6.4.3 Growth of EV workforce

We have noted how, in some of the new businesses in the transport and mobility sector, they value flexibility and a breadth of experience and that, in return, their new recruits are attracted by working for an entrepreneurial business that is addressing climate change and seeking to make a tangible difference. This is a strong selling point for **attracting workers from parallel industries or for upskilling those with relevant trades**. For example, electrical and construction skills, particularly as applied to renewable energy, are in demand as forming a good basis for upskilling. Similarly, managers in other parts of the energy system are useful, and, as one interviewee said, moving out of fossil fuel into EVs feels like a good move for the future. To maintain quality of service delivered through EV CP infrastructure, as well as to accelerate its installation, a growing **workforce of electricians and construction workers needs to be upskilled**, alongside well-trained IT technicians and maintenance teams to undertake data analysis and support fault identification and resolution, as well as ensure good customer experiences across the network.

7 Building and Retrofit Sub-System - Heat Pumps: Findings from Data Analysis

Within the ESO project, the buildings element is all about domestic heating and is effectively a separate element to the rest of the project, operating in isolation and independent of the progress of any other part. The aim is to install up to 300 ground source heat pumps into local housing. At the time of writing of this report, heat pump installation is nearly complete in one area of social housing, that of “Blackbird Leys’ which is owned by Stonewater Housing Association. Thirty heat pumps are being installed to replace outdated storage heating systems.

Kensa, who are leading this element of the project, are a UK-based heat pump company who design, manufacture and install heat pumps. For the ESO project, they are deploying a shared ground loop array approach where the individual heat pumps in each home are connected to shared boreholes. This approach is easier to deploy in social housing where there is a single customer.

7.1 Barriers and enablers for the building and retrofit sub-system

Factors impacting the roll out of heat pumps and associated infrastructure are summarised in Fig. 7.

Government policy

There are a number of areas of inconsistent or changing government policy which have hindered this (and similar) projects. During the writing of the proposal, ESO included ECO funding which is designed to support low-income households in becoming more energy efficient. Between writing the funding application and the award of funding, the ECO regime changed from ECO2t to ECO3 which meant different rules and a reduction in funding support. An inconsistency between demanding EPC D or below whilst also needing insulation to fund a heat pump meant mutually exclusive clauses (E3) which were impossible to reconcile, reducing funding. Similarly, Renewable Heat Incentives (RHI) funding has been reduced ‘three times since starting the project’ (E3) which currently makes installation of heat pumps expensive compared with conventional boilers and is a barrier to scaling up (E10). The announcement of the Green Homes Grant (GHG) might have been another avenue of funding support but has proved to be difficult to engage with, the more

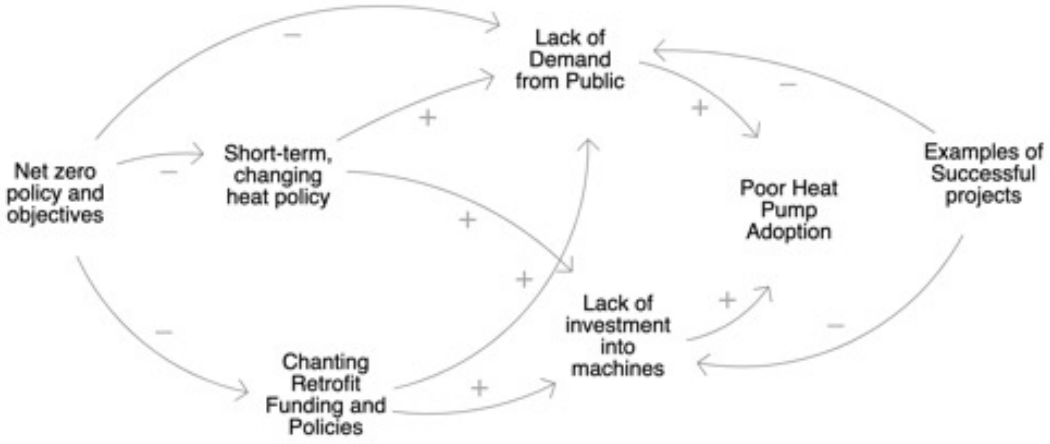

Figure 7: Heat Pump Adoption and Scaling

recent local authority scheme might be a better avenue but housing providers and installers are wary of committing: '…we can put in some applications and just hope that they come through in time but we could be in a situation where in July we're still waiting for our vouchers and we've got a programme with 300 heat pumps to install next financial year. So do we just get on and deliver them? And maybe we don't get the vouchers or what do we do?' (E10)

Regulation

While cost and grant support for heat pumps or other forms of electrified heating is one issue, lack of policy drivers is another, without a clear steer from government on where it sees future heating solutions and when, e.g. : "…if the government really set out its mindset on that, then I think that would make a significant difference because then everybody would know that they can't put gas central heating in from [e.g.] 2025 and they need to start looking for other methodologies now" (E14) and '…there's been mixed messages from government around whether hydrogen will become a solution or they will be able to decarbonise gas in some form, we're apprehensive about replacing gas on a large scale until we know…' (E10)

Consumer acceptance

Within ESO, for the heat pump to be most effective, consumers are expected to adopt agile energy pricing and allow smart thermostats to learn their homes and habits in order to optimise heating and reduce costs. In our social housing example, this is quite a leap from the familiarity and feeling of control presented by pre-payment meters. However, as stated by E11: "…If social housing tenants don't really embrace time of use tariffs, then the efficacy of our smart heating controls is not going to be maximised. If they insist on staying with their existing provider then we're not going to see the financial savings that they could." However, where heat pumps are replacing old storage heaters, householders have been pleased with the results and even on pre-payment meters consumers have reported savings: …most customers are happy. I've had a few customers commenting on the cost reductions that they've seen already…. So they're able to see an instant impact in their consumption rather than waiting for a bill to come through, to see on a day to day basis as they check their prepayment meter that the money is not going down as quickly as it used to' (E10)

Supply chain
Kensa have been 'scaling up at a pace', opening a new factory for heat pumps early in the ESO project to meet increasing demand across a number of large-scale projects nationally. Alongside this scaling up, with parts coming from other areas of Europe, Brexit is being anticipated as an initial issue with three months of reserve materials built up to accommodate any issues. There are reservations to scaling up, identifying the lack of policy certainty as a significant barrier: 'If we were to get the long-term support from government to say 'Here's long term targets and long term funding programme' then from the conversations we've had we believe the supply chain is well positioned to start to scale up to deliver that. However, they're not willing to invest or they're not in a position to invest until the work is there. (E10) Similarly, on the construction side, investing in new equipment needs demand certainty, 'that's not something that you can do quickly because buying a [drilling] rig is like buying a house, these are not small purchases' (E3).

7.2 Skills for the building and retrofit sub-system in relation to ESO

In our analysis of current and future skills needs and shortages, we have aggregated these into different generic skills areas, identifying specific types of skills required across the domain of heating retrofits.

7.2.1 Energy system skills for the building and retrofit sub-system

- **Energy surveying for heat pump installation**: Supporting installation of new systems, each home needs an energy survey using 'people that would do an EPC survey, that's enough. And there are thousands of those out there' (E3). However, surveyors carrying out wider property assessments do need some upskilling in installation and operation of heat pumps in order to 'assess properties in the first place to ensure that they are suitable to have heat pumps …' (E10).

7.2.2 Engineering skills for the building and retrofit sub-system

- **Groundworks Design for Heat Pumps** skills within ESO focus particularly on the whole process of installing the shared array ground source heat pump system. Each borehole array needs site specific design to accommodate geological conditions and the heating needs of connected properties, this is largely accomplished through bespoke computer design software operated through an understanding of heating systems and geology (E3). Additionally, the connecting pipework design has to accommodate topography and existing site features such as other utilities, buildings, roads etc (E6).
- **Mechanical and electrical system design for heat pumps**: the heat pumps are straightforward to install in individual homes, however, a shared loop system design requires mechanical and electrical design skills in order to upgrade the systems and communicate needs 'talking to installers and customers explaining why something is working the way that it does' (E5). This is not an entirely new skill, but an additional technology to which the engineers need to be upskilled.
- **Hardware engineers** have a role in the design of hardware solutions (such as smart thermostat) to interact with the heat pumps.

- **Software engineering skills** are not specific to the heat pump projects, but are still in short supply (e.g., as noted by E5: 'we are looking to hire [software engineers] again and it is quite difficult to find the right people'). These include:
  - **Design of multi-objective optimisation algorithms**, as management of heat pumps is driven by the 'the electricity prices, weather forecasts and all of that data to find an optimal solution to the heating problem of the house, to make sure that house is heated during the cheapest times of the day, and while still achieving the user comfort. So that's to reduce the cost of electricity that customers pay and trying to get the heat pumps to start competing with other heating technologies.' (E5)
  - **Machine learning/data science** as the control algorithm needs to 'learn about the house, how long it takes for it to heat up and cool down again, the different external temperatures and all of that [which] is then fed into the algorithm' (E5).
  - **Practical knowledge of good Software Engineering Practice guidelines**, including design for scalability as 'the system that we're building is made to scale, the tools and everything that we use is made with that in mind and this can become a million devices kind of thing' (E5) so that as demand rises rapidly, software systems can keep up.
  - **User interface design and frontend development**: heat pump apps require 'user interaction which … is one of the most important bits for getting through to the customer and making sure that they're happy with the way that the system is working' (E5). This is an area of in-demand skills, in particular …'a struggle to hire for these areas because React Native for example … it's quite in demand in terms of skillset. So finding these people is quite difficult' (E5).

7.2.2 Trades skills for heat pump installation in the building and retrofit sub-system

- **Groundworks**: shared array heat pump systems need qualified groundwork trades to correctly install the boreholes and associated pipework, these skills are currently in short supply:
  - **Borehole drilling** is a specialist operation with substantial overheads in terms of equipment with 'different sizes of drills rigs... [from] tiny ones that will fit through a garden gate …to 220 metres. So size matters because it impacts on the amount of equipment that people can afford and the staff that they can keep on' (E3). This was identified as a potential bottleneck in scaling up: 'Frequently we find that drilling teams are hard to come by and they're not always available when the client wants to start the work (E6)
  - **Trenching**, i.e., laying ground-source collector pipes, which is often carried out by the same team as drilling (e.g., E6: "some of the companies that we use do interchange drillers and trenching teams).
- **Heat pump installation**: the interviewees who took part in this study all agreed that, with conventional heating system knowledge, heating installers can be trained up to install heat pumps in a relatively short time. E.g. E10 noted: "if you're taking a heating engineer [or plumber] who could install a gas boiler and you're just training him to install a heat pump, it's probably not a huge amount of training" though all agreed that some upskilling (which could be done within a day's training) is required.

- **Electricians** also need to be upskilled in regulations on how the heat pumps need to be "connected up correctly" (E6) and certified. This, again, is not a substantially new skill, but rather some additional knowledge for this specific technology.
- **Retrofitting insulation**: the heat pump systems are only effective if the homes are well insulated so, in advance of heat pump installation, insulation needs to be checked and installed. Although interviewees did not comment on retrofit skills shortages in ESO case, they did point out that it is not always done to a good standard and needs correction (e.g. E10 "extracted all of the cavity wall insulation and have refilled to ensure that it is all up to standard because we did find that there were some gaps in the insulation…").

7.2.3 Management skills for the building and retrofit sub-system

- **Project management at a strategic leve**l brings together design knowledge and oversees a pipeline of projects to keep sub-contractors employed.
- Housing stock management for heat pump projects requires 'the skills and the knowledge to:
  - identify which properties are suitable and then
  - **oversee contractors** and understand that they are doing what they should be doing and what has been specified' (E10).
- On site management, in overseeing the installation of heat pump systems, 'quite a wide skillset' (E6). is needed to:
  - **'know** a little bit **about geology … and groundworks**
  - …manage people … and be firm with subcontractors.
  - **… can discuss design plans**.
  - …and understand tenants [needs]'. (E6)
  - In relation to **Health and safety** - ESO is 'a notifiable project, so we have to notify the HSE what we're doing' (E6), and provide welfare facilities 'for them to shelter …and have a hot drink' (E6)

7.2.4 Finance and Business skills for the building and retrofit sub-system

None of the below skills are particularly unique, but require upskilling in heat pump technology understanding:

- **Estimation of costs** does not appear to be problematic although the need for estimators specific to the heat pump industry is growing: "I don't think that those things are going to be a huge problem for … although we do see an increasing demand [for estimators]" (E3).
- **Sales skills for home heat pumps installation** require the ability to sell as well as understand technical properties of the heat pumps and work with the household customers: "… it's difficult to find someone that's got the right skills, the right sales skills as well as a knowledge of heat pumps that's suitable to go and spend a long time with customer… the key sticking points that we've had through this project have been we could have done with more capacity from the sales team" (E3).

7.2.5 Policy skills for the building and retrofit sub-system

Delivery of effective retrofit and low carbon heating solutions are driven by and impacted upon by central and local government policy. This is still a relatively new area and government policy and has been evolving which has impacted particularly on funding regimes.

- **Engaging with current policy**: providers need to stay current with policy and funding drivers and to engage with policy makers to ensure that changes do not adversely affect the sector's growth. E.g.: "In the regulation of the Town and Country Planning Act, Regulation 14, it states that we can carry out installation of heat pumps. But not every local authority either agrees with that or even knows about it. So that's a bit of a struggle to explain that to them and sometimes they simply don't agree and we have to do a full planning permission application.' (E6)

- **Aligning local policies**: climate policy does not necessarily accord with other local drivers. For instance, whilst installing heat pumps delivers carbon savings, they cost more to install than gas boilers and where council properties already have gas heating there is no financial benefit…" (E14).

7.2.6 Soft skills for the building and retrofit sub-system

In this project, the key soft skills centre on communication with both customers / householders / the public and also with teams internally and within the project.

- **Householder engagement and education** skills, though not unique to this project, are often under-invested. For ESO it has mainly focused on upskilling householders in knowledge about SLES, with the key communication area being the new systems so that they operate effectively and maximise energy efficiency for each home. Specific areas are:

  - More detailed information about future energy systems and how this installation contributes
  - Understanding of flexible energy pricing
  - Understanding (and trusting) the automated system which makes optimised decisions based on detailed analysis of home behaviour, weather, energy pricing etc

- **Internal communications**: for project partners who have less technical teams (eg housing associations), explaining how future energy systems might work: I've got quite good technical knowledge of buildings and low carbon heating solutions. So from that perspective that was useful for me to explain to others in the organisation who might not have that knowledge. (E10)

7.3 Training for the building and retrofit sub-system

7.3.1 Training needs

Building on the skills areas identified above, we identify the following key training areas:

- **Heat pump installation**: this is mostly upskilling existing heating trades. However there are barriers: 'just providing the heating courses, as in heat pump courses is not sufficient because they're losing out on the work on that particular day when they're training. So who pays for that upskilling?' (E5)

- **Operational oversight** requires additional knowledge in order to effectively oversee retrofit programmes, ensuring that there is a knowledge of the required processes and standards of delivery on site.

- **Groundworkers** will be needed as operations continue to scale up, this is for boreholes, trenching, pipe-laying, cabling etc.

- At the consumer end, the current level of **public awareness and acceptance** is low so this is a further area of education and training. Many consumers never switch energy suppliers and, switching not just to a new supplier but to a new type of agile tariff requires a level of engagement and education. This also extends to understanding how smart thermostats work and building trust in the system.

7.3.2 Modes of Training

- **Higher education** is key to developing sufficient engineering skills across all areas, particularly in the design and presentation of smart home controls and optimisation systems.

- **FE colleges** need to be brought onboard if new entrants are being brought into the industry, but this takes longer 'in terms of training engineers to be able to install heat pumps and be MCS accredited and things like that. I suspect they'd probably need a 12 to 24 month lead in time between a programme being announced and them actually being able to get enough people through the training that's required" (E10).

- **Internal upskilling**: training is provided at the workplace, in Kensa, for example if they take on a new subcontractor they 'do a morning's training before they start on site' (E3) where the more experienced colleague would then support the initial practical installations.

- **Training from manufacturers** introducing the technology, e.g.: '… go to their sites and maybe undertake a half day training on what installers might do, sort of a lighter version so that they can witness the process and what they need to know when they're overseeing works onsite' (E10).

- **Apprenticeships**: for example in groundworks: 'a mini apprenticeship with the drilling and trenching companies. And that would be something that would be suitable for young people to do. Even if they didn't want to do that for the rest of their lives it would be a good foothold into the industry and give them a good grounding for going further on in the same industry later on.' (E6)

- **Public awareness** raising is necessary to improve understanding and acceptance of technologies across by the citizens, e.g. 'Agile tariffs [which] are not for everyone, but I think people should be first educated to understand how they work' (E5).

7.4 Insights and recommendations

7.4.1 Skills Needs for Ground Source Heat Pump Projects

This part of the report focuses primarily on issues to do with domestic heating and does not attempt to address the wider retrofit sector. In relation to the technologies deployed in ESO, namely those of shared ground loop heat pumps we note the following key skills issues:

1. Groundworks: whilst not, by and large, new technology, the groundworks element of GSHPs is a key element of the installation and potentially a block on scaling up as it takes some time to train personnel and more **time to acquire the specialised expensive equipment which is a risk without a secure market**.
2. Training up existing heating installers is a relatively quick exercise but it may be necessary to **fund training** for some installers to undertake it. All future heating engineers training should include heat pump knowledge as standard.
3. Operational managers and surveyors need to have an **understanding of retrofit technologies** including heat pumps so that they can properly manage installations and recommend future works in this area, they also need good consumer engagement skills to build trust in new systems
4. Future energy systems are increasingly reliant on **digital infrastructure** and domestic heating is no different, we see a need for a range of data scientists, front and back-end developers, programmers, and software engineers at degree and postgraduate level

In parallel with professional skills, there is also a need to build **public awareness** at several stages:

- Greater knowledge of how the energy market is changing and the constraints that it operates under – for example localised generation, demand peaks, potential flexibility measures and new smart technologies to help manage both domestic consumption and local supply.
- Different types of energy tariffs
- Heat-pump specific knowledge and its benefits in order to build demand
- Digital management of domestic energy use

7.4.2 Policy Needs for Heat Pump Adoption

At a policy level, better engagement with policy-makers to build knowledge of policy implications and ensure a **consistent and supportive regulatory environment is key to future scaling**. As noted before, drilling and trenching equipment requires significant investment, which will not be committed while the demand and policy support for heat pump installations is uncertain. Moreover, heat pump installation is only an effective heating solution where the installation premises are well insulated already, else the technology will not function well and trust into its utility will be further undermined. Thus, the priority for policy makers should be on:

- Fostering demand for heat pumps through long term, consistent policy (e.g., funding/loans for heat pump installation) accompanied by

- Consistent policy supporting wider retrofit activities as a pre-requisite for heat pump installation;
- Both of the above points should be delivered in parallel with a **wide-scale public awareness raising** campaign, educating homeowners and tenants about retrofit, its financial and environmental impact and funding opportunities.

At a local level, different parts of local government need to be engaged together to ensure **clarity and consistency across different policy areas** – for example planning, climate emergency response etc.

Another area where local / national government could intervene is in supporting technology use via **land allocation for infrastructure development**. It was suggested that installation of clusters of boreholes connected to distribution pipework would help facilitate wider connection by a range of householder types – similar to district heating arrays but with greater levels of individual control.

In summary, the lack of policy clarity and funding support to enable heat pump solutions to scale up is putting a substantial barrier in the way of this as the future of domestic heating. Relevant professional education providers need to ensure that training is included in their courses, and that updating skills is accessible to all. In parallel, unfamiliarity and nervousness by consumers means demand is still low. Pilots like that of ESO will help to prove the technology and usability but this is a slow way to approach carbon neutrality in domestic heating.

8 ICT for SLE Sub-System: Findings from Data Analysis

ICT infrastructure is the key element that enables the different parts of the system to be optimised and to connect with each other and the wider energy system. We have noted in the different subsystems where there are particular issues to do with ICT – for example in the non-interoperability of chargepoints or consumer resistance to smart domestic heating management. Here, we reflect on the higher level system skills needed to facilitate SLES in the ESO approach.

8.1 Barriers and enablers for the ICT sub-system of ESO

The drivers and obstacles of the ICT sub-system in the ESO SLE project are demonstrated in figure 7 below.

Energy markets are the key enabler for the emerging smart energy system. ICT systems support a range of activity in the energy market, enabling optimised deployment of renewables and flexibility alongside domestic and EV connectivity into the system. The ESO platform is innovating with optimisation of batteries, connections to the transmission grid and EV chargers.

Novel smart energy services are also becoming more important due to the **NetZero targets** set by the UK's local and national governments. Driven by these targets, various funding opportunities have been made available, such as the Green Homes **grant**, which, in turn, has increased the consumers interest in heat pumps, battery storage, and EV solutions, motivating creation of **new services** and development of new business models around such services. The **falling cost of renewable energy-based technology** has also led to improvements in the price and performance **competitiveness** of these projects. This has also been supported by success of the recent **example/demonstrator** smart energy projects.