Part 3. Policy, market, and skills gap analysis – evaluation of current trends and potential solutions

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Table of Contents

Introduction - action on low-carbon building market growth

Approximately half of global energy consumption is related to heat; accounting for 40% of global energy-related carbon emissions. In the UK, approximately 24 million end-users rely upon natural gas boilers for hot water and space heating. Transition away from this technology is an essential component of UK domestic decarbonisation and green growth strategy. The UK's commitments to cutting greenhouse gas emissions from buildings are linked to the contemporary social and economic development policies described under the umbrella of the 'Levelling Up' agenda. Within this policy platform, the concept of a "green industrial revolution" has gained political traction in the UK government's clean growth strategy. Former Prime Minister Boris Johnson outlined a 10-point plan for green industrial revolution, the tagline of which was to "build back better and build back greener". In the context of the built environment, this policy strategy is designed to stimulate improvements to residential, retail, and industrial building fabric efficiency, through insulation and other energy efficiency measures, making changes to the technologies used for both space heating and cooling within buildings, and improving the energy efficiency and performance of domestic energy services.

Notable among potential domestic decarbonisation measures within the Heat and Buildings Strategy is a commitment to provide 600,000 air/ground source heat pumps by 2028. Despite positive policy commitments to sectoral decarbonisation, in this paper we explore the barriers to uptake of heat pumps within the new build and retrofit of domestic housing stock, with an emphasis upon policy, regulatory, market and skills progress within the sector.

Buildings strategy and levelling up through domestic decarbonisation

The goals of net zero and socio-economic development through so-called levelling up policies, involve a range of market mechanisms designed to stimulate changes to energy systems within domestic and commercial properties. The Government's 2021 buildings strategy [3] states:

> "…decarbonising buildings will help the economy grow, create new green jobs, and deliver greener, smarter, healthier homes and workplaces with lower bills. Delivering energy performance improvements and low-carbon heating systems will create new jobs in all parts of the UK – offering enormous potential to support our 'levelling up' agenda."

In practice, a net zero buildings strategy requires improvements to both the efficiency and design flexibility of domestic buildings (e.g., moving away from traditional/legacy housing stock designs through the Future Homes Standard discussed below), changes to UK supply chains, and support for alternative low-carbon heating technology options. At the household scale there are range of issues that influence the uptake of new low-carbon space heating technologies [the following list is primarily derived from 36, 37, 38]:

- Consumer knowledge and choice of heating technology (including advice from installers)
- Implementation factors (such as 'hassle costs' of installation, maintenance, and use).

- Technology availability and supply chain management for space heating in the context of growing national and global consumer demand for building materials and components, and supply disruption from continued Covid-19 lockdowns in China and other global manufacturing centres.
- Rapid cycles of innovation, such as the rapid obsolescence of recent to-the-market technologies including early adoption of air and ground source heat pumps.
- Affordability of new heating technologies given the upfront costs of installation under conditions of a national cost of living crisis, inflation, and rising interest rates affecting loan costs.
- The relative price of electricity. Heat pumps are popular in some European nations due to the relatively low running cost. Heat pumps use a smaller amount of electricity than other electric heating methods that are normally used (e.g., electric fires or radiators). However, in the UK as of October 2022 the energy 'price cap' puts the unit cost of gas at 10.3p/kWh, vs electricity at 34p/kWh [1]; thus the relative cost saving is lower than in some other European countries (e.g. France where electricity is €*0.1899* per kWh). This makes heat pumps comparatively less attractive to UK consumers.
- Policy mechanisms to support market uptake under the Energy Security Bill. These include: the replacement of the Renewable Heat Incentive with a potential Low Carbon Heat Scheme, The Home Upgrade Grant and Social Housing Decarbonisation Fund which provide targeted support to heat pump installations. Practical supply push measures include announced a five-year zero VAT rating for heat pumps and their installation. This raises equity implications if government support for high-cost installation of low-carbon technologies that lead to energy savings are taken up by wealthier consumers (i.e., subsidy for wealthy consumers to install heat pumps upfront, that then lead to cost savings for them in the long-term does not benefit the poorest consumers).
- Human resources necessary for manufacture, installation, modelling, project management, maintenance, and repair of novel technology solutions.

Against this backdrop of overlapping challenges, the Government's strategy in the low carbon building sector is to [3]:

> *[Support] 240,000 skilled, green jobs by 2035, concentrated on areas of the UK where investment is needed most.*

The link between housing decarbonisation and economic opportunity is clearly articulated in current UK policy. The UK has some of the oldest and most energy inefficient housing stock in Europe. Roughly 90% of existing homes are expected to still be in use in 2050, and so Government, social housing authorities, private sector developers, owners and residents are tasked with collectively upgrading up to 27 million homes. The economic potential of a low-carbon heat transition is significant. At present total energy services are estimated at gross added value (GVA) of £26.5 billion to the UK economy [39]. Analysis of the business opportunities presented by low-carbon innovation in buildings, including domestic retrofit of existing building stock, are modelled at a peak of £5.7 billion gross value added (GVA) per annum and 82,000 jobs in the UK by the mid-2030s [40]. The 'primary' GVA potential of low-carbon buildings achieved through energy efficiency, growth in domestic markets for retrofit, design and construction of low-carbon homes, offices and manufacturing centres, and the export of designs, expertise and construction materials, and the sale of new electricity demand reduction and space heating technologies (including smart heating appliances) (REF). The secondary economic benefits include lower electricity and gas bills for consumers (improving the spending power of households), and housing market uplift – as energy efficiency tends to improve property values (EPC C rated properties are worth approximately 5% than EPC D rated properties, all other factors being equal). The overall national-to-regional economic and social benefits of domestic low-carbon transition are clearly articulated across a range of academic and industry studies [41-45], making this an urgent policy priority to meet twin levelling up and net zero goals.

Heat pump installation

One key growth technology in the decarbonisation of heat in the home, is the air or ground-source heat pump. The International Energy Agency (IEA) reports that around 190 million heat pump units were in operation in buildings worldwide in 2021, with the global stock increasingly steadily in primary heating markets – North America, Europe and northern and eastern Asia despite global supply chain disruption in 2022 [46]. In the UK, the **Building Services Research and Information Association (BSRIA)** estimated a 27% increase in average sales for heat pumps designed for commercial use in major European markets [47], driven primarily by concerns over domestic energy affordability and energy efficiency brought about by the reopening of the global economy leading after the easing of Covid-19 lockdown restrictions leading to a surge in fossil fuel demand, and the Russian invasion of Ukraine leading to economic sanctions and restricted gas flows to European markets [48], and the push for reversible heat pumps driven by twin space heating and cooling challenges in the face of climate change. However, against this backdrop of technology growth, heat pumps cover around 10% of the global heating demand in buildings, with deployment levels remaining too low to meet the net zero emissions by 2050 Scenario. It is notable that 85% of heating systems operating in the UK are still natural gas boilers, and 1.5 million gas boilers are installed yearly, making it the biggest boiler market among European nations [49]. The IEA argue that further policy support and technical innovation to reduce upfront costs, remove market barriers to complex renovations, improve energy performance and durability, and exploit the potential of heat pumps as an enabler of power system integration and flexibility are needed [46].

Though growth in the heat pump sector is emerging, progress in the UK has lagged due to a lag in policy implementation. In 2013 the Climate Change Committee advised the UK government that domestic space heating decarbonisation should aim to install 600,000 heat pumps *per year by 2020* to meet the 2050 net zero target. Seven years later (in 2020) this ambition was renewed as part of "The Ten Point Plan for a Green Industrial Revolution", with the government simply shifting the deadline back to install 600,000 heat pumps per year by 2028 (BEIS, 2020c). Recent policy research shows that the UK government hadn't put any significant policy measures in place during that time to deliver on the recommendations of the CCC in 2013. As such, the heating sector will need to decarbonise eight homes every minute for the next 29 years to meet net zero by 2050 [50]. Thus, although the potential economic and carbon savings opportunities from heat pump transition are promising, there remain a range of significant societal, policy and market barriers which stymie progress towards domestic net zero in the private ownership, rental and social housing sectors. These can be broadly defined into two related domains assessed in this part 3 of the report:

- Policy and market barriers to heat pump installation

- Skills gaps in heat pump installation in low-carbon retrofit and new build
- Policy and market barriers to heat pump installation

Despite national commitments to low-carbon building construction and retrofit of existing domestic and commercial stock, multiple policy, regulatory and market barriers remain. We identify these barriers as:

- Housing policy and buildings standards
- Housing supply and new build
- ‘Fabric-first’ retrofit of existing properties
- Installation quality, consumer confidence, and trust
- Housing policy and buildings standards

The key national policy drivers to low-carbon domestic transition are the Heat and Buildings Strategy (HBS) [3], the Future Homes Standard [51] and the closure of the Domestic Renewable Heat Incentive and the implementation of its replacement: Low Carbon Heat Scheme through the Energy Security Bill.

The proposed Low-Carbon Heat Scheme mirrors that of other industry-focused policies designed for supply-push of low emissions vehicles or renewable electricity generation. The plans which will be supported by secondary legislation, will place obligations on manufacturers of fossil fuel heating appliances (e.g., natural gas boilers) to meet ever-rising standards for heat pumps sales as a proportion of their total appliance sales (through some combination of selling their own models or purchasing credits from other heat pump manufacturers – in a cap-and-trade-type approach). This provides a clear policy signal to the market, and simplifies the incentives for manufacturer heat-pump adoption, thus helping to build a heat pump supply chain and maximising consumer choice among manufacturers [52].

Industry incentives for supply push of heat pumps are matched by a regulatory framework from 2025, that makes it a core requirement for CO2 emissions produced by new homes to be 75-80% lower than those built to current standards. The Future Homes Standard requires new build homes to be 'zero-carbon ready', with no subsequent retrofit work required to benefit from the decarbonisation of the electricity grid and the electrification of heating [51]. From 2021, the interim measure is that new homes are expected to produce 31% lower carbon emissions. Existing homes will also be subject to higher standards – with a significant improvement on the energy efficiency standards for extensions to improve fixed lighting, heating efficiency, and ventilation standards. The core elements of the Future Homes Standard, are that:

- New homes will not be built with fossil fuel heating (replacing the current standard of natural gas combi-boilers).
- Homes are intended to be future proofed with low-carbon heating and high levels of energy efficiency for lighting and in-built electrical appliances.
- No further energy efficiency retrofit work will be necessary to enable them to become zero-carbon as the electricity grid continues to decarbonise.

- Low-carbon heating system will be integral to the specification of the Future Homes Standard and the Government anticipates that heat pumps and heat networks will become the primary heating technology for new homes.

Changes to building standards are one key policy mechanism to ensure technological change within the home. However, housebuilders commonly aim for minimum compliance with efficiency standards, meeting the most basic criteria at the lowest cost [53, 54]. Improved building standards though the Future Homes Standard may provide incentives to housebuilders to deploy existing innovations in low-carbon space heating such as air and ground source heat pumps but may not stimulate innovation or upscaling to go beyond existing performance standards. The regulatory environment for new buildings is therefore not a major driver of technological innovation to ensure 'future-proofed' net zero homes, however, it will likely encourage market uptake of heat pumps. Local authorities will play a key role in setting energy efficiency requirements for new homes that go beyond the minimum standards set through the Building Regulations. Proposed new planning reforms will clarify the longer-term role of local planning authorities in determining local energy efficiency standards. It is vital therefore that local planning authorities aim for *ambitious* buildings efficiency standards across new build and extended homes across their respective regions.

Housing supply and new build properties

Retrofit sits against a concern for overall housing supply within the economy. The 2019 General Election manifestos of all political parties included commitments to improve the housing supply in England. The Conservative manifesto pledged progress towards the target of 300,000 new homes per year by the mid-2020s, committing to at least 1 million more homes built over the next Parliament. However, greater clarity is sought over how this target of 300,000 units per year is to be achieved. There is a specific backlog of need amongst people living in unsuitable accommodation, and an affordability gap particularly for first time buyers, which prevents people from accessing the housing that they require, creating knock-on negative social and economic impacts such as overcrowding, impaired labour mobility, and increased levels of homelessness [55]. The problems of housing supply were exacerbated during the COVID-19 pandemic due to slowdowns in house building, rising property prices due to a stamp duty holiday to encourage internal labour migration, and supply chain disruptions in building materials [56, 57]. The twin commitments of the 300,000 new homes per year building rate, and the low-carbon Future Homes Standard will put enormous pressure upon supply chains for heat pumps and associated wall, roof and flooring insulation, and so government intervention through the low-carbon heat scheme is necessary to alleviate the cost 'pinch points' within supply chains (including key materials, labour and supply costs).

Fabric-first retrofit of existing properties

Changes to building standards only affect new build properties in the first instance. For the aging UK housing stock a "fabric-first" approach to low-carbon retrofit of existing buildings is the main driver of low-carbon transition. The logic of *fabric first* is to design processes that first maximise the performance of building components and materials (primarily in this instance: insulation – either wall cavity, loft or internal or external cladding), and then consider mechanical and electrical systems second (in this case heat pumps and solar PV and hot water systems). A fabric-first approach improves electrical and thermal efficiency and reliability of the building itself, ultimately improving long-term cost efficiency (including reduced maintenance costs), and carbon emissions reduction. The fabric-first approach counters the relatively high levels of embodied fossil fuel-based emissions involved in energy technology construction, and provides other benefits, such as passive efficiency as they do not require active user control [58]. A 'robust' fabric-first approach is called for by multiple actors in the residential sector [53, 59], yet this is highly dependent upon the level and type of skills, availability and supply chain efficiency across local housing markets. Moreover, there is a high 'hassle' cost associated with fabric-first retrofit, particularly when it involves changes to high use/high-cost room renovation such as bathrooms and kitchens, internal wall cladding (requiring the moving of furniture) or changes to electrical or hot water fixtures and fittings. The rollout of domestic fabric-first retrofit therefore operate around cycles of renovation that minimise disruption to homeowners/tenants.

There are essentially two models of retrofit – the one-off, whole-house approach, or a step-by-step approach over several years – the former is often construed as the least disruptive approach, though this is context specific, and neither the planned/emergent character of the retrofit nor the time scale over which they are completed seems to be linked to the carbon savings achieved, making a one-size-fits all approach impossible. Though a whole house approach reduced the overall timescale of disruption for the project, retrofit projects over an extended period of time allow residents to recover from the disruption of building works in between smaller projects, to save for the next phase of works, and plan retrofit in a way that fits with current investment patterns in housing [60]. Whole-house retrofit would likely work best at the neighbourhood scale, in which a large volume of similar designed houses/flats all install a fabric-first approach to insulation and then new low-carbon technologies. Policies adapted to a retrofit approach, commonly stress the economies of scale that come from this approach, particularly in relation to lower labour costs, and material purchases. However, this approach best suits social landlords who have the capacity for rolling retrofit across a large housing stock [61], but is challenging in mixed-use developments where owner-occupiers, the private rented sector, and social landlords share buildings (such as flats) or adjoining properties.

Social housing providers remain key innovators in residential low-carbon transitions – they have control over the building management of large housing stocks, greater opportunity to access funding to retrofit on a large scale, and work to foster a close relationship between decarbonisation, resident quality of life and the place and communities they serve. They are therefore key 'middle actors' who not only facilitate but also realise low-carbon transitions through retrofit [15]. In broad terms, the definition of net zero for the social housing sector is that housing associations need to eliminate a collective share of the 13% of direct, regulated carbon emissions produced by the burning of fossil fuels to heat space and water in residential buildings in all our current and future housing stock [62]. For most SHOs, the decarbonisation process is through roll-out retrofit, making use of the £3.8bn Social Housing Decarbonisation Fund promised in the Conservative Party manifesto [63]. The roll-out retrofit approach has shown modest success for social landlords in the past. For example, Radian Housing, a social landlord with 16,000 properties, was funded by the European Regional Development agency for a series of 36 low-carbon renovations of near-identical houses in southern England. Gas and electricity consumption were monitored before and after the renovation works for a small number of these homes. The study showed that monitored gas consumption reduced by 50-60% whilst electricity consumption remained broadly unchanged or only showed small reductions during the same period [64, 65].

The fabric-first approach faces a number of market challenges. Davies and Osmani [66] showed that the high capital costs for micro-generation technologies (such as solar-PV) and energy efficient materials; the disparity in VAT between new build and refurbishment; and the complexity of the UK existing housing stock are the most considerable low-carbon retrofit challenges for the residential sector. They recommend tax rebates on technologies and materials, removal of the VAT difference between new build and refurbishment, action to encourage more affordable micro-generation technologies (though notably solar-PV costs have come down considerably since 2011); and increased government supplied low-carbon programmes to drive successful retrofit.

The Government-led Heat and Building Strategy aims to ease consumer costs through a system of financial support mechanisms. These are primarily funded through the domestic Renewable Heat Incentive. However, from April 2022, the Clean Heat Grant provides support to households purchasing heat pumps. However, given the high upfront financial cost of installation, there is a risk that higher income households, motivated by pro-environmental action, are more likely to be early adopters and thus be more likely to take advantage of any government grants which are typically wound down over time [67]. As seen with previous incentives schemes (such as the feed-in-tariff), there is a risk that government taxpayer funded incentives for decarbonisation are taken up by the richest households. This is an issue of energy justice, in which the distribution of government-backed financial incentives disproportionately benefits with the wealthiest consumers. Ensuring mechanisms for uptake of Clean Heat Grants from low-income households (such as a staggered grant based upon means testing, with larger grants for lower income groups) would improve the overall fairness of the scheme.

Installation quality, consumer confidence, and trust

The considerable market barriers to retrofit, affect consumer confidence and trust in the process and outcomes of low-carbon transition. There is growing consumer interest in domestic low-carbon transition, though this is not yet matched by market demand. As shown in chapter_ a lack of impartial information on retrofit options, the support and finance needed, and long-term economic gains from energy saving are key barriers to uptake. Moreover, the limited consumer awareness or understanding about the benefits of improved building energy efficiency (specifically energy saving materials and technologies, and cost savings) often leads to insufficient incentives for interventions [40] and a narrative for energy efficiency that focusses primarily on minimising costs alone, rather than a fuller set of benefits related to saving costs alongside maximising health, improving comfort, and other benefits.

When it comes to disseminating information about the benefits of low-carbon heating systems, BEIS and the Heat Pump Association report that installers are the main contact for homeowners, and installers and tradespeople remain key trusted groups to advise on which heating system to install in the home [68]. Making sure that installers can therefore confidently and accurately provide information on the range of social, health and cost benefits of a low-carbon system requires further training, assessment, and communication practices. However, even when consumers decide to proceed with installation work, they need to have confidence in the quality of the finished product, and that promised outcomes meet expectations. Research conducted through the Energy Catapult for The Gatsby Foundation found that the sector requires drastic improvements in quality and consistency across the residential sector. Too often, poor quality work either goes unnoticed, or is insufficiently penalised, not only creating disadvantage to consumers that receive expensive and poor-quality craft and materials, but also penalising those small and medium enterprises (SMEs) that perform good quality work by stimulating consumer distrust in the sector in the whole. Ensuring the quality of installation, maintenance and repair through active monitoring and assessment of installations would hold installers to account, therefore driving quality improvements across the supply chain [50]. Also new retrofit buildings standards are aiming to improve the quality of installation. The new PAS2030 Installer Certification Standard, and 2021 MIS 3005 heat pump installation standard are now built into contemporary Building Regulations to ensure the quality of heat pump installations, and to raise standards in the delivery of retrofits by introducing additional skills requirements. Installers carrying out work as part of government schemes are now required to be registered with a licenced industry body, retrofit designs have to be carried out by an architectural technologist, architect or chartered surveyor (depending on the project), and all retrofits must be led by a trained project manager [69]. However, there is currently no actual legislative requirement to be qualified or accredited to install a heat pump in the way that there is for natural gas boilers. Heat pump installers need to be Microgeneration Certification Scheme (MCS)-registered to receive payment for work done under government schemes such as the Renewable Heat Incentive or the incoming Boiler Upgrade Scheme, but there is no requirement for private sales to consumers. We argue therefore that the roll-out of MCS-certification requirements for all installers will help to establish consumer trust through timely, good quality and cost-efficient retrofit. This, in turn, will encourage rapid market uptake, which in-turn will grow the sector, providing further economic and social benefit gains.

Summary of market barriers

The two main market barriers for the low-carbon transition in domestic heating are:

1. The future homes standard, which requires heat pumps as a standard replacement for gas boilers. The lack of installers means that rapid upscaling of skilled labour, improvements in supply chain efficiency, and subsidisation are necessary to meet net zero goals for the sector.
2. The upfront costs, quality assurance, and proposed savings from low-carbon retrofit are a major barrier to consumer uptake. Action to ensure low cost finance of installation for consumers, provide monitoring and assessment of standards for new installations, and action to subsidise electricity costs for new consumers – would collectively alleviate these barriers and improve market uptake. This would provide primary and secondary economic benefits from infrastructure investment, energy savings and action on climate change mitigation.

Though increasing the market up-take (the ‘demand-pull’ of low-carbon retrofit) is crucial, the housing industry still suffers a range of specific barriers to skills and human resource development in modern construction, buildings retrofit and the implementation of novel domestic space heating technologies (the ‘supply push’ within the market). These collectively stymie the development of a cost-efficient and high-quality low-carbon transition service in the domestic residential sector. In terms of a skills gap, we identify two primary sets of challenges. The first concerns training in installation, maintenance, and repair of new innovations across the housing industry. The second is recruitment and retention of skilled staff. Review of the literature shows that overall concerns raised within the industry cover a range of issues within these two broader challenges [40, 70, 71]:

- The lack of training providers specialising in building physics, energy efficient design, technology design, maintenance, and repair.
- The porosity of skills markets and high demand for building sector services – i.e., highly trained individuals can take the skills elsewhere making it hard for SMEs to capture the full benefits of training.
- Limited opportunities for career progression for aspiring employees.
- High turnover of staff between employers, and to a lesser extend industry sectors.
- Limited requirements to demonstrate experience and accreditation for relevant skills.
- Limited ongoing training provision, access and demand.
- Low levels of formal skills dissemination across the sector
- Lack of partnership working across training providers
- Limited support or funding for the SME sector to access training and skills.
- Limited demand for training amongst employees.

In the following section we break down these challenges into four components:

- The size of the employment and training pool
- Challenges of diversity and representation
- Technology-specific installation challenges
- Training provision challenges

The size of the employment and training pool

Though the UK heat pump industry will become a major player in the overall transition to net zero in the residential sector under the Future Homes Standard, at present the size of the market, the level of installation skills, inconsistent policy support and the lack of consumer demand has stimulated a major skills gap within the industry. The Government's Heat and Buildings Strategy (HBS) is key in setting out the overall vision for the transition to high-efficiency low-carbon buildings in the UK, but as shown by research conducted by the Social Market Foundation, the HBS is a "good start", but fails to address the extent of the workforce demands needed to make low-carbon domestic heat a reality [72]. The HBS states that there are currently 1,100 Microgeneration Certification Scheme (MCS)-registered and qualified heat pump installing *companies* in the UK [3] (MCS is an accreditation scheme run by the Microgeneration Certification Scheme Service Company Limited), but provides no detail on the demographic make-up of the workforce (for example, how many are sole traders?), nor details any provision of tailored support for different types of suppliers.

The Heat Pump Association state that in 2019 there were an estimated 35,000 heat pumps installed in the United Kingdom and by 2020 the sector employed fewer than 2,000 workers [67, 68], though these estimates are difficult to verify [72]. For comparison there are 130,000 registered gas boiler installers in the UK. Given the phase out of gas boiler installation in new homes from 2025, the current supply of skilled labour falls well below the numbers laid out in the 2011 UK Renewable Energy Roadmap [73], which estimated that 150,000 jobs could be supported by the UK heat pump and biomass heat sector by 2020. The Heat Pump Association analysis of future market trends shows that the number of installers available in the sector needs to grow from this low base to around 70,000 by 2035 [68].

In the Tees Valley specifically, our analysis using the EMSI Labour market analytics database report for all jobs within the 2021/22 “Engineering Activities and Related Technical Consultancy Industry Sector” found that of the 12,000+ jobs posted within this sector across the Northeast of England, 3% of these jobs were within the “Plumbing, heat and air-conditioning installation category”. Though at the level of individual job postings, across the Tees Valley, we found only 6 unique postings for plumbing or boiler installation across 2021. It is unclear however whether the low rate of installer postings represents a low level of sectoral employment, or whether this represents uptake in the self-employed/SME sector. Searches for heat pump installers across the Tees Valley sub-region turned up 11 results for small enterprises/sole traders, compared to 47 for gas boiler installation, representing considerable room for local growth within this sector.

Challenges of diversity and representation

Branford and Roberts [67] find that the impacts of a persistent heat pump skills gap reach beyond the jobs market and emissions reduction criteria – there are concerns about a *just transition* in the heat sector in which the social and economic benefits of heat transition can be felt across whole communities. They note that younger and older generations of workers are the ones most exposed to the risks of an industry skills gap. Younger people could potentially benefit from growing job opportunities in the heating sector, but low wages for apprenticeships, inconsistencies in quality of training and lack of routes into the sector need to be rapidly addressed. Older workers, including those moving from legacy carbon-intensive industries such as oil and gas or steel, are usually required to pay upfront to benefit from heat sector skills development, and often take unpaid leave to complete training. Lack of long-term government strategy on skills training in the sector have made personal investment in training a high-risk opportunity for many workers, thus exacerbating the skills gap challenge. Additionally, there is also an identified lack of diversity within the pool of trained employees, meaning that the heat sector (reflecting broader trends in the energy engineering sector) struggles to attract a diverse workforce. This not only reduces the talent pool available but also reduces the attractiveness of the sector overall, further limiting the future labour pool available. Despite attempts to address imbalances across the sector to attract workers across different backgrounds of gender, ethnicity, and disability, progress has been disappointingly slow at the sectoral level [74]. Collectively these skills gap barriers are cumulative. Thus, action to address pay, training costs, and active recruitment and retention of a workforce from a diverse array of demographics and social circumstances will not only grow the potential talent pool necessary to meet the 70,000-installer target by 2035, but will also address a ‘just’ heat transition by alleviating problems of representation within the energy and engineering sectors.

Technology-specific installation challenges

Trade Sector representatives interviewed by Branford and Roberts [67] described the complexity of heat pump system installation. Unlike traditional gas boiler, heat pump installation requires a complex mix of skills including pipefitting, heat systems engineering, refrigeration, and electrical skills. Project installation is also more time-consuming than a traditional gas boiler, as identified in chapter_, the external installation of the heat pump, electrical connections, new pipework, skirting boards, radiators, and a hot water tank is estimated to take roughly twice as long as a new natural gas-powered boiler system. Though typical installation takes an average of 2.5 days, complex projects can take "several weeks" if new electricity connection or fuse upgrade from the distribution network operator are required, or where radiators and pipework need to be replaced [75]. Also, though there are projected cost savings from heat pump installation, the process can cause unexpected risks, costs, and social impacts. For example, heat pumps can emit noise which breaches legal limits, and could actually increase fuel bills if the right insulation is not installed first. Understanding the practical implications of heat pump installation under real-world scenarios for different housing types is a key research challenge. Of note in this regard is the Electrification of Heat Demonstration Project, led by The Energy Systems Catapult for the Department of Business, Energy, and Industrial Strategy (BEIS). This £14.6 million demonstrator project will lead to the installation of heat pumps across 750 homes in the UK across a representative range of housing archetypes and social groups (the majority on the gas grid). By monitoring the process and outcomes of installation and use, the demonstrator will provide useful data to assess the technical and practical feasibility of a large-scale rollout of heat pumps [76] and thus could potentially aid contemporary training in installation and project planning for different housing types and community contexts.

Training provision challenges

Of the 130,000 existing trained boiler installation practitioners, the Governments Heat and Buildings Strategy purports to upskill this workforce to install heat pumps through training that would take around one week to complete [3]. One of the core difficulties is providing sufficient foresight so that training providers can focus their efforts in a cost effective manner, when trying to meet the skills needs of new and rapidly evolving markets, using new tech and installation practices [77]. As such, the Heat Pump Association [68] report that contrary to the assertions of simple access to heat pump skills, the current route to becoming a heat pump installer remains costly, bureaucratic and confusing, with outdated content still being taught by many existing training providers. Low quality or out-of-date skills training risks perpetuating a cycle of poor quality installations as SMEs and sole traders pass on out of date knowledge to new apprentices and trainees within their organisations. This would ultimately damage consumer trust in the sector and further damage opportunities for market uptake of low-carbon heat systems.

Qualitative research with installers reports a varying degree of quality in training provision across the sector [67, 72]. However, there is growing standardisation and certification emerging. The most commonly recognised qualification is a Level 3 qualification that complies with National Occupational Standards and is recognised by the Micro-generation Certification Scheme (MCS) registration bodies. This means that the NVQ/SVQ is commonly recognised as an acceptable qualification to join one of their respective schemes (see discussion of the MCS above). This type of MCS-compliant heat pump training provision is provided by a range of education sector and private training suppliers. The NVQ/SVQ level training typically covers how to install, commission, handover, inspect, service and maintain heat pump system installations non-refrigerant circuits [78]. Prerequisite learning for heat pump training is usually a minimum NVQ/SVQ Level 2/3 qualification in plumbing or conventional heating engineering, or a demonstrable number of years of relevant experience, plus demonstrated knowledge of Water Regulations/Byelaws. Acceptable prerequisite qualifications include NVQ/SVQ Level 2/3 in either Plumbing, Heating and Ventilating (Domestic

Installation, or Industrial and Commercial Installation), Oil-Fired Technical Services, Gas Installation and Maintenance, or else Heating installation experience (minimum 3 years) in wet central heating system installation shown either by manufacturer courses certification or Gas Safe register, OFTEC, MCS, HETAS registration [79]. In the North East, however, there are a limited number of training providers offering this level of qualification. One of the first was Decerna (NDE) that offered a fully-funded accredited heat pump training courses to North East based heating engineers in 2017. Decerna NDE is an independent SME based in Blyth, Northumberland. The skills funding was provided by the European Social Fund (ESF) and co-financed by the Skills Funding Agency (SFA). To be eligible, a company must be based in the North East LEP area (Northumberland, County Durham or Tyne & Wear), be a sole trader or SME (under 250 employees and under £40 million turnover), and be undertaking the course for the first time [80]. There was no equivalent training provider in the Tees Valley that we could find.

Since 2022, new training providers such as “Go Green Training Academy” in Peterlee have emerged to help plumbing and heating engineers take fully certified LCL Awards Air Source Heat Pump qualifications [81], though these are not fully funded. Given the withdrawal in ESF financing of skills training, it behoves local authorities to capitalise on Levelling Up funding to replace this for heat pump incentives – particularly given the urgent skills gap within the sector.

Within the Tees Valley, multiple providers offer NVQ-LEVEL TRAINING LEVEL 2 in Plumbing and Heating:

- Beyond Housing
- Darlington College
- Hartlepool College
- JTL Training
- Redcar and Cleveland College
- South Tees Hospitals NHSFT

However, through our desk review and stakeholder mapping we could find none that currently offered heat pump specific training, meaning that there are currently no accredited providers of this specific training within the Tees Valley. This is however clearly a growth area, with numerous training organisations poised to enter the skills market.

Potential solutions to the skills gap in the Tees Valley

At present there are multiple partnership programmes that encourage multi-stakeholder engagement and co-production of training needs assessment, and support for SMEs across the sub-region. Notable is The Tees Valley Collaborative Skills Development Partnership (Skills for Growth Programme SfGP): a joint initiative between Tees Valley Business and Teesside University, part-funded by the European Social Fund* as part of the 2014-2020 European Structural and Investment Funds Growth Programme in England. The Skills for Growth Programme is a key hub to address business skills gaps in low-carbon development, and to access employee training. The SfGP is aimed at small or medium-sized enterprises with fewer than 250 employees based in the Tees Valley (Darlington, Hartlepool, Middlesbrough, Redcar and Cleveland and Stockton-on-Tees) [82]. The programme specifically offers:

- Business skills advice for training and business planning supported by Skills Development Officers
- Productivity enhancement through upskilling SME current workforce
- Differentiated plans for (among others): work experience, work placements, traineeships, apprenticeships and graduate placements.
- Qualifications including degree apprenticeships, T Levels, NVQs,

Within this broader training assessment and provision platform, “Energy and renewables” is one of the key areas of skills analysis and planning offered within the programme, though how this translates to renewable heat network training provision requires further scrutiny by the University and the business community. We echo the findings of other regional low-carbon skills assessments [70]: that training providers need to develop the necessary training and short courses to enable people to learn, share and practice low-carbon and green skills, with a specific need for clear progression opportunities from levels 2-7. This includes the development not only of accredited NVQ-SVQ options, but also a range of alternatives including T-Levels, HTQs and apprenticeships leading to high quality installation outcomes suitable to meet the needs of mass roll-out retrofit and new build programmes to meet government-led decarbonisation pathways in the residential sector. Growth in the provision of flexible, ideally fully funded short courses will support lifelong learning across the Tees Valley, and thus alleviate problems of persistent under-representation of workers from marginalised demographics and cultural backgrounds.

Specifically, we recommend that courses for low-carbon heating solutions, including retrofit technologies and energy efficiency alongside low emission vehicles and infrastructure need to be implemented as an urgent action. Though individual FE and HE providers currently provide a range of courses in heating and ventilation, the curricula need to develop, specifically with individual courses to address specific skills gaps. Establishment of coherent longer-term strategy of partnership working between Teesside University, the TVCA, FE partner colleges and private training providers is needed to develop suitable low-carbon skills provision, with dedicated support to SMEs to access these services to train their existing (small) workforces at low/no cost.

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