

How to scale a highly skilled heat pump industry

July 2022



About Nesta

We are Nesta, the UK's innovation agency for social good. We design, test and scale solutions to society's biggest problems. Our three missions are to give every child a fair start, help people live healthy lives, and create a sustainable future where the economy works for both people and the planet.

For over 20 years, we have worked to support, encourage and inspire innovation. We work in three roles: as an innovation partner working with frontline organisations to design and test new solutions, as a venture builder supporting new and early stage businesses, and as a system shaper creating the conditions for innovation.

Harnessing the rigour of science and the creativity of design, we work relentlessly to change millions of lives for the better.

Find out more at [nesta.org.uk](https://www.nesta.org.uk)

If you'd like this publication in an alternative format such as Braille or large print please contact us at information@nesta.org.uk

Authors

Codrina Cretu, India Kerle, Dimitris Sarsentis, and Andrew Sissons

Acknowledgements

There are many individuals and stakeholders who have contributed to this report and we would like to thank them for their contributions.

We are grateful to the Microgeneration Certification Scheme (MCS) for allowing us to use its data for this research. We also want to thank representatives from MCS, Social Market Foundation and HomeServe Foundation for reading an earlier draft of this report and providing us with very insightful comments. We are also grateful to the interviewees who took the time to speak with us and provided us with critical pieces of information and knowledge. Thank you to our Nesta colleagues for their input and help with reviewing the paper.

Contents

Summary	4
1. Introduction	9
Methodology and research approach	10
2. The current state of the low carbon heating workforce	11
Size of the workforce	11
Skills	12
Training routes	14
3. The current state of low carbon heating businesses	19
Heat pump installation company landscape	19
4. What will the low carbon heating industry look like in the future?	23
How many heat pump engineers will we need?	23
How the structure of the heat pump installation market could change	26
5. Key challenges and opportunities	31
Incentives to join the low carbon heating industry	31
Quality of training	35
Productivity	35
Diversity	37
6. What action is needed to grow the low carbon industry?	38
Leadership to oversee the industry's expansion	39
Attracting people into the industry	40
Improving existing training pathways	44
Increasing productivity in the low carbon heating industry	47
7. Conclusions and next steps	49
Nesta's plans for future work	50
Appendix	51
Endnotes	52

Summary

The UK's low carbon heating industry will have to grow its capacity rapidly in the coming years.

Replacing gas and oil boilers with low-carbon alternatives is crucial if the UK is to meet its net zero emissions target. Over the next three decades, around 25 million fossil fuel boilers will need to be swapped for less polluting heating systems. That cannot be done without skilled people to do that work.

The UK Government's main focus so far has been on increasing consumer demand for heat pumps, which is undoubtedly crucial. We see some indications that **demand is beginning to increase** – for example, our recent research¹ suggested that more than 1 in 10 homeowners would choose a heat pump over a new gas boiler, even before factoring in government subsidies.

In this paper we argue that growing the supply of highly skilled engineers and having productive companies to employ them may be even more important and challenging than increasing demand. **The low carbon heating sector needs concerted action from governments and others** to increase the number of skilled people in the workforce and improve productivity, so that the sector can install more heat pumps.

We estimate that there are currently 3,000 trained heat pump engineers in the UK, and that will need to increase to at least 27,000 in the next six years, an average increase of 4,000–6,000 per year. This is a significant challenge. It means **training more new engineers every year than are currently in the whole industry**.

These new engineers need to be highly skilled. Installing heat pumps is challenging work, and the consequences of poorly installed heat pump systems will be serious, both in terms of high energy bills and damage to the reputation of heat pumps.

Part of the solution concerns training. There is currently no single, clear route for someone new to the industry to train as a heat pump engineer, and **training offers are fragmented and sometimes inconsistent**. Providing clearer pathways, such as a low carbon heating apprenticeship, will make the training journey simpler, more comprehensible and attractive.

But training is only part of the problem. **Heating engineers also require hands-on experience and guidance from experienced engineers** in order to learn to do the job effectively. To get that hands-on experience, they need a company to work for – that could be either via employment with a company or setting up a new accredited company.

Having enough companies and experienced engineers to take on and help train new workers is therefore vital to growing the heat pump industry. For this reason, it will be important to **attract both experienced gas engineers and new entrants into installing heat pumps**. If the industry tries to rely on new entrants and apprentices alone, there will not be enough experienced engineers to provide hands-on training and oversight.

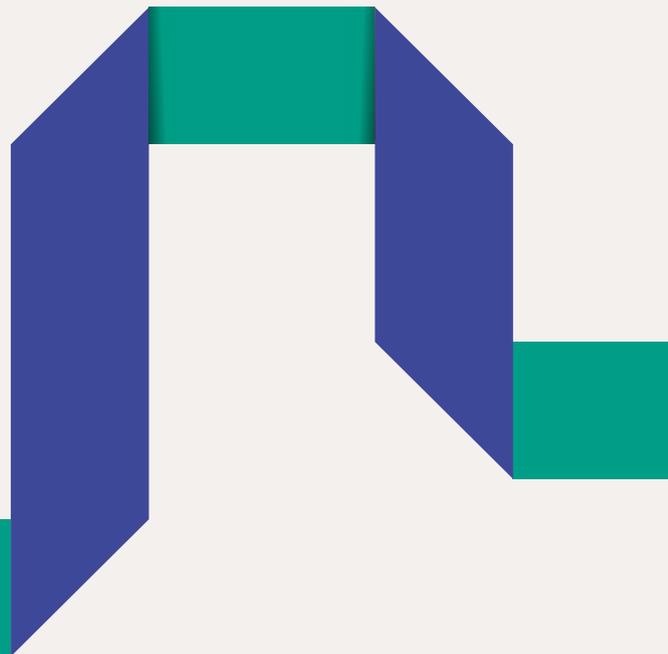
Diversity is a central aspect of this puzzle as **the heating industry is one of the least diverse parts of the UK economy**. Considering the high average age of engineers, and that many will be retiring within the next decade, the industry needs to cast the widest possible net to attract recruits who are currently underrepresented.

Existing heat pump companies will also need to take on and train new employees – either existing gas engineers or new entrants – and may need to grow their companies as a result. Because of this, we advocate a company-led approach to thinking about skills challenges, not only a worker-led approach. We need to recognise the central role companies will play in training and growing the low carbon heating workforce, and provide support to them to do so.

The incentives in the market are not currently strong enough either for workers to train as heat pump engineers or for companies to take them on. As we and others have previously reported, some engineers are hesitant to invest in retraining because they are unsure how the heat pump market, and government commitment to heat pumps, will develop in the long term.² However, our research shows that **there is also currently no wage premium for installing heat pumps compared to gas boilers**. Improving incentives to work in the low carbon heating sector should be an important priority for UK governments.

Increasing productivity in the industry, which has remained stagnant for the past few decades, is critical as this will translate to higher wages for engineers and reduced costs for consumers. Adopting new technologies and labour-saving aids could help to raise productivity in the industry, as could increasing company sizes and enabling workers to specialise in different skills.

The heat pump market is changing rapidly, with some larger companies (energy suppliers, manufacturers) entering the market along with a number of start-ups. The existing installation sector is dominated by micro-businesses and small traders but may soon include many different types of companies; the structure of the market may look different in the future than the current sole trader-led model. These market changes present opportunities for the heat pump industry, but such rapid changes in a small industry present risks as well. It is essential that the quality and efficiency of heat pump installations be maintained, which means ensuring all engineers are highly skilled and work to high standards.



Recommendations and what needs to happen

Leadership to oversee the industry's expansion

There is currently no oversight of the low carbon heating industry's expansion, and the UK Government has so far proposed very little action to help scale up the industry. The industry would benefit from oversight and leadership to own this problem and help businesses to grow and training providers to upskill the workforce.

To achieve this, we recommend that:

1. **The UK Government should appoint a body to oversee the expansion of the low carbon heating industry and workforce.** This body should develop a clear action plan together with colleges, training providers and the industry, and should also gather

and publish data to track the growth of the sector. This body could be an existing institution or a new task force bringing together key organisations within the low carbon heating industry.

Attracting people into the industry

The low carbon heating industry needs to focus on attracting both **new trainees and experienced gas engineers and plumbers**. However, these two groups face different barriers to entry which require different approaches:

- > For new entrants, the focus should be on making routes to training clear and accessible, and ensuring there are jobs available for them to develop skills
- > For experienced engineers, the focus should be on providing better financial and non-financial incentives to switch to heat pumps.

To achieve this, we recommend that:

2. **Colleges, training providers and governments** should work together to establish direct routes to training as a heat pump engineer via low carbon heating apprenticeships and college courses. There are already such courses in development, rolling them out should be a priority for colleges and governments.

3. **Governments** in the UK should trial how effective a cash incentive would be in attracting people to train as heat pump engineers. This trial could test the best size of incentive, and whether paying money to the trainee overcomes other training barriers faced by prospective trainees. Another option would be to trial a minimum income guarantee for newly trained heat pump engineers.
4. **Governments** in the UK should trial how effective a cash incentive given to companies would be in encouraging companies to take on and train new workers. This trial could test the best size and structure of incentive.
5. **Governments** in the UK should launch a national campaign about net zero homes, heat pumps and the crucial role of heat pump engineers to help crystallise a new image for the sector.

6. **Installation companies** should review their hiring processes. This could be done by developing dedicated recruitment pipelines for women and people from minoritised groups, rolling out targeted outreach to minoritised and disadvantaged groups, and debiasing job advertisements and interviews.
7. **Installation companies** should ensure that their internal policies encourage employee retention, experience and promotion. This could be done by ensuring the clarity and transparency of processes for pay and promotion decisions, investing in the development of staff from minoritised groups and promoting flexible working and support for parents returning to work.

Improving existing training pathways

There are a range of existing training offers for low carbon heating, many of which can improve and become more widespread. Low carbon heating should be more often integrated into existing heating and plumbing training courses, while more specialised training – including lifelong learning for low carbon heating engineers and plumbing and heating tutors – would help the industry continue to raise its skills levels. Governments should also explore ways to make apprenticeships easier for both businesses and apprentices to access.

To achieve this, we recommend that:

8. **Colleges, training providers and governments** should work together to integrate in-depth heat pump modules into existing college courses and apprenticeships.
9. **Training providers** should work with heat pump installation companies to develop options for separate, specialised design and installation training. Heat pump installation companies should also consider hiring designers and system installers separately.
10. The UK's **governments** should offer time-limited grants for continued professional development to certified heat pump engineers (either employees of MCS-certified companies

or members of umbrella schemes). These could be spent on additional training and productivity-enhancing measures.

11. **Governments** should support the wider take-up of shared apprenticeship schemes to help attract and train more people into the industry and encourage more employees to take on apprentices.
12. **Governments and training providers** should better support those providing training via college courses and apprenticeships by rolling wide industry-wide 'Train the trainer' programmes for existing plumbing and heating trainers and providing employees that are taking apprentices with teaching guidance, resources and financial support.

Increasing productivity in the low carbon heating industry

As well as expanding, the low carbon heating industry also needs to become more productive. Businesses could raise their output per hour by adopting new technologies, improving processes and making use of more specialised skills. To do this, businesses will need support and to develop more capacity to learn, invest and specialise.

13. Existing small heating **installation companies** may benefit from taking on additional employees. Moving from micro to small companies could enable more specialisation of skills, as well as creating more options to raise productivity. This could be achieved by existing engineers

taking on and training up new employees, or by sole traders merging into new partnerships or other company structures. This could be facilitated by **government** grants to take on new workers (as under recommendation 4).

14. **MCS and governments** should provide more formal support for cooperatives or umbrella arrangements, which let small heating installation companies group together and pool resources. This model may be a good option to enable more training, productivity improvements and business growth.

15. Heating **manufacturers** should consider getting more directly involved in training engineers and helping them to raise their productivity. If large new entrant companies come to dominate the heat pump market by being more productive, this may reduce manufacturers' power in the market.

Paying for these recommendations

Our recommendations include new government funding for heat pump installation companies and workers. While this would cost governments money, it would be significantly cheaper than the ongoing subsidies for heat pump installations. Even at generous levels, the incentive payments outlined here would not exceed tens of

millions of pounds, compared to £450 million already committed to the Boiler Upgrade Scheme. While subsidies are an important part of government policy on heat pumps, investing in the supply side of the market is also essential, and the modest amounts of funding suggested in this paper should be seen in that context.

Who these recommendations are aimed at

Our recommendations are targeted at different organisations in the low carbon heating industry, including:

- > **Governments** – the UK Government along with the devolved governments of Scotland, Wales, and Northern Ireland (which have responsibility for further education, skills and other key policy levers)
- > **Colleges** – further education providers who provide education and training to people from 16 years of age and up
- > **Training providers** – specialised low carbon heating training organisations that offer more advanced, specific training to heating engineers
- > **Businesses** – this includes heat pump manufacturers, installation companies and other businesses – such as energy suppliers, merchants, start-ups – involved in the low carbon heating industry. Specific types of business are specified where relevant.

1. Introduction

The UK needs to replace roughly 25 million oil and gas boilers with low carbon heating systems over the next three decades. Heat pumps are currently likely to be the best low carbon heating option for most of our homes. They are highly efficient, use electricity that is increasingly generated from renewable sources, and can be adapted to heat almost all homes effectively.

Heat pumps are currently relatively rare in the UK – there are around 250,000 residential heat pumps – although much more common in many other countries. The UK Government wants to see the number of heat pumps grow rapidly and has set out a target to increase annual installation numbers from around 30,000 before 2020 to 600,000 by 2028. The Scottish Government aims to install 80,000-100,000 heat pumps cumulatively over 2021-2026, and install 170,000 units in 2030.³

However, the Heat and Buildings Strategy published in October 2021 by the Department for Business, Energy and Industrial Strategy (BEIS) made only a few references to the skills required to install heat pumps on such a massive scale. Policies such as the Boiler Upgrade Scheme and Home Energy Scotland provide grants to make heat pumps more affordable and, as a result, increase the demand for low carbon heating. However, these policies do not address the supply of skilled labour necessary to achieve the installation targets. Increasing demand for heat pumps will eventually lead to an increase in supply, but this will not happen overnight. Given the current low numbers of skilled, experienced engineers and the length of time it takes to train someone from scratch, it is important that we address the issue of supply concomitantly.

This paper looks at the current state of the heat pump market from a skills, training and productivity perspective. It also suggests ways of increasing the supply chain's capacity to install heat pumps. We have mainly focused on air-to-water heat pumps given that they are the most suitable type of heat pump for most UK homes, but the findings of this report are directly relevant to other low carbon heating technologies. We are focusing on the domestic retrofit market, as this currently poses the greatest challenge in domestic heat decarbonisation, although we acknowledge that there are many shared lessons for the new build and commercial market as well.

We hope this report will be of use to a variety of stakeholders and that it helps inform and steer decisions by policymakers and intermediary bodies involved in home heating. We hope this report will be of use to those at the centre of this report: heating engineers themselves. We also hope to identify key areas for further research and action by Nesta and by other organisations.

Methodology and research approach

The findings in this paper are based on:

- > A literature review covering the current state of the gas and low carbon heating engineer market, the training available on heat pumps and barriers to training
- > Interviews with 14 stakeholders, including industry experts, training providers, think tanks and other specialised foundations, manufacturers and heating engineers
- > Quantitative analysis of two data sources to investigate skill, salary and heat pump company insights: Nesta's own [Open Jobs Observatory \(OJO\)](#) and MCS's Installation database of certified heat pump installation companies.

The OJO is an ongoing project from Nesta that provides free and timely insights on the skills mentioned in UK job adverts. We began collecting online job postings in January 2021 and the OJO now contains millions of job adverts. Information on skill demands is not available from official vacancy statistics, and so the OJO aims to fill this important data gap. As with any novel data source, it is important to bear in mind its limitations. First, not all work is advertised via online job adverts, such as work awarded via a contracting process. Second, the skills mentioned within an advert may not necessarily reflect all the skills required for a job.

We used OJO to extract findings related to job vacancy salaries and skills. We did so by first querying OJO to identify job vacancy ads for gas engineers, boiler engineers, air conditioning engineers, underfloor heating engineers, electrical heating engineers, solar thermal engineers and heat pump engineers. Once we identified relevant job vacancies, we were able to run summary statistics on our findings, investigating skills demanded and salaries across the identified job titles. There are more details on our querying strategy in the Appendix.

MCS provides a central online database of MCS-certified installations in the UK since 2008. While the MCS database does not provide a comprehensive list of all the companies designing and installing domestic heat pumps (as MCS certification is not mandatory), we assume that the database includes the vast majority of domestic heat pump companies. We used MCS data primarily to: 1) aggregate, normalise and map the number of installer companies per 100,000 population by UK NUTS2 region and 2) investigate the number of installations that companies complete each year.

A note on terminology

We use the terms 'engineer' and 'installer' to refer to a person who designs, installs and maintains heating systems. It is worth noting that unless explicitly referring to only the process of physically fitting the heat pump unit and auxiliary equipment into a domestic property, the term 'heat pump installation (company/ process)' refers to the process of assessment and design as well as physically installing the heat pump system into homes.

2. The current state of the low carbon heating workforce

This section sets out the state of the heating installation workforce as it is now, looking at the skills required and training routes available to prospective heat pump engineers.

Size of the workforce

There is no definitive data available on the number of people or companies currently installing heat pumps. BEIS estimates that there were between 3,000 and 4,000 heat pump engineers in 2021,⁴ while the Independent Networks Association on the Future Homes Standard estimate that the number is closer to 1,200.⁵

Our analysis of the Microgeneration Certification Scheme (MCS)⁶ database shows that there are about 1,300 enterprises⁷ certified with MCS that install heat pumps. Many of these businesses are sole traders. The Social Market Foundation⁸ estimates that 51% of the plumbing, heating and ventilation

engineers workforce in the UK are self-employed, and our research revealed that the majority install a small number of heat pumps (fewer than 15) per year. These businesses typically offer other services too, including gas and solar installation. However, as MCS certification is not mandatory⁹ and it is businesses (including sole trader businesses), not individual engineers, that get certified, this doesn't provide an accurate indication of the total number of engineers. With this in mind and given that the workforce is dominated by sole traders, our best estimate is that the number of heat pump engineers is around 3,000.

Skills

The skills required to install heat pumps into domestic properties can be broken down into three categories:

- > Assessment and system design.
- > System installation.
- > Electrical work.

Assessment and system design

The first stage of installing a heat pump is typically the assessment of the property and the design of the heat pump system, taking into account a property's heating needs and the preferences of the customer. The process usually involves the following:

- Discussion with the customer to understand what they are looking for and surveying the property.
- Performing heat loss calculations for the property to determine the heat pump size required.
- Sizing heat emitters (eg radiators).
- Sizing pipework and materials.
- Setting control options such as space heating controls and hot water controls.

Heat loss calculations and heating system design are taught in gas and oil training courses, but they are rarely employed in practice during boiler installations. Many boilers are currently installed without a home survey, and industry practice favours oversizing boilers and overspecifying their flow temperature to mitigate against the lack of system design. However, given that heat pumps run efficiently at lower flow temperatures (around 45°C, compared to 60-80°C for gas boilers),¹⁰ poor heat loss calculations and design can lead to the heat pump system not achieving the desired efficiency and, as a result, lead to increased energy bills and poor thermal comfort. Therefore, high-quality assessment and design is essential to any domestic heat pump installation.

System installation

The physical installation of the system involves fitting the heat pump and any auxiliary equipment into the property and making it operational by connecting it to the heating emitters and pipework.

While the system installation process is more lengthy and complex than that of installing a gas boiler, the skills required to complete the installation are very similar. Our analysis of job adverts in the OJO database revealed that the skills required of heat pump engineers are very similar to those of other heating, ventilation, and air conditioning engineers engineer roles.¹¹ As it can be seen in Figure 1, almost all of the top skills requested across installer job postings are requested in heat pump installer job postings (the exceptions are 'industrial heating systems' and 'install heat pumps').

This overlap in skills was further confirmed by our interviewees, who shared that, unlike the process of assessment and design, installing the heat pump into the property requires more limited knowledge of heat pumps, as it largely involves laying pipework, installing heating emitters and fitting in equipment.

Separation of design and installation standards

The design and assessment process requires a different skill set from the process of installing a heat pump. From 1 April 2022, MCS reflected this difference by splitting the existing Heat Pump Standard into two separate standards: one for Heat Pump Design and one for Heat Pump Installation. Given that it is not necessary for the same engineer to complete both the design and the installation, this separation gives engineers the option to focus and specialise on either process.

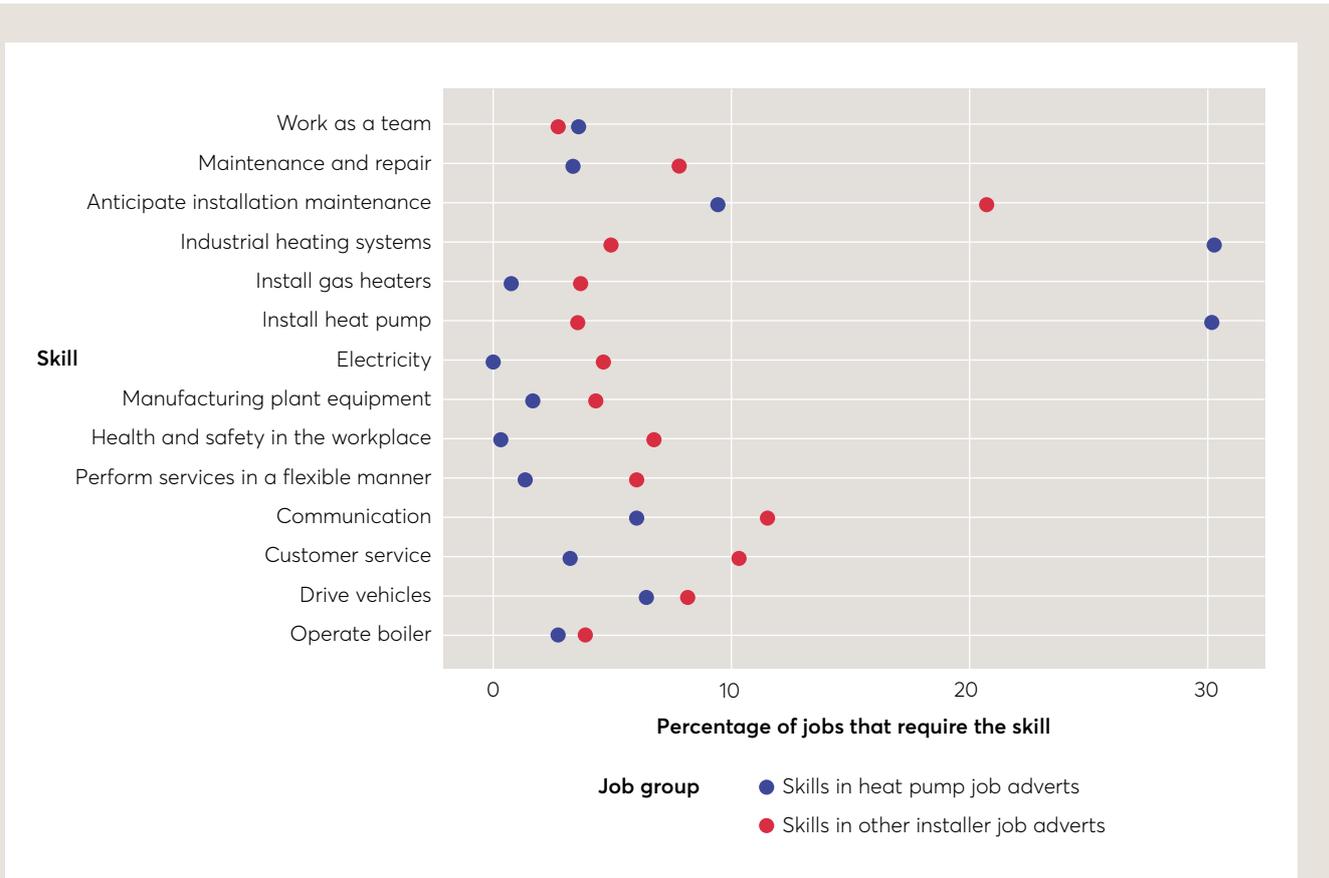


Figure 1. Top skills requested in installer and heat pump job adverts

Non-technical skills

In addition to technical skills related to the system design and installation processes, heat pump engineers need to also demonstrate non-technical, interpersonal and communication skills. Our analysis revealed that skills such as 'team work', 'customer service', 'driving', 'communication' and 'flexibility' were consistently mentioned in adverts for heat pump engineer jobs (see Figure 1). These skills are essential in ensuring good communication with customers, managing expectations and understanding and meeting their customers' needs and wishes. Good interpersonal skills are particularly important as they can affect the customer's experience and, as a result, the likelihood that they might recommend a heat pump to others.

Electrical work

The electrical work requires a qualified electrician with knowledge of configuring the heat pump and the wiring and assessing the electrical network capacity. While electrical skills are an essential part of the process of installing a heat pump and there is a shortage of qualified electricians on the market,¹² the skills required and the training pathway are very different from those of a heat pump engineer. For this reason, electricians will not be a major focus for this paper.

Training routes

To become a fully trained heat pump engineer, a new trainee must typically first qualify as a plumber or gas and oil heating engineer before attending a heat pump specific training course (see Figure 2). This

makes it particularly difficult for the heat pump industry to attract newcomers with no previous experience into the industry.

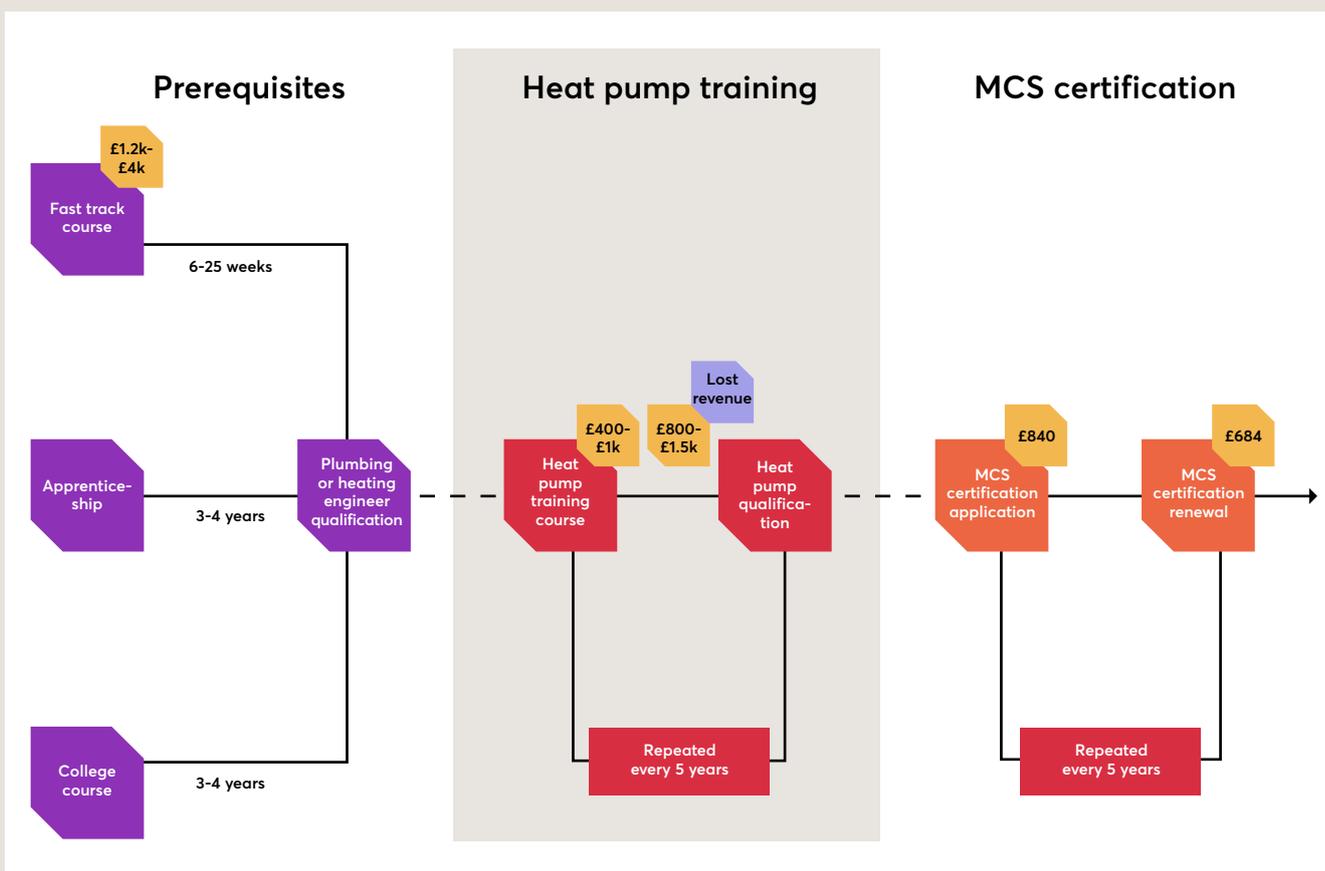


Figure 2. The route to training as a heat pump engineer

Moreover, unlike with gas boiler installations, where an installer is required by law to be registered in the Gas Safe Register¹³ heat pump qualifications and certification are not mandatory. This means that the type, cost, duration and quality of training can vary a great deal.

While there is no heat pump equivalent to the Gas Safe Register, engineers need to be employed by an MCS-certified company to be eligible to install heat pumps funded

through the Boiler Upgrade Scheme.¹⁴ This means that, after completing their heat pump training, many sole trading engineers pursue an MCS certification or start working for an MCS-certified company. Companies (including sole trading companies) are assessed by an independent certification body to ensure that they can complete an installation of the renewable technology in line with MCS standards and that the installation meets the quality standards. They get on-site assessments of the installation for each technology applied for.

Retraining as a heat pump engineer for existing gas and oil heating engineers or plumbers

Training as a heat pump engineer is a more straightforward process for those already working as gas and oil engineers or plumbers than for new entrants, particularly given the overlap in skills needed to install a heat pump and those needed to install a gas or oil boiler.

This means that for boiler engineers and plumbers, a three to five-day heat pump training course is usually sufficient to gain the necessary installation and, more importantly, assessment and design knowledge needed to get started as a heat pump engineer (see Figure 3). These courses are delivered by private training providers or colleges throughout the UK and the qualification is valid for five years.

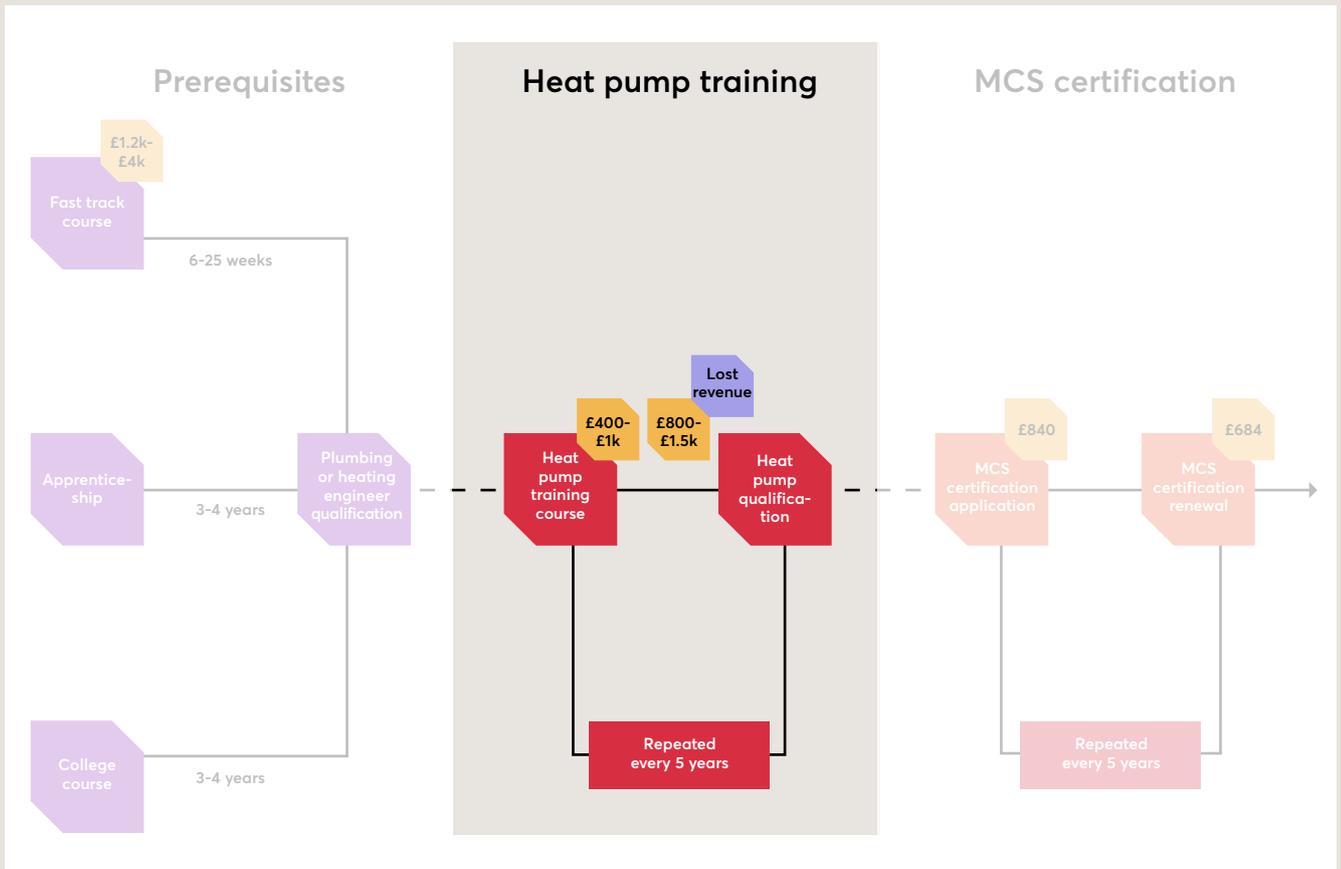


Figure 3. The route to training as a heat pump engineer (for a gas and oil heating engineer or plumber)

There is considerable variation in the heat pump training course offer available.

Duration and delivery: most courses take three to five days, although there are some that can take only a few hours.¹⁵ They are delivered either in-person or online, with most in-person courses also including additional practical elements.

Cost: the price of courses ranges from £400 to £1,000, although it is worth noting that this cost is sometimes covered by employers. Engineers can also incur indirect, opportunity costs in the form of lost revenue, which differs based on hourly rates or salaries and the length of the course. As a result, the total cost of attending a short course on heat pumps can range from £1,200 to £2,500 for a self-employed sole trader.¹⁶

Admission requirements: many courses have specific entry requirements. Most require individuals to have a National Vocational Qualification (NVQ) or equivalent qualification¹⁷ in plumbing/heating, as well as qualifications in Water Regulations (WRAS) and Energy Efficiency for Domestic Heating. Others are less strict and accept people who have completed none or some of the above awards but can show 'demonstrable experience'.

Syllabus: though the syllabus might vary slightly, courses generally cover heat pump basics, types of heat pumps, heat pump installation and sizing, heat pump maintenance, and health and safety.

Method of examination: participants need to complete an assessment in order to obtain a qualification. Most often, the examination is multiple choice and sometimes it might include practical elements.

Accreditation: although it is not mandatory, most courses are regulated by bodies such as BPEC, LCL Awards and EAL, who award engineers the qualification on completion of the course. While MCS provides a list of recommended courses for MCS-certified companies, this is not exhaustive, and aspiring heat pump engineers may choose to attend other courses instead.

In addition to these training provider courses, many engineers choose to attend manufacturer-run courses, which provide applied, practical and on-product training on one or more heat pump models produced by said manufacturer. Most often they are delivered free of charge or at a small charge of about £50. These courses help engineers familiarise themselves with the specifications and details of specific heat pump models. Manufacturers use this

opportunity to develop a trusted pool of engineers who are trained on their specific product and incentivise engineers to attend by offering them product discounts or longer warranty periods. In an effort to standardise training provision, manufacturer's courses are increasingly including recognised qualifications to trainees, such as the LCL Awards Level 3 Award in the Installation and Maintenance of Heat Pump Systems.

New entrants

Entering the heat pump market as a newcomer is a more complex process than that of retraining from adjacent specialisations

as they typically have to train as gas and oil heating engineers or plumbers first via an apprenticeship, a college course or a fast-track course (see Figure 4).

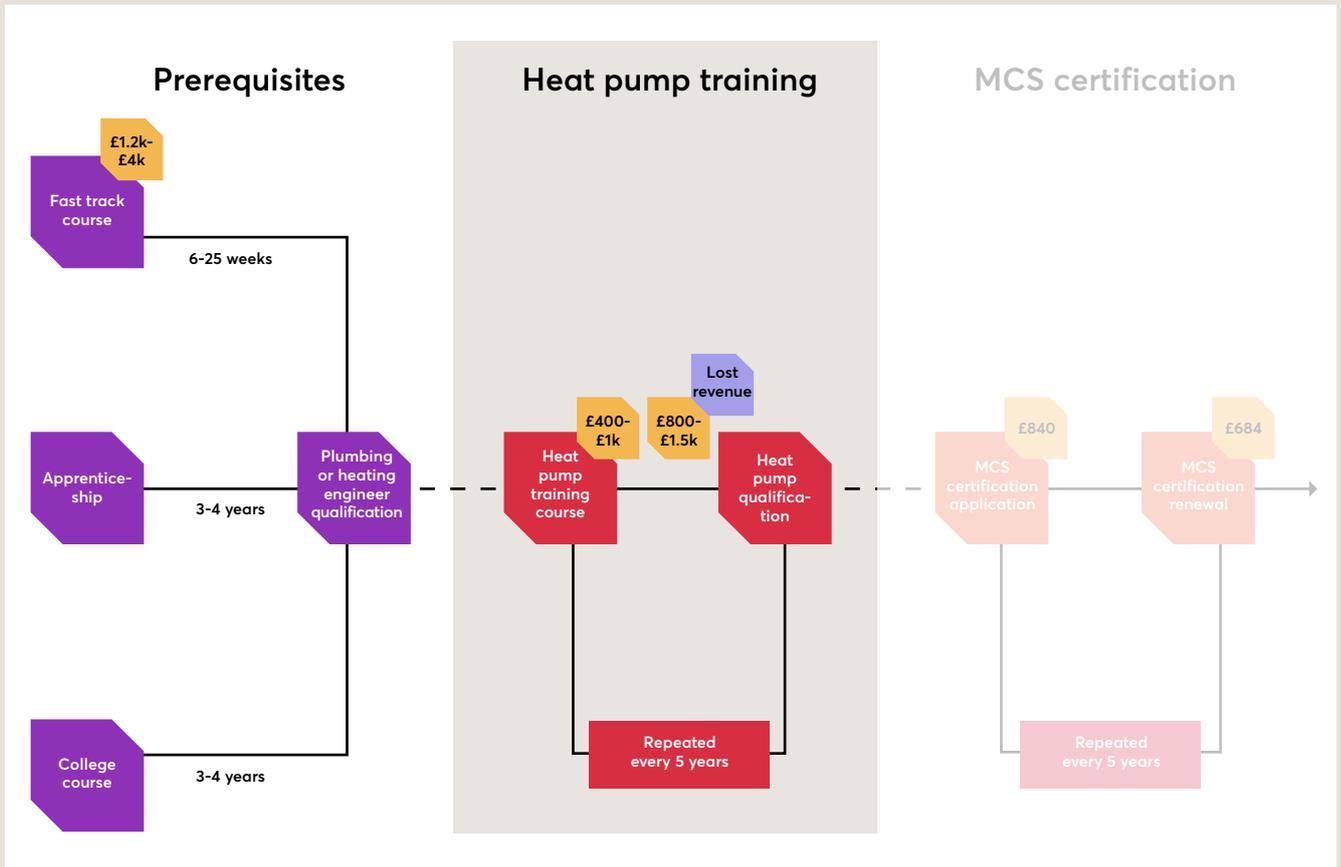


Figure 4. The route to training as a heat pump engineer (for new entrants)

Apprenticeships take approximately three to four years to complete to gain NVQ Levels 1, 2, and 3 and are premised on the idea of learning on the job. At least 80% of the apprenticeship is spent 'on the tools' with the remaining 20% on guided learning in colleges.¹⁸ Apprenticeships are particularly valued because of their practical experience, but they are also fraught with challenges. Our interviews revealed that many in the industry, particularly sole traders and small SMEs, are unable or unwilling to hire apprentices. These

challenges can potentially undermine the ability of apprenticeships to attract enough new entrants into the workforce.

While air source heat pump training is sometimes included in the Plumbing and Domestic Heating Technician Level 3 apprenticeship,¹⁹ few colleges currently offer it as an option due to the lack of necessary technology or expertise to teach it. Therefore, most prospective trainees enter the industry via the gas engineer and plumbing route.

Others enter the heating and plumbing industry through the college route. Plumbing and heating qualifications are offered up to NVQ Level 3. This process lasts three to four years in total. College courses tend to be less hands-on than apprenticeships and are sometimes less valued by employers in the sector, despite receiving the same qualification on completion.

Newcomers can enter the workforce much faster via a paid, fast-track plumbing or heating course. These courses can take as little as six weeks to complete and may cost between £1,200 and £4,000 depending on the provider, length and qualification awarded. For some of these fast-track courses, attendees are awarded the NVQ Level 2 following the completion; the rest are unaccredited. Due to the short duration of these courses, they are more likely to be appealing to those entering the workforce later in life, or who

are unable to commit to an apprenticeship or college course. However, the short length of the training can sometimes compromise the quality of training provided, with industry professionals sharing that these courses do not always equip their students with the knowledge and skills required to succeed in the field.

Regardless of the pathway followed, for those entering the industry via a gas heating or plumbing apprenticeship or college course, learning about heat pumps is likely to be minimal. Instead, a large proportion of the training is focused on teaching gas and plumbing skills that are not always directly related to the skills needed to design and install heat pumps.



3. The current state of low carbon heating businesses

Heat pump installation company landscape

The market is dominated by sole traders and small businesses

The heat pump installation industry is relatively small and dominated by sole traders. Given the low demand and number of heat pumps installed every year compared to gas boilers, there are few major players in the market and the vast majority of companies install very few heat pumps. This has important implications for entry into the sector, productivity and the future trends in the heat pump engineer sector, which will be discussed later.

Our analysis has found that there are approximately 1,300 installer companies MCS-certified to install air source and ground source heat pumps in the UK.²⁰ However, almost 15% of these companies only installed one MCS-certified heat pump in total from 2010 to 2022, which implies that a substantial minority of companies in the market have limited experience with heat pump installations.

On the other side of the market, larger scale companies with contractors across the UK install at far greater numbers. For example, one company installed over 7,000 heat pumps since 2010. Indeed, the top 10 companies by the number of installations were responsible for 16% of total MCS-certified installations from 2010 to 2021.

The highly skewed distribution of installations per heat pump company (see Figure 5) reveals that the vast majority of heat pump companies install only a few heat pumps. This is consistent with the current evidence that suggests that heat pump companies tend to be small. Furthermore, it is likely that this indicates that most companies do not focus solely on heat pump installations, and offer adjacent services, such as gas, plumbing and renewables.

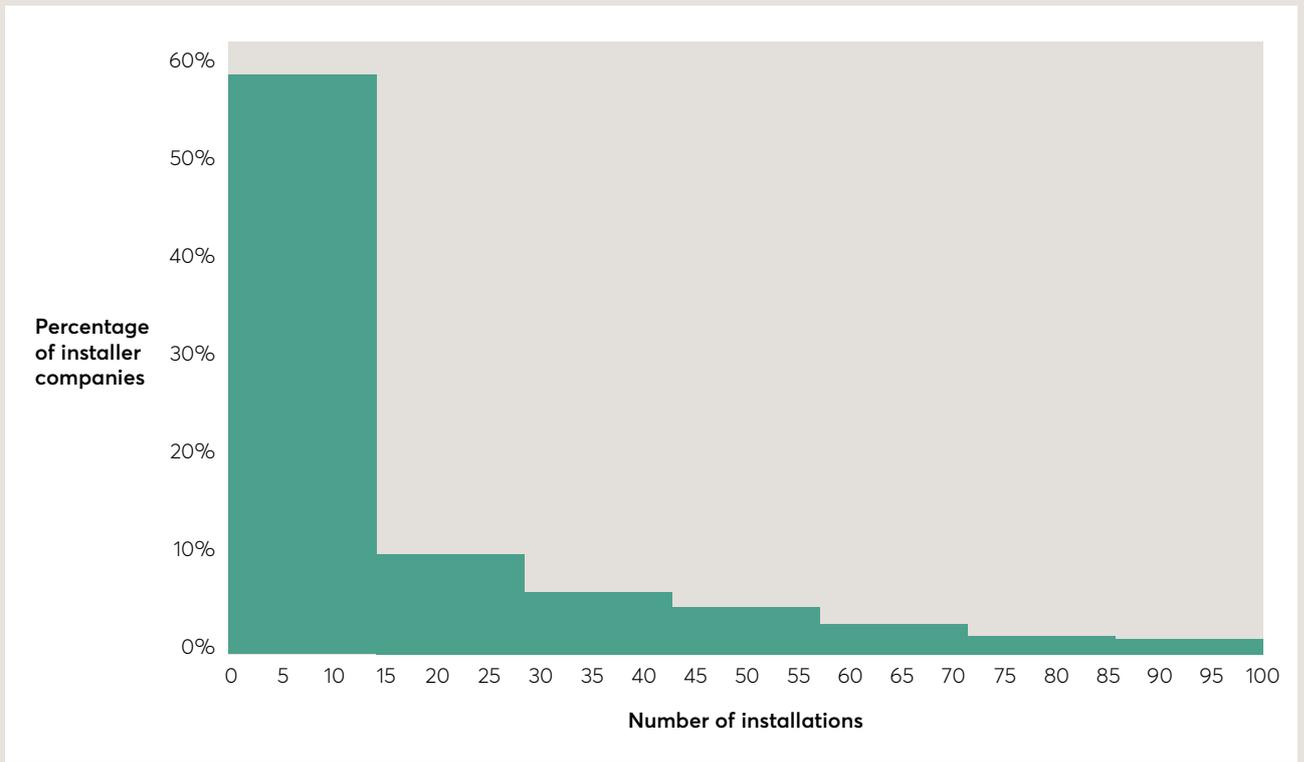


Figure 5. The distribution of the number of installations per installer company

A few of the companies with the highest number of installations have been operating for at least 30 years, offering adjacent services such as gas heating installations and have pivoted to heat pumps. Others have entered the market over the last decade and have always focused on green home technologies and home retrofitting.



Where are low carbon heating companies located?

Low carbon heating companies are more concentrated in certain areas of the country, particularly rural areas. The highest concentration of MCS-certified installation companies per 100,000 people is in the Highlands and Islands region of Scotland (see Figure 6). The concentration of heat pump installer companies in the Highlands and Islands is approximately 1.4 times higher than in Cornwall and the Isles of Scilly, which has the second-highest concentration. Highlands and Islands has 11 times more installer companies than West Midlands, the area with the lowest concentration (see Figure 7).

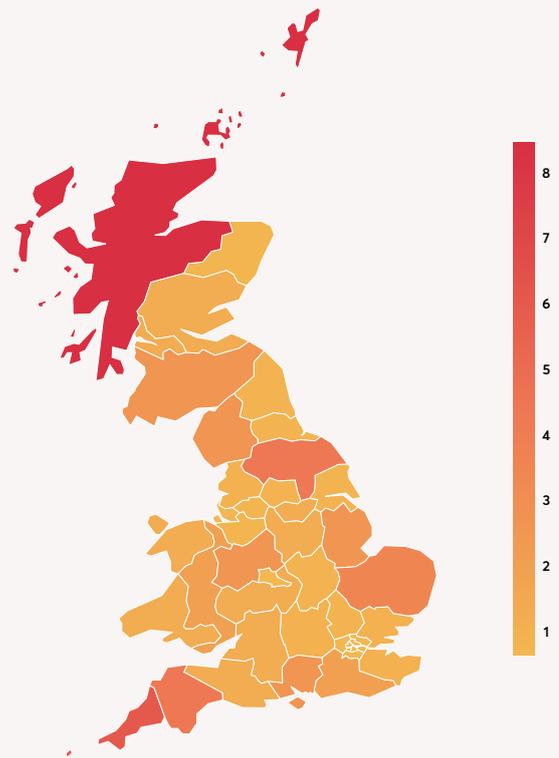


Figure 6. The concentration of installer companies per 100,00 population per NUTS2 region



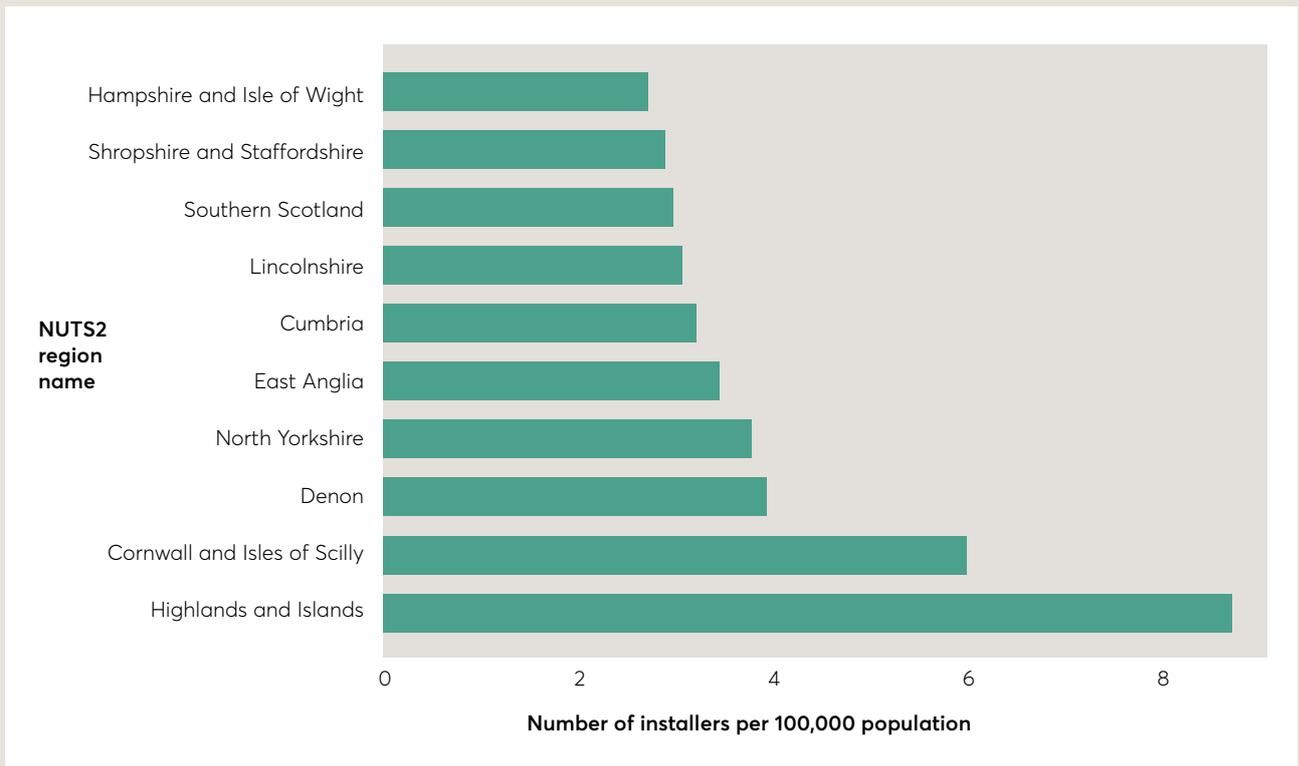


Figure 7. The top 10 NUTS2 regions by number of installer companies per 100,00 population

This finding is not surprising for several reasons. From a policy perspective, Scotland in general has put more emphasis on low carbon heating than England, such as by funding the consumer advice service, Home Energy Scotland, and through financial support for households to purchase home renewables through the Home Energy Scotland Loan, a no-interest loan and cashback scheme, which has been running since 2017.

The Highlands and Islands region has higher average demand than other regions in Scotland: it is primarily rural and off-gas grid. The data shows that the number of installer companies per 100,000 people and the number of heat pump installations are correlated. The higher number of engineers is therefore partly explained by higher demand in the region. Comparatively, the nearby Southern Scotland region is less rural and has less than half (5.18 installer companies per 100,000 people vs 12.3 installer companies) the number of installer companies compared to the Highlands and Islands. Previous Nesta analysis²¹ shows that demand for heat pumps is generally higher in off-gas grid areas because heat pumps compare more favourably to oil and other non-gas heating options.

4. What will the low carbon heating industry look like in the future?

How many heat pump engineers will we need

The UK will need significantly more heat pump engineers if it is to scale up the supply of heat pumps, and keep pace with demand. The exact number is a function of two factors: how many heat pumps need to be installed; and how many heat pumps each heating engineer can install a year.

How many heat pumps will be needed?

There are various different projections and targets, but they all involve a rapid increase up to 2030. The UK Government has set a target of 600,000 heat pumps a year being installed by 2028. In its Sixth Carbon Budget,²² the Climate Change Committee recommended a more rapid expansion, with over a million heat pumps installed a year by 2030 in its Balanced Pathway. Demand for heat pumps could reach around 1.7 million a year after 2035, the year when new gas boilers are scheduled to be phased out for existing homes. This is likely to be the ceiling on demand, as around 1.7 million heating systems need replacing each year.²³

How many heat pumps can each engineer install?

At present, we estimate that there are between 20 and 25 heat pumps fitted per trained installer per year.²⁴ This is partly a function of how long it typically takes to design and install a heat pump, but also reflects the fact that most engineers also do other work, such as fitting gas boilers or solar panels.

Figure 8 below shows an estimate of how many engineers will be needed based on the UK Government's target of 600,000 installations by 2028. To construct this 'government target pathway', we have used the trajectory set out by the Climate Change Committee's Sixth Carbon Budget before 2028, but adjusted for the Government's 600,000 target. This chart also includes different levels of output by the low carbon heating workforce.

These figures suggest that:

- > Around 27,000 heat pump engineers would be needed to meet the UK government's 600k target in 2028, assuming current levels of installations per worker. This is a roughly nine-fold increase in six years.
- > If the number of installations per worker per year remains constant, around 37,000 installers would be needed by 2030 and 62,000 by 2035.

- > If the industry can increase how many installations each worker performs to 30 per year, the number of workers required drops to 20,000 in 2028 and 46,000 by 2035.
- > Increasing installations per worker per year to 40 would reduce the number of workers required further, to 15,000 in 2028 and 35,000 in 2035.

Other estimates for the growth of the heat pump installation workforce – such as the Heat Pump Association's²⁵ – follow a similar, although not identical, trajectory to these figures.

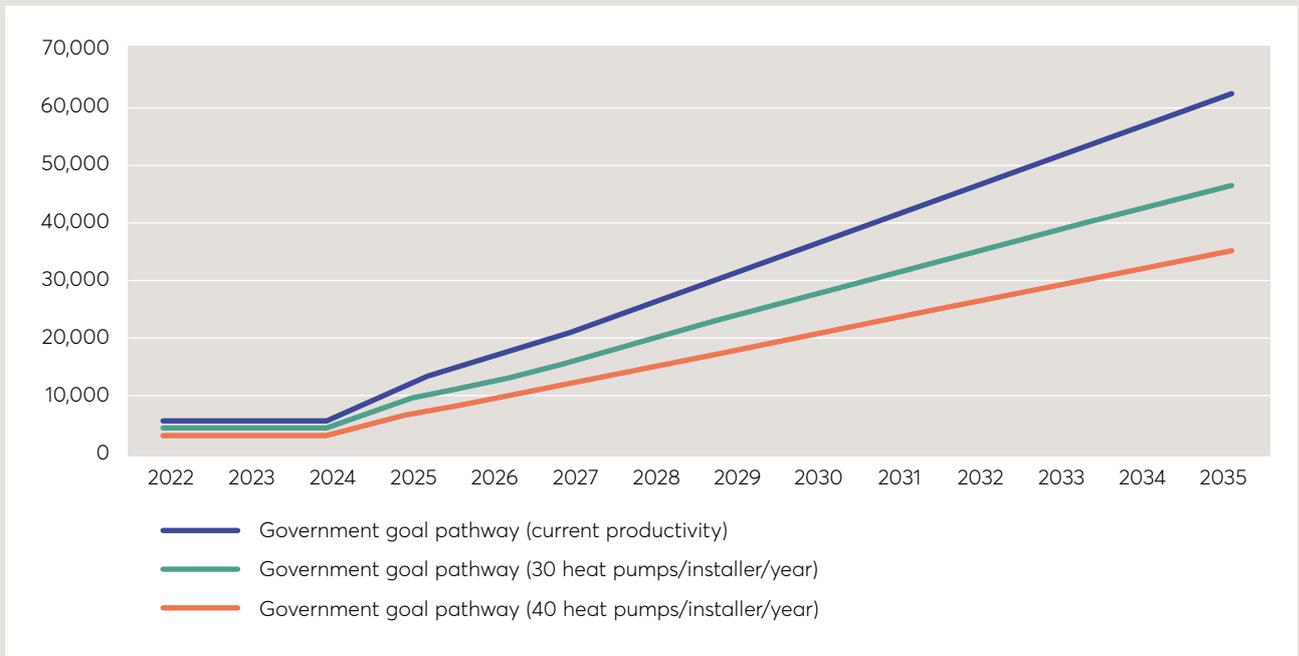


Figure 8. Total heat pump engineers needed

Figure 9 breaks the estimates down into the extra number of engineers that the industry would need to add each year under these scenarios (both assuming current levels of productivity). The data suggests:

- > There will need to be a rapid increase in engineers from 2025 onwards. This reflects the fact that regulations are due to ban new boilers in new homes (2025) and off-gas grid homes (2026), which is likely to drive a significant increase in heat pump demand

- > The industry will need to add roughly 5,000-7,000 engineers every year from 2025 until 2035 (after which the growth of the industry should begin to level off). This is assuming current number of installations per worker per year
- > Increasing installations per worker per year to 30 reduces the number of new engineers needed each year to between 4,000 and 5,000, while increasing to 40 would require 3,000 to 4,000 new installations per year
- > These figures include gradual retirements and exits from the low carbon heating industry, assuming 2.5% of installers leave the industry every year.

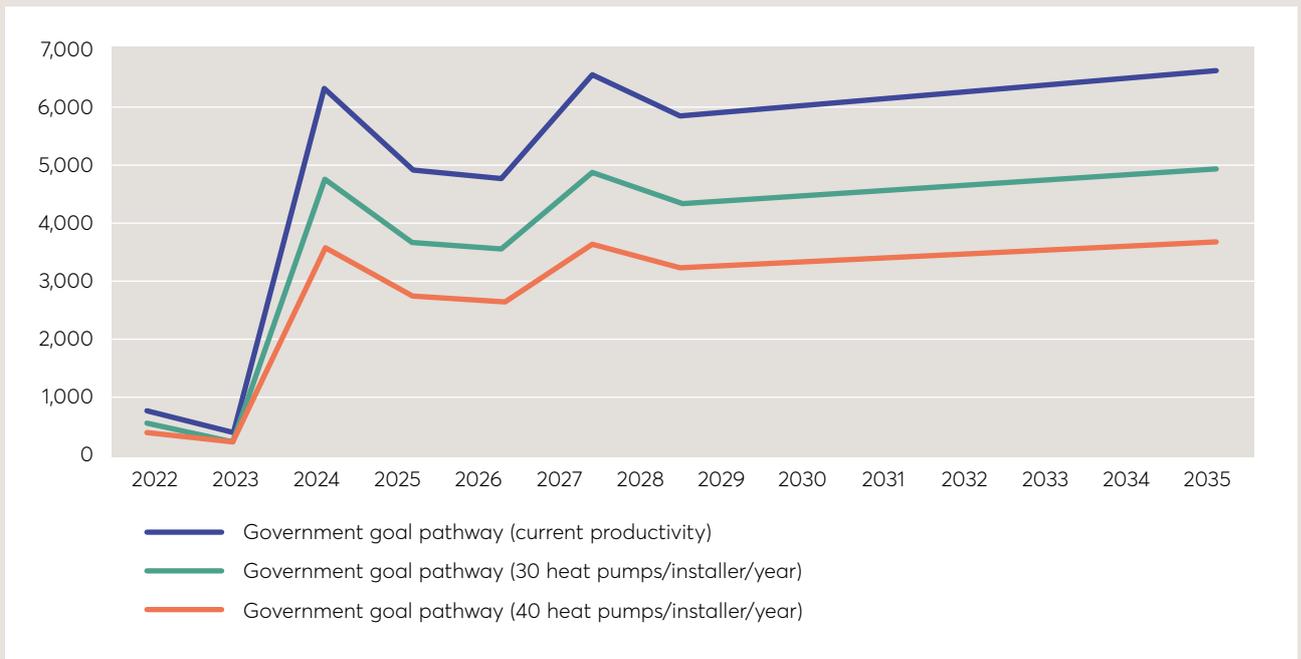


Figure 9. Total heat pump engineers needed

How the structure of the heat pump installation market could change

The low carbon heating industry does not just need more skilled people working in it, it also needs increased capacity within the industry (by either increasing the number or size of more companies), or bigger companies, to employ those people and to install heat pump systems.

The structure of the installation market – its mix of companies, big and small – matters for several reasons:

- > It will affect how quickly and to what level of quality the market can recruit and train new recruits, especially given the level of on-the-job training required.
- > It will influence productivity in low carbon heating, as it is companies that invest in productivity-enhancing technology and improve processes.
- > It will affect the wages earned by engineers, and therefore have a direct influence on incentives to join the low carbon heating industry.

The current, sole trader-led model

At present, the market for heat pumps is mainly comprised of manufacturers and installers, with energy suppliers and merchants playing a secondary role. In most cases, installation companies are the main interface with customers, which makes engineers the focal point of the market.

As set out above, heat pump installer companies (for both gas and heat

pumps) are generally sole traders or micro enterprises with fewer than 10 employees. However, installation companies are often affiliated with a particular manufacturer (manufacturers tend to be medium or large businesses).

Boiler manufacturers typically provide support, some training (covered in Chapter 2), and often incentives in return for the engineer

recommending and installing their products exclusively. It is difficult to tell how widely this manufacturer-affiliation model has transferred over to heat pumps, but given many boiler manufacturers also make heat pumps, it is likely to be widely used. Figure 10 gives an overview of how this current sole trader-led model operates.

Installers are mainly sole traders, and may have relationships with manufacturers

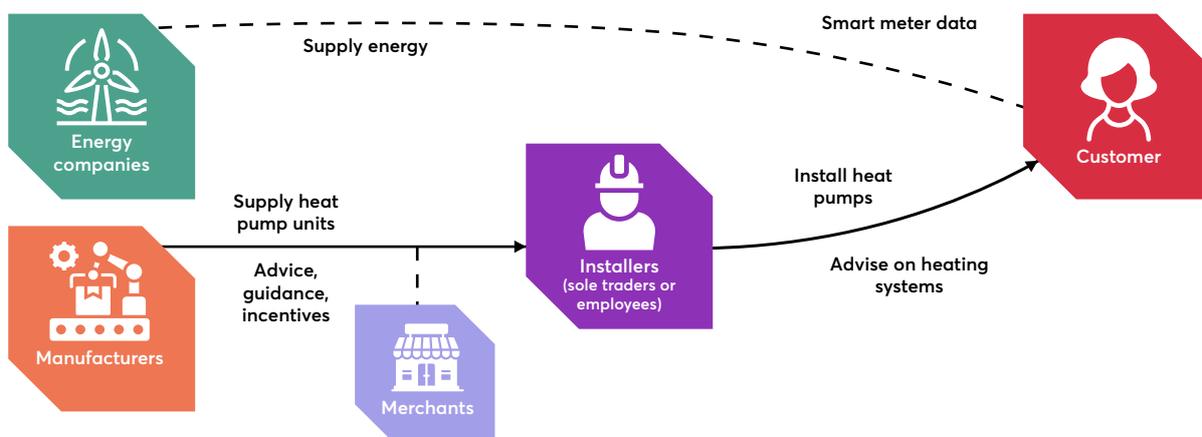


Figure 10. The current model: sole trader-led

The following sections consider some possible alternative models that could emerge in the heat pump market in the future. Of course, more than one of these models could coexist at the same time. In future, it may be possible

for a household customer to choose to buy a heat pump from an energy supply company, a heat pump manufacturer or a local heating engineer.

The energy supplier-led model

Octopus Energy's entry into heat pump installation is significant and well-documented,²⁶ and it is widely reported that other energy suppliers will also begin offering heat pump installations directly to customers.

Under the energy supplier model, heating engineers would be employees of the energy suppliers (although a sub-contracting model is also possible) and would be hired, trained and have their equipment

procured by a larger company. Manufacturers would still play an advice-and-guidance role under this model but would primarily sell their products to energy suppliers. This would give energy suppliers a degree of procurement power and may enable them to drive down prices from manufacturers through bulk contracts. Manufacturers would primarily compete to win supply contracts with larger energy supply

companies (or partner or merge with them), rather than competing to gain household customers or affiliated engineers.

Energy suppliers would likely be able to run large-scale recruitment campaigns for heat pump installers. However, attracting enough high-level skills to train and oversee new recruits could prove challenging for any new entrants to the installation market.

Energy suppliers supply heat pumps to customers, sub-contracting or employing installers

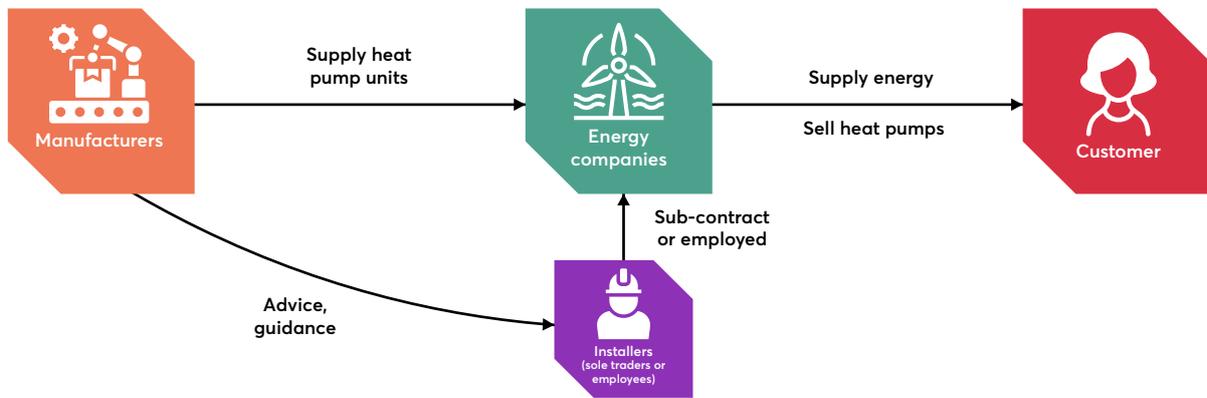


Figure 11. The energy supplier-led model

The manufacturer-led model

Another possible model for the industry is for manufacturers to sell heat pumps directly to households, including installation. This would mean manufacturers either employing or sub-contracting engineers, and vertically integrating most aspects of the heat pump supply chain – including manufacturing, sales and customer service, system design, and installation – into one company.

Boiler manufacturers may start to take a more active interest in heat pump installation because of the UK Government’s proposed Market Based Mechanism for Low Carbon Heating.²⁷ Under this policy, likely to come into effect in the coming years, boiler manufacturers would need to sell a certain number of heat pumps relative to how many boilers they sell. This would mean manufacturers needing to ensure heat pumps are

actually installed in homes, and therefore needing closer relationships with heat pump engineers. To address this, manufacturers may go down the existing affiliation route with self-employed engineers (potentially increasing incentives and competing with each other for engineer partners), or they may enter the market more directly and begin selling installations directly to households.

Manufacturers vertically integrate the heat pump supply chain, and sell heat pump systems directly to customers

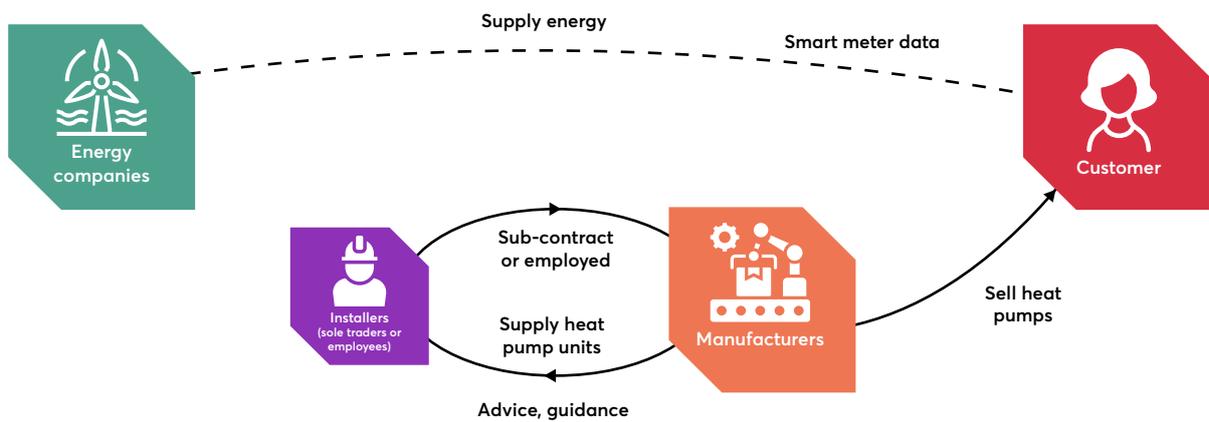


Figure 12. The manufacturer-led model

The aggregator-led model

There is also the possibility of new 'aggregator' businesses entering the market and becoming the focal point of the heat pump market. An aggregator would most likely be a technology platform, connecting households wanting to buy heat pumps with engineers and/or manufacturers. This role could be

played by a new entrant, such as a tech start-up, or conceivably by an existing market player. British Gas currently offers a service somewhat like this, providing a sales platform for heating engineers. Under such a model, there is likely to be initial strong competition between aggregators to capture market share,

before a small number of companies dominate the market. Under such a market, it is likely that the aggregator companies would have a high degree of market power, particularly on the procurement side, and could exert downward pressure on manufacturer and installer prices.

Customers interact with an aggregator company who 'sells' heat pumps and sub-contracts installation from installers

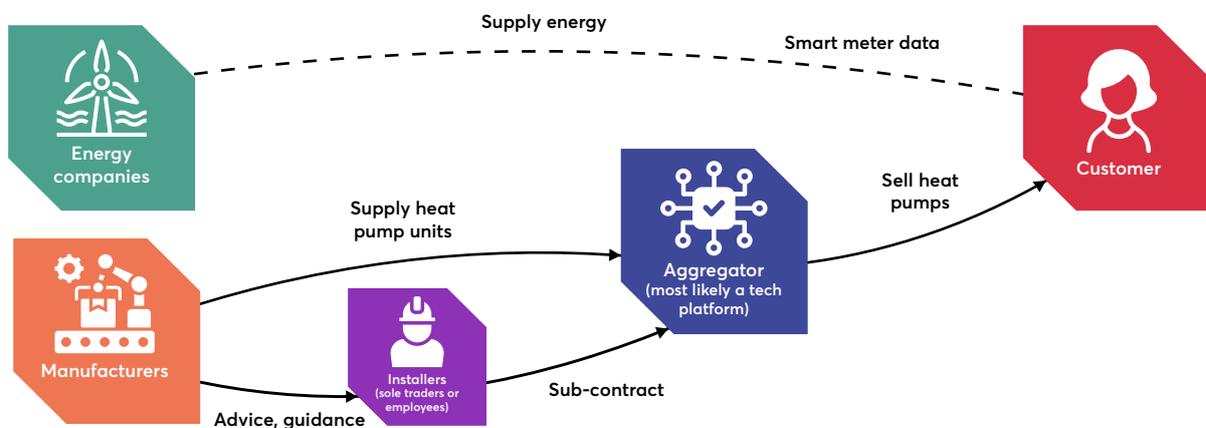


Figure 13. The aggregator-led model

The larger installer company model

Finally, the market may evolve such that specialist installation companies remain the key point of contact for customers but grow larger and specialise. In most cases, this will see installation companies remain as SMEs, perhaps typically with around

10 employees each. Even this modest expansion in company size would enable greater specialisation of skills, along with more capacity for training new heat pump engineers.

By expanding slightly, heat pump installation companies could employ

specialist staff in the different professions they require. This could include heat system designers, engineers who can follow designs, electricians, and potentially project managers and customer service specialists.

Installation companies get larger, can specialise in roles and offer more customer service

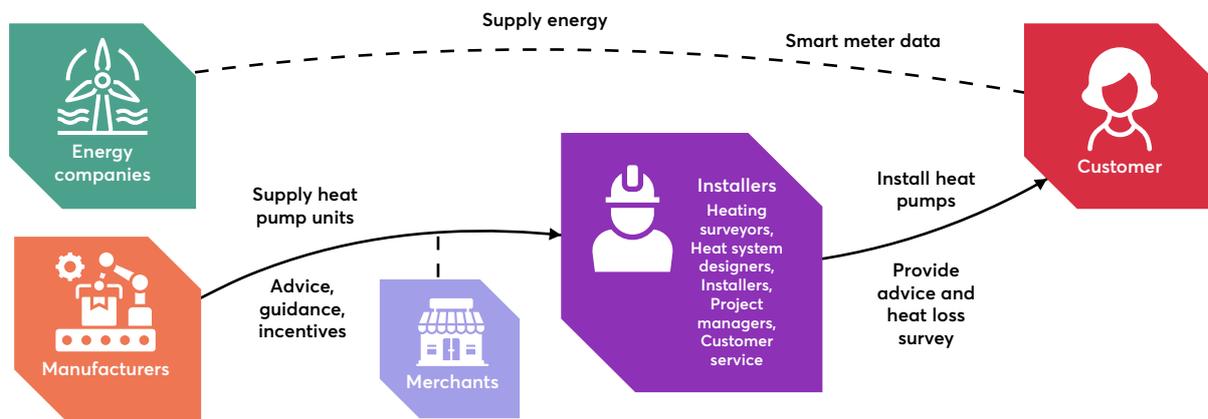


Figure 14. The larger installer company model

Other possible market models

Aside from the market models outlined above, there are other possible delivery models:

- > A retrofit charity-led model – where a charity, public service or other non-profit institution acts as a retrofit coordinator for properties and brings together engineers, equipment and advice for customers.
- > A housing developer-led model – it is possible that housing developers or other construction firms may offer heat pump installation or wider retrofit services directly to customers. This is more likely to apply to new homes, but could also be extended to retrofits.
- > A local authority-led model – it is possible that local authorities or housing associations could act as retrofit coordinators and be the lead point of contact for customers. This is likely to be especially relevant for social housing.

5. Key challenges and opportunities

The heat pump industry needs to expand its capacity and its workforce rapidly, but there are currently numerous barriers that are making this transition challenging. Alongside these barriers, there are also opportunities for attracting a wider range of people into the industry and increasing the capacity of existing companies to take on new workers.

Incentives to join the low carbon heating industry

Both the current workforce of gas and oil heating engineers and plumbers and prospective new entrants face different, complex barriers to training as heat pump engineers. Addressing the barriers faced

by both groups concomitantly will be important in building a sustainable, dedicated and committed workforce to support the transition to low carbon heating.

Gas and oil heating engineers and plumbers

Recruiting experienced heating engineers and plumbers into the industry will be particularly important. Given that they already possess many of the skills and experience needed to install heat pumps, it should be easier and cheaper for them to retrain as heat pump engineers. Once fully trained, they will also be able to support building the training and development capacity needed for new entrants to join the workforce. However, the barriers they face include the age of the workforce, a lack of confidence in low carbon technologies, the cost of training and the lack of any financial incentive to retrain.

An ageing workforce

Gas Safe data from 2019 shows that there were about 130,000 registered gas engineers,²⁸ with 82% of them 41 and over and 58% 51 and over.²⁹ This is particularly significant, as gas engineers typically start to retire at the age of 55.

This is compounded by the fact that younger workers represent only a fraction of the total number of gas boiler engineers; only 6% of the total labour force are under the age of 35.³⁰

Lack of confidence in the heat pump market

Even if they are not planning to retire, there is a perception that heat pumps are either never going to scale or will only become important in the future. For many heating engineers, the market for heat pumps is not yet fully developed, and the perceived demand is low. Given the bias towards short-term thinking and the tendency to discount future potential earnings, for many heating engineers, training to install heat pumps is a problem for the future.

This is partially because of the lack of knowledge about heat pumps, distrust of governments and uncertainty about the future net-zero home heating strategies. Since the UK Government has not yet published its strategy for the role of hydrogen in home heating (expected by 2025), gas engineers are reluctant to undertake additional training until they are confident about the future direction of policy.

Some engineers are also afraid that they will enter the heat pump market but may struggle to find customers. Our research³¹ suggests this is not likely to be the case – demand for heat pumps seems to be growing strongly – but what matters is the perceptions of gas engineers. Gas engineers tend to be in high demand for their work and, despite a recent decrease in gross pay, their wages are still around £5,000 above UK average even if they work solely with gas. Therefore, for many at present, there is no urgent financial need to retrain.

The high cost of training

As we have highlighted in Chapter 2, the cost of training can be high, especially for self-employed engineers whose training costs are not covered by their employer. A sole trader can incur costs of up to £2,500, which includes the cost of the course itself and the cost of the loss in customer revenue. It is also worth noting that training needs to be repeated every five years.

There are also costs associated with obtaining MCS certification. With access to the Boiler Upgrade Scheme only open to MCS-certified companies, a high percentage of installations completed over the next three years are likely to take place under the scheme. To install air source heat pumps under the MCS contractor scheme, an installation company would typically have to pay³² £840 for their initial registration³³ and an annual renewal fee of £684.³⁴ Other costs might include assessment fees or administration fees. There is also an opportunity cost coming from the time taken to complete the application process.

Lack of a wage premium

In addition to the relatively high cost of training, there is little financial motivation to encourage existing heating engineers to transition into heat pump installation and design. Our data analysis has revealed that there is no wage premium attached to heat pump installations.

Figure 15 shows advertised salary ranges for heat pump engineers and all installation engineers using job advertisement data from OJO,³⁵ an ongoing Nesta project that collects adverts from job advertisement boards to provide free insights into skill demands. Advertised salaries tend to be advertised as ranges. As a result, we can provide ranges of those salaries provided in job adverts.

The charts therefore show that:

- > The minimum annual average advertised salary for all installation engineers (including gas and heat pump engineers) is approximately **£37,000** per year while the minimum annual average advertised salary for heat pump installations engineers is approximately **£35,200** per year.
- > The maximum annual average advertised salary for all installation engineers (including gas and heat pump engineers) is approximately **£46,000** per year while the maximum annual average advertised salary for heat pump installations engineers is **£42,200** per year.

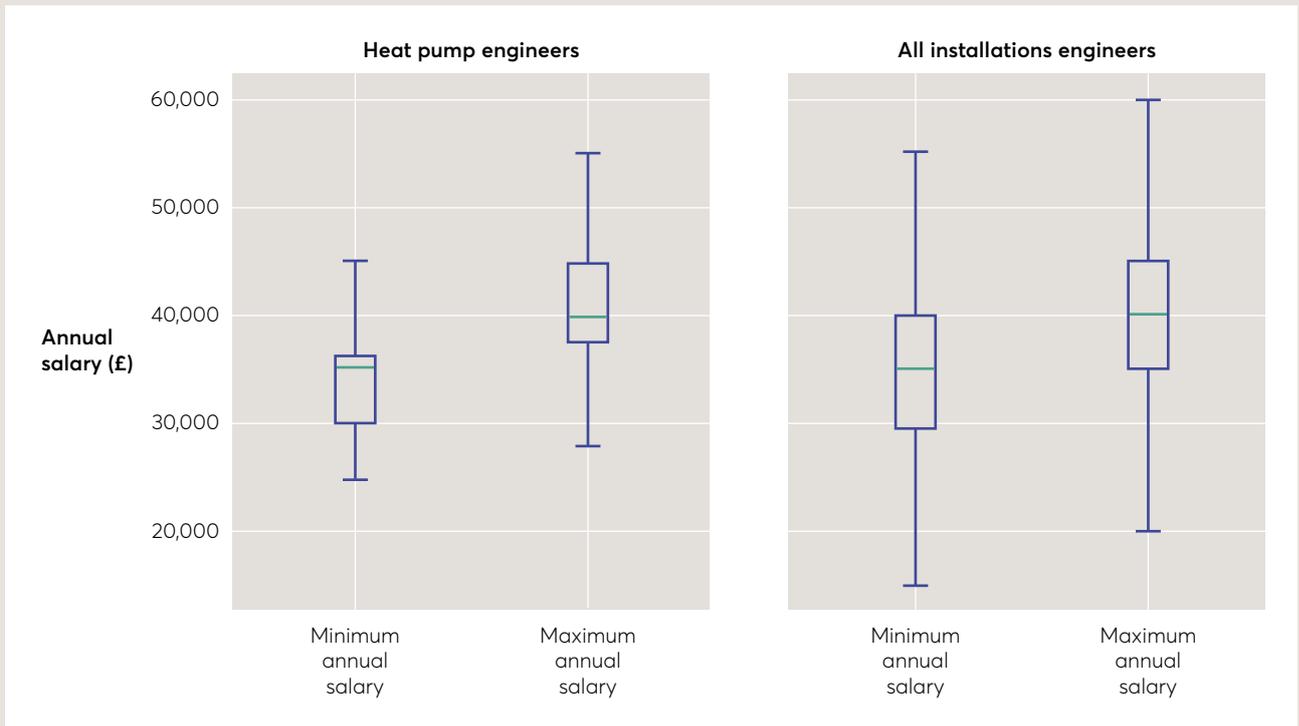


Figure 15. Salary whisker plot for heat pump engineers and all installation engineers

This finding is important as it suggests that there may be **no wage premium for installing heat pumps**. This means there is no obvious monetary and wage incentive for a gas engineer to retrain in heat pump installation. If the heat pump industry is

to attract more gas engineers to retrain, it will need to either change the balance of wages or use non-monetary incentives to make installing heat pumps more attractive. Chapter 6 explores these incentives in detail.

New entrants

New entrants face barriers prior to even considering a career in the industry. The structure, composition and perceptions of the plumbing and heating industry may discourage potential new entrants from considering a career in the industry in the first place.

Perceptions and recruitment in the sector

There are many upsides to pursuing an apprenticeship or a technical college course such as being paid while learning (in the case of apprenticeships), receiving recognised qualifications, and gaining theoretical and practical skills and real-world experience. An NVQ in heating and plumbing can lead to good employment prospects and earnings on its completion and will likely provide lifelong skills.

However, the heating and plumbing industry, and trades more broadly, can be perceived negatively as less favourable career options. For this reason, many people, and particularly women, might not consider heating and plumbing as a viable career option.

On the other side, there is currently little incentive for companies to take on apprentices. It takes a long time for apprentices to be fully trained and be fully productive. Given that many heating engineers are sole traders, training an apprentice is very resource-intensive and expensive for sole traders and small companies. If there are no aspirations to grow the business in the future, there is little business motive to hire an apprentice.

Complex routes to training as a heat pump engineer

When looking at heat pump engineers more specifically, the complexity of the routes to training as a heat pump engineer is a great barrier for prospective trainees. The three to four-year process of first training as a gas and oil heating engineer or plumber via an apprenticeship or college, then transitioning into heat pumps can be discouraging, particularly for those looking into joining the industry as a career change later in life. On the other hand, the negative reputation of fast-track courses can also dissuade people from entering the workforce.

Little exposure to renewables

Moreover, for those entering the industry via a gas heating or plumbing apprenticeship or college qualification, learning about heat pumps and renewables more generally is likely to be minimal. There is little focus during training on what the role of the sector in achieving the net zero agenda could be. Moreover, the low carbon heating expertise among plumbing and heating college tutors is limited.

Quality of training

A key challenge with growing the heat pump engineer workforce is to ensure a high quality of training. Training heat pump engineers at a faster rate runs the risk of negatively affecting the quality of training provided.

The issue of heat pump installation quality has also been getting a great deal of attention in recent months, particularly in the context of the now-defunct Green Homes Grant. Stories of badly installed heat pumps that left homeowners without heat or hot water or have drastically increased people's energy bills made headlines in mainstream media. Many are concerned that the rapid growth of the industry will exacerbate this issue and encourage 'cowboy installers' to take advantage of government grants and the sudden increase in demand. Low-quality heat pump installations are a significant risk to the industry because of the reputational damage they cause and the significant costs to customers of having an inefficient system.

There is a great deal of variation in the type, duration, price and quality of heat pump training courses available. It is likely that a half-day training course will not be able to cover the same amount of teaching material as a five-day course. Moreover, some courses include practical elements while some are purely theoretical. Engineers can therefore come out of training with varying levels of competency. At the same time, there is insufficient focus on heat pump system design skills. These are critical considering the particularities of heat pumps in comparison with gas boilers.

Lastly, the industry as a whole does not encourage lifelong learning. Gas engineers and plumbers are generally not encouraged to learn about new developments and technologies throughout their professional career, meaning that many can be reticent towards innovation. As the heat pump industry expands and sees new entrants and technologies, engineers can benefit from ongoing learning and exchange of ideas and advice.

Productivity

Productivity in the wider home installation sector (which includes plumbers, electricians and a wide range of other trades alongside heating) has been stagnant since 1997, and possibly longer than that. Although there is no data specific to the heating industry available, it is likely that the heating industry broadly follows this trend, given the similarities in methods and industry structure.

By contrast, productivity in the manufacturing sector, which includes heating devices, has grown by around 70% since 1997, while overall productivity in the economy has grown by around 30% in that time. Figure 16 shows these figures. This suggests that, while boiler and heat pump manufacturers have been reducing costs and increasing returns in their industry, the cost of heat pump installation has not decreased.

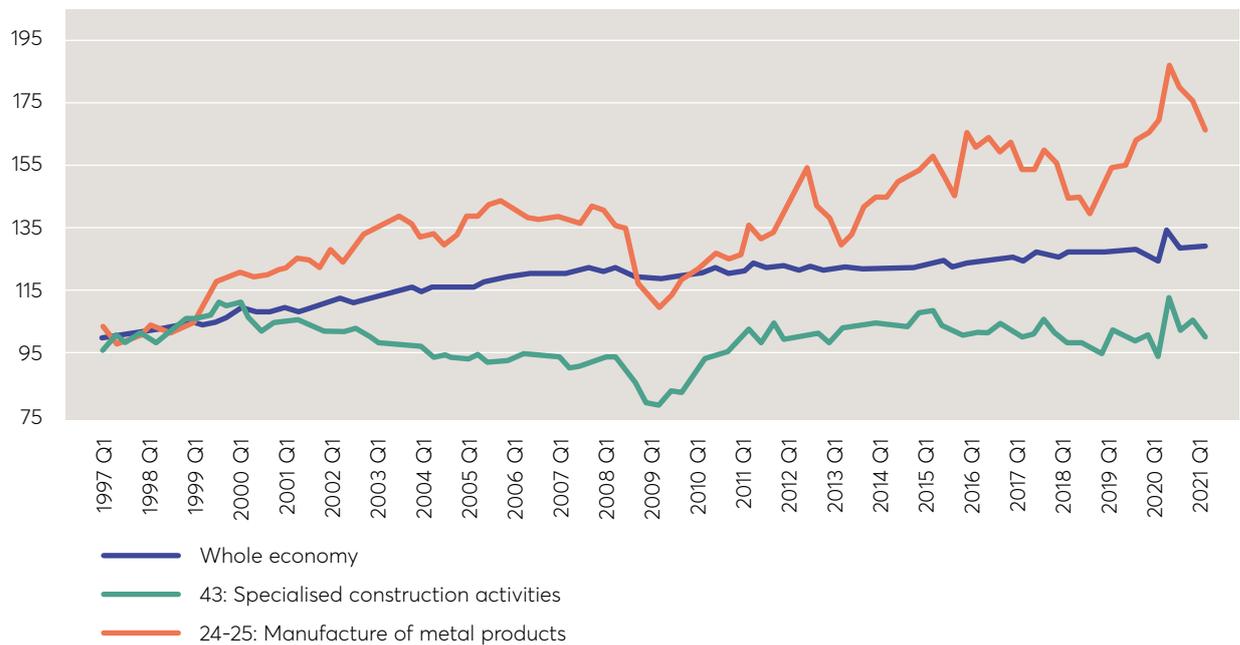


Figure 16. Productivity (output per hour) in different parts of the heating industry and whole UK economy

There are different ways of measuring productivity, but the most important is how many person hours it takes to install a heat pump (known as labour productivity).

Productivity is important for at least three reasons:

- > **Each engineer can install more heat pumps** – if heat pumps take less time to install, the UK will need to train fewer new engineers to meet its goals. For example, if each engineer could fit 30 heat pumps a year rather than 20, that reduces the number of engineers required by a third

- > **Increased wages for engineers** – productivity is the main determinant of wages because it's a basic measure of how much you produce for each hour you work. Increasing productivity should increase the wages of heat pump engineers, although it may take time for wages to increase
- > **Reduced cost of heat pumps** – if heat pumps require less labour to install, this should reduce the cost to customers of buying heat pumps.

In the short term, there is likely to be a trade-off between increasing installer wages and reducing costs to customers; it is the price customers pay that ultimately covers engineers' wages. But, over time, rising productivity should both allow costs to fall and wages to rise in the industry, as other prices and wages adjust in the economy.



Diversity

The heating and plumbing sector is an industry dominated by men. In 2021, for every 100,000 Gas Safe registered engineer, fewer than 500 were women. The lack of gender diversity is a wider problem in the construction sector, with 70% of UK citizens having never had a woman tradesperson in their homes.³⁷

Despite this, there is a demand for women working in trades and construction. A study by the Federation of Master Builders discovered that 30% of homeowners would prefer a woman tradesperson.³⁸ Considering the low number of women engineers, those who enter the industry are likely to be in high demand.

The causes for women's underrepresentation are multiple, some of them deeply structural. In the construction industry more broadly, research has shown that women face discrimination, with 77% of self-employed tradeswomen having personally experienced discrimination.³⁹

Additionally, the imbalance between men and women in the workforce prevents women from entering the sector. This is particularly important as we look to build a sustainable heat pump engineer workforce for the future. There are currently very few female gas and heat pump engineers, which negatively affects how likely women are to enter the industry in the first place. This is particularly evident when looking at the number of women taking up apprenticeships in the sector. Government research revealed that, in 2019, only 4% of apprentices in the construction, planning and the built environment sector were women,⁴⁰ the lowest performing sector in terms of gender representation.

Moreover, gender is only one aspect of the lack of diversity. There is already a shortage of gas engineers and many are reaching retirement, a problem that will be aggravated in the future. If the industry is not to shrink further, it needs to be attractive to people from a diverse range of backgrounds. Casting the widest possible net will attract the greatest number of new entrants. Other characteristics including, but not limited to, ethnicity, disability and neurodiversity should be considered, particularly in the context of separating the process of assessment and system design (which can be partially performed remotely) from that of installing the heat pump system.

6. What action is needed to grow the low carbon industry?

Given how quickly the low carbon heating industry needs to grow and the various barriers to new people entering the industry, the UK will need to take significant action. To date, the UK Government has put little emphasis on skills and capacity in the low carbon heating industry. Unless this changes soon, there is a significant

risk of demand for heat pumps greatly exceeding supply, leading to high prices, lower quality and a failure to roll out heat pumps at the speed the climate emergency demands. This section details the actions we think governments, businesses and training institutions need to take to grow the low-carbon heating industry.

Is this expansion of the heat pump industry achievable?

Growing the number of heat pump engineers by 4,000 to 6,000 each year from 2025 onwards is a significant challenge; it means growing by more than the current size of the industry every year. On current trajectories, there are not many signs of this scale-up starting.

However, there are a number of ways such an expansion of the industry can be achieved. First, larger companies entering the market, such as energy suppliers and manufacturers, may be able to recruit and train new workers more rapidly than the current small business-led market. Manufacturers have suggested that, currently, at least 7,000 people can be trained each year.⁴¹ Second, there is a large pool of experienced gas engineers who could make the switch to installing heat pumps relatively easily. Third, there may be opportunities to attract new entrants into the heating industry, through apprenticeships and other routes. As the interest in climate change and energy security

grows, and heat pumps become increasingly prominent as a leading solution to both, there should be opportunities to attract new people into the industry.

However, the logistical challenges of rapidly expanding an industry – particularly one that relies heavily on specialised skills and experience – are considerable. Ideally, trainee heat pump engineers would learn on the job, under the supervision of experienced heat pump engineers. This could be extremely challenging given the ratio of currently experienced heat pump engineers to newly trained engineers required. The risk is that, without this oversight, the quality of heat pump installations may suffer, especially in businesses that expand rapidly but do not have large numbers of experienced heat pump engineers.

One way to tackle this is to attract more experienced gas engineers into installing heat pumps. While gas engineers will require some

retraining and upskilling to switch to heat pumps, their wider experience should help them master heat pump installations more quickly. In 2019, there were around 130,000 engineers recorded on the Gas Safe register,⁴² which is twice the number of heat pump engineers projected to be needed by 2035. If 3% of the current Gas Safe registered workforce trained as a heat pump engineer every year from 2025 to 2035, that would be enough to meet the needs of the heat pump market. If more experienced gas engineers can join the industry, it may then be easier to bring in more new entrants under their guidance.

One of the main assumptions we make in this paper is that the new heat pump engineers will originate from the existing pool of gas engineers and from completely new entrants to the market. These are two different groups, with distinct characteristics and priorities, and therefore different policy instruments and measures should be used to attract each.

Leadership to oversee the industry's expansion

There is currently no oversight of the low carbon heating industry's expansion, and the UK Government has so far proposed very little action to help scale up the industry. The

industry would benefit from some oversight and leadership to own this problem and help businesses to grow and training providers to upskill the workforce.

Recommendation 1

The UK government should appoint a body to oversee the expansion of the low carbon heating industry and workforce. This body should develop a clear action plan together with colleges, training providers and the

industry, and should also gather and publish data to track the growth of the sector. This body could be an existing institution or a new task force bringing together key organisations within the low carbon heating industry.



Attracting people into the industry

Focus on both new entrants and retraining

There are two different groups of people who will make up the future heat pump workforce: current gas and oil engineers, who will need to retrain; and new entrants, who are currently in secondary education or completely unrelated industries.

New trainees require hands-on experience and guidance from experienced heating engineers in order to learn to do the job effectively. Attracting young workers into the heating industry will ensure that we build a sustainable workforce able to support the 2050 net zero goals long term.

The low carbon heating industry needs to focus on attracting both new trainees and experienced gas engineers and plumbers. However, these two groups face different barriers to entry which require different approaches:

- > For new entrants, the focus should be on making routes to training clear and accessible, and ensuring there are jobs available for them to develop skills.
- > For experienced engineers, the focus should be on providing better financial and non-financial incentives to switch to heat pumps.

Create new, direct pathways to train in heat pump installation and design

For a new joiner, the pathways to becoming a qualified heat pump engineer are lengthy, complex and often indirect. This can be discouraging for new entrants, who typically have to qualify as gas engineers or plumbers before being able to complete heat pump-specific training. This indirect route is long and focuses on teaching skills related to gas or oil that are less relevant to installing a heat pump. The current routes also make entry particularly difficult for those looking for a career change and who cannot afford to complete a four-year college course or cannot make ends meet under an apprentice salary.

Establishing direct apprenticeship and college training routes should be a priority for government and training providers as they can make it easier for new entrants to join the workforce. This will ensure that heat pump engineers receive high-quality, in-depth heat pump-specific training. This is also likely to improve the quality of installs, as more time can be spent on teaching design skills. With direct routes to training, and the phase-out of gas boilers, becoming a heat pump engineer can become a career in its own right, rather than being an add-on to a career in gas, oil or plumbing. This can simplify the process of becoming a heat pump engineer and open the market to new entrants.

At the time of writing, MCS is developing a three-year low carbon heating apprenticeship that is due to be launched in the next year. This is a positive first step and government and training providers need to prioritise rolling out and delivering this training.

Recommendation 2

Colleges, training providers and governments should work together to establish direct routes to training as a heat pump engineer via low carbon heating apprenticeships

and college courses. There are already such courses in development and rolling them out should be a priority for colleges and governments.

Cash incentives for engineers

Given the cost of training and the lack of a wage premium for installing heat pumps over oil and gas boilers, governments in the UK should consider offering financial payments to people who train as heat pump engineers. Such payments – sometimes known as 'golden hellos' – have sometimes been used by public sector organisations, notably in recruiting teachers, although evidence of their effectiveness is limited.

An alternative to a cash payment would be to offer a guaranteed income to newly trained heat pump engineers for a certain period of time. This would overcome some of the uncertainty about having enough work, but may not help as much with training costs or providing wage incentives for existing gas engineers.

In considering a cash incentive policy, there are four relevant considerations.

- > **Targeting** – cash incentives are likely to be more effective for existing oil and gas engineers, rather than new entrants. New entrants to the market are likely to consider the appeal of the career – including wages – and are less likely to be influenced by a single payment. For existing heating engineers, a cash payment may provide a stronger incentive.

- > **Size of payment** – the size of the payment would likely need to be at least £5,000, approximately half of which would cover the full cost of retraining as a heat pump engineer. It may be helpful to test the incentive effect of different levels of payment in a trial before rolling out the incentive payments.

- > **Conditionality** – cash payments need to come with some conditions, to ensure recipients do actually train and enter the heat pump market. The incentives should be clawed back if certain conditions, such as installing a set number of certified heat pumps, are not met.

- > **Cost of the policy** – a cash incentive scheme would be a relatively cheap policy option for governments. A £5,000 payment to 5,000 heating engineers per year would cost £25 million a year, which is six times less than the annual £150 million cost of the UK Government's current Boiler Upgrade Scheme. Paying to increase supply capacity could have a much bigger payoff than subsidising homeowners to buy heat pumps.

Recommendation 3

Governments in the UK should trial how effective a cash incentive would be in attracting people to train as heat pump engineers. This trial could test the best size of incentive and whether paying money to

the trainee overcomes other training barriers faced by prospective trainees. Another option would be to trial a minimum income guarantee for newly trained heat pump engineers.

Encouraging companies to take and train on new workers

While providing financial incentives to prospective trainees can be a powerful tool for attracting gas and oil engineers and plumbers into the heat pump industry, governments should also explore the possibility of paying businesses instead of workers. It may make more sense to give a cash incentive payment to businesses who

take on new heat pump engineers, rather than to the workers themselves. There is a significant barrier around businesses' ability to take on and train new engineers; offering this incentive could help businesses to grow and take on more staff. Further, the business could use the payment flexibly – to cover training costs, to pass on to the new employee as an incentive, or to support the growth of the business.

Recommendation 4

Governments in the UK should trial how effective a cash incentive given to companies would be in encouraging companies to take

on and train new workers. This trial could test the best size and structure of incentive.

Clearer signals and engagement from governments

There is currently a great deal of uncertainty about the future direction of the industry and government policy in regard to net zero and low carbon heating. Many gas and oil engineers are waiting for clearer signals from governments with regards to the phase-out of gas boilers and their hydrogen strategies before entering the low carbon heating workforce. Increasing transparency and setting out government plans beyond 2025 will help engineers make a long-term plan for their career and investments in training.

There is also a great opportunity to attract people into the low-carbon heating industry by emphasising the crucial role heat pump engineers will play in decarbonising our homes and tackling the climate crisis. Launching a national campaign about net zero homes, heat pumps and the crucial role of heat pump engineers can help crystallise a new image for the sector. Initiatives such as the Climate Heroes campaign proposed by the Social Market Foundation⁴³ could help recruit engineers into the sector by recognising their immense contribution and celebrating them as Climate Heroes.

Recommendation 5

Governments in the UK should launch a national campaign about net zero homes, heat pumps and the crucial role of heat

pump engineers to help crystallise a new image for the sector.

Attracting a diverse workforce

The UK needs to grow its heat pump engineer workforce nine-fold in the next six years and, in doing so, it must also focus on attracting people from a diverse range of backgrounds. The lack of gender diversity is an important issue to tackle, but other characteristics, including, but not limited to, ethnicity, sexual orientation, disability and neurodiversity should also be considered.

Creating dedicated recruitment pipelines for minoritised groups has become an established practice across some other industries. Dell⁴⁴ has been running a successful recruitment programme for people with autism. This is rooted in the belief that everyone has unique skills to offer and that traditional hiring processes act as a barrier to truly diverse hiring. They have redesigned the hiring process and, as a result, use a specially designed skill-based interview process.

Larger installation companies have an important role to play in this process, as they employ more people, are more likely to have dedicated human resources processes and could lead the industry by example. Dedicated recruitment routes could be implemented in the heating and plumbing industry to attract diverse and currently underrepresented talent. Targeted outreach to minoritised and disadvantaged groups, as well as de-biasing job advertisements and interviews, can increase the diversity of those who apply for opportunities. Moreover, more research is needed into the industry representation, experience, and barriers faced by other minoritised groups beyond gender.

Focusing on diverse candidates is not enough to improve diversity scores in all ranks of an organisation.⁴⁵ In addition to focusing on recruitment, there needs to be a similar focus on employee retention, experience and promotion to successfully increase diverse representation across the organisation. Companies need to put safeguards in place to ensure that their diverse workforce has positive experiences of working in the industry and will want to continue working in the company and industry. Clear and transparent processes for pay and promotion decisions, investing in the development of staff from minoritised groups, and promoting flexible working and support for parents returning to work can help ensure that staff feels like they belong and are included.

Lastly, the current routes into the industry don't always lend themselves to attracting diverse workers. Apprentices aged 19 and over are paid £4.81 per hour in their first year and the National Minimum or Living Wage thereafter. Moreover, the lack of any direct routes into training means that for entry-level workers, it can take up to four years to qualify as a heat pump engineer. These are significant barriers for people with caring responsibilities or who are entering the industry later in life. Creating new, direct pathways into training as a heat pump installer could mitigate some of these barriers. Additionally, separating the processes of design from installation (discussed in more detail in the following section) and, as a result, separating the corresponding training could make training and work more accessible to more people.

Recommendation 6

Installation companies should review their hiring processes and create dedicated recruitment pipelines for women and people from minoritised groups. Using specially

designed skill-based interview processes and ensuring that safeguards are put in place can help attract and retain a more diverse workforce.

Recommendation 7

Installation companies should ensure that their internal policies encourage employee retention, experience and promotion. This could be done by ensuring the clarity and transparency of processes for pay

and promotion decisions, investing in the development of staff from minoritised groups, and promoting flexible working and support for parents returning to work.

Improving existing training pathways

Improving existing gas, oil and plumbing training routes is as important as creating new, direct pathways to training, particularly in the short term.

Increased emphasis on heat pumps within existing training pathways

There is currently not enough emphasis on renewables in colleges and apprenticeships. College students and apprentices have a lot to gain by being exposed to heat pumps early on in their careers.

Integrating heat pump design and installation modules into existing college courses and apprenticeships would help upskill students and apprentices early in their careers. This will add to their knowledge and could open up new career options for gas and plumbing trainees.

Recommendation 8

Colleges, training providers and governments need to work together to integrate in-depth

heat pump modules into existing college courses and apprenticeships.

Specialisation of skills

The recent split of heat pump standards into design and installation standards by MCS provides an opportunity to attract more people into the industry and improve the quality of training and installs by focusing on specialised skills. Given that it is not necessary for the same engineer to complete both the design and the installation, this separation gives engineers the option to focus and specialise in either process. This could enable engineers to undergo specialised training and use their skills optimally.

Separating the training for design and installation could also shorten the duration of the training journeys for those retraining from gas and oil engineering work. Given that the skills required for the installation of a heat pump are very similar to those of installing

a gas boiler, many current gas and oil boiler engineers could transition to installing heat pumps with minimal or no training. Meanwhile, special focus could be placed on teaching design skills to those who want to specialise in assessment and design.

Additionally, the assessment and design process involves little physical labour (besides physically assessing the property and taking measurements) compared to the process of installing the heat pump and any auxiliary equipment. This can provide an opportunity to attract more diverse talent into the industry who might prefer the less physically demanding aspects of the job.

However, it is worth noting that some engineers, particularly sole traders, may not want to specialise in either design or installation, and might wish to be able to complete both parts of the process.

Recommendation 9

Training providers should work with heat pump installation companies to develop specialised design and installation training if there is enough demand. Heat pump

installation companies should also consider hiring system designers and installers separately.

Lifelong learning

For trained and experienced heat pump engineers, it is important to continue refreshing and developing skills and keeping up to date with new developments in the industry. There is a healthy culture of peer-to-peer discussion within some parts of the heat pump installer community, which helps develop skills and solve complex technical problems as they arise. As the sector grows and more heat pump engineers are trained, it will be important to keep expanding this approach to lifelong learning, to maintain quality across the industry.

Governments could also help by offering payments or other support to trained heat pump engineers to encourage them to keep developing their skills. This could also help to increase the overall attractiveness of the job, and indirectly reduce household energy bills.

There are a number of emerging platforms to help formalise this lifelong learning. In Scotland, the Flexible Workforce Development Fund offers up to £15,000 to SMEs and apprenticeship levy payers to upskill or reskill their employees. This includes training in the installation of low carbon heating technologies. In England, the proposed Lifelong Loan Entitlement could help provide funding for ongoing learning by heating engineers, depending on the eligibility criteria.

Recommendation 10

The UK's governments should offer time-limited grants for continued professional development to certified heat pump engineers (either employees of MCS-certified

companies or members of umbrella schemes). These could be spent on additional training and productivity-enhancing measures.



Better training support for employees, trainers and apprentices

Apprenticeships are an important route into the sector, but they are also fraught with challenges. For many in the industry, particularly sole traders and small SMEs, it is very difficult to hire apprentices. These challenges can potentially undermine the ability of apprenticeships to attract enough new entrants into the workforce.

Wider take-up of shared apprenticeship schemes could help attract and train more people into the industry as well as encourage more employers to take on an apprentice. This is because smaller employers tend to not have the time, resources and structure to manage an apprenticeship end-to-end including mentoring, administration and providing consistent levels of workload.

Wider take-up of shared apprenticeship schemes could help attract and train more people into the industry as well as encourage more employees to take on an apprentice. For shared apprenticeship schemes, a shared apprenticeship agency acts as the employer for the apprentice. It manages the training requirements for the apprentice as well as the terms and conditions with the workplace providers. Usually, one apprentice is assigned to two or more sole traders/SMEs should one of the workplace providers not provide enough work placement for the requirements of the apprenticeship. Shared apprenticeships

reduce the time burden required to mentor the apprentice and the risk associated with committing to employing an apprentice given that apprenticeships can be as lengthy as four years. Though shared apprenticeships are more complex to administer for the shared apprenticeship agency that employs the apprentice, and the hourly cost will be higher for employers as it will include other costs such as income tax, they could be a good solution for a part of the industry who is looking for flexibility and does not want to grow its permanent worker count.

Moreover, there is currently a shortage of experienced low-carbon heating college teachers and trainers that are able to deliver the courses needed to expand the industry. Rolling out continuing professional development via industry-wide 'Train the trainer' programmes among plumbing and heating trainers would enable them to gain practical experience in working with low carbon technologies and could help increase the pool of tutors and improve the quality of training. More support with training should also be given to those taking on apprentices. Training an apprentice requires a great deal of time and resources, but little support is given to employees taking on apprentices. Providing them with teaching guidance, resources and financial support can improve the quality of teaching and the learning experience of apprentices.

Recommendation 11

Governments should support the wider take-up of shared apprenticeship schemes to help attract and train more people into the

industry and encourage more employees to take on apprentices.

Recommendation 12

Governments and training providers should better support those providing training via college courses and apprenticeships by rolling out industry-wide 'Train the trainer'

programmes for existing plumbing and heating trainers and providing employees that are taking apprentices with teaching guidance, resources and financial support.

Increasing productivity in the low carbon heating industry

Aside from increasing the number of heat pump engineers, the productivity of companies in the low carbon heating industry is also important. Productivity in the installation sector seems to have been stagnant for at least 25 years, so increasing it should be a priority for the industry.

How could the heat pump industry increase its productivity?

In the context of installing a heat pump, increasing productivity primarily means reducing the amount of labour required to install a heating system without compromising on quality. It may also include reducing input costs (eg using fewer materials). Any measure that saves time or materials can therefore increase productivity. Such measures may include the following.

- > **Software and digital systems** – such as heat loss calculation software, design aids and customer service systems. There are already a number of software tools available which can streamline the heat loss survey process; in some cases, these may also be able to integrate with administrative requirements, so that engineers can save time on filling out paperwork. It may also be possible to develop methods for doing some aspects of installation, such as heat loss surveys, remotely, which could save travel time and allow engineers to work more quickly.
- > **Labour aids for installation** – activities such as heating installation tend to be hard to automate because they are bespoke and take place in people's homes (we're unlikely to adopt the types of robotics that are common in the manufacturing industry, for instance). However, there may be some labour aids, such as tools that help lift the weight of heat pumps or which speed pipe fitting, that could speed up the process and improve work quality for engineers.
- > **Process improvements** – streamlining the process of fitting a heat pump can also increase productivity. Activities such as reducing travel times, speeding

up procurement, organising tools more effectively, or looking for other time savings in the process are all non-technological ways to boost productivity.

- > **Higher skills levels and experience** – as engineers get more skilled and experienced, they should be able to do installations more quickly and to a higher quality.
- > **Specialisation of skills** – there may also be gains in skill specialisation, so that each person in a team uses their skills optimally (eg allow specialist system designers to only work on system design, leaving most installation work to less experienced engineers).

Increasing productivity is not the sole responsibility of individual engineers; most productivity gains will likely come from new tools and aids developed by other organisations. Possible ways in which productivity aids may be developed include:

- > **Tech and service firms selling productivity aids to engineers** – there are a number of new entrant companies offering specific technologies and aids to engineers, such as heat loss software. Engineers can then choose the technologies to suit their needs
- > **Manufacturers, merchants or aggregators offering productivity aids** – it is possible that heat pump manufacturers, or merchants or new entrant aggregators, may offer software and technologies to engineers as part of their support package.
- > **End-to-end service overhaul** – some larger companies entering the low carbon heating industry are aiming to redesign the whole service of fitting a heat pump, from customer service and heat loss survey through to installation and travel. It would also be possible for sole traders and micro firms to adopt this end-to-end approach if there were companies offering service design/consultancy to help them do so.

What incentives are there for heating engineers to adopt productivity aids?

Although there are numerous routes for heat pump engineers to increase their productivity, there is a risk that many companies will be unwilling or unable to do so. It is challenging for sole traders or very small firms to invest time and money in innovation, given their limited working capital and available time. For some productivity aids, there may be benefits in establishing cooperatives or umbrella bodies to enable joint purchasing and implementation of new technologies between numerous small heat pump companies.

The incentives for installation companies to increase productivity may also be weak, given the costs and time investments may take to pay off. There are several ways this lack of incentive to raise productivity might be overcome. Competitive pressure from peers or new entrants may force engineers to raise productivity, although this depends on supply increasing more quickly than demand. Having clearer financial incentives to increase productivity – such as moving towards flat fees rather than hourly rates – might also help. Further, there are a range of non-financial incentives, such as keeping up with peers and making the job easier.

Recommendation 13

Existing small heating installation companies may benefit from taking on additional employees. Moving from micro to small companies could enable more specialisation of skills, as well as creating more options to raise productivity. This could be achieved by

existing engineers taking on and training up new employees, or by sole traders merging into new partnerships or other company structures. This could be facilitated by government grants to take on new workers (as under recommendation 3).

Recommendation 14

MCS and governments should provide more formal support for cooperatives or umbrella arrangements, which let small heating installation companies group together and

pool resources. This model may be a good option to enable more training, productivity improvements and business growth.

Recommendation 15

Heating manufacturers should consider getting more directly involved in training engineers and helping them to raise their productivity. If large new entrant companies

come to dominate the heat pump market by being more productive, this may reduce manufacturers' power in the market.

7. Conclusions and next steps

Installing 600,000 air-source heat pumps per year is just the beginning; if the net zero legally binding targets are to be met, the number of installations needs to increase to over a million per year installed by 2030. The analysis in this paper makes it clear that there is a lot of scope to make heat pump training more desirable, accessible and effective to increase the number of qualified engineers.

The key is to make installing heat pumps an attractive opportunity and to enable and support businesses to take on staff. At the same time, it is very important to ensure that those trained are of a high skill level and are able to use the latest tools available to increase their productivity.

Considering the rapid scale-up in the number of skilled workers required to install heat pumps and the existing barriers and frictions in the market, we remain unconvinced that the process can happen organically. The central and devolved administrations, training providers, accreditation institutions, manufacturers, colleges, and the existing heating engineer workforce all have important roles to play in spearheading the UK's transition to a net-zero future.

This report makes five core recommendations:

1. The heating industry needs to become more diverse.
2. Create direct routes to train on heat pump installation and design.
3. Existing heating engineers will need incentives that address their real motivations.
4. Make use of different skills to specialise
5. Need more experienced heat pump engineers to take on apprentices.

Nesta's plans for future work

As part of our Sustainable Future mission, Nesta is pursuing a range of projects to help accelerate the UK's switch to low carbon heating. By bringing together our specialist expertise in areas such as

data science, design, behavioural insights and experimentation, we aim to find new solutions to the biggest challenges involved in decarbonising home heating.

We currently have five areas of focus within the mission:

- > Making heat pumps more affordable to people across the income spectrum.
- > Increasing the appeal of heat pumps.
- > Increasing skills and capacity in the heat pump supply sector.
- > Helping households use their existing heating systems more efficiently.
- > Enabling and incentivise householders to use electricity flexibly.

This paper has set out a clear agenda for further work on the third area of focus, building the supply capacity of the heat pump sector. Based on the analysis in this paper, we will consider what role we can play in:

- > Designing and trialling cash incentives for people to join the low carbon heating workforce, or for businesses to recruit and train new employees.
- > Developing or supporting training courses or pathways for new entrants to the low carbon heating industry.
- > Increasing diversity in the low carbon heating industry.
- > Developing productivity aides for engineers to use.

Appendix

OJO querying strategy

To query OJO, a two-step exact fuzzy matching approach was taken.

Firstly, job titles were cleaned to:

- > Remove 'bad' characters such as &.
- > Lower case.
- > Remove punctuation.
- > Remove digits.
- > Remove one-character tokens.

Once job titles were cleaned, they were exact matched with a list of 'seed' keywords. These keywords were: 'gas', 'boiler', 'solar', 'heating', 'heat', 'air conditioning', 'air condition', 'renewable' and 'heat pump'.

To ensure that jobs that contained seed keywords were indeed about engineers, a fuzzy match approach was then taken. We generated a list of job titles we wanted to investigate including: 'gas engineer', 'boiler engineer', 'air conditioning installer', 'underfloor heating engineer', 'underfloor heating installer', 'installation engineer', 'electrical heating engineer', 'solar thermal engineer', 'solar thermal installer', 'heat pump installer', 'heat pump engineer', 'solar pv engineer', 'solar pv installer', 'renewable energy engineer'.

We then generated similarity metrics between the exact matched job titles and our list of job titles. We calculated the mean of its 1) jaccard similarity; 2) levenshtein similarity and cosine similarity. Job titles in the 75% mean similarity score quantile across the similarity scores were considered jobs of interest. This yielded almost 9,000 job adverts across all job titles total between 21-12-2020 and 2022-04-29. Specifically, this yielded approximately 5000 job titles containing the term 'gas'; 1600 job titles containing 'heat'; 250 job titles containing 'pump'; 570 job titles containing 'solar'; and 150 job titles containing 'boiler'.

Similar job titles

Gas engineer, boiler engineer, air conditioning installer, underfloor heating engineer, underfloor heating installer, installation engineer, electrical heating engineer, solar thermal engineer, solar thermal installer, heat pump installer, heat pump engineer, solar pv engineer, solar pv installer, renewable energy engineer.

Endnotes

1. Londakova, K, Park, T, Chan, E, Stuijzand, B and Whitwell-Mak, J (2022) *How to increase the demand for heat pumps*. London: Nesta. Available at: nesta.org.uk/report/how-to-increase-the-demand-for-heat-pumps
2. Eg, Gabriel, M, Cretu, C, Elliott, H, Porter, A and Kiley, D (2021) *Heating engineers could hold the key to unlocking the low carbon revolution. How do they feel about it?* London: Nesta. Available at: nesta.org.uk/project-updates/unlocking-low-carbon-revolution
3. Norman, A and O Regan, N (2022) *Installing for time? New evidence on the attitudes of home heat installers towards decarbonisation and heat pumps*. London: Social Market Foundation. Available at: smf.co.uk/publications/installing-for-time
4. Climate Change Committee (2021) *Progress in reducing emissions in Scotland: 2021 Report to Parliament*. London: Climate Change Committee. Available at: theccc.org.uk/wp-content/uploads/2021/12/Progress-reducing-emissions-in-Scotland-2021-Report-to-Parliament-1.pdf
5. Lowe, T (2021) 'Less than half the number of qualified heat pump installers than government claims, report finds'. *Building*, 14 June. Available at: building.co.uk/news/less-than-half-the-number-of-qualified-heat-pump-installers-than-government-claims-report-finds/5112269.article#:~:text=The%20Department%20for%20Business%2C%20Energy,pump%20installers%20in%20the%20UK
6. EY Parthenon (2021) *Review of the Future Homes Standard*. Egham: Independent Networks Association, p 59. Available at: ina.org.uk/wp-content/uploads/2021/06/EY-Report-on-the-Future-Homes-Standard-June-2021_Final-1.pdf
7. MCS is an independent certification scheme that certifies renewable energy products and installation companies provide some indications of the market size
8. This refers to MCS data until Q1 2022
9. Norman, A and O Regan, N (2022) *Installing for time? New evidence on the attitudes of home heat installers towards decarbonisation and heat pumps*. London: Social Market Foundation. Available at: www.smf.co.uk/publications/installing-for-time/https://www.smf.co.uk/wp-content/uploads/2022/02/Installing-for-time-Jan-2022.pdf
10. MCS certification is required for installations that are using government funding such as the Renewable Heat Incentive or the Boiler Upgrade Scheme.
11. Heat pumps are an example of a low temperature heating system. It is a type of heating system in which the temperature of the water leaving the heat generator does not typically exceed 45°C.
12. For more details of our approach for querying the OJO database and the HVAC roles we analysed please see the Appendix.
13. Navkiran (2021) 'Shortage of Electricians in the UK'. *Trade Helper*, 29 April. Available at: tradehelper.co.uk/shortage-of-electricians-uk. Border States (2022) *The State of the Electrician Shortage in 2022: New Data on the Impact of COVID-19*. Fargo, ND: Border States. Available at: solutions.borderstates.com/the-electrician-shortage
14. The Gas Safe Register is the official gas registration body of gas businesses and engineers in the UK, Isle of Man, Jersey, and Guernsey. By law all business and gas engineers must be on the Gas Safe Register. Gas engineers become registered if they hold an approved qualification.
15. The Boiler Upgrade Scheme launched in 2022 in England and Wales funds part of the upfront cost of low carbon heating systems including air source heat pumps.
16. Note: Only the three to five-day courses that result in regulated qualifications or personal certifications are recognised under MCS.
17. Oswald, D, Taylor, S, Whittaker, D, Moore, L, Lee, T, Ward, M and Hollowed, S (2021) *Building Skills for Net Zero*. Bristol: Eunomia for Construction Industry Training Board (CITB). Available at: citb.co.uk/media/kkpkwc42/building_skills_net_zero_full_report.pdf
18. NVQs are practical work-based awards in England, Wales, and Northern Ireland. The equivalent in Scotland is the Scottish Vocational Qualifications (SVQs). They are awarded following the completion of higher education college courses or apprenticeships and are awarded in levels 1-8. Many gas engineers have an NVQ Level 3 in Gas Installation (or equivalent).
19. Education and Skills Funding Agency (2019) *Apprenticeships: off-the-job training*. London: Education and Skills Funding Agency. Available at: www.gov.uk/government/publications/apprenticeships-off-the-job-training
20. City & Guilds (2021) *Level 3 Diploma in Plumbing and Domestic Heating (918904/05/06/07): Qualification Handbook*. London: City & Guilds. Available at: www.cityandguilds.com/-/media/productdocuments/building_services_industry/plumbing/9189/on-programme/9189-04-07_l3_diploma_in_plumbing_and_domestic_heating_handbook_v2-1-pdf.ashx
21. This refers to MCS data until Q1 2022.
22. Williamson, C (2022) *Using Energy Performance Certificates to predict heat pump uptake*. London: Nesta. Available at: nesta.org.uk/project-updates/using-energy-performance-certificates-predict-heat-pump-uptake

22. Climate Change Committee (2020) *Sixth Carbon Budget*. London: Climate Change Committee. Available at: theccc.org.uk/publication/sixth-carbon-budget
23. Sharpe, J (2020) '2019 was record year for gas boiler sales'. *Installer*, 20 January. Available at: installeronline.co.uk/2019-record-year-gas-boiler-sales
24. This estimate is based on the Heat Pump Association's estimate of 65k- 67k heat pumps installed in 2021, divided by our best estimate of the heat pump installation workforce (3,000).
25. Heat Pump Association (2020) *Building the installer base for net zero heating*. Reading: Heat Pump Association. Available at: heatpumps.org.uk/wp-content/uploads/2020/06/Building-the-Installer-Base-for-Net-Zero-Heating_02.06.pdf
26. Dann, L (2021) 'How Octopus Energy is preparing to shake up the heat pump market'. *Utility Week*, 21 December. Available at: utilityweek.co.uk/how-octopus-energy-is-preparing-to-shake-up-the-heat-pump-market
27. Department for Business, Energy and Industrial Strategy (2022) *Market-based mechanism for low carbon heat*. London: Department for Business, Energy and Industrial Strategy. Available at: [gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat](https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat)
28. Lowes, R (2019) *Heating engineers, skills and heat decarbonisation*. London: UK Energy Research Centre. Available at: ukerc.ac.uk/news/heating-engineers-skills-and-heat-decarbonisation
29. Sustainable Energy Association (2019) *Heating installers have their say*. Press release, 28 October. Available at: sustainableenergyassociation.com/heating-installers-have-their-say/press-release
30. Macdonald, N (2019) 'The heating workforce is shrinking and that's a problem'. *Heating Ventilation & Plumbing*, 3 May. Available at: hvpomag.co.uk/The-heating-workforce-is-shrinking-and-thats-a-problem/11401
31. Londakova, K, Park, T, Chan, E, Stuijzand, B and Whitwell-Mak, J (2022) *How to increase the demand for heat pumps*. London: Nesta. Available at: [nesta.org.uk/report/how-to-increase-the-demand-for-heat-pumps](https://www.nesta.org.uk/report/how-to-increase-the-demand-for-heat-pumps)
32. These figures are inclusive of VAT and accurate as of June 2022 for NICEIC; these costs are higher for companies installing additional technologies.
33. This includes the initial application fee, the fee for installing one technology and the MCS Licence fee.
34. This includes the annual renewal fee for one technology and the MCS Licence fee.
35. Three key limitations that could bias the results are that 1) not all work is advertised via online jobs adverts; 2) the dataset would not capture sole traders and 3) not all job adverts contain salaries. As a result, the salary ranges may not be fully representative of the industry at large.
36. McClelland, B (2022) 'Where Are All the Female Heating Engineers?' *Boiler Guide*, 17 June. Available at: boilerguide.co.uk/articles/female-heating-engineers
37. Registered Gas Engineer (2021) 'Most Brits have never had a female tradesperson in their home, says survey'. *Registered Gas Engineer*, 23 June. Available at: registeredgasengineer.co.uk/most-brits-have-never-had-a-female-tradesperson-in-their-home-says-survey
38. Federation of Master Builders (2018) 'A third of home owners would prefer a female tradesperson, new FMB research reveals'. Press release, 8 March. Available at: fmb.org.uk/resource/a-third-of-home-owners-would-prefer-a-female-tradesperson-new-fmb-research-reveals.html
39. Harding, C (2022) *Women On The Tools: A research document into women in construction: 2022*. Birmingham: On The Tools. Available at: mcusercontent.com/d8823903f477eae488b11e372/files/667a11ae-6da7-2f1a-07d7-12967877eb14/WOTT_Whitepaper.pdf?goal=0_7e74f478f5-9577b86335-129283385&mc_cid=9577b86335&mc_eid=b5db00a536
40. IFF Research (2020) *Apprenticeships Evaluation 2018-19 – Learners*. London: Department for Education. Available at: assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/875553/Apprenticeships_Evaluation_-_Learner_Report.pdf
41. Heat Pump Association (2020) *Building the installer base for net zero heating*. Reading: Heat Pump Association, p 7. Available at: heatpumps.org.uk/wp-content/uploads/2020/06/Building-the-Installer-Base-for-Net-Zero-Heating_02.06.pdf
42. Lowes, R (2019) *Heating engineers, skills and heat decarbonisation*. London: UK Energy Research Centre. Available at: ukerc.ac.uk/news/heating-engineers-skills-and-heat-decarbonisation
43. Norman, A and O Regan, N (2022) *Installing for time? New evidence on the attitudes of home heat installers towards decarbonisation and heat pumps*. London: Social Market Foundation. Available at: [smf.co.uk/publications/installing-for-time](https://www.smf.co.uk/publications/installing-for-time)
44. Dell Technologies (nd) *Dell Neurodiversity Hiring Program*. Round Rock, TX: Dell Technologies. Available at: jobs.dell.com/neurodiversity
45. Dean, J, Rice, J, Williams, W, Pineros, B, Acosta, D, Panchar, I and Snelgrove, M (2020) *The Real Reason Diversity Is Lacking at the Top*. Global: Boston Consulting Group. [bcg.com/publications/2020/why-is-diversity-lacking-at-top-of-corporations](https://www.bcg.com/publications/2020/why-is-diversity-lacking-at-top-of-corporations)

58 Victoria Embankment
London EC4Y 0DS

+44 (0)20 7438 2500

information@nesta.org.uk

 [@nesta_uk](https://twitter.com/nesta_uk)

 [nesta.uk](https://www.facebook.com/nesta.uk)

www.nesta.org.uk