proposed outcome being optimised consumer system offerings, lower future bills and increased network capacity with improved consumer confidence in system design.

4.3.2 Key Tasks

- Coordinating expert advisory panel workshops to co-design the heat pump ready survey process
- Liaising with supply chain to gather insights and costs of different survey techniques and technologies
- Understanding where efficiencies could be made in process of heat pump and energy retrofit survey
- Understanding the reporting process and information sharing approach between different stakeholder groups involved in heat pump design and installation
- Coordinating the testing of the survey methodology in small number of test homes in collaboration with the Stream 2 project MEASURED
- Participating in resident engagement events to gather feedback on their requirements for heat pump surveys

4.3.3 Deliverables

- Heat Pump Ready Survey process design
- Costed Heat Pump Ready survey approach

4.4 Work package 3: Community Engagement and Customer Journey – Centre for Sustainable Energy (CSE)

Community engagement is seen as the 'heart' of the model in that the consumer forms the centre and focus of delivering a quality output which is attractive and delivers significant value over and above the current business as usual process. This is predicated on turning the relationship around whereby currently the onus is for the consumer to engage and manage the supply chain relationship whilst we believe we should provide a service model brings the value proposition in a targeted manner to the consumer. We also believe community engagement is key to success in providing local knowledge and routes to engagement with consumers that would otherwise not be possible.

4.4.1 Summary

The aim of WP3 was to develop an understanding of:

- customer offers and a customer journey that are appealing to households
- capacity and willingness of the supply chain to deliver this
- level of interest of local community groups to support delivery

CSE deployed a multidisciplinary approach combining data analysis, consumer research and community consultation to deliver WP3. Consumer segmentation data has been used to profile the residents of Westbury-on-Trym and subsequently the target clusters. This segmentation has been used to inform our approach to community engagement i.e., sequencing of cluster engagement and techniques used to target our online survey and recruit householders for the focus group.

Working closely with the local community group Sustainable Westbury-on-Trym (SusWoT) we engaged residents of Westbury in three phases, namely:

- Warming up the community – local community events, newsletters, leaflets and drop-ins
- Consumer research – an online survey and focus groups
- Stakeholder engagement – using our stakeholder mapping matrix we convened a community workshop bringing together community groups, local early adopters, installers, Bristol City Council, The Green Register and CSE.

Alongside the community engagement, CSE consulted heat pump installers working on existing grant funded programmes locally and attended key workshops and meetings for WP2 and WP4 to help refine the customer journey further. This engagement helped shape the customer journey to deliver at scale by finding ways to remove supply chain inefficiencies and provide customers with the cost and service they require.

4.4.2 Key Tasks

To provide a detailed strategy for WP3 we identified the following key tasks:

- Meeting with the leads of WP1 (Buro Happold) and WP2 (Bristol City Council) to agree the key target criteria for homes to be deemed "heat pump ready" and then briefing local groups on the criteria to aid engagement.
- Segmenting the local population and key target clusters to help inform the customer journey and our approach to community engagement.
- Developing a local stakeholder map to aid us in the identification of the influential groups within the proposed deployment area of Westbury-on-Trym and begin initial engagement.
- Developing, publicising and delivering a consumer workshop involving influential stakeholders to share some of the findings from WP1+ WP2 and provide deeper engagement with local groups.
- Engagement with the community through a variety of different approaches (events, drop-ins, online consumer survey etc.) to better understand what skills currently existed within the community; gauge interest in heat pumps within the community; map the customer journey; and identify what support services could be made available to those wanting to support the subsequent engagement activities.
- Support the University of Bristol, SusWoT and Bristol Energy Network to deliver focus groups which delivered insight into the proposed heat pump ready scheme.

4.4.3 Deliverables

The following summarises our key deliverables:

- Detailed breakdown and schedule of WP3 tasks for the BHPR strategy document.
- Collated MOSAIC data (a consumer classification dataset from Experian) to provide consumer profiling of residents within target area for heat pump roll out, both for Westbury-on-Trym and the identified clusters.
- Identified key stakeholders and local influencers and produced a stakeholder matrix.
- Collaboration with WP1 and WP2 leads to agree the heat pump ready property criteria.
- Supported revised cluster analysis based on DNO preliminary planning document.
- Developed and promoted an online survey for local residents to gauge their interest in heat pumps, identify the types of residents who may be interested, gateway technologies such as PV and any key barriers to take-up.
- Ongoing support to the local community group (SusWoT) to explore existing skills within community and produce a skills mapping document with findings from conversations with the groups.
- Supported SusWoT to run a community engagement event at the Westbury Fayre; generate news articles for local newsletters; run drop-ins at local venues; and signpost residents to an online heat pump ready survey.
- Further refinement of MOSAIC data analysis to include DNO grid constraints to establish the numbers of target homes for the Heat Pump Ready programme.

- Developed, publicised and carried out HPR workshop and provided a report of the findings.

4.5 Work package 4: Supply Chain Training and Skills – The Green Register (TGR)

4.5.1 Summary

The BHPR model will have some very specific elements that change how the current supply chain interacts with consumers. It is also reliant on guaranteeing quality through a trusted brand. This implies careful selection, training and certification of installers who will adhere to the BHPR process.

Development of a coherent training and ongoing learning offer for installers of heat pumps and fabric measures were provided to increase the capacity and capability to deliver high performing installations. Innovations were explored in peer-to-peer learning (BetaTeach) and TGR utilising its experience in training and supply chain standards to tailor specific offerings that align with the consumer proposition.

4.5.2 Key Tasks

- Identified and enlisted an advisory panel from key areas of the supply chain to develop a model for training and working together
- Identified the size of local market and select groups for engagement
- Engagement with the supply chain to research and develop approaches to high quality installations
- Assessing and quantifying an effective model for effective supply chain co-working

4.5.3 Deliverables

- Collaboration with WP1, WP2 and WP3 to agree overall project approach and test ideas
- Tailored training pathway diagram
- Supply chain hub model diagram
- Devised and delivered two workshops with key stakeholders
- Recommendations and costs

4.6 Work package 5: Business Models – Buro Happold

4.6.1 Summary

The development of a novel service model that will present consumers with a cost efficient and independent offer will target stimulation of heat pump uptake. The project team have leveraged its extensive network to develop the overarching model which will be self-sustainable in future deployment in any location.

4.6.2 Key Tasks

- Researching and outlining existing business models
- Appraising viability of existing business models in line with BHPR approach and methodology
- Reviewing constituent elements of various business models and packages to combine for an innovative approach

4.6.3 Deliverables

- Refined an overall self-sustainable model that can be replicable and delivered at scale without further public funding

4.7 Work Package 6: DNO/DSO Interface – Buro Happold

4.7.1 Summary

This package focusses specifically on the network impact and planning of electric heat systems. It links to multiple work packages, in particular WPs 1, 2 and 5. Ongoing discussions with NGED present commitment from the DNO regarding how to improve their processes for network planning and heat pump install.

4.7.2 Key Tasks

- Collection of DNO data and integration to Work Package 1
- Ongoing communication with NGED regarding findings from study
- Outline of cluster areas for targeting deployment

4.7.3 Deliverables

- Analysis of DNO infrastructure constraints for discussion with NGED [delivered in Phase 1 or developed for delivery in subsequent phases]

4.8 Work package 7: Project Management – Buro Happold

4.8.1 Summary

This work package involves the project management and stakeholder engagement activities, including the establishment of a Project Board and implementing best practice, coordinating all activities and ensuring delivery of agreed deliverables and milestones to BEIS.

4.8.2 Key Tasks

- Management project programme, progress and finances
- Integration with HPR Stream 3 participation
- Project reporting and evaluation to BEIS
- Set up, management and reporting to the Programme Board steering group

5 Methodology for Feasibility Study

The following subheadings set out the approach for each work package within Phase 1 and also defines any analysis carried out.

5.1 Work Package 1: Digital Planning

Establishing a list of datasets and information was key to ensuring that the work package could be efficiently delivered in time with a condensed programme. The dataset requirements were set out and obtained as follows in line with GDPR requirements. GDPR compliance in Phase 1 was achieved by avoiding the use of personal data in the data mix, instead using only publicly available data. Community data received by CSE was also anonymised only indicating potential areas of deployment not actual personal data:

• **Data Collected**	• **Data Source**
• OS Mastermap	• Ordnance Survey
• OS AddressBase Plus	• Ordnance Survey
• Parity Projects	• Parity Projects

• Social housing ownership data
  ○ BCC owned properties
  ○ LiveWest housing provider data
  ○ Places for People housing provider data
	• Bristol City Council
	• LiveWest
	• Places for People

• DNO data
  ○ Substation polygon areas (20K shapefile)
  ○ Distribution Substation capacity (excel data)
	• National Grid

• MCS data on existing installs	• Bristol City Council

The following process was carried out to enable filtering of suitable dwellings deemed "Heat Pump Ready" and categorise them in different levels of suitability. The following filters can be described as layers that, by use of the digital twin, can be stacked in different scenarios to establish a range of results.

Filter the dwelling fabric performance criteria

- Wall construction type – i.e., cavity with insulation fill, external wall insulation, internal wall insulation
- Roof insulation level – i.e., type and thickness
- Glazing type – i.e., double, triple

Generation of output maps

- "Green" map at a scale of 100x100m for dwellings deemed immediately suitable for installation of a heat pump without substantial building fabric improvements
- "Amber" map at a scale of 100x100m for dwellings deemed to be suitable however system design and efficiency could be improved by first carrying out relatively low-cost fabric retrofit/improvements

Further dwelling filtering criteria:

- External rear garden space to establish whether there is sufficient space for a heat pump to be installed
- Property type to enable targeting of specific archetype – detached, semi-detached, etc.
- Heating system type to determine whether the dwellings have an existing system suitable to be served by a heat pump – i.e., remove dwellings with all electric (panel/storage) emitters
- Fuel type to filter to heating systems served by gas fuel
- Final dwelling maps for both Green and Amber properties at a scale of 100x100m grid to determine a set of clusters and areas for targeted consumer engagement

Following the layering of dwelling suitability, the DNO network data was added to the digital twin to enable further data stacking to outline where constraints could be used to further refine the target cluster areas as follows:

1. Determine potential heat pump electrical load for remaining dwellings from dwelling suitability using property floor area, annual heat demand/consumption data and target SCOP.

2. Determine 25% density KPI compliance:

a. Define quantity of consumers required to sign up to meet the density requirement of 25% per distribution substation by assessing the DNO data and number of existing connections.

b. Set out substation area coverage by DNO boundary data.

c. Determine the number of green and amber dwellings within each substation polygon boundary.

d. Analyse which substations have sufficient green and amber dwellings to meet the 25% density requirement.

e. Determine potential headroom capacity on substations by the DNO data of rating and maximum registered demand to indicate likelihood of no requirement for network infrastructure upgrades.

3. Carry out analysis on electrical loads vs potential substation headroom to establish which substations would not be suitable to proceed with and refine clusters further to enable targeted consumer engagement and sign up.

4. Defined outputs in regards to electrical network analysis as follows:

a. Best case scenario – 25% of consumers with the lowest anticipated calculated electrical load to understand lowest potential total load to be added to the network.

b. Worst case scenario – 25% of consumers with the highest anticipated calculated electrical load to understand highest potential total load to be added to the network.

c. Maximum number of potential consumers that could install a heat pump before substation headroom is exceeded. This was determined in Phase 1 through using NGED transformer polygon data and determined potential total load of properties with heat pumps and comparing to transformer ratings.

d. Address list by cluster to enable subsequent analysis.

The final layer of data analysis under the phase 1 methodology is to stack the tenure type on top of all previous analysis to enable determination of compliance with project constraints in limited social housing quantities.

5.2 Work Package 2: Heat Pump Readiness

The aim of this work package was to design a heat pump ready survey process that maximises system design accuracy and optimises the customer experience.

A desktop review was undertaken of existing heat loss calculation and heat pump sizing tools looking at data regarding perceived and actual accuracy where available. An advisory panel was formed which met twice to co-design the approach. Local installers, industry representatives and technology suppliers were involved to bring their expertise to the design process. The first workshop focused on understanding the barriers to accurate heat pump sizing and system design whilst also identifying what the current marketplace offered around this.

The second workshop drew out solutions to achieving the optimal survey process. Between meetings, draft designs were shared amongst the advisory panel members for critique.

To verify the acceptability of the process the approach was firstly discussed at a community engagement event to draw out how this approach would meet the requirements of residents interested in heat pumps. Excellent feedback was received with a clear demand from residents for high quality information they could trust that combined insights on both heat pump system design and retrofit measures.

The methodology was designed around some specific outputs including a step-by-step home survey customer journey process, a draft output report for homeowners, an approach to incorporating Veritherm's/Build Test Solutions building performance data and a cost model.

5.3 Work Package 3: Community engagement and customer journey

5.3.1 Stakeholder Matrix

We produced a stakeholder matrix of key local actors and stakeholders within the Westbury-on-Trym area. The matrix includes local authority officers, community groups, political actors and local installers of heat pumps and retrofit. It provides contact details for all stakeholders as well as supply chain information i.e., services offered, current qualifications and accreditations held by each supply chain contact.

CSE holds a database containing details of companies that we currently work with, therefore we initially looked at these to begin putting together the stakeholder matrix and established if any of them were considered to be influential within the Westbury-on-Trym area. Following on from this, we carried out an internet search, used social media platforms and local community pages to identify what other stakeholders were influential within the Westbury-on-Trym area.

5.3.2 Designing the Customer Offer – Consumer Profiling

Different consumer groups have different goals, priorities and drivers for retrofitting their homes. CSE's previous work on Futureproof (previously funded by BEIS as part of the local supply chain demonstrators programme) has shown that different market segments have different motivations for improving their home and installing low carbon technologies. Understanding these motivations was a key tool in interpreting some of the key messaging from the Phase 1 community engagement work, designing our customer journey and planning future community engagement activity.

5.3.2.1 Stage one – Profiling Westbury-on-Trym

To help inform the initial understanding of consumer appetite for heat pumps across the target area, CSE used Experian MOSAIC data to profile the area. MOSAIC is a segmentation tool that allocates individuals and households into consumer types which allow you to tailor your communication and engagement approach accordingly. For example, the “legacy elders” are concerned about the environment and climate change but will only invest in a product that helps protect their retirement fund. The profiling report was then shared with all partners and BEIS.

5.3.2.2 Stage two – Reviewing draft HPR clusters

The draft outputs from WP1 identified a series of seven target cluster areas for community engagement. The maps identified those homes and streets where green and amber properties were available for engagement. CSE then data-matched the clusters to Experian MOSAIC data. Once the clusters had been profiled, these were shared with our community partner, SusWoT, to better understand how best to engage residents living within those areas, as well as the likely priority for engaging them (see events, focus groups and drop-ins below).

5.3.2.3 Stage three – Analysis of final clusters

Following further analysis from National Grid Electricity Distribution (NGED) the clusters were refined to the final three for initial targeting and engagement. These were discussed in detail with SusWoT as part of our phase two proposal to BEIS i.e., the priority order for engagement and our proposed engagement techniques.

5.3.3 Community Engagement (overall description)

From the offset, engagement on this project has been carried out in conjunction with SusWoT, a locally rooted and representative community group with a focus on taking action to mitigate, and adapt to, the effects of climate change in the area. SusWoT's involvement has not only provided us with key on-the-ground insight and experience from previous local engagement initiatives, but also a legitimacy that has facilitated a broader engagement with local people than we could have achieved without their involvement in the partnership.

Using the clusters identified through WP1, a community data review was carried out alongside SusWoT (see Stage two above) and a stakeholder map was developed. This information was used to develop a targeted programme of activities to reach residents living in those clusters, with different approaches utilised in each cluster to maximise effectiveness and test approaches for deployment in subsequent phases. This programme included:

- An online householder survey, publicised through targeted leafletting in clusters identified through WP1
- The use of local print media (including the Henleaze and Westbury Voice and BS9 newsletters)
- The utilisation of trusted local people in respective clusters to build interest through word-of-mouth
- Attendance at local events and project specific drop-in events in clusters to identify householder concerns and build interest in home retrofit and heat pump installation
- A workshop with early adopters and local leaders to explore the local customer journey and further test WP2 outcomes
- A focus group exploring local awareness of, and appetite for, heat pump installation.

These activities are outlined in more detail below.

5.3.3.1 Community Data Review

As discussed above, CSE shared the target cluster data generated through WP1 with SusWoT for sense checking and comment. This happened both with draft clusters at the beginning of Phase 1 to inform the engagement approach, as well as at the end of Phase 1 to refine clusters for targeting and deployment of the methodology following input from local residents and NGED. The draft clusters and the accompanying MOSAIC analysis were key to the development and trialling of an effective and bespoke place-based engagement approach that we intend to use when deploying the methodology.

5.3.3.2 Community Communications, Events & Drop-Ins

As identified through the data review and initial stakeholder mapping it was agreed that it was crucial to have a physical presence in the local area. Given their learning and experience from similar programmes in the past, SusWoT suggested that it was crucial engagement is carried out alongside trusted local residents to give us legitimacy in the area. To this end, we worked with SusWoT and other local leaders to deliver a range of communications and engagement activities, including:

- The development of a myth buster page for local people (based on learning from previous engagement carried out in the area) - find it here: https://www.cse.org.uk/advice/renewable-energy/heat-pumps-and-the-boiler-upgrade-scheme.
- Articles in Westbury and Henleaze Voice and BS9 newsletters publicising the myth buster page and future drop-in events
- Targeted leaflet drops in cluster areas to promote the online householder survey, heat pumps, the myth buster page and the informal drop-in sessions
- The identification and use of trusted local people from respective clusters to engage and publicise the above activities and resources with their neighbours.
- Weekly informal question and answer drop-in sessions led by SusWoT and hosted at community spaces such as local pubs
- An information stall at Westbury-on-Trym village fayre, providing an opportunity for local people to ask questions and learn about heat pumps

As detailed previously, the use of data from WP1 and MOSAIC analysis, combined with SusWoT's on-the-ground experience, enabled us to tailor our engagement approaches for different clusters in order to receive the best responses from each. For example, the approach needed to build trust in cluster 3, a higher income, more professionalised and less climate conscious cluster on average, differed to that used in cluster 7, a generally older and less affluent cluster (for more detail on this, refer to Section 6.3).

5.3.3.3 Online Householder Survey

At the outset of the engagement process, a comprehensive 26 question survey was developed to be pro-actively targeted at residents living within identified cluster areas. Questions ranged from building readiness and existing insulation measures to customer appetite, awareness and willingness to invest personal capital. Residents were also asked about their preferences for installation, including how they would like to be engaged, their preferences for installers and their expectations in terms of legitimacy.

5.3.3.4 Community Workshop – engaging the supply chain, early adopters and key local leaders and influencers

In addition to the wider resident engagement programme CSE worked with SusWoT to deliver a community workshop. The workshop invited a wide cross-section of key stakeholders from our matrix to come together and form a collaborative view of our ability to deliver heat pumps at scale. These included:

- Supply chain representatives (local installers, builder's merchants and manufacturers) to help determine their ability to deliver at scale, ways to remove supply chain inefficiencies and provide customers with the cost and customer journey they have asked for
- Local early adopters to help review our customer journey, explore process bottlenecks and test appetite for WP2 proposals
- Key local leaders to explore local communication needs and gain buy-in for future local engagement proposals
- Phase 1 work package leads to ensure cross-fertilisation across the project.

To this end, attendance at the workshop included representatives from The Green Register, Evolve HES, Ecocetra, Bristol City Council, SusWoT, Community leaders, University of Bristol and CSE.

5.3.4 University of Bristol Focus Group – Engaging Local People to Ascertain Key Conditions for Success

Alongside SusWoT, the University of Bristol (UoB) and Bristol Energy Network (BEN) collaborated to recruit local households to attend a focus group, with the aim of better understanding different local cohorts of residents and their appetite for having a heat pump installed. Participants were identified using CSE's existing data tools, SusWoT's ongoing engagement activity and via the online householder survey.

Through a range of activities, participants were asked for their opinions on acceptable cost thresholds for installations, potential packages that might improve local interest and uptake (e.g., combining solar PV and heat pump installation), and the level of support required for householders to feel confident in the decision-making process.

The outputs of the focus group were used to help inform and develop the customer offer proposed for the methodology and deployment and testing.

5.3.5 Cross Work Package Engagement – Designing the Customer Journey

We have taken an innovative multidisciplinary approach to identifying and addressing non-technical systemic barriers within the customer journey. Our approach worked with stakeholders from different sectors to scope out the optimum customer journey and help develop community capacity to support future heat pump deployment. In particular, we used an innovative approach to segmenting the local population by their heat pump potential and motivating factors which then informed our community engagement approach. The direct involvement of community energy groups provided a bridge between technical desk-based analysis and the targeted consumers.

Typical project planning processes tend to focus on the known infrastructure and technical barriers to engagement and take-up, rather than working with the local ecosystem to lay the foundations for a successful project. The Bristol Heat Pump Ready programme has used a highly inclusive and collaborative approach which is truly innovative.

5.4 Work Package 4: Supply Chain Training and Skills

5.4.1 Supply Chain and Training Research

The Green Register began by defining who may be considered a stakeholder within the supply chain, their roles and at what points in a heat pump installation project they would interact. Through our work on the Futureproof project, training contractors in retrofit, we understood the need for accurate assessment and adequate preparation to ensure the heat pump readiness of a building; this is reflected in the range of supply chain stakeholders.

Desktop and first-hand research was undertaken into training pathways and providers, especially in relation to heat pump installers. Since the Microgeneration Certification Scheme (MCS) is the accreditation body used for renewable technology installers including heat pumps, this was examined as a priority. MCS accreditation represents the industry standard and an entry requirement for installer inclusion in government-funded schemes since members must comply with a Consumer Code that aims to protect customers from disreputable practices.

5.4.2 Supply Chain Capacity

Research was undertaken to understand the capacity of the local supply chain of heat pump installers. Contextual information was gained through reports such as the Heat Pump Association's *Delivering Net Zero: a Roadmap For the Role of Heat Pumps*[1] and WECA's .

We undertook searches of MCS registered installers both in proximity and those who serve a wider area; additionally, meeting with an MCS representative helped to understand the aims of the organisation and how installers are supported. Conversations with builders' merchants, contractors and manufacturers explored further aspects of the supply chain, such as availability of materials.

5.4.3 Skills and Knowledge

In creating an innovative approach to streamlining high quality installations, we were keen to explore gaps in knowledge and skills in the local supply chain. We led two workshops bringing together the knowledge and experience of supply chain stakeholders such as heat loss assessors, retrofit assessors, fabric installers, heat pump manufacturers, retailers and heat pump installers. Representatives of all other work packages were also present to optimise collaboration and to ensure a harmonised outcome for the project.

[1] https://www.heatpumps.org.uk/wp-content/uploads/2019/11/A-Roadmap-for-the-Role-of-Heat-Pumps.pdf

https://www.westofengland-ca.gov.uk/wp-content/uploads/2021/07/WECA_Green-Jobs-and-Skills_Phase-2-Report_Final_01_06_2021.pdf

5.5 Work Package 5: Business Models

The business model work package was centred around exploring sustainable business model options and assessing value for money propositions to then come up with a viable solution that BHPR can operate under delivering a set of stacked benefits.

The overall approach considered:

- Current subsidy models
- Market pricing for activities including surveying and training
- Cash flow
- Consumer procurement options
- Models for membership and certification
- Discounting

Consultation was undertaken with project partners and advisory members including supply chain representatives.

The objectives for a BHPR model (linked to those described above) are that it should;

- Be commercially sustainable and achievable post the trial of the methodology
- Be adaptable to be able to target more than just able to pay early movers
- Be transferrable to any UK city with defined roles

The sources of finance were identified which could fund the model. These are primarily centred around consumer financing as all finance ultimately comes from the consumer (acknowledging the contribution that will come from subsidy currently).

Activities from the BHPR methodology that is defined through the other work packages are then reassessed to understand the cash flow to fund them. This includes activities associated with;

- Consumer engagement
- Home surveys
- Training
- Provision of digital planning services
- Heat pump installations
- General running costs of the BHPR solution

Once these are identified it can then be determined how the source of cashflow can be reasonably distributed.

The model currently focusses on the BHPR deployment for heat pumps only but the structure should enable the offering of other packages in the future for example combined heat with solar PV and/or fabric retrofits.

5.6 Work Package 6: DNO/DSO Interface

National Grid Electricity Distribution (NGED) formally Western Power Distribution is considered a critical stakeholder in the BHPR process. The acceleration of heat pumps at scale will put pressure on the local electricity system. This pressure is considerably increased if heat pumps are clustered as part of that accelerated uptake. On average, based on current DNO standards, the installation of a heat pump could triple or even quadruple the allocated capacity required per property. This is based on the current NGED policy of applying little or no diversity to heat pump loads for older buildings. With typical heat pump thermal loadings varying between approximately 4 and 16kWth and applying an average coefficient of performance of 2.5 then between 1.6 and 6,4kW electrical load would be applied. This compared to average ADMD base power figures of approximately 1.5-2.5kW.

Part of the methodology under Work Package 1 is to incorporate the DNO data into the digital planning capability so as to be able to ascertain the following:

- Number of consumers per distribution substation in an area (to meet the 25% KPI)
- Headroom of the distribution substation to determine approximately how many heat pumps could be installed

In addition, discussions are held with the DNO to discuss aspirations to adjust their standard in applying diversity. This could make a significant difference to how many heat pumps are able to be installed. Currently NGED does not permit any diversity to be applied; however other UK DNOs are starting to allow some, so this is not a national view.

In the methodology being developed there is also the opportunity to provide 2-way information transfer to the DNO which is to be explored further as part of testing the methodology. This includes the possibility of an Application Programming Interface (API) linking the two systems together for transfer of data. This would allow the DNO data systems to support them in understanding where clusters of heat pumps are likely to be installed and be able to better plan for the proposed connections.

Direct correspondence was held with NGED during Phase 1 including discussing available data sets and future provision. The opportunity to be included in Equinox (a Network Innovation funded project managed by NGED) was also discussed as part of the Phase 1 proposal process to be factored into the subsequent trial of the methodology; whereby it would be possible to sign up consumers to this innovation project and they would receive rebates for provision of flexibility provided from their heat systems.

Whilst flexibility itself is not a key part of the BHPR business model, any service that appears to enhance the value of installing a heat pump and/or reduce the annual cost of running it should be factored into the market offering component.

6 Findings from Work Packages

6.1 Work Package 1: Digital Planning

6.1.1 Dwelling Suitability

The key findings following the digital planning are as follows.

The study area of Westbury-on-Trym included filtering and data management for 8,551 dwellings, of which 859 were identified as green properties and 3,613 as amber properties.

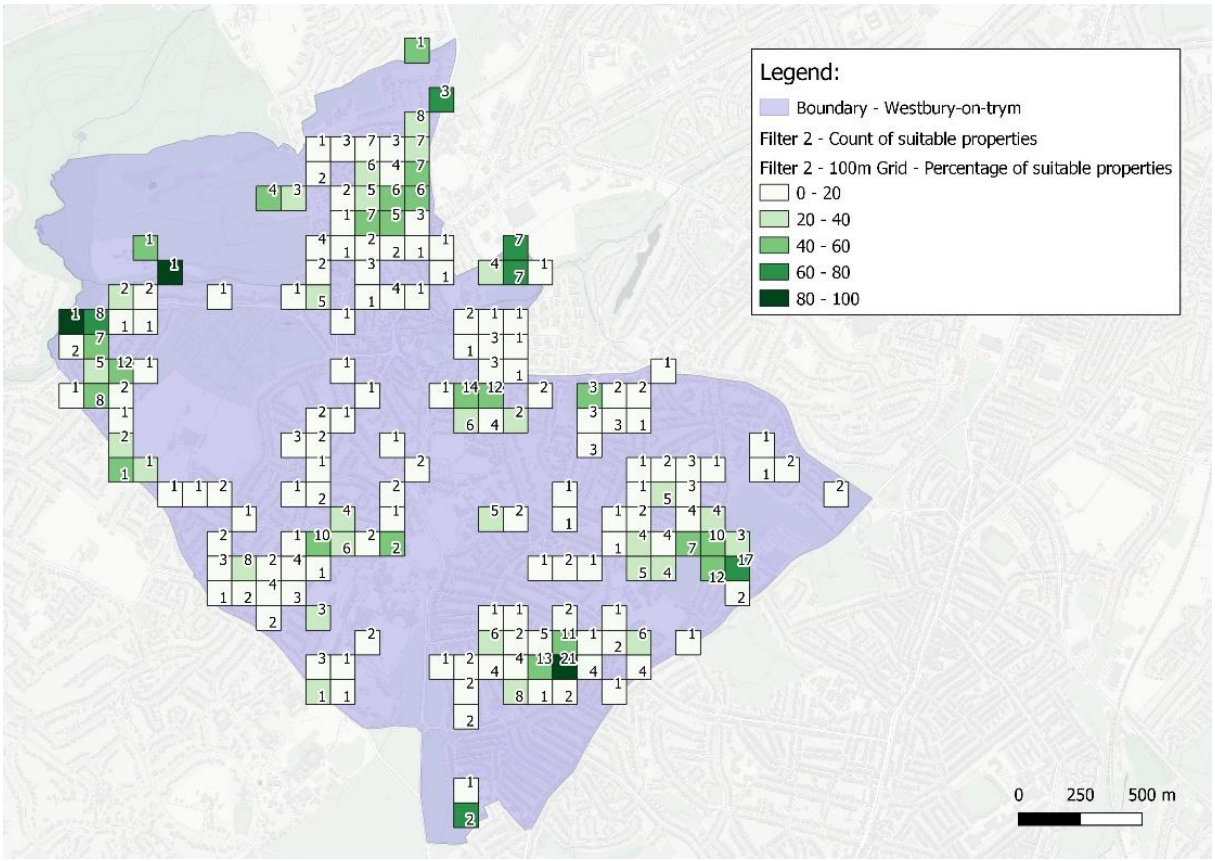


Figure 6—1 Green Dwellings – 100x100m grid

The green scaled grid in Figure 6—1, overlaying the map, indicates the percentage of "Green" properties in comparison to all of the properties that can be found within each 100m grid cell, in which the darker the shade of green the higher the percentage as can be seen within the legend. The number indicated within each grid cell refers to the number of green properties within that grid cell.

Figure 6—2 indicates the same information for the amber properties.

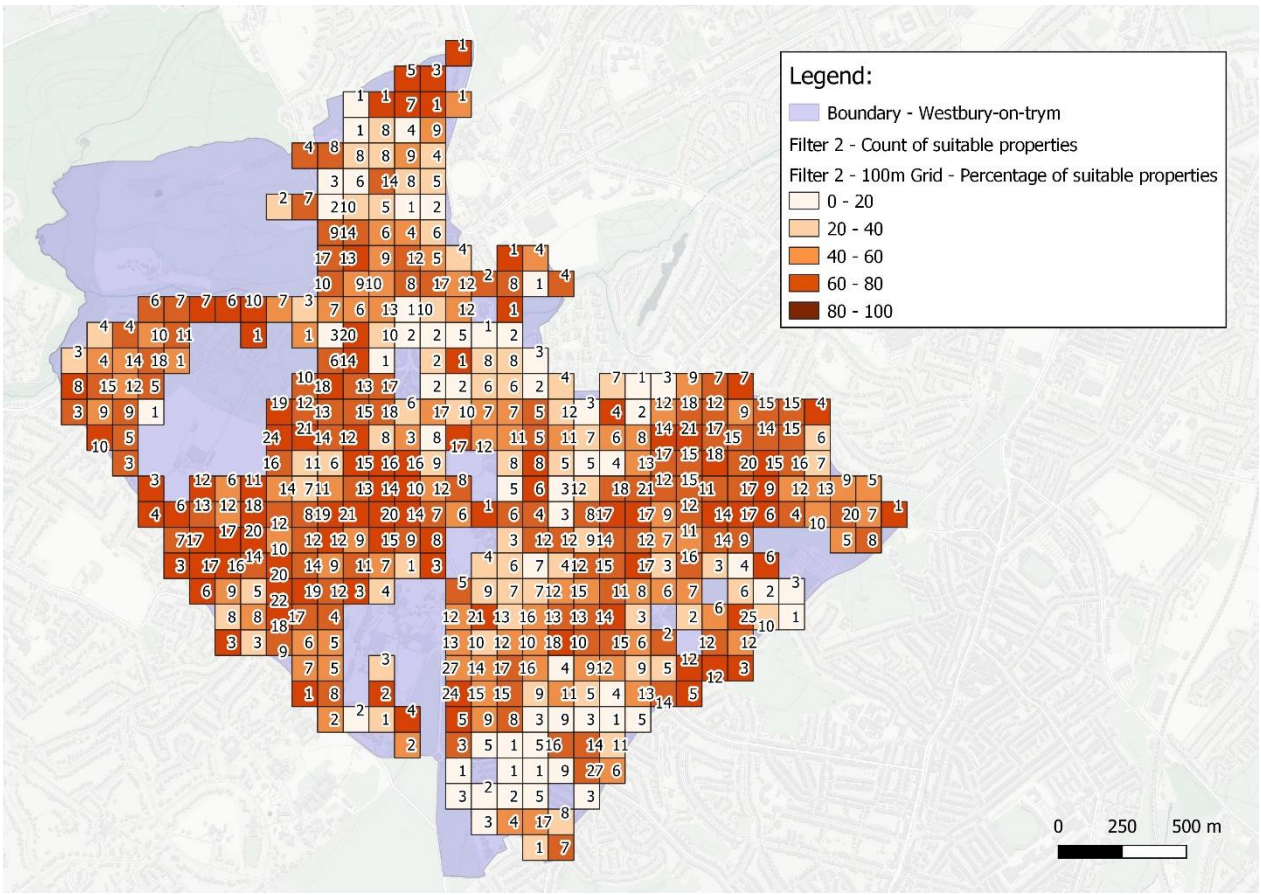


Figure 6—2 Amber Dwellings – 100x100m Grid

Figure 6—3 highlights seven areas that are considered areas of high density of either/both green and amber properties, in comparison to the total number of properties.

The map indicates green as point locations overlaid with the 100m density grid for the amber properties and is supported by Table 6—1.

Table 6—1 Dwelling Suitability Cluster Counts

Cluster Reference	Total Green Count	Total Amber Count	Total Unsuitable Count	Total Suitable	Total Property Count	% Green and Amber vs Total
1	62	34	29	96	125	77%
2	57	39	20	96	116	83%
3	28	80	18	108	126	86%
4	44	98	88	142	230	62%
5	19	18	2	37	39	95%
6	84	120	249	204	453	45%
7	52	152	72	204	276	74%
Total	346	541	478	887	1,365	65%

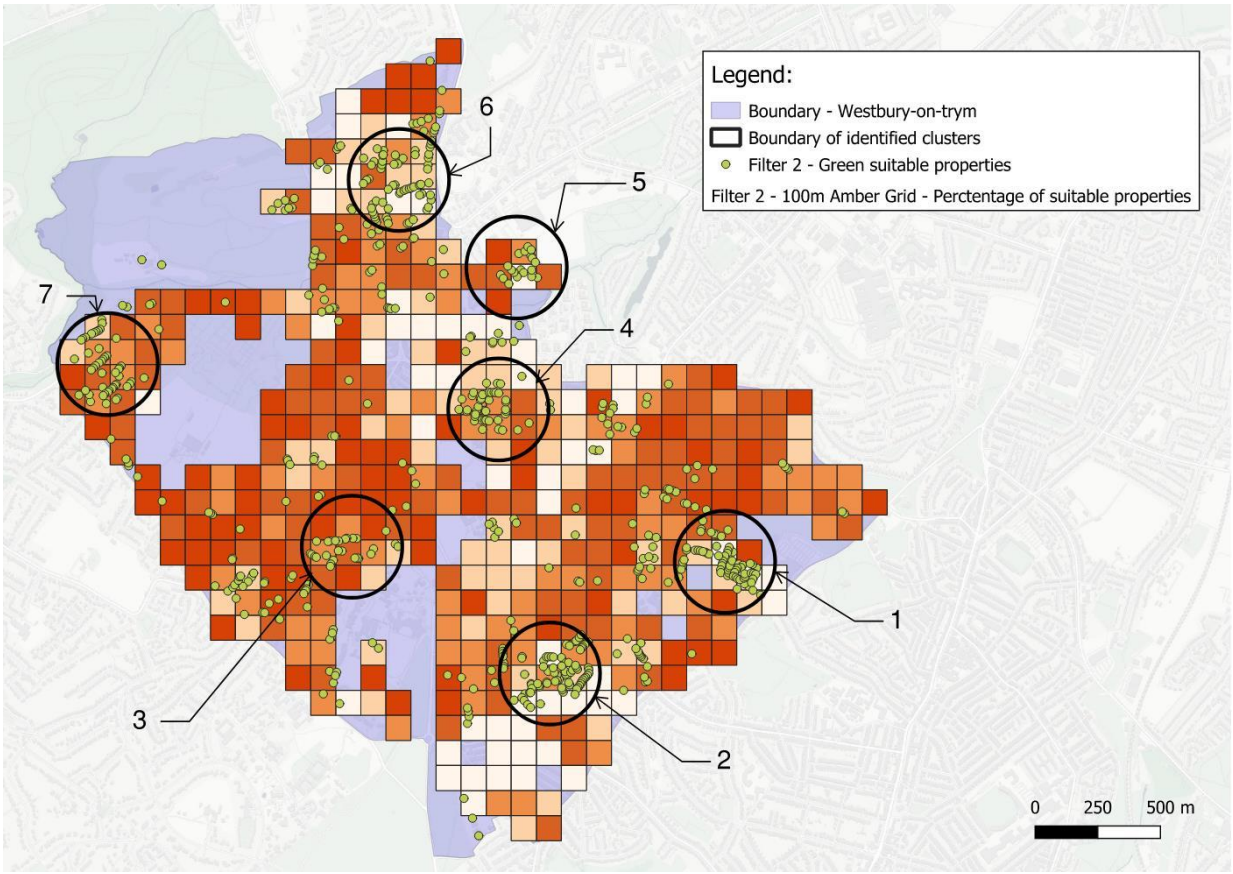


Figure 6—3 Dwelling Suitability Clusters

6.1.2 DNO Network Data Stacking

Figure 6—4 indicates the cluster boundaries (black polygons) previously identified in relation to the dwelling suitability and to enable general consumer engagement on existing heat pump knowledge.

In line with the BEIS KPI of signing up 25% of consumers on a distribution substation, further analysis was carried out. The NGED substation area coverage shapefiles were applied to our target cluster areas to determine how they overlaid with our cluster zones.

As anticipated, the NGED substation areas (red polygons) did not directly align with the cluster zones, therefore the target areas for trailing the methodology and consumer sign up have been adjusted to include green and amber properties outside of the cluster but within the substation polygons.

This enabled further assessment and improved opportunity to target the BEIS KPI of an uptake of 25% of substation customers.

In some scenarios, properties previously identified within a cluster were removed from the target engagement properties for the trial stage of the methodology and consumer sign up due to the 25% KPI consideration.

A number of substations that only cover a small area of various clusters were also omitted from the analysis as the 25% KPI was deemed to be unachievable. The excluded substations have been indicated by a red diagonal hatch.

Clusters 5 and 6 were identified as unsuitable areas following the substation polygon overlay, due to the grouping of properties and the boundaries of substations making it significantly difficult to target the 25% KPI.

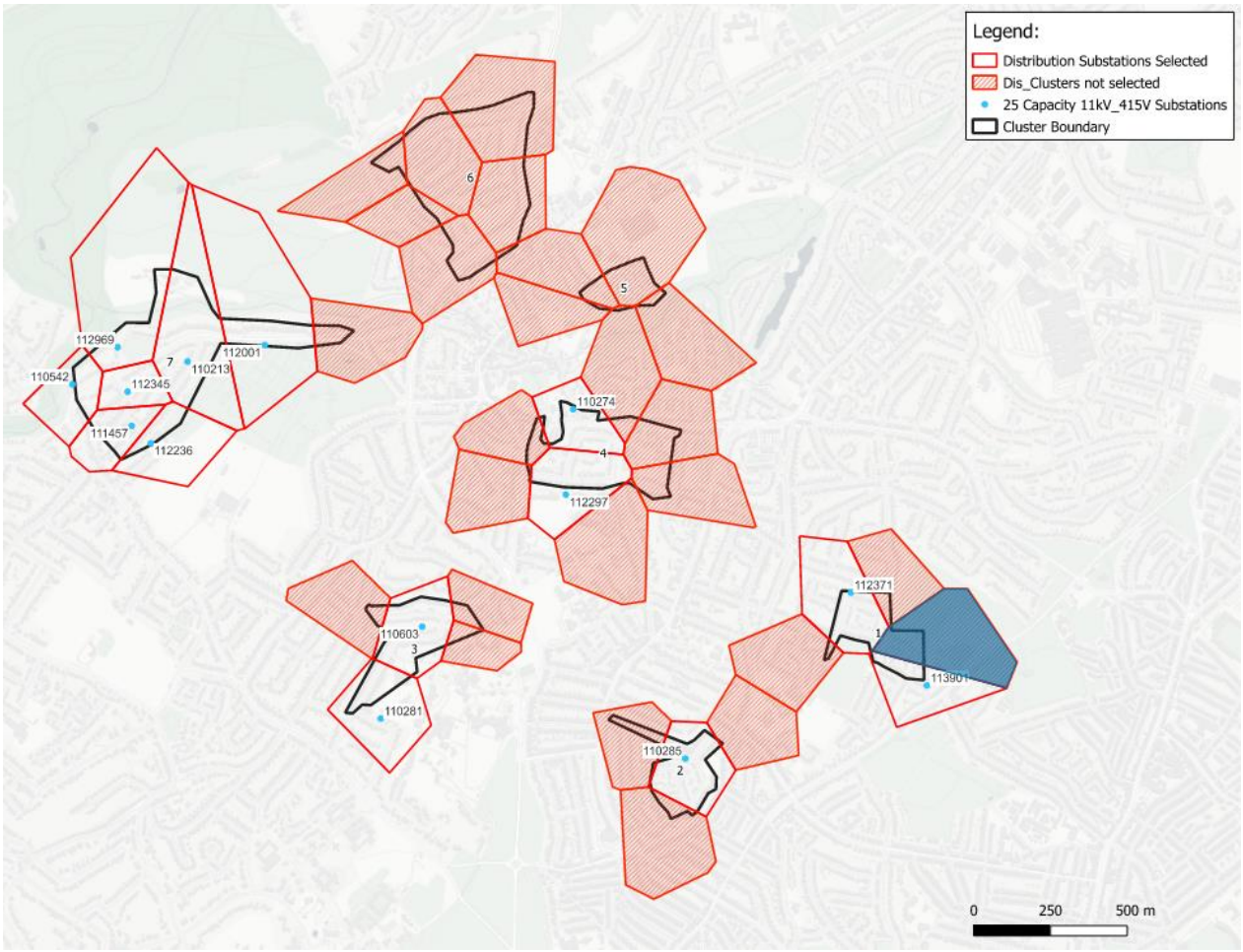


Figure 6—4 DNO Substation Boundaries

A number of discrepancies were discovered with the NGED data in relation to the number of consumers that are connected to a substation against the number of properties that are contained within each polygon. Both the number of connections and the substation boundaries were obtained from the same source, NGED data portal. For this reason, the data has been used as a guide to demonstrate the methodology to assessing and confirming compliance with the density KPI, however this will need to be coordinated efficiently during the subsequent stages of trialling the methodology.

The substation area in cluster 1, identified by the blue colour fill, indicates a discrepancy in its substation identification. It is understood that there is a privately owned substation dedicated to the Tesco supermarket and therefore the polygon does not truly reflect the area that it is serving.

The NGED data also does not distinguish between commercial and domestic connection types, therefore this should also be considered when assessing the total number of connections indicated within the different datasets.

To eradicate the discrepancies and enable accurate representation within subsequent phases of deployment, further connection identification data would be required in order to confidently understand which substations consumers are connected to. Without this information further analysis on the capacity and impact to the DNO network would be based on a number of assumptions and make it difficult to evidence compliance with the 25% KPI.

Table 6—2 outlines the summary results from the analysis against the three scenarios of best case, worst case and maximum potential dwellings possible in regards to the estimated available headroom per substation.

This demonstrates where substations can accommodate the estimated loads in relation to their capacity if certain groups of dwellings were to sign up for heat pump installation.

Discrepancies appear in clusters 3 and 7 in relation to the number of green/amber properties against the number of connections stated by NGED, therefore further information and coordination with NGED will be required to add further confidence to the analysis in the next phase.

Table 6—2 DNO Substation Overview

		Counts			Ratings			Scenarios		
Cluster	**Dist. Sub. ID**	**Quantity of Green/ Amber Dwellings**	**No. connect -ions defined by WPD substati on data**	**No. required to sign up (25% of substation connec- tions)**	**Rating (kVA)**	**Max. Peak Demand (kVA)**	**Est. Headr oom (kVA)**	**Best Case Scenario Demand – 25% dwellings with lowest estimated load (kVA)**	**Worst Case Scenario Demand – 25% dwellings with highest estimated load (kVA)**	**Max no. dwellings before headroom exceeded**
1	112371	115	120	30	500	148	352	99	425	71
1	113901	74	222	56	500	315	185	240	379	47
2	110285	100	117	30	315	142	173	77	390	53
3	110281	56	98	25	500	177	323	131	427	42
3	110603	87	54	14	500	122	378	46	261	56
4	110274	43	145	37	500	179	321	167	239	43
4	112297	77	122	31	800	294	506	84	275	77
7	110213	50	101	26	500	171	329	123	326	45
7	110542	13	42	11	300	73	227	62	112	11
7	111457	62	55	14	200	57	143	47	256	31
7	112001	31	32	8	300	46	254	39	226	23
7	112236	33	92	23	750	248	502	129	324	33
7	112345	40	40	10	315	43	272	30	143	39
7	112969	13	38	10	500	57	443	32	94	13

The analysis indicates that substation ID 113901 within cluster 1 has a best-case scenario load of 240kVA, exceeding the estimated headroom of 185kVA and therefore was not considered a suitable target area for deploying heat pumps in the trial of the methodology and will be removed from the analysis at this stage.

Cluster 2 was also considered unsuitable in relation to consumer profiling and outreach areas covered by the community engagement work package delivered by CSE and SusWoT.

This left clusters 3, 4 and 7 as the target areas for the trial of the methodology and deployment with a total target of 209 dwellings to meet the 25% density across the various substations. The total suitable green and amber properties for the selected substations and clusters is 505, meaning that approximately a sign up of approximately 40% of the currently suitable dwellings is required.

6.2 Work Package 2: Heat Pump Readiness

They key findings from the work package to design a heat pump readiness in home survey include:

- Households want high quality surveys to have their system designed based on robust data
- Households are willing to pay up to £500 for the multi-faceted survey which compares favourably with current market prices for less accurate heat loss surveys averaging £350
- A contribution from households to the survey cost would help in reducing dropouts and causing programming issues
- Households would prefer the supply chain to be locally based undertaking this work and want to build a relationship with the installer
- A measured approach to heat loss calculation is the only truly accurate way to ensure appropriate system sizing and design. This is particularly important for lower income households
- A repeat of a heat loss measurement may be required if substantial thermal performance improvements have been made ahead of heat pump install
- Splitting out the majority of the in-house survey work from the sole responsibility of the installer is beneficial as trained individuals following the survey methodology would be able to generate enough information for installers to provide outline quotes therefore reducing the time demand on the sparse installer base
- To meet the project delivery requirements, it would not be possible to have finalised quotes for all households ahead of the stage gates therefore outline costs are to be provided for customer sign off then verified ahead of installation
- Residents wish to build a relationship with an installer so within the process a critical element is the installer verification visit to provide the finalised quote and build a rapport with the household
- Households in the project area generally did not struggle to accommodate the vacating overnight for the rapid test; however, this might be more of a challenge for other households
- The rapid overnight test used a substantial amount of electricity in larger homes so customers would have to be warned of this expense (on average around £10 at current electricity prices)
- The survey being decoupled from a vested interest like an installer or energy supplier maximises the potential for a successful and fair installation that maximises benefit to the householder
- A large volume of surveys would need to be undertaken to meet our overall target numbers however the digital planning exercise should help reduce the risk of low conversion rates
- To deliver large survey volumes will require a large organisation with capacity that can be block booked in advance but in the longer term there are several opportunities for local survey supply chain strengthening and delivery support for example organisations such as CSE taking on this role or Energy Tracers
- Combining thermography, air tightness and measured heat loss can bring significant economies to the process for all stakeholders

- An appetite for works questionnaire is essential to understand the householders' potential preferences around disruption and willingness for this
- Households have given good feedback on the tested process highlighting the professional experience they received and quality of outputs
- A survey including recommendations for retrofit to improve heat pump performance is essential to ensure fabric first is high on household planning agendas
- Enhanced thermal imaging and associated shallow retrofit advice, although an excellent asset for the households, is challenging to deliver within the short timeframe and budget constraints though could be something to develop within local supply chains in future.

Figure 6—5 Testing the HPRS Method

Figure 6—6 Data Output Example from Thermal Performance Test

Overall, the design process has been carefully considered with expert advisors to produce the first of its kind comprehensive but cost-effective in-home survey process to meet the needs of both households and installers. The innovation in the methodology is the process and combining of the various survey tools in to one comprehensive package for households. Even if the household did not progress with a heat pump install it would be valuable as a standalone document and still represent excellent value for money when compared with the cost of undertaking these surveys separately. Another element of innovation is how the information will be shared with heat pump engineers to provide outline costings in a time effective manner. Installers will effectively be provided with nearly all the key information they would collect themselves on a site visit to reduce the risk of inaccurate system design that takes more time out of the supply chain for call backs and remedial works. Installers will provide outline quotations and running costs that will fit within the overall customer information pack sent to households which will be managed through CSE.

Some of our key findings from the test surveys include:

- Having two surveyors on site simultaneously helps increase efficiency and maximise customer interaction and experience.
- Households generally did not struggle to find alternate accommodation when asked to move out for the night
- Households enjoyed the interactivity of the thermal imaging survey element
- The level of technical detail met the expectations of the householders who had previously felt they needed more from other installer quotations (where applicable)
- Households who had engaged with heat pump installers prior to this found that the heat pump size recommended was smaller than expected.

The findings from this work package inform the overall business model's work package in terms of understanding the pre installation costs and who might pay for these in future. Furthermore it has helped shape the customer journey planning and dialogues around data sharing and data management procedures amongst the supply chain.

6.3 Work Package 3: Community Engagement and Customer Journey

The following section presents the results from WP3.

6.3.1 Consumer Profiling

At the outset of the project, we profiled the whole of the target area to help inform all stakeholders understanding of the local community (particularly our early discussions around heat pump acceptance and our engagement plans). Table 6—3 below shows the top 10 MOSAIC categories. The demographics and motivators for the top 3 categories were summarised and submitted to BEIS as part of our evidence.

Table 6—3 MOSAIC Profile for Westbury-on-Trym (top 10 categories)

MOSAIC Public Sector	Total
D14 Cafe and Catchments	1780
F22 Legacy Elders	1105
D17 Thriving Independence	764
B09 Diamond Days	697
C13 Uptown Elite	688
B08 Premium Fortunes	638
J40 Career Builders	635
N58 Retirement Communities	493
B05 Empty-Nest Adventure	450
B07 Alpha Families	345

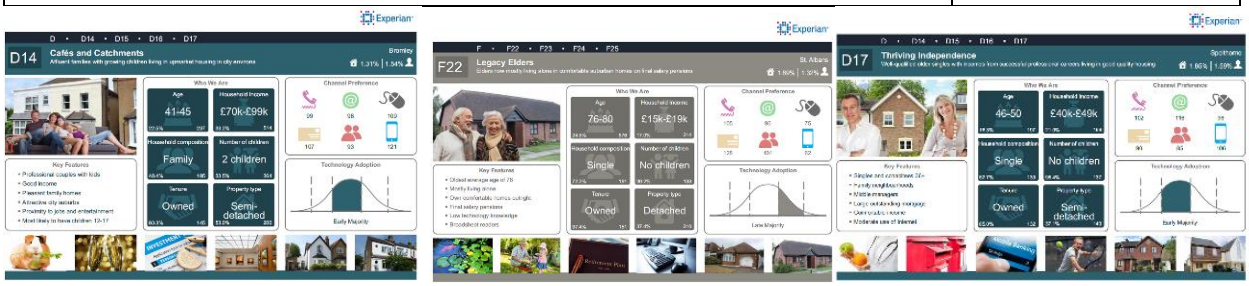


Figure 6—7 MOSAIC Pen-Portraits including Channel Preference

The following summarises some of the key findings from this analysis:

- All comfortable on household income (pre-cost of living crisis). Unfortunately, it's not possible to quantify the impact of the cost-of-living crisis on household incomes or motivations, but Westbury-on-Trym is an affluent area of Bristol and the findings of the group work corroborated the insights provided by MOSAIC.
- High levels of education with higher densities of engineers, finance and University education professionals.
- Variation in channel preferences has an impact on the marketing approach needed, with digital channels working particularly well for Café and Catchments. Legacy Elders will engage better with council branding and peer-to-peer communication.
- Well off families are likely to improve rather than move. This long-term investment is driven by increasing family size.
- Technology adoption also suggests higher potential engagement from the Café and Catchments, as well as Thriving Independence.
- Thriving Independence and Legacy Elders have above average engagement on energy usage, recycling and making compromises to help the environment.

Based on the cluster analysis from WP1 we provided a more detailed evaluation of the proposed clusters. Following further feedback from NGED on sub-station capacity the seven clusters were refined further to the three clusters proposed for trialling out the methodology. Table 6—4 shows the distribution across the MOSAIC clusters for these areas.

Table 6—4 MOSAIC Profile for the Selection of Deployment Clusters

MOSAIC Public Sector	1	2	3	Total	Mean income £
D14 Cafe and Catchments	24	56	51	167	£75,665
F22 Legacy Elders	6	18	68	164	£27,867
B09 Diamond Days	23	1	25	115	£45,485
B07 Alpha Families	30	2	18	77	£92,029
B08 Premium Fortunes	38	4	9	74	£108,188
B05 Empty-Nest Adventure	11	10	23	67	£52,920
D17 Thriving Independence	2	16	29	65	£51,675
B06 Bank of Mum and Dad	8	8	11	47	£72,927
C13 Uptown Elite		1		4	£70,373
D16 Mid-Career Convention			2	2	£57,979
E19 Fledgling Free			2	2	£43,130
E20 Boomerang Boarders		1	1	2	£40,384
J40 Career Builders		2		2	£47,650
E18 Dependable Me			1	1	£25,997
E21 Family Ties			1	1	£48,564
H32 Flying Solo			1	1	£23,171
H35 Primary Ambitions				1	£49,407
M56 Solid Economy	1			1	£25,039
N58 Retirement Communities		1		1	£18,932
Total	**143**	**120**	**242**	**794**	**£61,350**

Once we had re-segmented the target areas the Thriving Independence segment became less influential. Cluster 3 contains a high concentration of Alpha Families and Premium Fortunes who are wealthy and have similar profiles in terms of family composition and motivations. The key findings and insights from our evidence submission are summarised below:

6.3.1.2 Cluster 1

- Higher incomes with school age children (generally secondary level). The location of their home is important, so they'd rather improve than move.
- Premium Fortunes have high levels of charitable giving and buy premium brands. Upfront cost is unlikely to be a barrier.
- More concerned about climate change and happy to pay for more environmentally friendly products.
- High recycling levels, but generally less motivated to do environmentally friendly behaviours specifically to save money.
- Not particularly energy conscious which is in part driven by their affluence i.e., historically their bills haven't been a significant concern.

6.3.1.3 Cluster 2

- Dominated by the Café and Catchments, previously a core target group for CSE's Futureproof project.
- They are the most climate conscious of all the segments in Westbury-on-Trym. They are concerned for their children's future and the planet, as such they are likely to install heat pumps because it's the right thing to do (not just to save money).
- Higher than average levels of social media usage and as such they access a lot of news content via Facebook.
- High use of smart phones, social media and the internet. Likely to want a good online customer journey.
- Heavily influenced by the behaviour of their peers and word of mouth experience.
- Not as affluent as Alpha Families or Premium Fortunes (cluster 3) and as such may need to access finance to afford a package of measures.

6.3.1.4 Cluster 3

- Mixture of Café and Catchments and Legacy Elders.
- The Legacy Elders are a very different market segment. They are managing their finances and savings through their retirement. They will have had work done to make their home more liveable, but the result running costs are important.
- The Legacy Elders spend more time at home and have more free time to invest in an exciting project, like home retrofit.
- They are concerned for their grandchildren and future generations. It's therefore important for them to leave a legacy for future generations.
- Different marketing approaches will need to be used in this cluster area to reach everyone. Open home events could work well as these aren't online and they do involve peer to peer engagement (which both segments enjoy).

We used the findings of the cluster analysis to help inform our engagement plan for the HPR programme. In particular, planning for a vibrant mix of community activities, promotion via social media, and open home events.

6.3.2 Results from the Community Engagement Work

6.3.2.1 Community Feedback – Westbury-on-Trym Fayre

As part of the Heat Pump Ready (HPR) project, The Centre for Sustainable Energy (CSE) were invited to the Westbury-on-Trym (WoT) village fayre by Sustainable Westbury-on-Trym (SusWoT). We utilised the event as a start to our consumer engagement, with the main objectives for CSE being understanding the appetite for heat pumps within the area as well as understanding the barriers people have when it comes to heat pumps.

CSE also spoke with people about the level of interest in attending workshops and focus groups as well as aiming to start getting an idea of the number of people that might sign up to a heat pump.

Over 700 people attended the WoT fayre and CSE and SusWoT spoke to a great number of people, asking them "are you interested in a heat pump?"

For the majority, the response was "yes but", with many different reasons for people not feeling they were ready for one. A selection of quotes which highlight the main barriers against heat pumps are included here:

- "*The technology isn't quite there yet.*
- *I've heard they don't work properly.*
- *I don't trust the installers I've spoken to, and I don't know how to find a good one locally.*
- *I don't want bigger radiators.*
- *I have micro pipes.*
- *I don't have the capital to insulate my property.*
- *The payback period is too long – it won't benefit me (this was the biggest barrier from the older generation).*
- *I would prefer to get solar before I have a heat pump installed.*
- *I have recently had a new gas boiler / my boiler is only a couple of years old – this was echoed by many. "*

Where those who felt the technology wasn't quite ready, or they didn't want upgraded pipe work or radiators, these conversations were relatively straight forward, and we were able to talk through some of these barriers. We also then signposted potential consumers to the CSE website to access the myth buster that we had created.

Some of the other barriers were not as simple to overcome with the main one from the older generation being that they didn't feel the payback period would benefit them (fitting with the Legacy Elders segmentation above).

Some potential consumers commented that they preferred they would want to have solar panels installed before any installation of a heat pump and a few discussions were held around using an installer that would be able to install both measures alongside each other, which appeared to be an attractive way of having the works done for some.

We saw a smaller number of other barriers, such as not having the capital to insulate or have a heat pump, or not being able to insulate externally but not wanting the upheaval of an internal insulation. For the residents voicing these opinions they tended to live in homes with single skin brick walls which fall outside of the homes included in our target clusters.

6.3.2.2 Community Workshop – Engaging the Supply Chain, Early Adopters and Key Local Leaders and Influencers

The workshop provided an opportunity for the supply chain, early adopters living in the community and local leaders to come together to share their previous experiences of the installation of heat pumps in Westbury-on-Trym. They were joined by work package leads, Bristol City Council staff and advice providers to ensure cross fertilisation and test emerging BHPR proposals.

The early adopters who've already got heat pumps or who plan to have one in the next few months shared their motivations, issues and learning. Members of the supply chain and leads from WP2 reflected on their understanding and the common issues faced by stakeholders and collectively our emerging customer journey was tested and developed.

With local leaders in the room, we also worked together as a group to identify key messages, tools and techniques to inform future engagement on heat pumps in the area, gaining local consent, buy-in and, crucially, offers of support and guidance for mass roll out of heat pumps.

There were 19 participants in attendance on the evening, and the following bullet points highlight some of the key findings from the session.

- Early adopters who attended generally started their journey to getting a heat pump by researching them on the internet and then reaching out to independent information sources such as CSE and Bristol Energy Network (BEN) for help with selecting installers competent to carry out the works.
- Householders who'd installed a heat pump, or planned to, identified similar reasons to those responding to the survey or attending the focus groups i.e., caring about the environment, contributing to net zero goals, investing in their homes and their current boiler nearing the end of its life.
- Nearly all the participants felt an independent assessment of the property would be beneficial instead of relying on the installer to do this, and there was general agreement that signing off their insulation requirements to ensure their homes were suitable for a heat pump was important.
- Most of the participants agreed that there needed to be a "Proof of Performance" test carried out on their installation by an independent competent person as opposed the installer to ensure their heat pump was running at the efficiency expected.
- Residents wanted to be confident in the installer they selected with almost all the participants agreeing that a competent local installer was important as opposed to non-local installers. People felt that it was vital to have confidence in the chosen installer.
- One participant mentioned that having funding available, such as the Boiler Upgrade Scheme (BUS) was an important factor and helped them make the financial decision to buy into heat pumps, as being of the older generation, had the funding not been available then the payback period would not benefit them in their lifetime.
- Confidence in installer quotations was identified as a barrier i.e., whether the quote for works was good value and whether the investment was right for their home.
- All the participants valued independent advice and intermediaries sitting between themselves and the installers.
- There was a split between two clear pathways for carrying out research. One group favoured the internet as it's quick and there is a huge amount of information to look through. The other group found the internet challenging as there is too much choice and a lack of clarity around financial interest. They felt that the internet was rather "salesy", with these people preferring to go to an independent organization for advice.
- On a local level there was a consensus that accessing support and advice from other community climate groups and / or forums was valuable to them and would likely be useful to others.
- There was agreement from most that there would be value from having a local open homes event. Local householders with heat pumps could then allow potential consumers to visit and not only see the heat pump working but also give them the opportunity to chat about their experience with heat pumps and the journey to getting one.

- The early adopters felt that targeting residents with solar PV already installed would gain the highest number of sign-ups for initial deployment, especially those with older boilers and those that had just moved into properties.
- Ideas for targeting households with PV ranged from using Google Earth to identify houses with Solar PV on their roofs, speaking with local estate agents (though it was noted that this was likely to be harder to target as GDPR laws would restrict estate agents from sharing personal data), liaising with local councils and potentially focusing on social housing providers.

The workshop provided a better understanding of the homes within their area that had been deemed most suitable for an installation of a heat pump, the proposed customer journey and the engagement approach for future deployment. As part of the workshop, we mapped out the early adopters existing experience from their heat pump installation i.e., the current customer journey. See Figure 6—8 for the output of this activity.

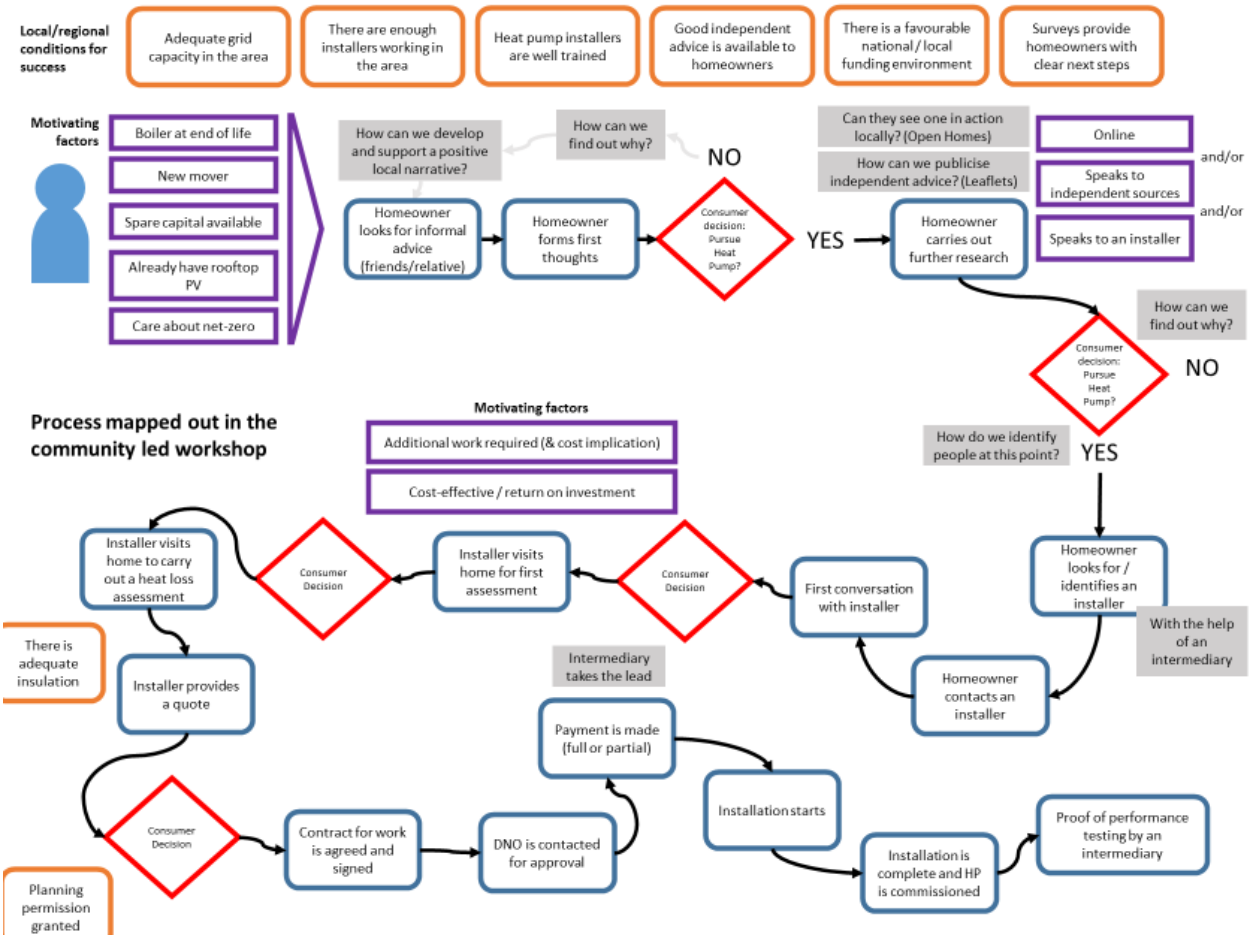


Figure 6—8 Existing Resident Experience of the Customer Journey

Following the workshop, we worked with WP2 leads to review the customer journey based on their proposed survey approach. Figure 6—9 shows our proposed customer journey with annotation for the key actors in the programme's delivery.

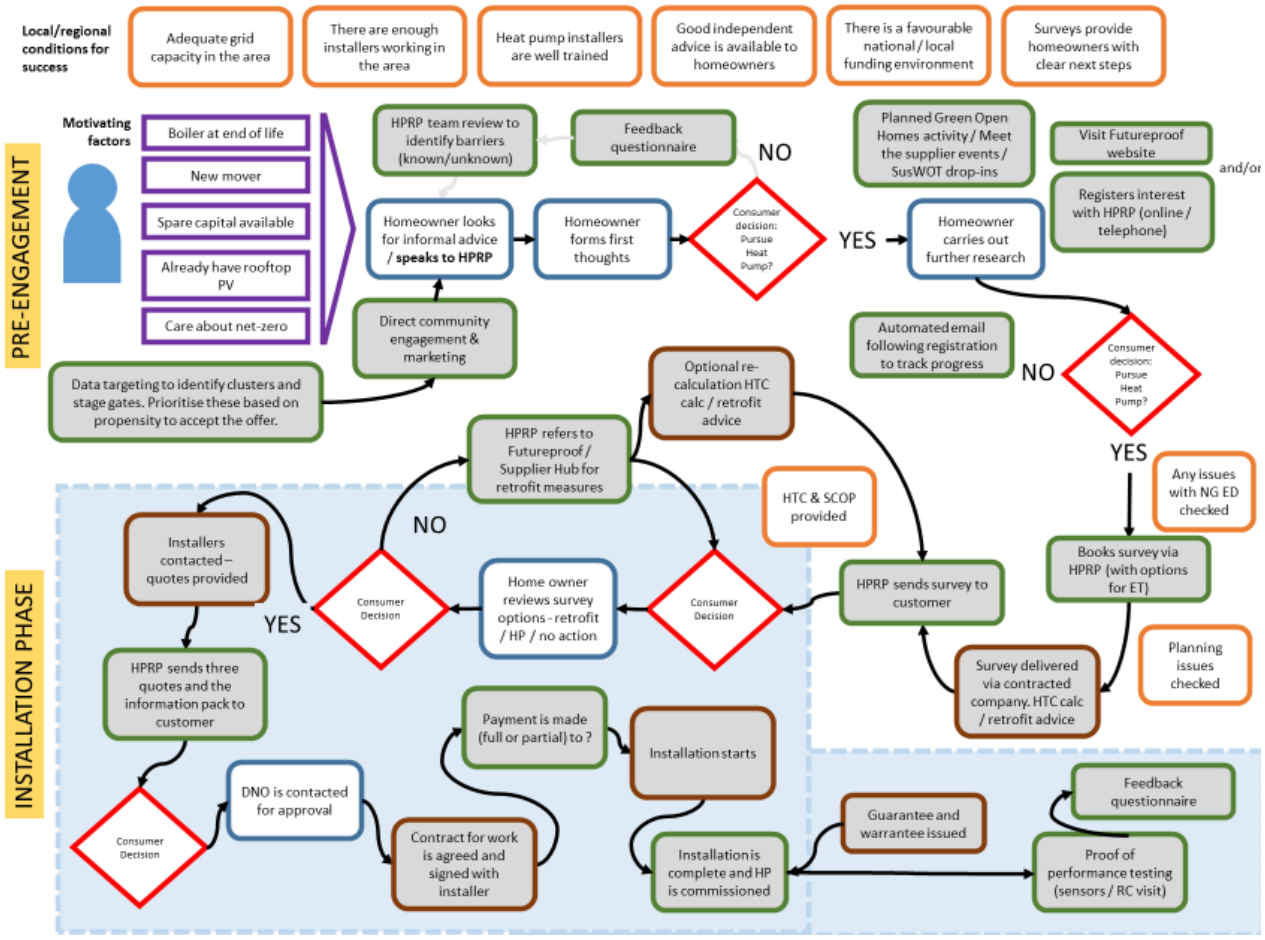
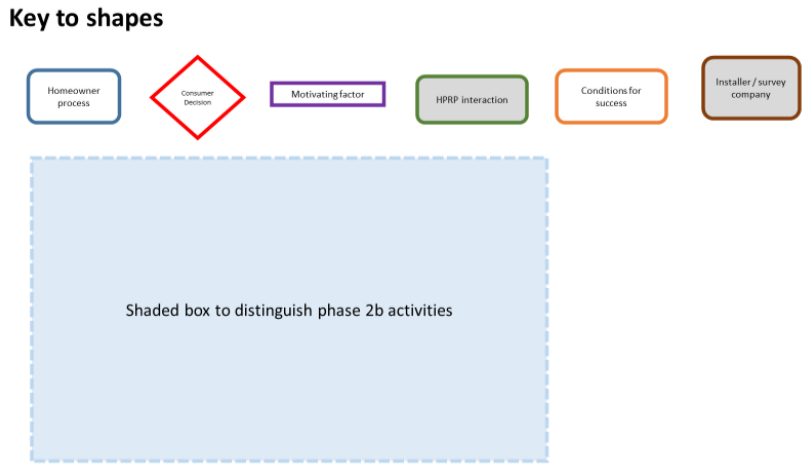


Figure 6—9 Proposed BHPR Customer Journey



6.3.3 Online Householder Survey

Following the initial data review and mapping, cluster homes were targeted via a leaflet drop and articles in the local Westbury newsletter. Residents were invited to attend regular drop-ins where they could learn more, complete our online survey and take part in the future focus groups. In total, 102 responses were received, with data used to develop our strategy for trialling the methodology. Key insights from this included:

- 39% of respondents actively considering installing a heat pump in the next 5 years, with a further 46% currently unsure.
- Of the 46% who stated they were currently unsure, 42% stated that the Climate Emergency was an important factor for them when considering energy efficiency measures. This was followed by Energy Prices (37%) and Improvements in Comfort (31%).
- 24% of households already have solar PV with a further 28% planning to install the measure.
- Solar PV appears to be a gateway measure with many PV owners seeing heat pumps as the next step in their retrofit journey.
- 65% of respondents are not confident they know what changes are required to their home before a heat pump is installed.
- 55% of respondents would be willing to spend up to £5,000 on energy efficiency improvements in order to prepare their house for a heat pump.
- Local independent or specialist tradespeople the highest choice for who they want to carry out installations.
- Quality assurance the most important factor they would look for with tradespeople in a retrofit scheme, followed by accreditation and minimum training requirements.
- 75% of respondents think it is either important or very important that they are able to choose their own tradespeople.

6.3.4 Focus Group Findings

The focus group had 37 participants registered in Eventbrite, of which 27 attended on the evening. Whilst it's not possible to provide a MOSAIC profile of those attending the focus groups, based on their age and family composition, the Café and Catchments and Legacy Elders segments were well represented. In particular, there were a high proportion of working age male residents with school age children.

The key drivers for installing a heat pump noted by the focus group participants were tackling climate change (also referred to as "being green"), moving away from the fossil fuels (as this was seen as "the right thing to do"), and saving on energy bills to reduce the total of my long-term energy costs. However, the recent increases in electricity prices compared to gas led to some doubts over a heat pump's ability to reduce people's bills. The majority of people felt that solar PV would be a bigger priority as this was more likely to reduce their electricity costs.

The most significant barrier identified by our focus group participants was a lack of knowledge on all aspects of heat pump adoption. While the message that householders have received so far is that heat pumps are a good thing to do, many are still unclear as to:

- What will the benefits be? (Or, in other words: what is the point of installing a heat pump?)
- How much work would one need to do?
- What really is needed?
- How much would it all cost?
- What efficiency gains could be expected?

Whilst a number of these questions can be addressed through improved educational materials and resources, attendees had other questions which were specific to their homes. Several attendees were aware that the heat pumps performance would vary depending on the energy efficiency of their homes and the existing heat distribution system. They didn't trust the installer to advise them on the best approach for their home.

"So, I'm not even sure how much …heat I'll be pulling in using a heat pump, let alone be able to balance it to keep my house warm. I just don't know. I can't read it up anywhere. Perhaps you could tell me there's somewhere easy I could go on the net and learn about it."

Quote from attendee.

Similarly, to the community workshop there was a clear desire and need for independent impartial advice that's provided by a trusted third party i.e., not the installer. The lack of trust in the supply chain's independence was compounded by attendees' previous experience of engaging tradespeople i.e., past experience of poor-quality workmanship. To address the trust issue, participants suggested regulated access to trades to only qualified trained workmen.

The focus groups explored residents' issues with investing in heat pumps. If an attendee had recently replaced their gas boiler, then similarly to these attending the fayre, they were unwilling to install a heat pump. Others raised concerns about the additional cost and disruption associated with changes that would be needed for a heat pump to operate efficiently i.e., internal or external wall insulation or replacing their radiators. Government grants were seen as important with half of those expressing an interest in a heat pump indicating that they would only undertake heat pump installations if government grants were available. This again echoes the community workshop where one participant said that the Boiler Upgrade Scheme (BUS) had made the investment in a heat pump economic for him.

Loans were the least popular option of financing energy efficiency measures. This was because the participants were unwilling to incur the upfront costs without certainty of these costs being repaid to them. This was particularly pronounced for older participants, who did not think that the repayment period from the energy efficiency measure will be completed within their lifetime.

Overall people felt able to try and coordinate improvements to their homes themselves; however, they were aware of some of the technical issues that were important in a heat pump installation which made them cautious. The majority supported the idea of a third-party coordinator service. Whereby an independent qualified retrofit coordinator with knowledge of heat pump installation process would be able to answer questions specific to their home and help them through the installation process.

Across all our engagement there has been a clear preference for well-trained and quality assured local installers with the right qualifications to install heat pumps to a high quality. During the focus groups it was suggested that the local authority could take on a "quality coordinating" role by:

- Maintaining and sharing list of accredited, trusted and tested installers and other energy efficiency focused tradesmen.
- Providing references to trusted information sources.
- Facilitating the energy efficiency upgrade processes by making it easier to apply for grants.
- Removing constraints on energy efficiency measures in listed buildings.
- Supporting setting standardised pricing for common energy efficiency related activities.

The proposal sits well with the outcome of WP4 whereby trialling of the methodology will include the development of a supplier hub.

The optimum survey approach was explored with participants. The majority were interested in a detailed survey which would help them to get data on a heat pump best sized for their property. People were willing to pay £100 towards the cost of the survey which aligns with our business model proposals. The preferences for overnight vs 3-week long home assessment options were not clear.

6.3.5 Consumer Research – Synthesis of Results

From the start of the project, we have worked closely with SusWoT to trial and develop a consumer engagement process that works for the residents of Westbury-on-Trym. As described previously, a place-based approach was used at a cluster level, with bespoke approaches chosen in different areas informed by local expertise, WP1 outputs and MOSAIC analysis. Across all clusters it was found that residents were more responsive to leaflet drops, emails and access to websites with relevant information as opposed to "door knocking". They preferred face-to-face engagement in an informal community setting, such as a local pub. Our approach has shown that there is a clear benefit to working with a local energy community group as residents are more likely to trust and approach this group than an installer or a commercial provider.

Our initial data segmentation work showed that residents in Westbury-on-Trym demonstrated a high level of engagement with environmental behaviours and were motivated to act to address climate change. This was supported by our online survey which found that 42% of respondents had selected "the Climate Emergency" as a key motivation for installing a heat pump, closely followed by energy prices and improvements in comfort. This was further corroborated by the thoughts gathered at the community workshop and the focus groups

Many of these households who responded to the online survey want to install solar PV before a heat pump and this again aligns with the workshop and focus group findings. Many of the respondents selected a preference in being able to select their own installer to carry out the works on their properties and had a preference that they were a local business. Over half of all respondents to the online survey were not confident they knew what works were required for their home to be "heat pump ready" and this was again echoed in the workshop and focus group.

Participants of both the workshop and focus group all had similar influencing factors for installing a heat pump. The main reasons identified during discussions covered financial and ecological reasons; such as the want to support the sustainability of the environment by no longer using fossil fuels, making a saving on their energy bills in the long term, having the capital to invest in their homes and their current boiler reaching the end of its life.

Alongside the influencing factors there were similar obstacles that people felt would deter them from having a heat pump installed. The biggest obstacle was many felt there was a lack of knowledge in the industry, especially technical advice and skills in installing heat pumps. This was followed by the worry of what other works would need to be carried out in their homes before a heat pump could be installed and where to turn to for help and advice.

Another finding from the work package was that almost all householders valued independent advice and intermediaries sitting between themselves and installers. It was a popular opinion amongst the participants that the local authority should take on a quality management role, providing references for trusted tradesmen and facilitating applications for grant funding.

All the participants voiced that once a heat pump had been installed in their homes, they would want to receive a performance evaluation report to ensure their heat pump was performing as expected. It was also strongly felt that a link between performance and payment should be implemented and where the energy performance of a property was below expected standards then payment to the installer be withheld until the heat pump was meeting the required standard. The opinion was that this could be tested by way of a two-part survey (pre and post installation) with the pre installation survey informing the householder of the expected improvements and post installation demonstrating the achieved minimum standards. It was noted that residents wanted both preinstall and post install surveys to be carried out by an independent body and not an installer to avoid any bias.

It was strongly felt that standardised pricing was needed across the board, many of the residents we engaged with had found that when researching heat pumps that the prices for the work varied greatly between suppliers and they did not know which of the quotes was a fair price, therefore causing residents to lose trust in the supply chain and not knowing where to turn.

The Key Recommendations from our consumer research on how to engage consumers during the marketing and deployment stages are:

1. Independent impartial advice – there was a strong desire for independent impartial advice from residents in Westbury. Across our engagement and survey activities we consistently found that residents recognised the need for property specific advice and wanted this to come from a third party.

2. Accurate and valued survey – residents expressed a clear preference for an independent survey that delivered valuable information about the size and performance of their future heating system.

3. Photovoltaic as a gateway technology – a high number of people engaging with Phase 1 of the BHPR study already had PV. They saw heat pumps as the logical next step. Targeting these households upfront to build momentum will be a key consideration when engaging consumers.

4. Building trust in tradespeople – to ensure a smooth customer journey we need to build trust in the supply chain. Local installers need to be supported to gain the qualifications and skills they need to be able to install heat pumps into consumers' homes. There also needs to be opportunities for local people to ask questions and understand the installation process in neutral venues through 'meet the supplier' style events.

5. Performance evaluation – there was clear interest in the option to have feedback on the measured performance of their heat pump. Such evaluation could be carried out as a pre and post heat pump installation survey, or via sensors monitoring performance.

6. Standardised pricing – those residents engaging with the research phase had issues with trusting the supply chain and some concerns about the pricing of work. Establishing standardised prices for heat pumps could prove useful, if undertaken by the local authority and trusted third party.

7. Community-led engagement – there's a clear benefit in involving local community groups in the roll out of heat pumps. Delivering Phase 1 in conjunction with SusWoT, a locally rooted and representative community group, has provided us with both legitimacy and on-the-ground insight and experience. During the next phase we will work together to further engage the community, run events and sign-up householders to our trusted scheme.

8. Place-based and bespoke engagement – as detailed previously in this report, communities are not homogenous and an engagement approach that is tailored to those that live there will be key to ensuring the successful rollout of the methodology. Our experience of combining data-based segmentation with local insight and knowledge in Phase 1 has demonstrated that future rollout must take into consideration that different techniques, messaging and messengers may be required at a street, cluster of streets or LSOA level.

6.4 Work Package 4: Supply Chain Training and Skills

In starting to consider the supply chain, it was essential to think about who and what encompasses the stakeholder. Those selected for initial research included heat pump installers, MCS, manufacturers, retailers plus retrofit assessors, thermal performance specialists and fabric contractors. It is important to think about the supply chain in its entirety due to the interdependence of the constituent parts e.g., availability of kit may impact upon installation programmes; customers may require enabling works by general builders or retrofit specialists prior to heat pump installation. It was challenging to speak with heating engineers who had not yet converted to heat pump installs, due to busy schedules, so insights are somewhat limited here. MCS-accredited heat pump installers are still fairly rare, though their number is growing thanks to the BUS scheme. Many of these installers cover a relatively broad geographical region e.g., WECA area, not just Bristol. However, the full order books of these installers highlight a strong need to improve and diversify the skills of local tradespeople who can deliver this work and meet customer desire to work with local installers, rather than national companies. When representative elements of the supply chain were gathered for workshops, there was broad agreement that training, collaboration and knowledge-sharing are among some of the key attributes of a successful scheme.

The findings from Work Package 4 are as follows:

- There is a scarcity of heat pump installers in the local area, indicating that developing training and skills is a priority to grow the supply chain in tandem with customer demand. Additionally, customers have indicated a preference for working with local installers over national teams
- Opportunities exist to diversify the skills of existing plumbers and heating engineers; this group is a priority for upskilling since these trades have existing knowledge and qualifications for fast-tracking heat pump installation training
- Quality assurance is key to customer engagement and satisfactory outcomes
- While MCS is the industry standard accreditation, there is some distrust amongst the supply chain around the efficacy of the scheme. It is seen by some as a 'box-ticking' process, rather than a measure of true competency and quality. Customer quality assurance was also found to be lacking. However, conversations with MCS had outlined ongoing plans for systemic improvement such as a five year competency reassessment
- A robust competence framework is needed, with meaningful assurances for consumers
- A collaborative approach to the supply chain is important; intertrade working gets the best results. Supply chain stakeholders include surveyors, assessors, fabric installers, heat pump installers, retailers, manufacturers plus ancillary trades e.g., electricians
- Customers must benefit from early recommendations by retrofit assessors and fabric installers to optimise the efficiency of their heat pump and reduce running costs
- A tailored training approach and specific training on the project methodology is needed to get the best from supply chain teams, ensure mutual understanding of the process and to refine skill sets within the project roles
- Mentoring is a useful strategy for new heat pump installers who need to gain competence and confidence
- Knowledge-sharing and mentoring within the supply chain helps to increase skills and keep standards high – this can be facilitated by a 'hub' style operational model
- A clear methodology that facilitates good communication between surveyors, installers and customers will enhance the outcome of the project. A clear plan that maps the customer journey is essential to ensure that all elements of the process are considered, from initial enquiry to after-care and annual maintenance
- Allocating pre-installation survey work to heat loss surveyors would reduce the impact on time spent by heat pump installers
- The hub should be independently run i.e., not manufacturer-led
- Installers would see benefit from hub membership as it allows them to focus their time most on installations rather than surveying and initial enquiry work
- Installers would also benefit from having quality information about the household in order to build an accurate system design from therefore de-risking the problem of unwittingly miss-sizing a system

- Overall, we found that there are many challenges associated with building capacity in the supply chain to deliver heat pumps at scale. Our hub approach tackles this head on and responds directly to feedback from customer wants in terms of having a local and highly skilled supply chain.

6.5 Work Package 5: Business Models

After exploring options and appraising the emerging BHPR service model; the corresponding business model was developed in line with the project methodology and Figure 6—10 sets out an example of the cashflow approach in order to demonstrate self-sustainability.

Due to the nature of the proposed model being delivered by securing volume discount to feed into the project and cover overheads, a number of notional values have been derived to demonstrate how the model would work. In practice these will be refined throughout the subsequent deployment stages to ensure by completion of the trial of the methodology that a sustainable model has been tested and can be deployed.

The following assumptions have been made outlined in Table 6—5.

Table 6—5 Cost Model Values and Assumptions

Inputs	Value	Comments
CAPEX		
BUS/HPR - HP Install	£5,000	Grant or government funding contribution
Consumer Contribution	£5,200	Value consumers would be required to pay on top of any grant or government funding, this is inclusive of the consumer volume discount secured against HP equipment
Total HP Install cost	£10,750	In line with cost to consumer calculator
HPR - Survey	£400	In the scalable model this would be required to be paid by the consumer
Customer - Survey	£99	Under HPR a notional value will be paid to encourage conversion to installation
Survey Supply Chain		
Survey Management Fee	£49	Assigned to the organisation managing the consumer journey from the expression of interest through to the survey deployment
Survey Provider	£450	Value awarded to surveyor for the HPRS
Supply Chain		
Supply Chain Hub Membership Fee	£250	Costs that supply chain members (installers/surveyors/ etc.) would be required to pay outside of HPR to enable supply hub maintenance and accreditation to be managed
Supply Chain Volume Discounts - Total	30%	On Materials - main equipment only (HP's and storage) as negotiated with suppliers and manufacturers for trial of the methodology. Ongoing discounts would be significantly influential in the cost model viability

Inputs	Value	Comments
Supply Chain Volume Discounts - Consumer	10%	Direct saving passed through to the consumer for obtaining a heat pump through the HPR methodology
Supply Chain Volume Discounts - Installer	5%	Discount saving passed through to installer to cover costs of design and system planning activities
Supply Chain Volume Discounts - Fed into Project	15%	Value fed back into the project overheads to enable annual management, analysis and delivery of the HPR scheme
Labour Costs	£3,500	Estimated average cost for a typical heat pump installation
Material Costs – Heat Pump	£4,000	Estimated average cost for a typical heat pump unit
Material Costs - Storage (water/thermal battery)	£1,500	Estimated average cost for a typical heating system thermal storage element
Material Costs - Emitters / ancillary	£1,750	Estimated average cost for a typical heating system part
Project Management and Delivery - Break Even Model		
Programme Management	£55,000	Annual cost to manage and deliver the overall scheme
Data and Visualisation Services	£120,000	License and Maintenance for Digital Twin platform to enable the targeted community engagement – pre customer journey
Community Engagement Services - pre customer journey	£29,000	Delivery of targeted community engagement to stimulate uptake
Customer Journey Management	£47,000	Delivery of enhanced customer journey following sign up through installation and evaluation
Training Delivery/HPR Certification	Fee Varies	Cost per Installer to carry out training required under the HPR scheme
Project Management and Delivery - Profit Model		
Programme Management	25%	% of fee above break-even fee per install for additional services/resource to manage increase in volume
Data and Visualisation Services	25%	
Community Engagement Services	25%	
Customer Journey Management	25%	

6.5.1 Break Even Cost Model

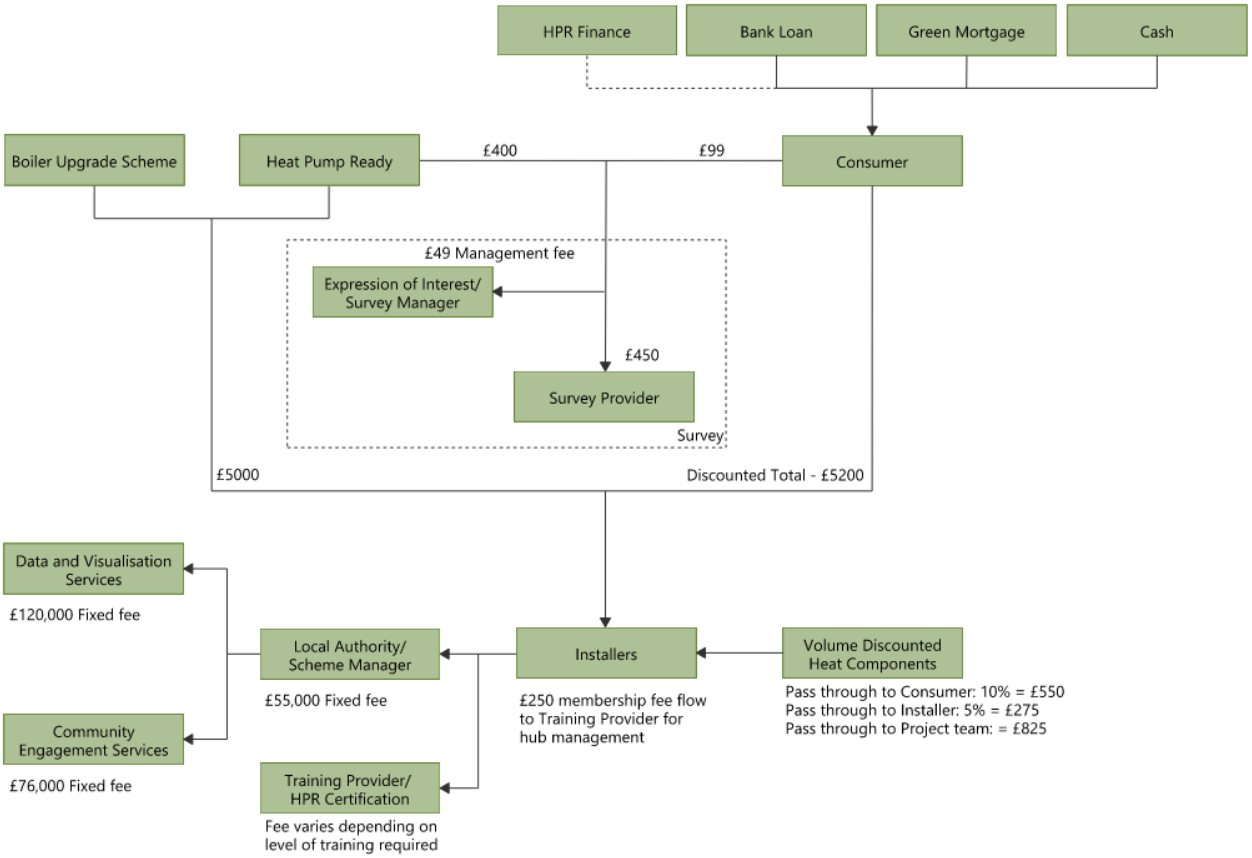


Figure 6—10 HPR Business Model Proposal

Based on the values outlined in Table 6—5, the number of heat pump installations required to make the model viable is 315 per annum.

It should be noted that the total volume discount on heat pumps and equipment demonstrated in this example is 30%, however up to 45% have been offered via select manufacturers. Further discount in addition to the notional 30% would result in a reduction of the number of heat pumps required to break even.

6.5.2 Profit Cost Model

Under this model, once the breakeven number has been met, there is opportunity to recycle any profit made back into a fund pot for further financial assistance with other initiatives or to fund the less able to pay market. An example of this has been set out below in line with the values in Table 6—5.

If the target number of heat pump installations is 1000 per annum, then there would be an approximate uplift of 35% on project costs from ~£250k to ~£400k given the additional community engagement, data analysis and project management that would be required to handle a further 700 installs above the breakeven quantity.

It should be noted that once the breakeven quantity has been reached, the project costs would decrease to approximately 25% of the original fee and then multiplied by the quantity of installs delivered above breakeven. This results in surplus profit of ~£430k for 1000 installs.

6.6 Work Package 6: DNO/DSO Interface

Engagement was undertaken with NGED at regular intervals throughout Phase 1. The process of liaising with NGED (Western Power Distribution at the time) was in itself informative in how new innovative approaches such as Bristol Heat Pump Ready also require innovation in the way a DNO needs to interact with the industry to achieve the goals of accelerate uptake of local carbon technologies such as heat pumps.

Multiple interfaces were required with the DNO including contacts with local teams, the central innovation team and policy team. A degree of coordination was required to manage these multiple interfaces.

The process of undertaking planning activities under Work Package 1 raised a number of challenges with current NGED data quality and processes in terms of being fit for purpose to deliver new models such as BHPR. In particular current published data sets do not permit the development of an accurate low voltage electricity map with individual property connections. Therefore, approximations have to be used for the properties assigned to individual substations for the purposes of planning, using 'polygon' data available. This polygon data does not assign households to transformers in a spatial context.

NGED was approached to discuss how more accurate data could be obtained and the BHPR project team was advised that for Phase 1 this would not be possible due to concerns on GDPR data conflicts. However should the project proceed to trialling of the methodology then discussions could be held on formalising a process through data sharing agreements and direct discussions with the NGED data team.

Initial discussions were also held on policy regarding heat pump deployment in particular relating to the application of diversity on planned connections. Current NGED policy is not to apply diversity to heat pumps which when compared to traditional ADMD assignments to properties for normal power loads; represents a significant increase in the capacity requirement for homes. This approach is not consistent with other UK DNOs and also does not recognise the potential for smart technologies to ensure diversity on systems. Indications received were that this policy is under review. Any application of diversity will significantly increase the allowed penetration of heat pumps into networks and is therefore considered a key area for further assessment.

7 High Density HP Deployment Methodology Developed Under Phase 1 for Future Deployment

The key outcome from the Work Packages is the design of the BHPR methodology which now has to be further refined and the underpinning tool kit and capability developed so it can be deployed at scale.

The methodology has been designed with various elements being pilot tested through Phase 1 in collaboration with the project partners and a large network of advisors to tailor an innovative and collaborative approach to consumer engagement and deployment of heat pumps in an urban environment.

The initial planning methodology deployed has been tested on a finite area of Bristol and determined that a data centric approach is needed to filter and identify heat pump ready homes. The outcome of the pilot showed that without any intervention only 10% of homes were actually heat pump ready which is already a useful piece of evidence on the challenge to be addressed in focussing on the initial uptake required.

The use of community information and data is already proving invaluable in closing down on heat pump ready homes by providing a layer of local knowledge that would otherwise be lost or difficult to analyse in conjunction with other information.

Whilst not tested yet the use of the advisory panel has indicated that changing the survey process used to incorporate more accurate building physics based analysis of properties will provide dividend to both consumers and the industry in more accurately appraising property performance and thus more accurately sizing heating systems.

The agnostic approach proposed to now directly contact consumers under a Bristol Heat Pump Ready brand sponsored directly by the local authority as the lead is also felt to be significant in driving consumer confidence.

The outcome is a service model which incorporates all of these elements and a business model build on the deployment of low or nil profit components which ensures no significant overheads will be passed on to consumers and in fact due to economies of scale will result in discounting that could not otherwise be achieved.

The business model designed in Phase 1 is intended to be self-funding, as it stimulates uptake though the delivery of economies of scale that deliver multiple benefits including lower consumer cost and lower overheads for the supply chain. Not only will heat pump numbers rise rapidly as a result, but the local economy will also directly benefit from increased installation work. There will be direct social-economic benefits derived also from the additional revenues retained by the programme manager on a non-profit basis which are then reinvested to enhance the offering to help those households unable to initially participate.

The business model derived from the methodology is self-sustainable and based on current estimates only requires 315 heat pumps per year. Based on our projections an initial investment into the methodology the approach would enable a local market worth over £30m per year and accelerate heat pump installations by 2028 in Bristol equivalent to the current national scale of deployment being seen under the Boiler Upgrade Scheme.

Reference is made to Figure 7—1 which outlines the overall process and roles of the stakeholders in the process. The model uses defined roles which are then assigned to relevant parties with the necessary experience and expertise. The cost model should also consider the nature of the organisation and the costs likely to be incurred as a result of the OPEX incurred. The model is predicated on a low profit offering from the parties involved to ensure consumer value.

The project delivery team, in any given location, should work closely with external stakeholders in the region. This includes the DNO, in this instance NGED, who will provide guidance and information on the electricity network in the area as well as taking into consideration the learning from the HPR process.

Below is a further explanation of the roles and process developed:

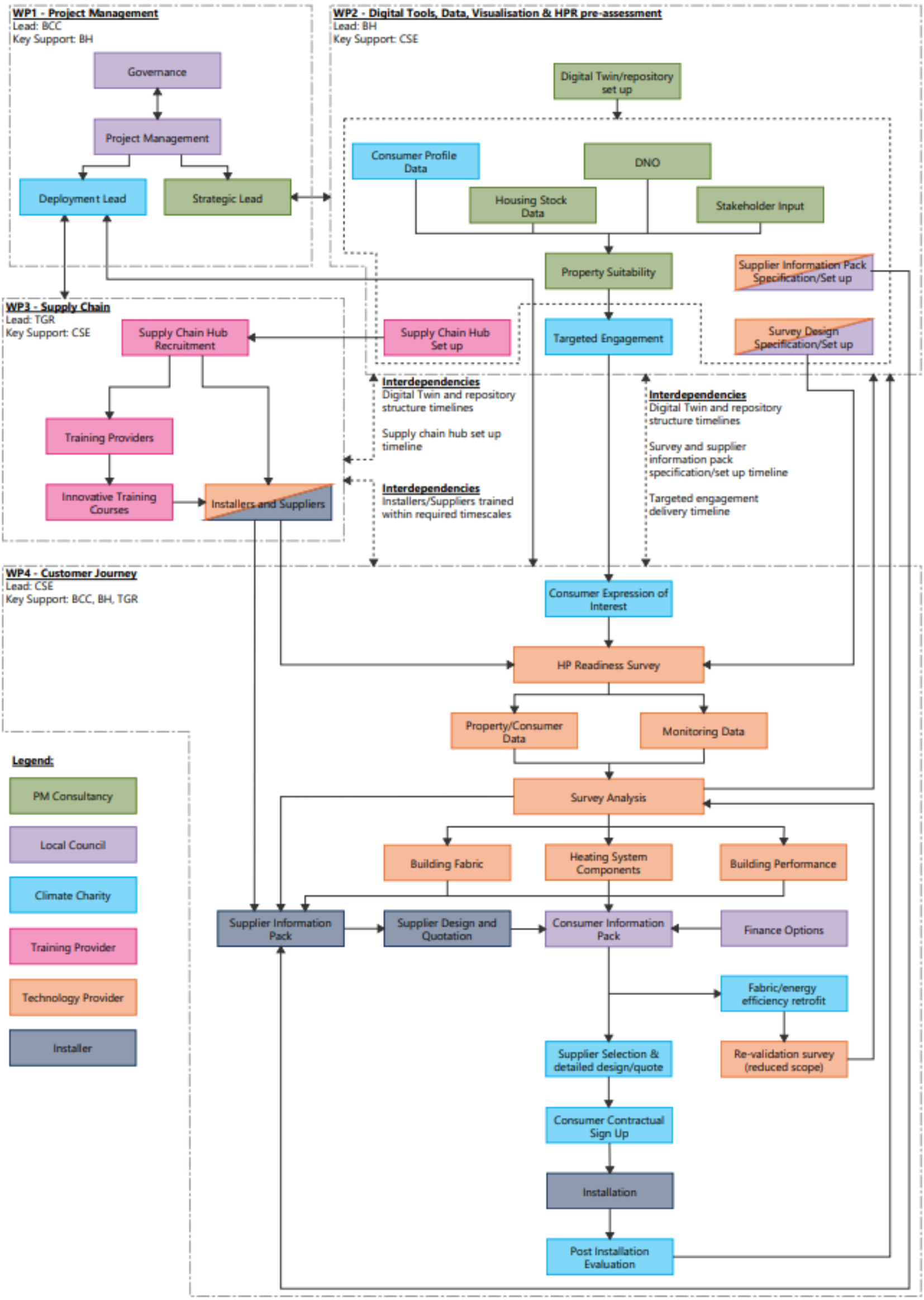


Figure 7—1 Proposed Methodology Process Flow

The methodology is based on the integration of four work packages which are described in more detail below and form the basis of the proposal for next stage deployment strategy (revised from the original work package structure discussed in WP1).

7.1 WP1 – Project Management (Bristol City Council)

This role will be the overall lead and enabler of the service offering. This will include accountability and implementation of the required governance. It will be supported however through the implementation of the model by a Deployment Lead and a Strategic Lead during the subsequent stages, as well as any subsequent role out of the methodology.

The key roles will include overall governance, ensuring value for public spend, consumer protection and proving a trusted backed brand to the service model. As the methodology matures into a commercially standalone model it is intended that it could then be transferred into other means of delivery vehicles or retained by local authorities as required in order to delivery at wider scales.

Contracted and overseen by the project manager, the Deployment Lead will be responsible for coordinating on the ground activities including consumer engagement, supplier engagement (for delivery of installations) and community stakeholder engagement (WPs 3 and 4).

The supply chain hub manager and training provider will be directly responsible for training and certification of the installers, which is required before they are permitted to deploy ensuring a process of quality assessment is followed. Under subsequent stages of deployment TGR may be contracted directly to BCC but under the service model they will eventually operate independently providing training courses and certification in return for revenue. This will reduce the overall overheads to BCC in administrating the process.

Contracted and overseen by the project manager, the Strategic Lead will be responsible for supporting in the activities associated with developing and deploying the overall strategy, gathering insights on success, failures and learning as well as overseeing the activities associated with WP2 digital planning and visualisation.

7.2 WP2 – Data Visualisation, Stakeholder Interfaces and Pre-assessment (Buro Happold, CSE)

This work package will significantly reduce the overheads associated with identifying and targeting consumers for uptake. The current industry process typically relies on consumers initiating the procurement transaction and the supply chain responding. This results in fragmented demand that can also originate from householders with properties that are unsuited for air pump use, and much wasted effort.

The approach within this methodology will also overcome multiple barriers to engagement and uptake. These include electricity network capacity and building efficiency.

The solution consists of two key components: data visualisation with mapping (digital twin) and customer relationship management (CRM). In the instance of Bristol HPR, Buro Happold will lead on the digital twin components whilst CSE will lead on the CRM components:

7.2.1 Spatial Mapping, Data and Visualisation

The approach to spatial mapping and visualisation is seen as key to being able to identify, locate and target heat pump ready consumers. The development of this part of the methodology will be utilising existing tools and systems but tailoring the application to align with the BHPR methodology.

The HPR delivery stakeholders will spatially map and grade areas within the city according to heat pump readiness based on:

- Current building efficiency (benchmarked)
- Fabric construction
- Ease of implementation of efficiency measures
- Electricity network capacity
- Demographics on occupants
- Learning from current and previous deployment and consumer interfacing

By cross mapping and overlaying this data it is possible to pinpoint properties that would be heat pump ready and then apply a sensitivity analysis for those not immediately ready, to determine what level of intervention would be required.

The initial objective is to identify groups of properties that require minimal fabric improvements, have external space to locate air source heat pump (ASHP), in a demographic that is able to pay, where there is sufficient electricity network capacity for deployment and initial consumer engagement is positive. Post trialling of the methodology this will be extended to other areas in the city as well as begin to widen the search criteria to slightly harder to reach consumers.

The comparative attractiveness will be visualised (e.g., red, amber, green) for easy recognition and communication. The search will be further refined and tailored as more information becomes available as the process and market matures. For example, it can be widened to search for properties that may still be suitable but will require slightly more intervention to make homes efficient enough for heat pumps, or where (subject to agreement with the DNO) network capacity could be recalculated or released to allow more heat pumps to be deployed.

Millions of data points will be needed for a city region, requiring the computing power of modern cloud systems. The latest in digital twin technology is available and will be used to process and manage this approach. Only the digital twin capability will allow users to visualise and analyse this data at scale.

The digital twin and visualisation capability provided through the portal will itself be built on a data hub which collects multiple sources of information and data. This will use existing tool sets and platform construction but will organise and structure the data and information from these sources to provide the BHPR service offering.

Additional data will also be collected and incorporated into this system to further enhance the value. Examples include:

- The collection of community data and survey information to enhance local knowledge. Active engagement by local community groups will provide useful input on where people have already expressed an interest, or conversely where they are unlikely to, and why.
- Outputs and learning from building monitoring undertaken in WP3. More accurate appraisals of building archetypes will allow more precise consideration of building performance and permit the refinement of benchmarking.
- Supplier intervention data on where suppliers have already targeted and their feedback.
- Collated information on where consumers have used the portal to express interest, received the heat pump ready service and gone on to install.
- Evaluation of barriers to take up, through the evaluation of those who expressed interest but then dropped out.

The hub will have an analytics capability to appraise and monitor how the heat pump market is developing within the city. It will monitor scale and deployment costs, consumer feedback and system performance.

7.2.2 The Installer Interface

There will be an interface for installers to understand the BHPR process and apply for membership and certification as well as to share useful information with each other.

Information on heat pump ready consumers will be provided as part of the referral process. An initial appraisal of where heat pump ready consumers are likely to be will inform the delivery partners on where to engage. Installers will use the interface to identify their customer base.

Underpinning the process is the certification and membership scheme for installers. The benefits of the methodology will be to provide them with access to market uptake and consumers at significantly reduced overheads. This will result in scaleup and economies of scale to make the process commercially viable. This approach has already been discussed with the local supply chain and there has been positive response.

7.3 WP3 – Supply Chain (The Green Register)

A supply chain hub will be created which will be designed to ensure quality of delivery of the methodology. It will be based on a membership model that requires certification in order to be a compliant BHPR approved installer. This will ensure consistency of approach and support the consumer perception of quality BHPR is designed to deliver on.

To ensure buy-in, the process will be co-developed with the supply chain and will involve carefully selected installers who wish to participate, share learnings and collaborate. It is not designed to replace existing installer training and certification, such as MCS, required by the industry, but to supplement it with training for installers on how the BHPR differs and how the supply chain needs to interact with the BHPR service and portals. Vitally it will add value in important elements of successful heat pump installations, such as training in fabric improvements, integrating building services and building performance.

The key areas of focus are:

- **Supply Chain Recruitment** – active recruitment and triage of local supply chain into the programme through networking and reputation
- **Training providers** – development of a network of training providers who are conversant with the methodology and the training material needed to appraise, train and certify installers
- **Innovative Training Courses** – the development of specific training courses and criteria including material and process of certification
- **Installers/suppliers** – will be able to apply for training, receive certification and become a certified member of the hub and scheme. Performance will continue to be evaluated based on consumer feedback through the process. A pool of certified installers will be recorded and opportunities presented to them from engaged consumers that are heat pump ready.
- **Mentoring** – nurturing and it is increasingly common industry practice to have experienced heat pump installers mentor others looking to gain experience.

7.4 WP4 - Customer Journey (CSE)

The customer journey is perhaps the most tangible component of the methodology; it involves direct interaction with consumers and the deployment of heat pumps into people's homes.

The work package contains the following aspects:

7.4.1 The Consumer Portal

A tailored consumer interface will provide information on the process, the value of participation, benefits and how to engage. Future developments will hold customer specific accounts linked to the CRM system allowing consumers to access their survey information digitally.

Consumers will have access via a portal which allow them to access information about their progress through the BHPR programme i.e., engagement to install. For example, they will receive information on the service, guidelines on how to use it, how to express an interest and what the benefits of using the service are. Quotations from installers will be provided through the portal once the survey process has been completed.

7.4.2 CRM

The CRM will utilise existing capabilities for consumer and community engagement but develop them to deliver the service model. This will include GDPR compliant customer relationship databases, web page interfaces and content.

7.4.3 Community Engagement

The Development Lead will build on the success of the initial community engagement in Phase 1 of the BHPR programme. Work will be carried out to deliver more in-depth engagement in the streets and communities that were identified by the outputs from the Targeted Engagement element of Work Package 2. To build a foundation and grow local interest in heat pumps, early adopters will be identified to establish "Open home" and "Meet the supplier" events in key geographical areas. Further surgeries and drop-in sessions will help allay consumer fears and disseminate the benefits of the programme. Early sign-up from this process via the consumer portal will help engage the DNO to identify any costly grid reinforcement actions which could cause delays if not flagged via community led expressions of interest.

7.4.4 Direct Consumer Engagement

Once community engagement has built a foundation for marketing, contact will be made with all targeted residents with the service offer. This will then be followed up by additional community engagement.

7.4.5 Consumer Expression of Interest

Local residents that express an interest (EOI) in the scheme will be encouraged to sign-up via the consumer portal. The portal will capture the key data points required for the initial screening processes. The EOI will include the following types of questions:

- Existing property efficiency and measures in-situ.
- Any installation barriers from the householder's perspective. This will include their willingness to make changes to their home such as changing radiators, removing flooring, locating a hot water tank etc.
- Understanding any possible network constraints e.g., the existing presence of an electric vehicle (EV) charger, battery or solar PV.
- Understanding any property constraints e.g., age of existing internal electrical circuitry.
- Confirmation of findings included in survey report.

A screening of applicants will be carried out and a contact made to those where an onward referral may lead to dropout due to the property being unsuitable. Any residents who do not wish to use a digital platform will be supported face-to-face or by telephone support to ensure the project is inclusive and doesn't exclude anyone digitally.

7.4.6 Heat Pump Readiness Survey

Once the homeowner has submitted their EOI and their commitment has been confirmed, they will be booked in for the HRPS, a tailored survey process for appraising homes which has been specifically designed for this programme. This includes elements of current practice but is enhanced through the use of building physics-based monitoring in conjunction with collection of building information and a conversation with the homeowner, which provides granular property performance data and profiles but also more information about the consumer, aspirations, perceptions and needs.

7.4.7 Survey Analysis

The survey assessment will accurately determine the heat transfer coefficient (HTC) for the property and thus size the heat pump system optimally. The survey will also appraise any efficiency measures that would be beneficial to the consumer which will in turn reduce heat pump size, improving installation cost, comfort and future bills. All of this information will be fed into two packs; the Supplier Information Pack and the Consumer Information Pack.

7.4.8 Consumer Information Pack

Following the assessment, the Consumer Information pack will be created and made available digitally via the portal or in hard copy depending on the consumers' preferences. This contains information in an easy-to-understand format, describing the offering and options for the consumer. This can include how the heat system will operate, expected performance, options for fabric improvements and indicative pricing information. Options exist to add supplementary information on financing and other services in the future. This can be updated as required and with the final system design. The pack will incorporate the supplier outline quotation and be updated with the final quotation and system design as described below.

7.4.9 Supplier Information Pack

In a parallel process the survey information will be passed to an installer as a digital pack that is supplied to heat pump contractors to access. This pack includes the necessary information from the survey process to allow installers to properly appraise options and be briefed before any consumer engagement. This will allow for a swift outline quotation that can be finalised at once the consumer has made a stronger commitment or intention to proceed to install.

7.4.10 Supplier Design and Quotation

With the information provided in the Supplier Information Pack, the installer will be able to generate an initial system design and provide a guideline installation cost as well as guideline running costs. This will then be added to the Consumer Information Pack and passed to the homeowner to review. Once the homeowner has confirmed they wish to proceed onto the next stage, the installer will visit the property in order to provide a final heat pump design and an accurate quotation. This is then added to the Consumer Information Pack and provided to the homeowner for consideration.

7.4.11 Finance Options

Initially, finance options will be limited to those available via the BHPR and able to pay consumers will be targeted. However, the service model will be adaptable for further finance options to be added in the future.

For example, council-backed lenders (such as Lendology), green mortgages, direct consumer finance and subsidy paid towards the heat pump. Emerging models such as the recently announced tie in between Halifax mortgages and Octopus to provide a £1000 contribution to heat pump costs will be monitored and included in consumer advisory services.

This will be explained to consumers early on in engagement through the consumer interface and survey process, in order to demonstrate high level research carried out and available products for consumers to assist financially. The Consumer Information Pack will outline the costs and benefits of different pathways to installing a heat pump, including payback and benefits of any fabric improvement options.

7.4.12 Fabric/Energy Efficiency Retrofit

A set of options coming out of the survey process will be presented to the consumer. These will outline the benefits case for installing additional measures, over and above the base threshold to ensure a heat pump is viable, such as options to improve comfort and/or reduce bills, or the heat pump installation cost.

The installer/supplier membership model is designed to allow retrofit specialists to join the hub and integrate with surveyors and heat pump installers, as opposed to considering fabric improvements separately from heat pump installations which is the default position for the industry at the moment.

7.4.13 Revalidation Survey

If a consumer selects a fabric/energy efficient retrofit option then it will be referred to a fabric specialist (which may or may not be the same installer) to provide a more detailed evaluation and quotation for these options. Where there are significant improvements, the household will be offered the option of a resurvey, at an additional cost to them, to provide a recalculated HTC.

7.4.14 Consumer Contractual Signup

The consumer will sign a contract directly with the installer as per the current standard process in industry. The installer will manage all aspects of the installation including guarantees and warranties.

For the BEIS HPR programme there will be separate agreement with BCC to provide the HPR payment to the supplier once the installation has been signed off and accepted by the consumer and the consumer has made their payment.

7.4.15 Installation

The installation process will be managed by the installer directly with the consumer. The consumer however will continue to have support from the HPR programme. They will be able to feedback issues directly by contacting the customer journey manager or feeding back issues via the portal.

7.4.16 Post Installation Evaluation

A key part of the learning is considered to be to consult the installer and consumer on their experience of accessing the BHPR programme. The team will use this feedback to refine and improve the service. A co-design exercise will be coordinated to ensure customer guarantees meet with both household expectations and industry acceptability.

In addition, subject to consumer approval, a process of monitoring will be implemented to collect useful data on actual system performance in-situ. This will help inform: the WP2 process to better refine the assumptions on similar archetypes and consumer categories; WP4 on improving the consumer engagement process; and WP3 on improving supplier training.

8 Areas for Innovation

The overall proposed approach to Phase 1 and determined model will be tested on real communities which in itself is considered innovative by virtue that there is no such service proposition currently in the marketplace. The model requires the coordination and collaboration of a number of different parties who would not have otherwise collaborated were it not for the BEIS HPR funding. Throughout the delivery of the Phase 1 feasibility study, a number of specific areas for innovation have been identified and further developed in consideration with encouraging the uptake of heat pumps and how this is carried out when being delivered at scale across any location in the UK. Some examples are identified below:

8.1 Targeted Consumer Engagement

The current market business as usual model typically relies on consumers to initiate engagement with the installers and if interested in subsidy also arrange the application for funding and organise the installation. Our approach turns this around so that consumers are targeted proactively.

The ability to deploy targeted consumer engagement presents opportunity to reduce resource and subsequently cost for the recruitment of consumers.

The methodology (Section 5.1) and the findings (Section 6.1) demonstrate the value in being able to stack data from various stakeholders to inform target areas. The concept of digital planning to identify heat pump ready consumers has been tested out in Phase 1 on a prototype basis in the absence of a digital twin. The target area used has in excess of 8000 properties, which is clearly small in comparison to the city as a whole but large in consideration as a community and sufficiently large to also be the location for the initial evaluation of the methodology in practice. The pilot method showed a detailed appraisal of multiple data sets can achieve significant results. Initial results clearly identified clusters and also showed that only 10% of properties in the area were heat pump ready without intervention but more could be ready with light intervention. This is based on opening available data. The alternative to not using planning would have meant more traditional field work in targeting consumers, door knocking, surveys etc. which was not possible within the timescales.

Utilising state of the art Digital Twin capabilities going forward this methodology will be enhanced and digitised to be viable for large scale city deployment allowing scaleabilty needed. The Phase 1 method was fine for looking at smaller scale areas but would not be able to cope with the complexity of a city application.

The development of an appropriate data governance and approach to integration of different existing platforms to support this will change the landscape in how to use a digital hub and visualisation capability for city scale deployment further innovating the approach.

Figure 8—1 summarises the concept of a heat pump ready data hub model. This was developed as a result of the Phase 1 activities for future deployment. This was done after identifying and categorising the different potential sources of information and information transfer needed for successful and rapid deployment at city scale. The quantity of different data sets and stakeholders that will feed into and utilise information out of the digital twin will be vast but can also be expanded and developed further in the next development stages. The transition of information can be one way or two way depending on the type of data, GDPR requirements and levels of required access. Two way transfer routes are necessary where an identified stakeholder requires information to be taken out of the hub for decision making. Examples can include the community engagement team taking the mapping data for targeting homes then

feedback back results of intervention or providing the forecasted plan of anticipated connections to the DNO so they can respond with a connections plan and advise on network impact.

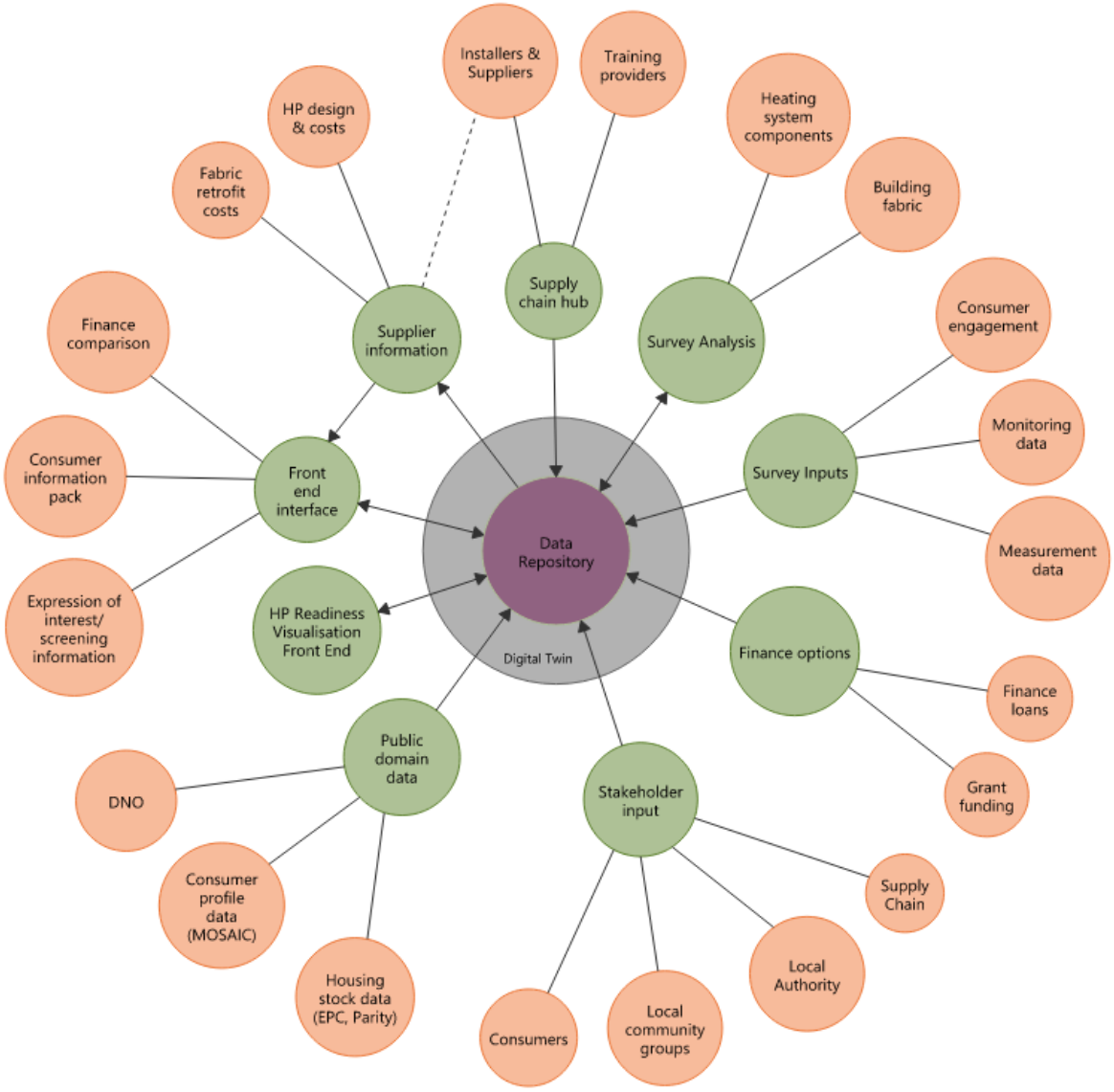


Figure 8—1 Digital Twin Data, Stakeholders and Structure Proposal

8.2 Managed Customer Journey

From the outset in putting together the Phase 1 offer we had identified the need to focus on the customer and their experience. This builds on the existing knowledge of the partners and advisory panel members. Whilst the customer journey for business as usual today was well understood, the customer journey and experience for the BHPR service model had to be carefully considered. Our proposed customer journey doesn't just offer an end-to-end solution for householders.; it's highly innovative for a number of reasons. Firstly, the process is designed to protect the customers best interest by decoupling the survey process from the installer. CSE and TGR's experience of working with installers throughout the previously BEIS funded supply chain pilot Futureproof are that they are very busy and as such their time for detailed accurate surveys when quoting for systems has diminished, they also have no driver to promote energy efficiency and thus reduce the size of the heat pump needed. What is more, large installer actors in the industry who are also energy suppliers have no vested interest to see accurate heat pump sizing. It is also understood from feedback that consumers would like the opportunity to have only one survey to determine their needs without feeling they are tied to a particular installer. Our innovative approach uses a cross-sectoral partnership approach to delivering this service.

Secondly the process designed in Phase 1 for refinement and implementation in subsequent phases will offer the customer a significantly enhanced customer journey. People will be able to register their interest via a consumer portal (incorporated into the hub model) and answer a number of screening questions to identify any barriers or blockers. Our PAS 2035 qualified staff will then be able to provide initial advice to households where necessary, before an onward referral for our survey. The survey results will provide installers with all the necessary inputs for an outline quotation. Our local authority backed installers have additional skills and training which further enhance community confidence.

Thirdly, our marketing approach is community led and provides a bridge between technical desk-based analysis (see the digital twin above) and the targeted consumers. Rather than a commercial organisation approaching the residents with a sales pitch for heat pumps, many of which carry bold claims for savings which people do not trust, we will work with early adopters to act as community mavens. During Phase 1 we worked with SusWoT to significantly enhance the community's capacity to support the next operational phase. We will utilise this community capacity to target and recruit 25% of households in our target clusters, thus demonstrating a high degree of innovation in our marketing approach.

8.3 Supply Chain Recruitment

The service model designed under Phase 1 is predicated on a membership and certification approach that ensures that installers are fully aware and compliant with the revised approach to delivering the service. The survey process has also been redesigned as compared to business as usual to include specialist surveyors who will use building performance monitoring. Initially, selected surveyors, installers and contractors will be invited to join the Bristol Heat Pump Ready hub who based on local knowledge and consultation have the necessary experience. This engagement process will build on the initial engagement through the advisory panel work already undertaken. These organisations will be chosen from project partner networks, including via our advisory panels, and represent trusted contacts. At this stage there will be an emphasis on recruiting experienced heat pump installers with MCS accreditation. The fabric installers, who will undertake enabling works for 'heat pump readiness' in appropriate homes will be approached via the Futureproof group – a pool of contractors trained by The Green Register in retrofit. Surveyors will be recruited from Veritherm, a key delivery partner specialising in in-situ heat loss measurement. Domestic Energy Advisors and Retrofit Assessors may be included to undertake training in thermography or other heat loss measurement methodologies, that will generate data for the homeowner's information pack. Figure 8—2 demonstrates the approach of the innovative supply chain recruitment and training process.

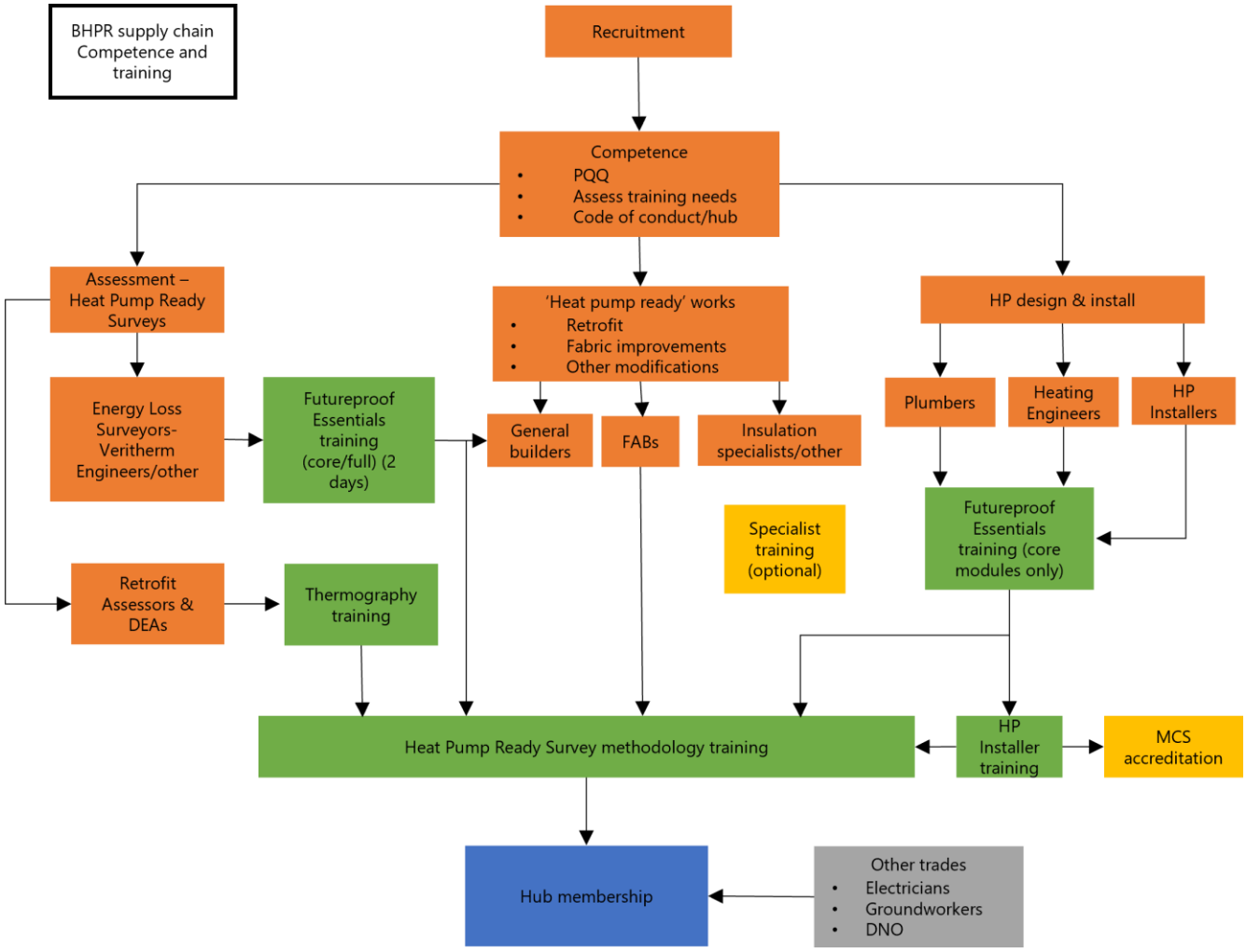


Figure 8—2 Supply Chain Competence and Training

Recruitment Target Groups

The following are identified as target groups for recruitment in part for the purposes of Heat Pump Ready driven by government requirements to only include MCS certified installers. The supply chain membership and certification process including training will be managed by the Green Register with further oversight and management facilitated by CSE during the installation process as the lead on the customer engagement process. They will be selected on the basis they can manage their own resources but have the competency to adhere to the BHPR process and interact with the service model and stakeholders. They will also be selected based on their desire to share learning and improve service delivery within the city.

- MCS registered heat pump installers
- Heat pump installers, through MCS umbrella scheme registers
- Existing heating engineers and plumbers will be targeted through local merchants
- Apprentices and newly qualified plumbers and heating engineers via local colleges
- Futureproof Associate Builders, who are trained in retrofit will be recruited for building fabric improvements and other enabling works
- Surveyors to be targeted through Veritherm, Build Test Solutions, CSE and community energy groups

A short questionnaire will be deployed, similar to a pre-qualifying questionnaire (PPQ) commonly used in supply chain frameworks, to be completed by each prospective member. This will assess any existing industry qualifications and experience and identify training needs. Members will be required to sign up to a customer care charter, designed to assure quality workmanship and aftercare.

8.3.2 Home Survey Approach

Under Phase 1 we explored the process of surveying buildings and calculating heat system sizing. We convened a series of workshops with an expert advisory panel to co-design the approach, based on industry best practice, latest technologies, and a customer focused approach. Attendees to the workshop included local installers, Nathan Gambling (Betateach) expert advisor, Energy Tracers CIC, Veritherm, Build Test Solutions, local renewable technology merchant PHC Renewables, a retrofit coordinator from CSE and The Green Register.

As a result we have developed a new approach to surveying which incorporates a building physics based approach. The approach centres around moving away from relying on assumption-based assessments using standard heat loss calculation approaches. We know from studies that this can result in heat pumps being oversized by up to 50%, resulting in high running costs and significantly greater grid loads than required. The approach incorporates the collection of building data (e.g., room sizes), assessment of building fabric, thermography, measured heat transfer coefficient (HTC), and an assessment of the homeowner's appetite for works. The constituent elements of the HPRS are tried and tested within the industry, but as yet we are unaware of any service offering that combines these to maximise the information available to heating engineers when designing systems i.e. resulting in accurately sized, high performing heat pump installations with reduced lifetime running costs.

Of further benefit is as well as being more accurate the time for deployment of the survey is significantly reduced. The HPRS will be undertaken within less than half a day and the householder would only need to be present for approximately 2 hours of this. The overall time commitment is more than a standard heat loss survey however is significantly enhanced given the multi-faceted nature. How the HPRS fits in to the overall customer journey can be seen in Figure 9—1.

The information provided to the householder will be detailed but understandable and also advises them on how to improve system performance through both shallow and deep retrofit.

We also believe taking into account the current end to end process we can reduce the overall cost by 50%, reducing the estimated current cost of constituent survey elements from £1000 to £499. This cost savings is achieved through combining multi survey techniques and tools in to one visit and training surveyors in a multi method approach.

8.4 Supply Chain Training

An innovative, holistic approach has been developed that brings together all elements of the supply chain. The proposed hub is founded upon a similar model, tried and tested through the Futureproof project 2018-2021where contractors benefited from learning together and from one another. The hub model fosters intertrade working, a step forward from the prevalent 'single measure' approach that represents a more coordinated approach to works. While each hub member would undertake a tailored training pathway relevant to their own project role and skills development plan, all will come together to understand the unique project methodology. This will put the team 'on the same page' from the outset and encourage effective communication. Aside from formalised training, we will facilitate informal gatherings to encourage team working and knowledge transfer to build competency and provide a supportive framework for hub members. Mentorship will be a key benefit to hub membership, with established installers offering practical support to newly qualified individuals. This may manifest in 'shadowing' on a job, or procuring advice via video call, for example.

Tailored training packages (Figure 8—3) will be offered to all hub members and delivered by hub training partners or associates.

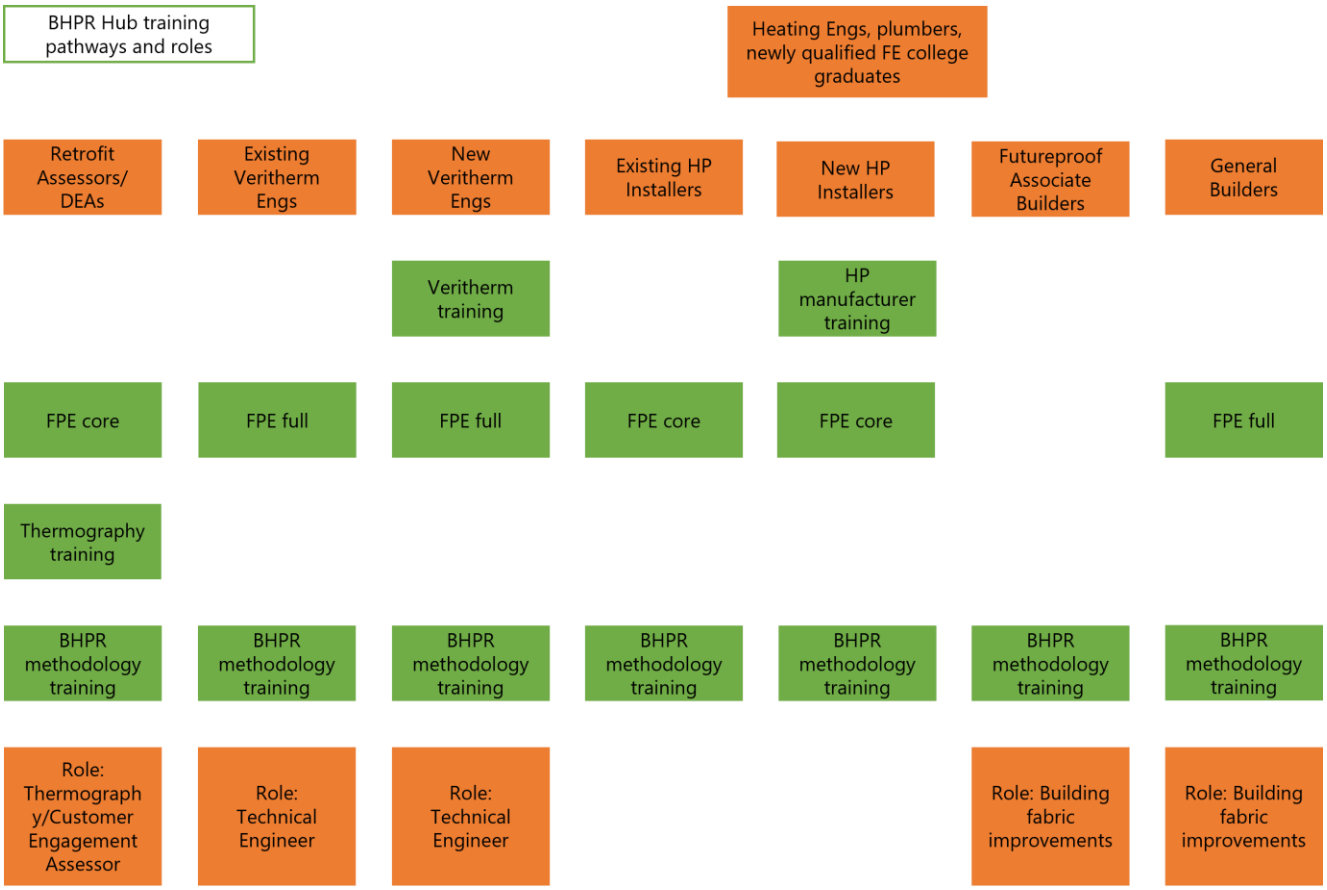


Figure 8—3 Training Pathways and Roles

Specific training or accreditation e.g. external wall insulation or MCS (with whom links have been established), will be signposted and supported. Whilst training needs will vary between members, all will complete the project survey methodology training to ensure harmonisation of knowledge within the project team and to create a tighter workflow. Feedback will be sought after each project from all team members, to stimulate any improvements in the process or training.

The key motivations for installers, contractors and surveyors joining the hub will include the following.

- Efficiency in workflow – The project methodology separates tasks between contractors and there is a clear sequence of works
- Vetted customers – The homeowners will be informed and supported by CSE and through the information pack generated before contact with installers/contractors for an efficient and productive service
- Knowledge share within the supply chain
- Economies – Installers will benefit from discounts from retailers and manufacturers associated with the hub
- Mentoring opportunities from experienced installers

8.5 Ongoing Insights and Analysis

The use of the Digital Twin capability presents significant value in ongoing insights and the ability to analyse further opportunities and efficiencies for not only the methodology but also for the design and installation of heat pumps.

By continuously feeding information and data back into the digital twin, the model can offer learning capability to improve workflows and enable more direct targeting or system efficiencies based on the breadth of data collected. Further design of the insights that could be developed is required in the next phase of the project to clearly set out where there could be benefits however a non-exhaustive list is provided below:

- Survey monitoring results fed into digital twin to enable analysis on the performance gap from the collected housing stock EPC based data
- Survey monitoring following fabric retrofit to analyse the impact and quality of the fabric upgrades
- Heat Pump and system performance via smart controls to continually analyse SCoP and ongoing running costs
- Consumer feedback forms to offer the ability to enhance and amend the process in line with recommendations
- The ability to integrate further third-party tools as technology and industry practices are developed or progress
- Integration of further financial aid products to aid consumers with knowledge
- Communication to DNO data portals to automate network analysis for infrastructure planning and connections

9 Approach for Mobilisation and Deployment

This section sets out our approach to the mobilisation and deployment of heat pumps at density and scale under subsequent stages following design of the initial approach under Phase 1. Further development is required as the implementation process takes place to refine the model based on actual feedback and cost information.

As described in previous sections the deployment of the methodology relating to the planning and identification of target clusters has been undertaken as a pilot under Phase 1. The area of Westbury-on-Trym was identified as a potential area based on local knowledge of the demographics of potential customers resident there. The Phase 1 pilot scanned an area of over 8000 homes to determine heat pump suitability identifying a number of prospective homes and clusters as described in Section 7.

Community sourced data and information has also been obtained as key part of the methodology to enhance the search. The benefit of the chosen area of Westbury-on-Trym (WoT) has been that the information can be supplemented with existing community data. SusWoT have been operating in the area since September 2010 with a good reputation and standing amongst local residents. From the outputs we are targeting approximately 10% (820) homes for community engagement.

The service model proposed that has been designed under Phase 1 described in Section 8 will be deployed which includes initial engagement of the targeted homes to provide the BHPR proposition and develop interest. This builds on the existing local community engagement that has already been happening in the area as well as the community sessions convened under Phase 1.

For the purposes of testing the service model in the area selected we have made initial assumptions that of the 820 targeted homes, we will carry out a target of 300 in-home surveys following the methodology and assume just under 30% of homes will drop out at this stage. This estimate is based on experience in other projects carried out within the Bristol area where dropout rates have ranged between 10% and 30%. We are therefore assuming worst case. With a strong focus on consumer engagement within the target areas this will lead to our target number of 209 installations of heat pumps. However these assumptions will be properly scrutinised against actual results during the deployment process with the ambition to reduce dropouts and encourage community engagement and uptake.

We have allocated clusters (refer to Section 6.1.2) in alignment with the BEIS KPIs and are using NGED polygon data to determine how many homes by substation are required to achieve a pass through a stage gate.

Using the polygon data in conjunction with the other data sets, we have identified three cluster areas within Westbury-on-Trym each containing multiple transformers. It cannot be confirmed at this time exactly which homes are actually connected to which transformer so whilst the criteria does not permit ranges, we should flag this as an indicator that the exact number of properties connected will need to be confirmed later as we work with NGED to improve granularity of the data. At the time of writing, we have apportioned number of target homes required as a factor related to the rating of the associated transformer based on NGED data. For the purposes of the stage gate, we have then taken the minimum numbers required. Within the 3 cluster areas the minimum number of heat pumps required to meet the KPI are 8,14 and 31 respectively, whilst the target of 209 will enable all substations within clusters to meet the density KPI set.

The rate of uptake will be carefully monitored as the stage gates are approached with a strategy to focus on the most likely areas where progress is demonstrated. For any cluster area that appears to be marginal then in accordance with

the heat pump ready programme governance a request to delay the stage gate and ramp up intervention with the community area will be performed.

Having done an initial assessment of the areas the target number of homes in each cluster (3, 4 & 7) is 143, 120 and 242 respectively i.e., 505 potentially heat pump ready homes have been identified. NGED has approximately 800 homes connected to the transformers. In analysing the archetypes to be targeted, each cluster is broadly split 60% detached homes and 40% semi-detached homes. All systems offered will be ASHP with either a hot water cylinder or thermal battery depending on whether hot water storage exists and the space available. System sizing will be bespoke to the home based on the measured heat transfer coefficient.

9.1 Heat Pump Ready Surveys (HPRS): Tackling Assumption-Based Assessments and Standard Heat-Loss Calculations

As mentioned previously in the report the survey process itself has revised as compared to the business as usual approach. As part of the BHPR deployment approach, the BHPR team will implement the new home survey approach in response to the low accuracy of standard approaches and customer demand for quality. We know from consultation that heat pumps are often oversized resulting in high running costs and poor performance. Our integrated and measurement-based approach tackles the current disjointed customer journey experienced by many looking to install heat pumps alongside considering fabric improvement and associated technology installations.

The process as with the entire customer journey will be delivered by a community engagement organisation in partnership with trained HPR surveyors to provide full survey offering including the key measurement technologies. Please refer to Figure 9—1 below for an overview of the process.

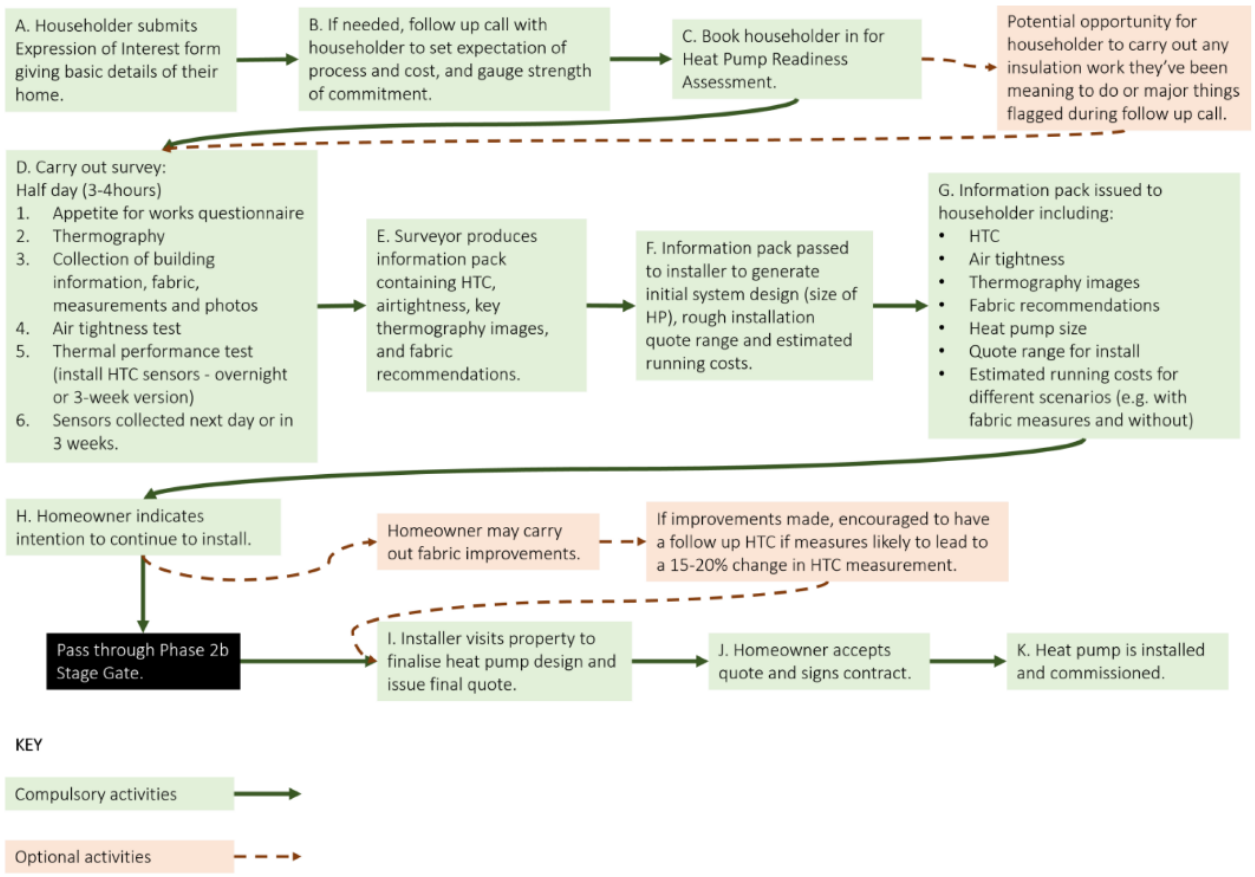


Figure 9—1 Heat Pump Readiness Survey Process

9.1.1 Stream 2 Integration and Testing of the Survey Process

By collaborating with the Stream 2 project 'MEASURED', we have been able to trial our heat pump ready survey approach in five homes in and around Westbury-on-Trym. Two households received the full process including a pilot appetite for works questionnaire and building fabric assessment as well as the thermography and both types of HTC measurement. The other three households received the thermography and HTC components. All households had to vacate for a night to trial the 12-hour rapid HTC test. This trial therefore further demonstrated that householders are willing to find somewhere else to stay while the test is carried out. The response has been overwhelmingly positive:

> *"I live in a detached 4-bedroom house built in 1995 and have been considering an upgrade from gas to air source heat pump but was uncertain if the fabric of the building would support a heat pump installation. The Heat Pump Readiness (HPR) survey has provided a very useful starting point. The entire process was professionally handled and the team were helpful and courteous at all stages, including post-survey communications."*
>
> *"Overall, we were very impressed by the technical expertise of the two Veritherm representatives and their positive interactions with us at all times. They were helpful in explaining the tests and their purpose in supporting householder decision on the size and type of heating installation that would be best for our style of property."*
>
> *"Altogether a positive experience which also gave us a chance to discuss the problems of cooling the house in a heatwave."*

9.2 Heat Pump Ready Survey in Home Approach

The following describes the steps taken in the BHPR survey approach.

Step 1: Appetite for works questionnaire (CSE)

Questionnaire aimed at;

- Building a thorough understanding of any limitations that system designers might have to account for from the householder's perspective e.g., willingness to change radiators, pull up flooring, locate a hot water tank etc.
- Understanding level of appetite for installing any insulation measures that may benefit heat pump performance.
- Confirmation of findings included in survey report.

Step 2: Thermography (Coordinated by Veritherm)

Thermographic survey aimed at;

- Understanding where heat loss is occurring through thermal imaging and issues such as thermal bridging, air leakage, defective insulation, etc.
- Key defects highlighted to householder
- Recommended actions contained within report

Step 3: Building Information (B Coordinated by Veritherm)

Building information survey aimed at;

- Capturing building information to inform room by room heat loss calculation and heat transfer coefficient survey accuracy
- Gathers information such as consumer unit fuse sizes that may be early obstacles to heat pump installation
- Provide a pictorial record for system designers to inform outline quotation (e.g., photos of potential location of hot water tank, consumer unit)
- Captures information relevant to associated technology installers such as roof makeup (solar panels) and consumer unit (cable runs for battery installation)

Step 4. Air Tightness Test (Coordinated by Veritherm)

Air tightness test designed to;

- Assess volume of air leakage in building
- Identify how draughty the house is and whether remedial action should be a focus for works
- Inform air change assessment

Step 5: Thermal Performance Test (Coordinated by Veritherm)

Thermal performance evaluation designed to;

- Provide installers accurate understanding of the building's Heat Transfer Coefficient to enable accurate heat pump system sizing
- Be deployed as an overnight rapid 12-hour test requiring occupants to vacate for the night, or a 3-week passive measurement where the occupant can continue living in the home as normal. Both tests give the same result but offering both allows the householder to choose the most convenient option.
- Test options will be balanced to ensure overall programme delivery is viable

Step 6: Collection of Sensors (B Coordinated by Veritherm)

- For the heat performance survey utilising sensors, these will be collected the following day if the overnight rapid 12-hour test has been used or 3 weeks later if the passive measurement technique is being used.

Step 7: Production of Information Pack (CSE/ Veritherm)

- A comprehensive information pack will be issued to both consumer and supplier (different versions tailored to the needs of the recipient. The Information pack contains recommendations for fabric improvements and heat pump size requirements including;
    - High level system design and outline quotation (that would be developed to a detailed level in stage with a verification site visit following confirmation of interest and willingness to proceed), including estimated heat pump installation and running costs
    - Assessment of cost savings if insulation measures are installed or if associated technology is installed (e.g., solar PV) informed by the building survey and monitoring data
- The pack provides a valuable asset to a home even if they are not able to proceed with an installation immediately.
- The householder is only required to engage in the first two steps of the HPR survey process and they would have the option of the overnight vs 3-week thermal performance test. If timescales are constrained then the overnight one will be encouraged where possible.

The approach is designed to supplement current survey techniques by designers and installers, which are assessed during the training and certification programme. Our evaluation under Phase 1 with local installers has shown a positive reception to this process, which should reduce the installer overheads and provide for more accurate heat pump and system sizing.

9.2.1.2 Approach to Consumer Engagement

Building on local relationships developed through Phase 1, CSE will work with SusWoT and other local leaders to design and deliver a comprehensive consumer engagement programme that not only capitalises on existing local resources but also seeks to develop them through the delivery of this work, growing capacity in the City and building a base of experts from experience that can be called upon going forwards in future implementation and rollout of heat pumps elsewhere in Bristol.

Following the feasibility study we have determined a process of engagement and uptake for future deployment. It should be noted that typical timescales for the BHPR process as part of the designed model vary from those determined to be required for deployment. This is due to potential constraints placed on trialling the methodology to achieve the necessary clusters. The normal heat pump ready process would be an ongoing process of engagement and delivery throughout the year. However, the home monitoring aspect of determining building performance and accurate system sizing can only be done during cooler months, typically September to March. Therefore, in the initial phases of deployment it is expected to constrain numbers based on the number of surveys that can be done within the period available. This takes into account the desire to secure homes before the next winter period. However, as the supply chain is developed the capacity to undertake surveys will increase significantly resulting in the necessary volume deployment required.

The following indicate the timescales provisionally planned should the project continue to a trial phase in 2023/24 (and therefore have to operate within prescribed timescales):

Foundation Building (Jan-June)

Building on current Phase 1 engagement, we will be starting with a programme of community-led events designed to build interest and confidence in our offer and approach. This programme will include, amongst other things:

- A Green Open Homes initiative, working alongside local early adopters identified through Phase 1 to showcase heat pumps in action in the community.
- A series of open conversations situated in local community venues (places of worship, pubs, schools) where the project team can be present to answer any questions people have about heat pumps or the programme in general.
- A communications campaign using both local channels (i.e., BS9 and Henleaze and Westbury Voice), and social media with information and advice, videos and FAQs highlighting best practice and local options available.

Expression of Interest (March-November)

Invitation of local people to sign up and complete an expression of interest (EOI) through the consumer portal. Once they have completed the EOI, they will be contacted to explore any preliminary or necessary works that they may wish to undertake prior to the HRPS.

Targeted Engagement (May-November)

Identified eligible households will be approached to inform them of our offer and their eligibility to receive it. This will also be an opportunity to provide signposting to useful advice and information online, as well as invite them to peer-support workshops. To maximise the window for engaging people and for them to express interest this will be commenced this as soon as feasible following the digital planning and data analysis being completed, and no later than June.

In line with the intention to use a local community-led approach, in the first instance, householders will be informed of their eligibility through focussed door-knocking, alongside SusWoT and other interested local leaders, providing an opportunity for householders' first engagement to be with an independent and trusted local organisation (identified as key through our Phase 1 engagement).

This will help to build trust in the process and give them an opportunity to ask initial questions. Householders will be provided with an information pack (which will be posted for those not engaged on the doorstep) and invited to formally express interest through the consumer portal.

Peer Support (June-December)

For those householders who have started on the customer journey (by submitting their expression of interest) regular peer support drop-ins will be offered alongside SusWoT. These will be opportunities for householders to come together with others and share questions and learning about the process.

9.2.1.3 Local Partnerships

The supply chain and training hub will directly enable BHPR approved training and certification of installers, so they are aware and compliant with the new methodology. In addition to the community engagement, there will be further integration with local installers and training providers. This includes enhancing the current service offering and collaborating with the industry to deliver consumer benefits.

For example, MCS has offered support with the project in terms of advice and use of a tool in development with Energy Savings Trust to simplify quoting from MCS registered installers.

It is also proposed that we will recruit two or more experienced, MCS accredited heat pump installers who will offer support to newly qualified installers.

9.2.1.4 Local Authority and DNO

Bristol Heat Pump Ready will be led by Bristol City Council as the local authority for the area in conjunction with the named partners which shall be subcontracted.

The local DNO (NGED) has provided a letter of support and will continue to engage through subsequent phases.

The relationship and involvement of the DNO is seen as critical in delivering the BHPR process given the potential barrier to deployment as a result of network constraints in accommodating both the transition to low carbon heat and transport. They will also need to be aware of the expected installations within the clusters to ensure network constraints are ok (including their knowledge of accommodating EV charging loads).

9.3 Quality Assurance Method Statement

Quality installations are paramount to the success of this project and in creating a scalable and replicable model for heat pump installations. BCC, as the lead, will apply its Quality Management System (QMS) to administer BHPR and integrate with the QMS of other providers. Allocated responsibility for delivering quality will be cascaded to the relevant provider:

CSE – Responsible for delivering a quality wraparound customer experience that delivers in-home surveys to the methodology specification and clear and accessible customer information at each stage, including hosting handover and warranty documentation for heat pump installations once provided by installers.

TGR – Supporting quality work by surveyors and installers through the activities of the supplier hub – assessing competency and relevant certification (including MCS certification), identifying training needs, offering tailored training pathways where needed with mandatory training on BHPR methodology, granting access to the supplier hub upon successful completion and evidence of certification, requirement to sign code of conduct (including following MCS Domestic Heat Pump Best Practice Guide) and facilitating knowledge sharing between members. If installers are falling short of the quality expected of them their membership of the hub can be revoked at any time.

Installer – Responsible for HP installation contract with householder, including liability and warranty.

BCC – Oversight of the whole programme and quality control throughout, including quality of the customer journey managed by CSE, the supplier hub managed by TGR, and governance of relationship between the customer and the installer.

BH – to manage data processes associated with the planning and visualisation process including data quality. This includes data agreement with NGED. No GDPR sensitive information is to be installed into the BH digital twin platform with a GDPR compliant process to be implemented by CSE and overseen by BCC. BH is to highlight any data which could represent a GDPR breach, and a process of containment will be implemented.

The approach to quality assurance covers system design, install and commissioning, consumer handover and ongoing consumer protection. At each stage checks will be carried out on surveyors and installers to ensure they are meeting our high-quality standards for workmanship and householder engagement.

9.3.1 System Design (Outline Designs Expected September to December)

To ensure the heat loss of homes is well understood and heat pumps are sized correctly, each home will be required to have a detailed survey using a variety of techniques including a measured assessment of the building's heat loss (its Heat Transfer Coefficient) – see Section 9.2 for a detailed description of the survey process which shall be undertaken by approved assessors

The supplier hub will require that installers working under this methodology are qualified and knowledgeable on high quality system design. Installers will be expected to have undertaken system specific training on the heat pump equipment they're installing. As indicated above the heat loss calculation is typically done in the months of March to September however the installers design can be done at any time following this survey having been undertaken.

The local DNO, in this instance NGED, will be engaged early in the project to ensure they can accommodate the density of heat pumps that will be installed through the project. To facilitate this, the consumers that will be targeted for the installation of heat pumps will be those that NGED specify are 'green' in their traffic light system, meaning no specific checks on the heat pump model or the property need to be carried out before the heat pump is installed.

9.3.2 Install and Commissioning (post December)

The supplier hub will ensure individual installers are suitably trained, qualified, and knowledgeable by carrying out checks before they are given access to the hub, and by providing a supportive training environment.

Knowledge sharing between members will ensure that best practice is followed, and mistakes are mitigated. All installers selected will be MCS accredited.

Installers will be able to install and commission systems following customer acceptance of the resulting offer received form the installer.

The local DNO, in this instance NGED, will be engaged early in the project to ensure they can accommodate the density of heat pumps that will be installed through the project as unlike business as usual today they will be expecting to receive a number of connections within a cluster. To facilitate this, the consumers that will be targeted for the installation of heat pumps will be those that NGED specify are 'green' in their traffic light system, meaning no specific checks on the heat pump model or the property need to be carried out before the heat pump is installed.

Subject to consumer approval a process, monitoring will be implemented to collect data on actual system performance in-situ, to potentially feed back into the digital twin and enable ongoing insights to be developed.

Spot checks on installations including collecting consumer feedback on experience will also be undertaken by CSE and/or an appointed community representative.

9.3.3 Consumer Handover

Consumers will have signed a contract with their installer, and it is the installer's responsibility to provide the correct handover information and guide the homeowner through operation of the system. This process will be tested as part of the BHPR certification process to ensure alignment with BHPR quality standards.

Any issues can be raised directly to the customer journey lead, in this instance CSE, who will resolve them or escalate to the programme manager, BCC.

BCC will retain the HPR grant payment to the supplier until the installation has been signed off and accepted by the consumer and the consumer has made their payment.

9.3.4 Ongoing Consumer Protection

The installer will be the consumer's first port of call for any further guidance or clarification on how to operate the system or any snagging issues they are experiencing. The installer will also issue the manufacturer warranty and installation warranty.

If a consumer is not provided with the level of support expected from their installer, the customer journey manager, CSE, and programme manager, BCC, will support them and manage the installer relationship, ensuring the installer is carrying out their business in line with the code of conduct signed on admission to the supplier hub.

If an installer is found to be not meeting the required standards, the programme manager will retain the right to remove them from the supplier hub with immediate effect, following an appropriate review, in order to protect the reputation of the methodology and its partners due diligence on the supply chain.

10 Consumer Value

The BHPR service and business models developed under Phase 1 have been designed to achieve the following main criteria:

- Increase customer confidence in heat pumps
- Developed a trusted, quality-based approach to engagement and delivery of heat pumps to consumers
- Ensure a competitive cost structure that offers financial value for engagement in the BHPR process

BHPR will deliver on these by delivering an enhanced customer journey which is predicated on;

- Providing useful, easily accessible and clear information to consumers to improve awareness of the benefits of heat pumps, what the stages are to procurement, key decisions and guidance
- A brand which can be trusted, underwritten by the local authority
- More accurately sized and tailored solutions which meet consumer comfort needs whilst ensuring that consumers only pay for what they need
- Reduced costs as a result of savings made in the deployment of the BHPR process in reducing supply chain overheads and delivering economies of scale

The BHPR model recognises that ultimately it is the consumer that will fund the service model whether this be directly or through accessed finance and government subsidy. The cash flow model therefore has to understand the flow of money from the consumer and the flow of value back to the consumer.

The BHPR model is therefore delivered through identifying key roles and responsibilities of stakeholders and ensuring those responsible for its administration are operating on a low or nil profit basis.

Based on consultation with the supply chain, it has been agreed that overheads can be reduced and volume increased as there are significant economies of scale to be realised which can then be used to fund the service model, increase margins to the supply chain and reduce costs to the consumer.

Examples of how the cost reduction are realised based on the current business model assumptions include:

- The end-to-end survey process demonstrates reductions in cost by up to 50% as compared to business as usual (currently estimated to be £1000) once refined.
- Typical volume discounts of around 30% (but up to 45%) have been identified through local suppliers and nationwide manufacturers, who have provided letters of support and have worked within the advisory panel during Phase 1. The typical model is set out in the following example.

Typical cost of the HP installs (as defined in the cost model) is £10,750 with a main equipment (HP and storage) cost of £5,500 generating a 30% volume discount on materials. Under the current design of the model developed under Phase 1, the 30% discount will be split via the key stakeholders as follows:

- Project delivery team: 15%
- Installers: 5%
- Consumers: 10%

As explained in previous sections the BHPR service is also reliant on the certification and membership of carefully selected installers which will ensure a quality of delivery to customers. The BHPR model then includes a referral of these selected installers to consumers. This removes the nervousness and risks associated with the consumer directly selecting installers themselves whilst still maintaining market competitiveness on price and the offering from the approved installers.

11 Long Term Sustainability

As described above the BHPR model is based on clearly defined roles and responsibilities of providers and the administration of the model being on a low or non-profit bases to ensure consumer value. The integration with community groups who typically work on a non-profit and voluntary basis means that further additional value is delivered in targeting heat pump ready households without any significant additional cost.

It is felt the model will when deployed offer a trusted source of information and access by consumers to the market for which there are currently a number of barriers as described elsewhere.

The business model which will be ultimately funded by the consumers works on a low-cost basis delivering volume discounts based on economies of scale which will ensure shared value between the consumer, supply chain and operators of the model. The low costs to administrate the model (currently estimated to be based on the sales of only 300 plus heat pumps) will then ensure the long-term viability.

Given the volume of heat pumps required to decarbonise heat in the system running into many tens or even hundreds of thousands and current MCS information indicating only some 200 existing heat pump installations in the city then clearly there is the volume requirement for the BHPR model to access and address. The opportunity to therefore create a local market offering is significant.

The BHPR business model also creates an opportunity to transition the service model to increasingly harder to reach consumers. The low-cost nature of the model means that if heat pump installations increase above the minimum threshold required to fund the service model, excess funds can be used to fund targeting households where some level of intervention is required. This could for example be to help subsidise aspects of the model or fabric measures etc required to transition those homes that need them.

12 Recommendations

The following is a summary of recommendations made to third parties based on current learning from Phase 1.

The overall recommendation is that based on extensive consultation, insights and resulting service model that has been developed, a low-cost operating model with clearly defined roles and putting the consumer front and centre of the service delivery model is critical. The current BAU approach places emphasis on the consumer initiating and managing the whole process. This we feel is not right and the service model should be about clearly outlining and bringing the benefits to the consumer in an easy to understand and low cost and effort manner.

With reference to Section 8, the service model developed has clearly defined roles and responsibilities. The model can only be delivered on a low/non-profit basis and supported by a mechanism enabling bulk data and information management. This implies that normally a local authority would lead although there are other options available including mature community energy groups and joint ventures.

More specifically the following recommendations are made based on the service model which should be read in the context of an organisation expected to lead or take a significant role in delivering the BHPR model:

- The use of planning and visualisation techniques will greatly reduce the burden and overhead associated with identifying and targeting heat pump ready homes which translates into rapid deployment at a lower cost. It is therefore recommended to incorporate a hub model with digital twin and visualisation techniques for analytics and mapping. Many millions of data points will be needed.
- The hub model should be flexible in that it can interface to third party systems which will vary depending on the stakeholder organisations involved city by city.
- Local knowledge should be sought wherever possible, often there are existing community groups working locally who have access to local knowledge not available anywhere else.
- Installers should be selected based on competence and reputation of quality who are willing to also share knowledge and insight to develop local market offerings.
- The establishment of a local heat pump ready 'community' such as the advisory panel set up in Phase 1 adds considerable value in obtaining local knowledge, buy in and identifying stakeholders to include in the delivery of the service model.
- Set expectations from the outset. Our findings determined that only 10% of buildings in the selected area may be immediately heat pump ready which was far lower than expected if open data is used. This may be representative of the immediately accessible market for deployment, but the BHPR methodology will seek to understand how this may change with better quality data, as well as quantifying measures needed on properties to increase this.
- Engage and work with the DNO to agree an approach to gathering and sharing information that supports the planning and deployment approach. They are a critical stakeholder although do not have to form part of the direct team.
- Clear governance will be required covering the delivery, management of data, sensitive information and roles and communication routes to deliver the model. This should be owned and managed by the lead.

- More accurate survey information using actual building monitoring could potentially deliver multiple benefits in more accurately sizing and specifying heat systems than current practice. It also uses non-invasive techniques.
- A credible training organisation will be needed which has the necessary practices and reputation to deliver training and certify installers.
- A credible consumer engagement organisation will be needed to manage the customer relationship management and oversee all aspects of consumer intervention including surveying, installation, and feedback.
- During deployment a mechanism will need to be in place for addressing consumer concerns and dealing with consumer issues outside of the installer but liabilities should still rest with the installer for quality delivery and warranties.

13 Conclusions

The project partners and advisory group have successfully responded to the requirements of the Phase 1 programme to provide a viable route to significantly increasing heat pump deployments in the city. The method that has been devised focuses on harnessing the local supply chain alongside combining the latest technologies in heat pump readiness assessment to maximise the customer journey experience and add value to all stakeholders involved.

The project team has applied for more funding as it fits with partner and city ambitions to create a step change in decarbonisation of homes whilst doing so in a way that creates a high-quality experience for all stakeholders involved. The strength of the partnerships developed would mean that even if unsuccessful in the bid there is commitment to source funding to deliver the designed methodology.

The key factors that informed the decision to submit a bid were:

- All partners were willing to commit to the second stage showing confidence in the methodology
- A viable cost model being collated that showed value for all elements of the supply chain
- Excellent feedback from our expert advisory group members on the designed methods providing reassurance that the approach could work in practice
- A strong relationship with local communities has developed building understanding and trust in commitment to shared goals and ambitions around heat pump deployment
- The network review and clustering approach shows there is network capacity available in the areas to be targeted
- Commitments given by supply chain were sufficient to give us confidence in our cost model and resource capacity

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