HEAT PUMP ASSOCIATION

heatpumps.org.uk

DELIVERING NET ZERO: A ROADMAP FOR THE ROLE OF HEAT PUMPS

ABOUT

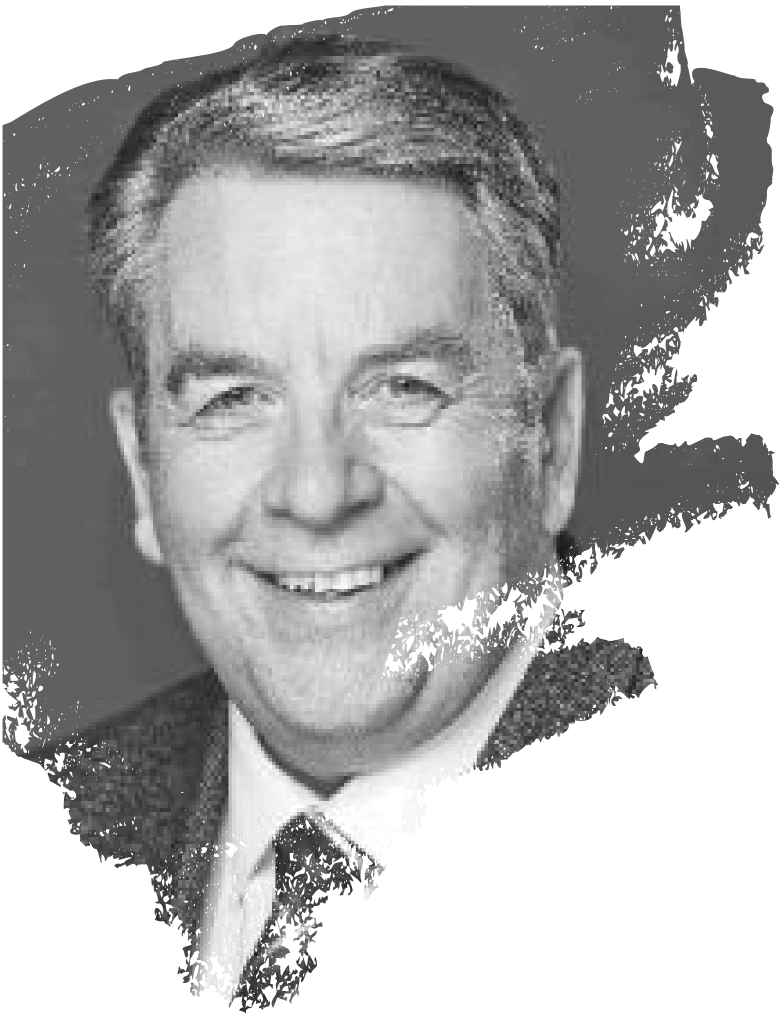
The Heat Pump Association (HPA) is the UK's leading authority on the use and benefits of heat pump technology and includes many of the country's leading manufacturers of heat pumps, components and associated equipment. Proposals put forward by the HPA are developed closely with a membership base that represents around 80% of the heat pump market manufacturing share, including several large multinational companies, ensuring that the proposals are workable and credible.

The Association works to support policymakers in the development of effective heat decarbonisation policy and other matters that affect the interests of end users, wider stakeholders and the industry. In addition, the HPA co-ordinates technical and market research into areas of mutual interest identified by members with the aim of improving market opportunities at home and abroad and helping markets to transform to low carbon solutions and technologies.

The HPA recognises that heat pumps will only fulfil their promise in the market if suppliers, installers and users fully appreciate their function and capabilities. A major objective of the association, therefore, is to raise awareness of heat pumps by informing prospective specifiers of their long-term benefits, reassuring end users and providing up-to-the-minute advice on the various systems available. The HPA conveys this message by generating publicity using exhibitions, literature, promotions and public relations in addition to helping costumers deploy the technology through managed sales and services structures.

FOREWORD

Graham Wright, Chairman, Heat Pump Association



The stark reality of the climate crisis and the consequences of inaction are clear to us. We must endeavour to do all we can to reduce our emissions immediately to prevent the worst of these consequences, there is no time to waste. The good news is that we already have the technology to lower emissions from our buildings. Heat pumps are one of these options, a well-established technology that offer immediate and substantial carbon savings compared to the heating systems being used currently. This report comes at a time where heat decarbonisation is now at the forefront of the challenge to deliver a low carbon economy with heat pumps needed to play a crucial role.

The next few years represent a critical period for effective policy development that could set the path to low carbon heating of buildings across the UK. In this report, the Heat Pump Association outlines the vision for increasing the deployment of heat pumps to a level needed to meet net zero emissions by 2050. The role of the industry in stepping up to the challenge of increasing heat pump deployment is discussed, alongside the 10 key policy asks which will need to be implemented to encourage the use of heat pumps during this key period of policy development. This report is a signal that the heat pump industry is ready to step up to meet the challenge and work with government to make sure that the decarbonisation of heat is delivered.

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EXECUTIVE SUMMARY

The scientific consensus is clear. Climate change is happening, and we are the cause. If we act now – decisively and dramatically – there is still a chance of avoiding the most disastrous impacts of climate change.[1] If we miss the window of opportunity, there won't be a second chance. Amongst the challenges facing climate policy in the UK, heat decarbonisation is a key priority.[2] The scale of change must be recognised with urgency so we can drive down carbon emissions from this sector in the years to come. Fossil fuel heating systems are still used in the majority of buildings here in the UK, contributing to the climate crisis whilst low carbon solutions wait in the wings. Heat pumps are already a well-established technology that can immediately and substantially reduce emissions from our heating and hot water consumption (see Figure 1). Efforts must be taken now to put them to good use.

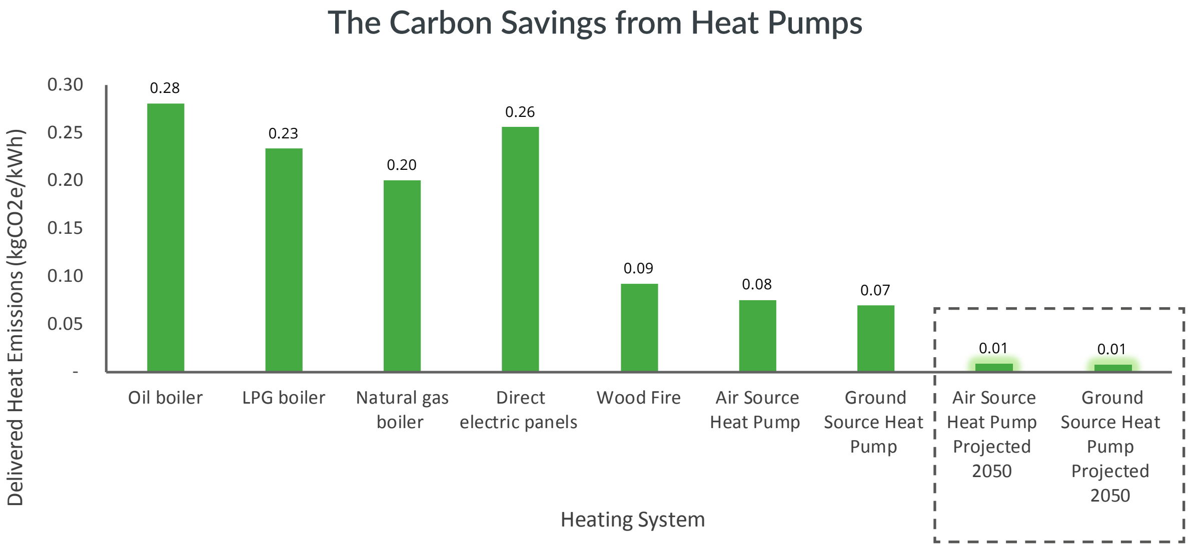


Figure 1: Common Heating System Emissions, 2019 (Source: HPA Calculations see Appendix for further details)

The UK has shown commitment to tackling the climate crisis in 2019 by setting a significant – and necessary – target to meet net zero emissions by 2050. Whilst this legislation makes the UK the first major economy to set such a progressive target, it is vital that the action taken to get there is just as bold and ambitious.

It is clear that installing heat pumps is essential to the immediate reduction of carbon emissions from heating and to meeting the net zero emissions target by 2050; efforts to carry this out must begin right away. Indeed, the Government's official advisors for this topic, the Committee on Climate Change (CCC), say that 19 million heat pumps need to be installed by 2050.[3] This begins with the urgent mass installation of heat pumps. Running on electricity in an extremely efficient process, heat pumps make the most of the widespread growth in renewable electricity generation over the past decade to provide a cleaner power source for heating. With renewable generation set to build on its rapid expansion to date,[4] the extensive carbon reductions achieved through heat pumps already are set to increase even further (see Figure 1).

Heat pumps also offer a considerable advantage through improving the air quality problem faced by many areas, since they do not emit any NOx, SOx or particulate matter (PM) locally, all of which are key contributors to air pollution. Through their installation, air pollution caused by heating in these areas can be eliminated.

Despite these benefits, heat pump deployment in the UK remains relatively low. Already widely deployed and saving carbon across much of Europe,[5] there are some lessons learned that could help the UK to increase its heat pump installations. Irrespective of the country context, heat pump markets can be encouraged with a long-term, stable policy framework consisting of direct regulation, carbon taxes, planning policy and upfront financial incentives. This policy suite should work in combination with support for the certification of skills and product standards, an area which the heat pump industry has a large role to play. With a coherent set of interventions in place, market growth barriers can be overcome to save carbon emissions and set the path to meeting net zero.

A clear signal is therefore needed from the Government through a set of policies that assures investors, manufacturers and installers that this is the direction in which the market is heading. Confidence is critical to accelerating the number of installers training in renewable heating technologies and to stimulating increased investment in heat pumps.

The Government has the opportunity to provide this clear indication with vital upcoming policy decisions that can be made in the near future to encourage the deployment of heat pumps and begin the process of heat decarbonisation. Following an approach based on the successful policies implemented elsewhere, the HPA believes that the outlined policy decisions can successively support heat pump deployment:

POLICY SUPPORT SUMMARY	
Building Regulations affecting energy performance of homes built in England (known as Part L)	1. Maximum flow temperature of 55°C in heating system installations in new build and retrofit 2. Ensure the delivery of the Future Homes Standard in 2025 3. End the ‘freezing’ of Building Regulations by closing current loopholes 4. Significantly tighten the Energy Efficiency Requirements in the 2020 Building Regulations 5. Ensure new builds have suitable electricity supply connections 6. Require the installation of hot water cylinders in new builds 7. Revise permitted volume for outdoor units (Permitted Planning)
Regulation of heat in existing homes via Part L of Building Regulations	8. An emissions standard for delivered heat: a. <220gCO_2e/kWh by 1st Jan 2025 b. <170gCO_2e/kWh by 1st Jan 2030 c. <110gCO_2e/kWh by 1st Jan 2035
Taxation and Spending Policy	9. An RHI successor scheme using an upfront financial incentive 10. A rebalancing of the taxes placed on electricity and gas to reflect carbon content

Policy Overlay with Potential Deployment Trajectory

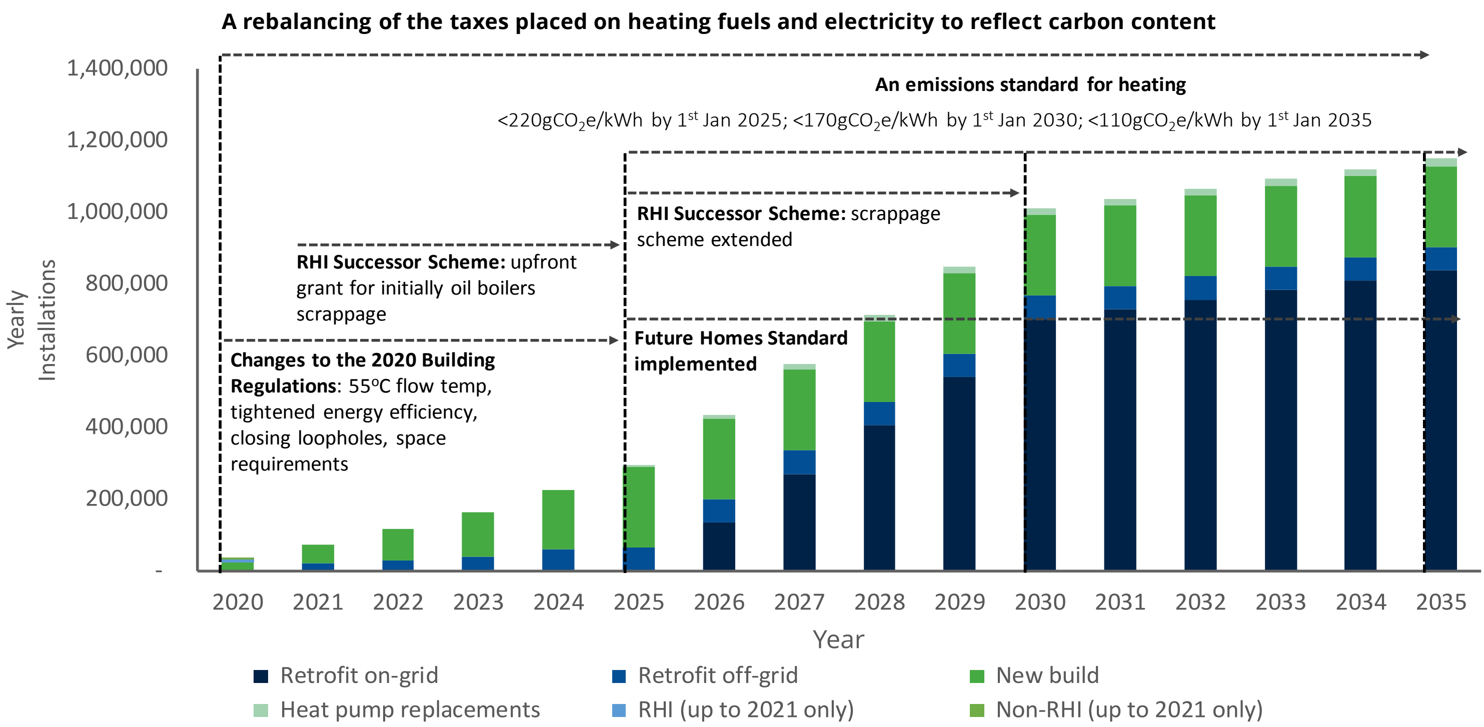
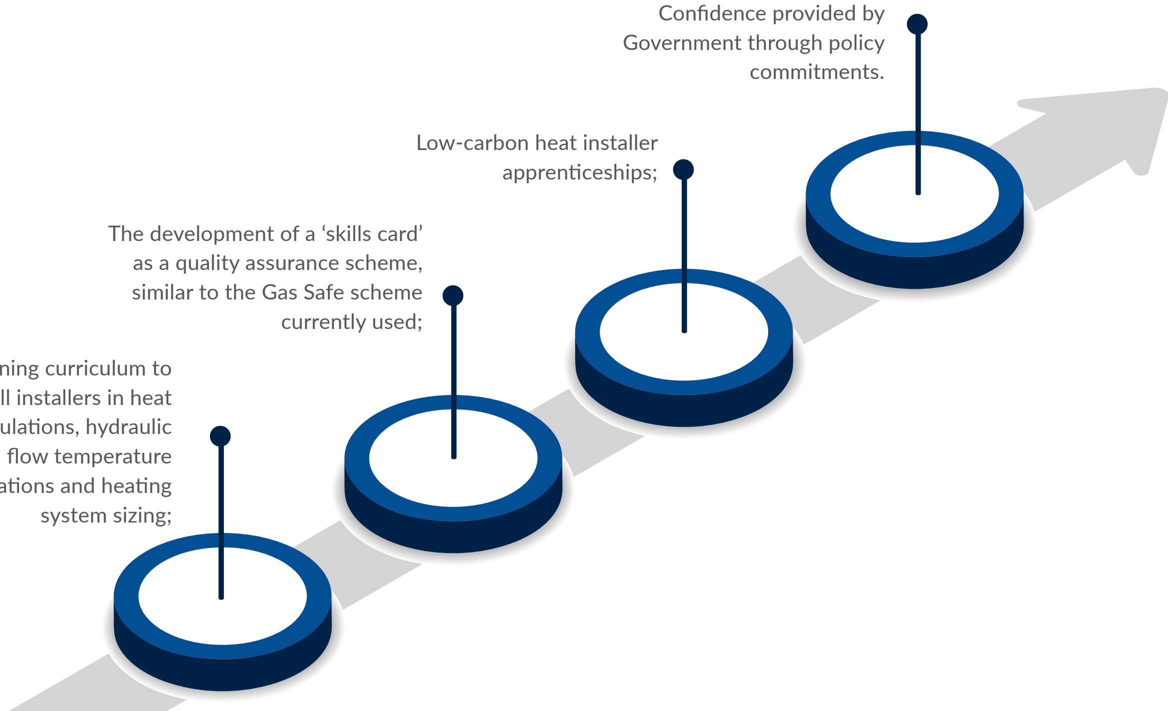


Figure 2: Policy Overlay with Potential Deployment Trajectory

In conjunction with confidence provided from this suite of policies, one of the key barriers in stimulating the deployment of heat pumps is the development of a well-trained and large installer base. Right now, most heating system installers would need to upskill to be able to install low-carbon heating methods, including heat pumps.[6] This can act as an obstacle to the uptake of heat pumps as consumers are usually reliant on the knowledge and advice provided by installers. Without this upskilling of the installer base and improvement in the knowledge of the low-carbon heating systems available, the deployment of low-carbon heat could be hampered.

This is a challenge that the heat pump industry is ready to meet by ensuring that thorough training is provided to upskill the current workforce and bring through the next generation of low-carbon heating installers. This will ensure that the quality of heat pump installations is high, the knowledge of the benefits that the technology can bring is commonplace, and there are sufficient installer numbers to scale up deployment to the levels required to meet net zero by 2050.

Developing the installer base: what needs to be done?



With this will come an increase in consumer awareness and trust in the benefits of heat pumps. Consumer acceptability will play a big part in increasing the deployment of low-carbon heating. This will be improved through the knowledge imparted by well-trained installers who are able to advise consumers on the benefits of heat pumps in terms of usability.

The consumer experience will also be vastly improved, as heat pumps guarantee comfortable, consistent heat in homes at the same time as offering the potential to revolutionise the consumption of heat.

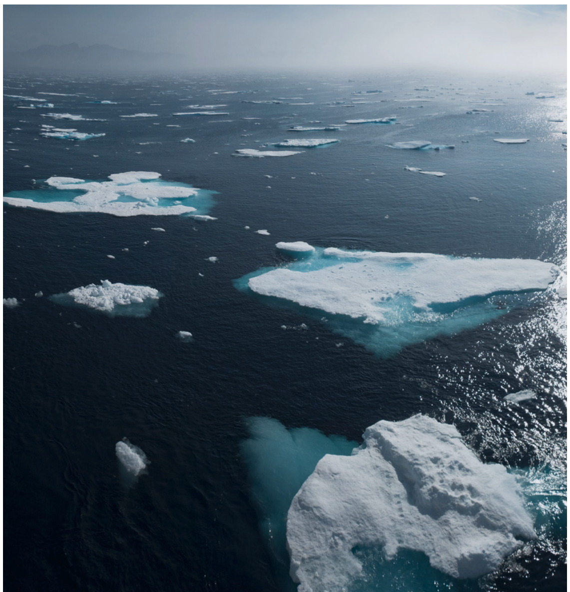
Heat pumps do not only maintain a comfortable and stable temperature throughout the day but can also allow for the 'smart' consumption of heat, utilising the 'Internet of Things' to provide a tailored service to match each consumer's individual preference. By allowing the shifting of demand to heat the home in periods of the day that avoid peak consumption levels, it can also lower fuel bills, provide grid balancing functionality and save the consumer money when combined with the use of dynamic price tariffs. The technology also has a significant advantage of providing cooling to consumers throughout the summer.

Consumers are more likely to take-up a new technology if it provides a better service than they currently experience. Heat pumps can do this, but consumers need to be aware of the benefits. With a highly skilled installer base, heat pumps can be deployed to a standard that ensures consumers get the most out of them and their benefits can be explained.

The decarbonisation of heating will be crucial to the UK meeting net zero by 2050 and to averting the worst of climate change. Too many years of slow progress and high levels of emissions have already passed us by to justify making the same repeated mistakes all over again. Heat Pumps are already a well-established solution and they can be deployed widely with the right support from government and efforts from the industry. By joining forces and taking on the challenge together, the benefits of this known carbon saving technology can be realised, and we can set off on the path to avoiding the climate crisis that lies ahead.

THE CHALLENGE WE FACE

The Intergovernmental Panel on Climate Change's (IPCC) 2018 Special Report[7] warns of rising sea levels and increases in hot extremes, heavy precipitation and the probability of drought from global warming of 1.5-2°C. Limiting global warming to 1.5°C will be crucial in reducing these potentially catastrophic risks. Currently, human activities are estimated to have caused around 1°C of global warming above pre-industrial levels. To ensure that this warming is limited to 1.5°C, rapid and far-reaching changes are needed at an unprecedented scale, not necessarily in terms of speed, but in terms of the depth and breadth across all sectors of the global economy



"What we do over the next 10 years will determine the future of humanity for the next 10,000 years." Professor Sir David King, former Chief Scientific Advisor to the Government. [8]

In June 2019, the UK became the first major economy to pass net zero emissions into law. The target means bringing all greenhouse gas (GHG) emissions to a net zero level by 2050, going beyond the previous requirement for an 80% reduction in emissions compared to 1990 levels. It represents a significant milestone in the UK's efforts towards tackling global warming.[9] Although a step in the right direction, for this target to now be achieved, there is a need for the immediate and widespread change across the whole economy stated by the IPCC.

This move comes at a time of increasing public pressure for government to address the UK's contribution to climate change[10] and was recommended by the Committee on Climate Change (CCC) as part of their 'Net Zero' report,[11] as a target which is achievable with known technologies and will deliver on the UK's commitment made as part of the Paris Agreement. Heat pumps are one of the known technologies that feature heavily in the CCC's evaluation.

Across the economy there will be a need for extensive changes to deliver net zero emissions in the UK by 2050. The electricity system will need to be decarbonised through the further addition of renewable generation. Capacity and flexibility will need to increase with the potential deployment of hydrogen for peak generation, alongside use of bioenergy with carbon capture and storage (CCS). Hydrogen may also need to be implemented widely as a fuel for industry and to power heavier vehicles.

Buildings will need to become far more energy efficient, alongside an expansion of heat networks and the use of heat pumps. People will need to change their transport methods, increasing levels of electric vehicle (EV) uptake and taking fewer flights on more efficient planes. Peatlands will need to be restored and trees planted. People will need to adjust diets and reduce food waste, with more efficient methods of farming to produce the food we eat. This will be among many other changes needed as outlined in the CCC's report and likely combined with some changes that cannot yet be predicted.

The focus of this report is to outline the pivotal contribution that heat pumps will provide in the decarbonisation of our buildings in order to reach the net zero target.

Heat pumps are a well-established technology that have already seen widespread deployment across much of Europe[12] (see Figure 3). They use a process harnessing thermal energy already in air, water or the ground, to upgrade and pump the energy to provide heat. This is an extremely efficient process, meaning that far less energy is needed to heat a building compared to traditional heating methods, helping to lower consumers' fuel bills at the same time as cutting emissions.

Heat pumps are commonly associated with Scandinavia where buildings are designed for high thermal efficiency with relatively abundant low carbon electricity. Historical deployment levels in Scandinavian countries are indeed high, yet latest sales figures show that UK acceptance of this technology is still far behind many other countries that also have a wide variety of aged building stock, climatic conditions and energy systems (see Figure 4).

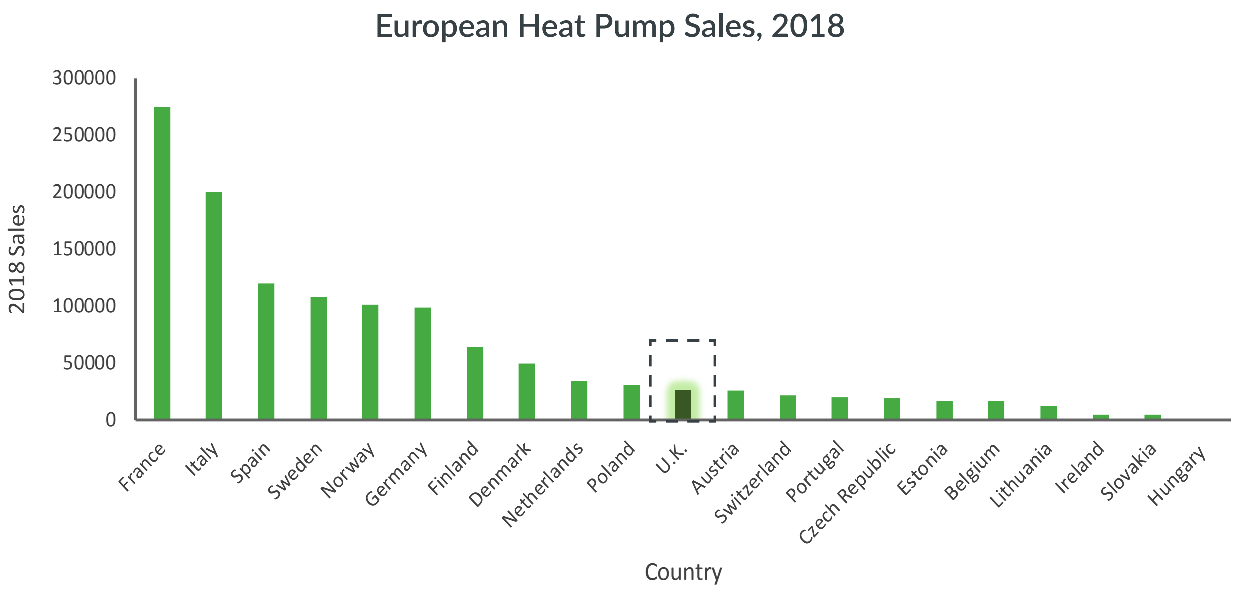


Figure 3: Heat Pump Sales Across Europe, 2018 (Source: EHPA)

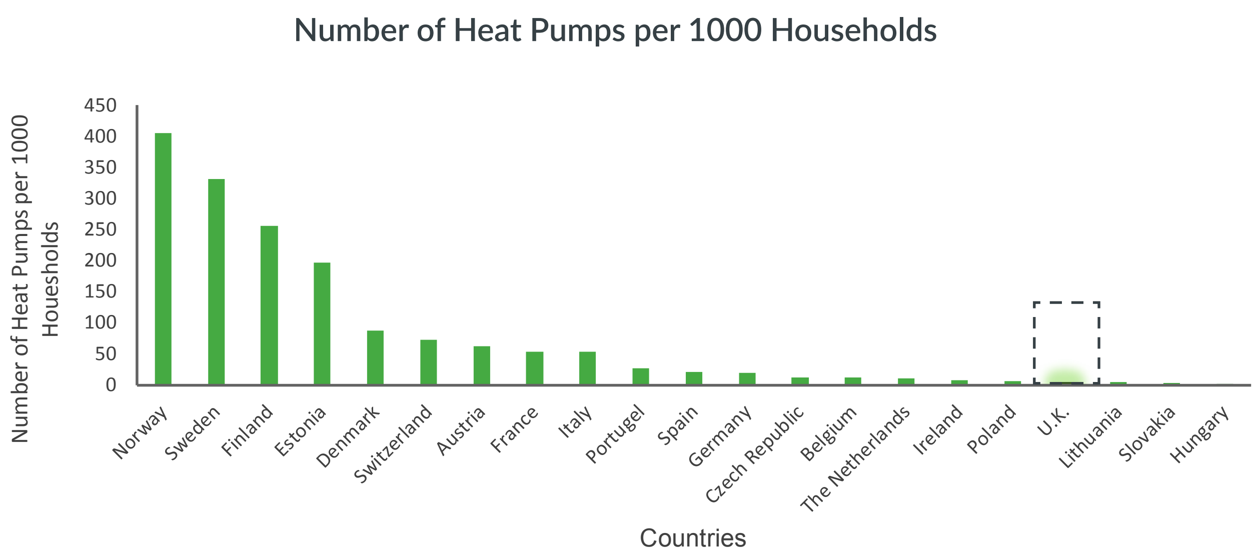


Figure 4: Heat Pump Deployment Across Europe per 1000 Households (Source: EHPA)

Heat pumps are powered with electricity, offering a long-term renewable heating solution. The carbon intensity of electricity is set to continue to fall with the further deployment of wind, solar and other renewable generation methods in the future.[13] The result of this will be an ever-cleaner supply of power for heat pumps and a continuously smaller contribution to GHG emissions.

This potential for huge reductions in emissions, from a heating technology well-established and already used widely in other countries, is a large reason why the CCC recommends the mass deployment of heat pumps in order to comply with the net zero target. Indeed, the CCC's net zero 'Further Ambition' scenario includes the deployment of 19 million heat pumps in homes. This represents a significant scaling up on the level of heat pump deployment in the UK to date.

Heat pumps also offer a solution to air pollution issues. There has been an increasing recognition around the issue of air pollution across UK cities of late. This is only added to through the burning of traditional fuels in the homes of these cities. In London, for example, domestic gas use accounts for around 13% of all NOx emissions. In addition to the carbon savings that heat pumps offer, they do not emit any NOx, SOx or PM to the locality, helping to eliminate the air pollution in these areas of concern.

It is clear that heat pumps are a core part of the solution to tackling the decarbonisation of heat. They are a known solution that can be deployed now without any further technological development to immediately create carbon savings across the country. However, deployment remains low and this represents a significant challenge to increase this level so that the substantial benefits of heat pumps can be realised.

ROADMAP FOR HEAT PUMP DEPLOYMENT

In 2018, heat pump sales in the UK were around 27,000 units.[14] In order to decarbonise the heat supply, it is thought that this number will need to rise to over 1 million annual installations by the mid-2030s.[15] At this rate, the deployment of the 19 million heat pumps recommended by the CCC in order to attain net zero by 2050 could be reached. The following graph is a potential trajectory and breakdown of how this increase could be achieved.

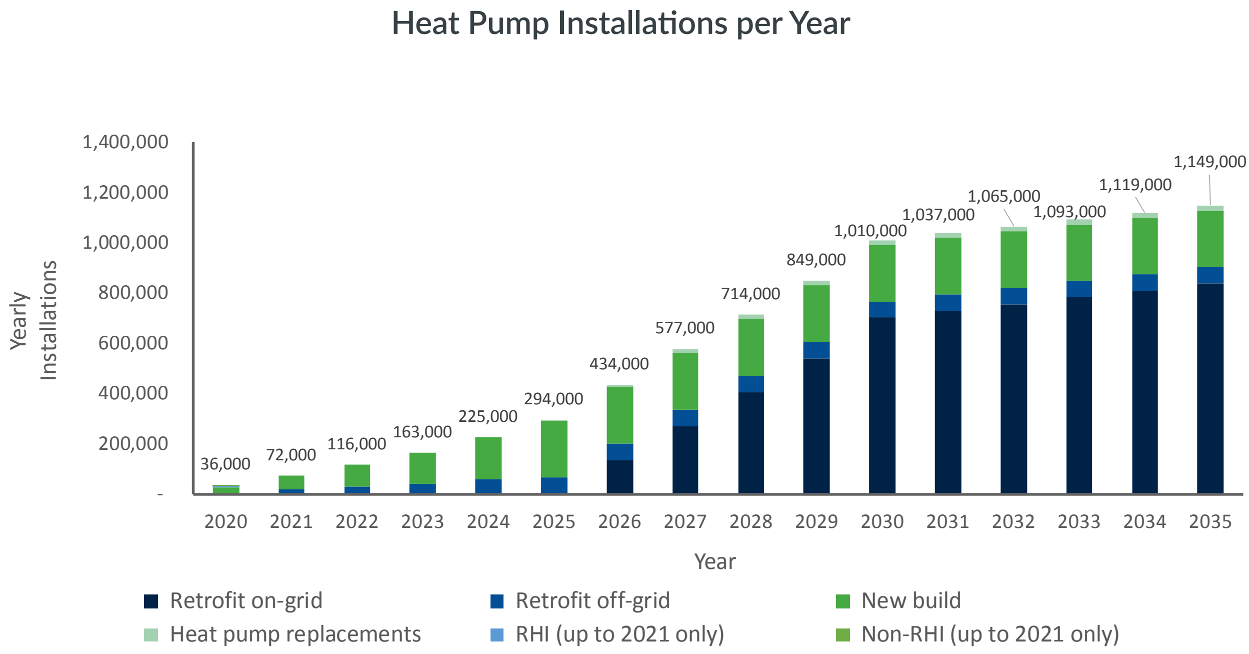


Figure 5: Potential Trajectory for the Increased Deployment of Heat Pumps

There are significant opportunities for the immediate deployment of heat pumps. In particular, heat pumps already provide a compelling case for installation in new build properties and houses that are off the gas-grid.

There are government commitments already made that should help to increase the deployment of heat pumps that have been considered as part of this trajectory. These pledges start with the low-hanging fruit of homes off the gas grid and new builds. The Clean Growth Strategy (CGS)[16] outlined the Government's commitment to phasing out fossil fuels off the gas grid in the 2020s. These homes, often heated through the use of oil, offer the opportunity for substantial emissions savings. In addition, the Future Homes Standard will ensure that by 2025 all new homes will be fitted with low carbon heating methods.

On top of ensuring that these commitments are delivered, there are several further policy steps that Government must make in order to see the sufficient deployment of heat pumps to decarbonise the UK's buildings in line with achieving net zero. These are discussed later in the report.

The numbers in the outlined trajectory represent only one possible pathway for the deployment of heat pumps needed for heat decarbonisation demonstrating the level of growth that will be necessary. It aims to show the size of the task that lies ahead and how this could be realised. Although there is uncertainty as to the route that will be taken, the considerable challenge that the industry and government faces in scaling up deployment from the relatively low current level to a level compliant with net zero is clear.

RISING TO THE CHALLENGE

The increase in the deployment of heat pumps creates some potential questions that will need to be addressed if this ambition is to be met. The higher yearly sales of heat pumps will rely on the development of a secure supply chain that can ensure the production and installation of heat pumps is achieved to a quality that provides consumers with a reliable heating source. It will also depend upon consumer demand and acceptability for a change in their heating methods. For this development to happen, manufacturers will need to ensure that they are producing sufficient heat pumps and also that there are enough installers who are then able to install these products. The relatively high upfront cost may also act as a barrier to consumer uptake. In general, these challenges will fall to the responsibility of Industry and can be split into 2 main areas that need to be addressed for the successful deployment of heat pumps and resulting decarbonisation of heat:

Challenge 1

Developing the Installer Base

Challenge 2

Consumer Acceptability

RISING TO CHALLENGE 1: DEVELOPING THE INSTALLER BASE

Meeting the manufacturing demand for this increase will not be a problem if confidence can be provided by Government. In order to scale up the production of heat pumps for the UK market, manufacturers need a clear signal from a decisive policy mix that this is to be the case and there will be secured demand ahead. Doing so will allow the increase in investment and production necessary in order to meet the demand. This has been shown already across Europe, where the sales of heat pumps have reached a mass market level in several countries, with sales of 1.8 million being achieved across the region in 2018.[12]

Alongside the increased production requirement, manufacturers also recognise the need to ensure that their products are installed to a level that guarantees the consistent, comfortable temperatures expected and all of the added benefits of their products are realised. Indeed, there are already training schemes offered by manufacturers to ensure the delivery of this standard.[17] With the high growth in the heat pump market will come a need to ensure that there are enough installers with the skills needed to provide these installations.

The HPA is leading on efforts to ensure that there are schemes in place for training of heat pump installers, a crucial aspect of Industry efforts in pushing heat pump deployment. The installation of heat pumps requires considerations on top of those typically carried out for traditional heating systems, such as gas boilers. There is, for example, a need to size heat pumps more carefully according to the heat demand of a building, heat emitters often need to be upgraded to work with lower flow temperatures and hydraulic balancing is carried out to ensure that the distribution of water in heating systems is optimised.

These methods would greatly benefit the performance of traditional heating systems and should already be completed. Hydraulic balancing, for example, is always needed to ensure that a heating system is working optimally, however these traditional heating types are not as sensitive to these works being carried out and so can often be overlooked or thought of as unnecessary.

This will mean that a high proportion of current heating installers are likely to need to upskill to be able to install low carbon heating systems, such as heat pumps. In addition, it will mean that new entrants to the installation market need to train to a higher level than previously expected in order to acquire the skills needed for the installation of carbon saving heating through heat pumps.

An indication of the number of installers that would be needed to meet the potential trajectory is provided in Figure 6. It shows that there will need to be considerable growth in installer numbers year-on-year up to the mid-2030s. These installers are likely to come through a combination of routes. Firstly, there will be new entrants to the market who will need to be trained up from the very basics. Here the HPA believes that apprenticeships should be widely encouraged to create the next generation of heating installers.

There will also be the potential to tap into current air conditioning installers, who have some of the skill set needed already to install heat pumps. For example, these installers will be particularly beneficial for installing split systems requiring refrigeration pipework.

The majority of installers are likely to come though from the current boiler installer base. As more traditional methods of heating are phased out, these installers will find a need to retrain to be able to install low-carbon systems such as heat pumps. While these workers already have many of the skills needed to install such systems, there will be a need to upskill upon these to ensure that the installation of heat pump technologies is carried out to a high standard. In a recent installer survey, 43% of installers said they had no experience at all in heat pumps with 42% saying that they would be confident installing a heat pump with manufacturer instructions irrespective of their experience level.[18]

The industry is confident in providing the delivery of this training through the development of suitable qualification schemes and administration of this. It is crucial that there is enough interest from people wanting to undergo this training. This is reliant on a firm commitment from the Government to indicate that low-carbon heat is the ‘direction of travel’ and fossil fuel heating will be phased out.

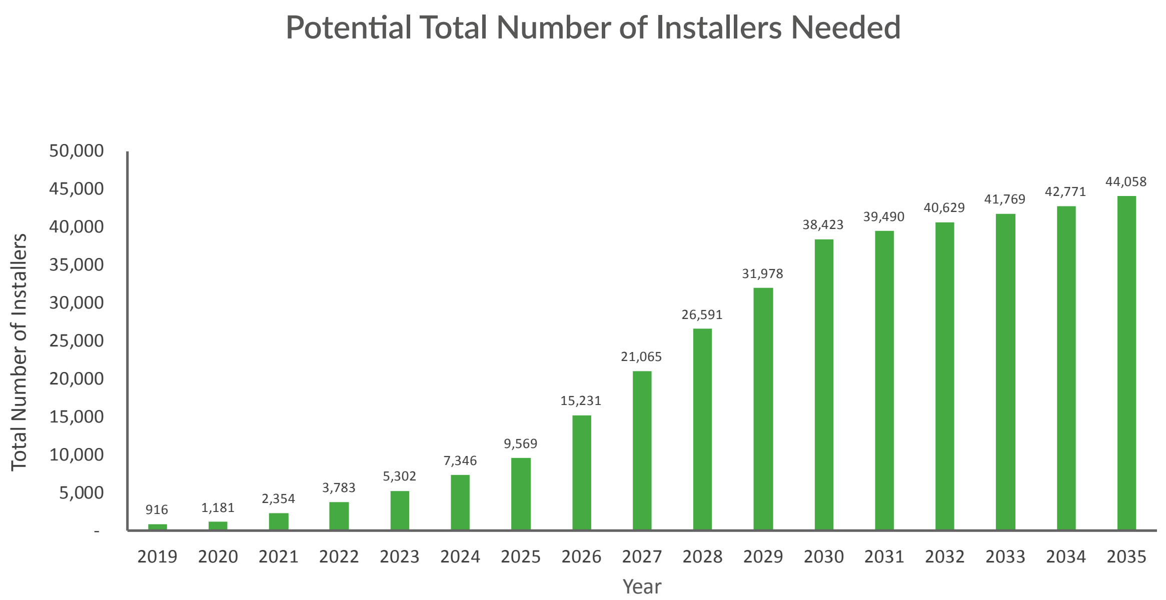


Figure 6: Potential Total Number of Heat Pump Installers Needed

A clear signal is needed to incentivise current installers to retrain and upskill to possess the skills to install heat pumps. Without a clear message that this is the direction that the market is heading, installers already operating in the heating sector will not see a need to retrain.

However, with confidence in the direction that the market is heading, installers will want to ensure that they are ready to make the most of the shift to the installation of heat pumps, meaning that they will plan ahead to retrain and there will be enough installers to meet the necessary growth of the heat pump market. This is exactly what is happening in France following the 'Coup de Pouce' offer,[19] (which provides a grant for heat pumps when replacing an oil boiler) with the number of professionals trained in the first half of 2019 up 264% for heat pumps compared to the same period in 2018.[20]

In addition to current installers, there is also a responsibility to ensure that new entrants to the installer base are adequately trained and possess the skills that they will need in the long-term. Here, the HPA supports the offering of apprenticeships to encourage the younger generation of installers to develop their skill base to a level suitable for the installation of low-carbon heating systems, such as heat pumps.

With the right training programmes in place, the quality of installations for heat pumps will be high, ensuring that the technology delivers a reliable and safe heating system. To signal the standard of training for installers, a 'skills card' should be developed for installers of renewables. This would work in a similar way to the current Gas Safe scheme to ensure the quality and reputation of heat pump installations is high and to reassure consumers that they can find a well-trained installer. The skills card could be used to highlight the separation in the abilities needed to install heat pumps, such as the design, install and commissioning functions. This division could allow specialisation across these skills and help to optimise the time for training and increase the labour force.

With this assurance in place and confidence provided by the Government to show the need to retrain, there will be enough installers with the skills needed to significantly scale up the deployment of heat pumps and to install these numbers at a high quality – crucial for the consumer experience.

RISING TO CHALLENGE 2: CONSUMER ACCEPTABILITY

Upfront Cost and Choice

A competitive market for products, installation, maintenance and other services such as finance will likely combine to bring down costs for consumers. Installation contractors, who are typically smaller companies, require predictable volume in order to efficiently deliver services. Increasing demand is also likely to encourage new entrants, scale and consolidation opportunities and innovation.

With a growth in installer numbers and demand, the upfront cost could reduce due to lower installation costs. This may come through greater competition between the higher number of installers and through increased familiarity with the products that they are working with. The growth in demand would help to increase the regularity of installations, which can mean a slicker and faster process of deployment of heat pumps that would lower costs as a result.

Also, as discussed further below, Building Regulations that drive the increase in home efficiency will help to reduce the heat demand of these properties. This will result in the use of less heating energy, smaller capacity systems and in theory lower capital costs. Here, Industry must rise to the challenge of ensuring that users are fully educated to guarantee ample domestic hot water and heat supply to get people to buy in to the heat decarbonisation process.

This will help in easing the transition to heat pumps for consumers, who are integral to the uptake of the technology. Heat pumps must be made as attractive a product as possible for the consumer.

Operation and Running Costs

Heat pump technology opens up the possibility for new ways of consuming heat that can add to the consumer experience. While heat pumps are an already established technology that yield considerable carbon savings, they also open up the prospect of enabling exciting new technological developments that could revolutionise the consumer offering.

These changes are a massive part of the future through the electrification of heat and Government's commitment to the roll out of electric vehicles (EVs) is complementary to this. Many of the options opened up by EVs are being embraced by consumers and are closely aligned with those also offered through the use of heat pumps. As both technologies use electricity, the infrastructural requirements can be considered simultaneously, allowing joint planning and creating greater confidence in developing the infrastructure needed for decarbonisation.

By focussing on the roll out of both EVs and heat pumps in combination, the Government will be able to largely tackle two of the harder areas of the economy in transport and heating to decarbonise with the same infrastructural focus.

It is also anticipated that maintenance will increase in availability and decrease in cost as numbers of installations increase. The skills and aptitude differ between install and service, such that the personnel are most often not the same. Hence, currently the HPA get calls from the public looking for maintenance organisations. Often the organisations who are prepared to take on maintenance of systems installed by others will have to travel significant distances between jobs and this increases the 'on-cost' of such maintenance. As the demand for maintenance increases, organisations will fill this gap and these costs should drop significantly. A gas fitter typically may only travel a few miles between projects whereas a heat pump fitter may have to travel between 10-30 times these distances.

Information Flow

Companies are engaging with the Internet of Things (IoT) that provides the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. This can develop the service provided to consumers offering enhanced system monitoring, prognostics and ensuring system efficiency is maintained. People can schedule warmth by time of day and temperature in each room with the system automatically taking the steps needed to achieve this pre-programmed goal. Systems can also be integrated to take advantage of the flexibility offered by both heat pumps and EV batteries; innovation that can massively enhance the level of consumer control and acceptability.

Smart Controls

One of these possibilities is the use of smart control systems, which are installed to allow the heat pump to operate according to market signals to help with grid balancing to the benefit of lowering consumer fuel bills. When demand on the electricity grid is high, the smart-enabled heat pump can automatically respond to this signal to temporarily switch off and help to ease any pressure on the grid, choosing instead to do the bulk of heating in times of lower demand. This demand response will create a smoothing of the peaks and troughs of the current demand profile for electricity that can benefit the consumer. Trials have shown that people enjoy having this improved control over their heating. [22]

Through this ability, dynamic pricing tariffs can be used to reflect the value when this action is carried out, allowing consumers to heat at times when the electricity price is lower. It is important that here the heat pump is in charge of these signals to ensure that the primary function of maintaining a comfortable temperature is achieved, rather than purely being dictated by grid demand at the time. The use of vehicle-to-grid (V2G) technologies will complement this and aid the spread of the technologies needed to enable this, allowing the batteries in EVs to combine with the demand smoothing offered by the heat pump when the vehicle is plugged in to a charging point. For the consumer, this could translate to reduced fuel bills without a noticeable change to the comfort of a house or heat level.

Hybrid Heat Pumps

Hybrid systems offer a route that allows a more gradual progression away from the current heating systems, which could help in shifting consumer preferences. Although heat pumps can operate solely when installed correctly in any housing type, they can also be combined with the heating systems already in place.

The extent of the integration between the two systems can vary, with the options ranging from a packaged system of two separate heating units to a truly 'hybrid' system, which responds to market signals to deliver the cheapest heating type to consumers. Hybrid systems offer an interim solution to help in easing initial constraints that could emerge with grid and heat loadings in the replacement market.

INDUSTRY AND GOVERNMENT COLLABORATION

Through the development of a mass market and opening up of new possibilities for the way heating is provided, heat pumps will offer an ever more attractive heating system for consumers. The increased competition from installers will help to see upfront cost reductions for consumers, which currently act as a barrier of uptake relative to historically deployed heating systems. They will also offer smart systems and the potential of a diversified approach to switch to low-carbon heat. These factors represent considerable opportunities for the heat pump industry to improve the consumer acceptability of the technology, a fundamental part in rising to the challenge for the increased deployment of heat pumps.

The size of the challenge in ensuring that enough heat pumps are deployed to meet the UK's net zero target is not one to be underestimated. Broader high-level industry engagement is probably required to dispel myths, reduce the opposition to change and encourage uptake across the construction industry as a whole. The heat pump industry is confident in stepping-up to meet this challenge and will endeavour to innovate continually, to improve the products available to consumers and strive to ensure that installer numbers and quality are at a level needed. For this to happen, government and Industry must work together to provide an unwavering message that this is the direction that heat is heading in.

POLICY SUPPORT

The decision to set a net zero target is a significant and necessary step-up in efforts to tackle the climate crisis. Government must now back this up by implementing policies to support the transition required. Indeed, the CCC state that achieving net zero by 2050 "is only possible if clear, stable and well-designed policies to reduce emissions are introduced across the economy without delay".[11]

> *"[Net zero] is only possible if clear, stable and well-designed policies to reduce emissions further are introduced across the economy without delay."*
> *The Committee on Climate Change, Net Zero Report*[11]

There is no exception to be made for the decarbonisation of buildings. In particular, low carbon heating is amongst the toughest challenges facing climate policy[24] and heat pumps, offering a low-regrets option, are available now. This is critical when action must be taken to avert the rest of the climate crisis facing us. The Government should meet the complexity of the task of low-carbon heat head on, providing certainty over a long-term period by immediately putting policy changes into place that set the path for this to happen.

By being brave enough to draw a clear line in the sand, policymakers will provide assurance that a switch to low-carbon heat is inevitable, whilst giving the time for businesses and consumers to adapt and plan for the change to take place. Through this commitment, confidence will be provided to investors to help create the scale-up in manufacturing and innovation. It will also demonstrate to installers the need to retrain and make the most of the industry support to be offered in this.

This will mean a necessary shift and alteration of the current products many businesses offer, as well as a change for the technologies that consumers use to heat homes. There may be some opposition, but in order to achieve net zero emissions, change is necessary. It has been shown in the past that companies in the heating sector are capable of change and will transition if the Government is brave enough to provide the certainty and support required through making a strong commitment and seeing through a change in policy (see Case Study 1).

CASE STUDY 1: LESSONS LEARNED FROM THE CONDENSING BOILER ROLL-OUT (SOURCE: POLICY CONNECT[25])

The Condensing Boiler Legislation, introduced in 2005, is viewed as a highly effective policy in the heating sector. The Government introduced legislation as part of Building Regulations mandating that all boilers installed after 1st April had to be condensing boilers with an A or B SEDBUK rating. These new condensing boilers were up to 30% more efficient than conventional boilers, and therefore reduced both fuel bills and CO_2 emissions associated with domestic heat. The proportion of condensing boilers in UK homes rose from just below 6% in 2004 to nearly 43% by 2011 and it is expected that the cumulative carbon savings from this regulation will be 11MtCO_2e by 2020, and 368 MtCO_2e by 2050.

Implementation of the legislation was not without controversy; there was a relatively short lead in time and although there was initially voiced opposition from the industry, once the decision was taken, they moved quickly to react to meeting the requirements put in place. Media coverage at the time reported homeowners and installers expressing concern at suspected increased costs and doubts over reliability, similar to those often voiced now about the move to low-carbon heating. However, the Government provided support to installers to increase their trust in the technology, including through an industry awareness programme and training and upskilling programmes for boiler installers. Similarly, households were supported through 'one-stop-shops' for advice and information on condensing boilers and a comprehensive communication strategy to raise awareness and trust in the technology. Various demonstrators were also run to show households how condensing boilers worked.

It has been concluded that the Condensing Boiler Legislation was "unambiguous, clear to installers and homeowners, and simple to enforce" and thus extremely effective policy. The parallels with the shift away from fossil fuel heating and to low-carbon heat are clear to see and lessons should be learned from the regulatory change. The strong will of the Government and support offered through the policy can certainly be repeated and the industry has shown that with this certainty in place it will adjust to the legislated alterations.

Policy support will play a vital role in stimulating uptake and beginning the process for consumers getting used to the new way of heating their homes. While Industry will endeavour to do all that it can to help with this process, the speed at which it needs to take place will require the additional push that policy can provide.

There are some areas that are easy wins for the immediate implementation of policy to support low-carbon heat, such as new build homes and homes that are off the gas grid. Other areas, such as homes already built that are connected to the gas grid, are more challenging, however, a plan to address decarbonisation of heat in the UK is urgently needed so that work can begin, and confidence can be provided. The new build and off-grid parts of the housing stock will therefore be an important first step in beginning the process to scale up the deployment of heat pumps and helping to work towards the harder areas of the housing stock to decarbonise; policy should not wait to encourage the deployment of low-carbon heat here.

There are some policy decisions to be made over the coming months that offer a crucial opportunity for this path to decarbonising heat. The unrivalled carbon savings that heat pumps, as a well established technology, offer now and are set to build on in the future, must be at the heart of the policy design.

It has been shown in markets abroad that are successfully deploying heat pumps to cut carbon that a supportive policy mix of regulation, taxation, building and planning standards and financial incentives is a recipe for success.[26] Considering this success elsewhere and the factors at play in the UK, Figure 7 below summarises the 10 key policy changes the HPA believes are needed to support the deployment of heat pumps.

POLICY SUPPORT SUMMARY	
Building Regulations affecting energy performance of homes built in England (known as Part L)	1. Maximum flow temperature of 55°C in heating system installations in new build and retrofit 2. Ensure the delivery of the Future Homes Standard in 2025 3. End the 'freezing' of Building Regulations by closing current loopholes 4. Significantly tighten the Energy Efficiency Requirements in the 2020 Building Regulations 5. Ensure new builds have suitable electricity supply connections 6. Require the installation of hot water cylinders in new builds 7. Revise permitted volume for outdoor units (Permitted Planning)
Regulation of heat in existing homes via Part L of Building Regulations	8. An emissions standard for delivered heat: a. <220gCO_2e/kWh by 1st Jan 2025 b. <170gCO_2e/kWh by 1st Jan 2030 c. <110gCO_2e/kWh by 1st Jan 2035
Taxation and Spending Policy	9. An RHI successor scheme using an upfront financial incentive 10. A rebalancing of the taxes placed on electricity and gas to reflect carbon content

Figure 7: Policy Support Summary

BUILDING REGULATIONS AFFECTING ENERGY PERFORMANCE OF HOMES BUILT IN ENGLAND

The technology and products are already available to make every new building zero-carbon. The Future Homes Standard consultation[27] offers a vital opportunity to reflect this by updating the Building Regulations in new build homes. All new build homes should be built to a standard that enables the deployment of low-carbon heat now. Not doing so will only push the problem further down the line, meaning that the decarbonisation of these buildings has to be dealt with at a later date and at a higher cost. The initial design and build stage of a new home is the best time to ensure that the home is built to high standards and avoids the potential for more expensive retrofit costs than if this were ignored.

New build homes offer the cost-effective deployment of heat pumps. The improved energy efficiency, air tightness and sizing of heat emitters of new builds make them most suited to heat pumps. Through a 'levelised cost' analysis using first-hand HPA data, heat pumps are shown to be cheaper than gas boilers in new builds from 2021 (see Figure 8), a finding that is corroborated by other studies.[28] It is clear that heat pumps will be the technology of choice in new builds for the foreseeable future. The Future Homes Standard consultation acknowledges this with the anticipation that "the installation of heat pumps will play a major role in delivering heat for homes built to the Future Homes Standard."[29]

> *"The installation of heat pumps will play a major role in delivering heat for homes built to the Future Homes Standard."* [29]

Likewise, new builds offer an excellent opportunity for the deployment of GSHPs. Currently, the cost of GSHPs is relatively high largely due to the cost of developing the infrastructure needed for the technology. Drilling costs are often high due to a lack of volume and requirement for the equipment to travel further to get to each site as a result. There is the potential for large cost-down savings with drilling as numbers increase, with the drilling equipment able to service a development of new build homes at the same time, for example.

The development of infrastructure for GSHPs should be seen as a long-term investment, similar to that of the gas network currently. If they were utilised in this innovative way, consumers could be charged a standing fee, like their current gas equivalent, to see the development of this infrastructure at the time of development. This would be particularly competitive on large developments where the economies of scale can be utilised and would also allow the option of free cooling in the summer to consumers.

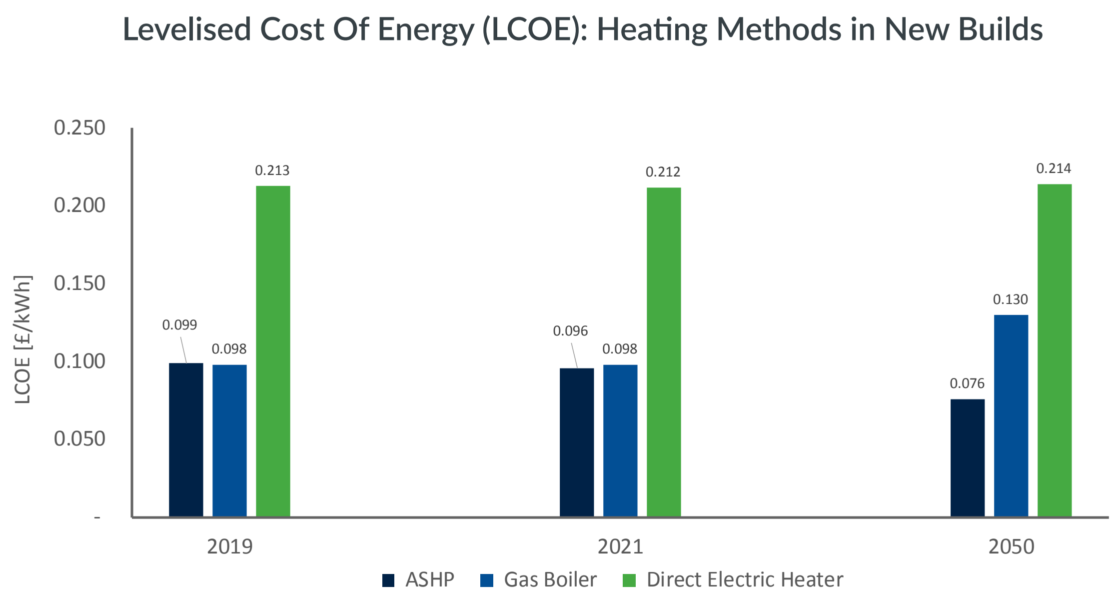


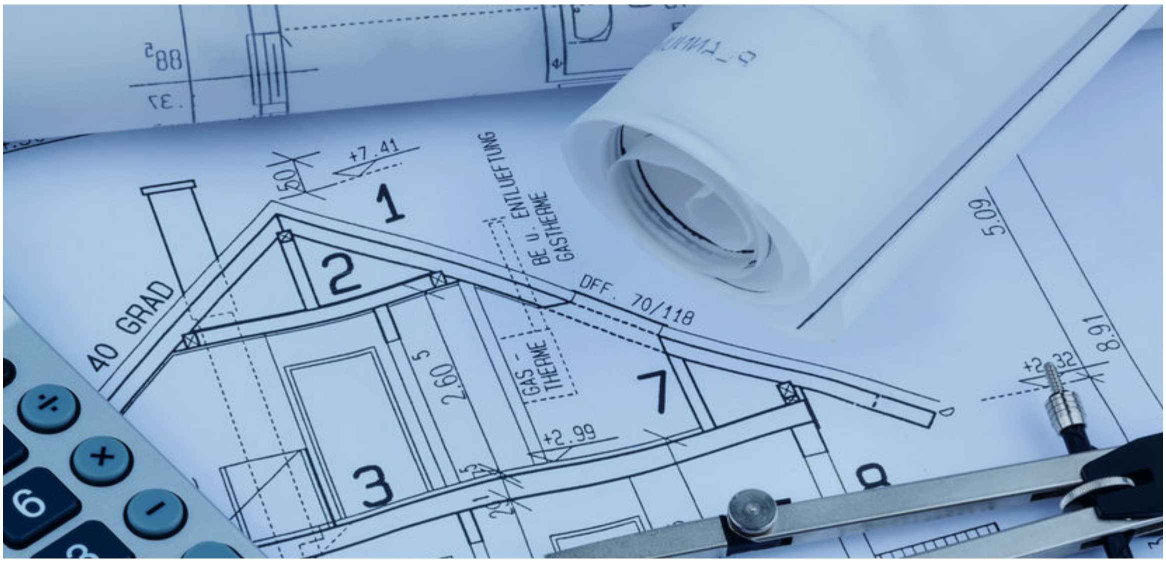
Figure 8: Levelised Cost of Heating Methods in New Builds (Source: HPA Calculations)

There is a danger that in the Future Homes Standard, direct electric heaters may appear as a tempting solution for housebuilders across a range of housing types due to their lower upfront cost of installation. This could have serious consequences for the occupier as direct electric heating can lead to far higher running costs than if a heat pump were to be installed, due to the considerable efficiency advantage of heat pumps. HPA analysis shows that even if the full additional cost were to be passed from the housebuilder on to the consumer through the mortgage, they would still be far better off with the installation of a heat pump rather than direct electric heating.[3]

As can be seen in Figure 8 above, the higher running costs of direct electric heating leads to a significantly higher levelised cost of heating compared to a heat pump. The efficiency of the heat pump means that there is a far lower electricity demand, reducing fuel bills and also the additional load placed on the grid as a result.

It therefore is vital that homes being built now are constructed to a level which is compliant with net zero and do not further contribute to the emissions coming from the housing sector. These newly built homes will represent a noteworthy share of the housing stock in 2050 and so should be a high priority for decarbonisation efforts; it is estimated that around 20% of homes the homes we inhabit in 2050 will be built between now and then. [30]

The Government has also made a commitment to review the regulations for existing domestic properties.[31] With the majority of homes in 2050 having already been built today, it is vital that this consultation recognises the importance of ensuring the delivery of low-carbon heat in these homes. The sooner we intervene to reduce carbon from our existing housing stock, the greater the likelihood of averting the worst of the climate crisis. Policies must be put in place that reflect this urgency and the solutions available to us today, such as heat pumps, to begin to decarbonise the existing housing stock, as well as ensuring that any new homes do not add further to the problem.



PROPERTY:

NEW BUILD HOME DEVELOPMENTS

PREVIOUS FUEL:

ELECTRIC STORAGE HEATERS AND IMMERSION HOT WATER SYSTEM

TECHNOLOGIES:

AIR SOURCE HEAT PUMP ✓

LOCATION: SOUTH COAST REGION

THE PROJECT

South Coast housing developer Crayfern Homes has wholeheartedly embraced renewable energy and specifies air source heat pumps for all its building projects.

The company has also taken steps to ensure that directors as well as staff in its design, construction and customer service departments all have a thorough understanding of the Daikin Altherma heat pumps it specifies.

The quiet reliability of Daikin Altherma heat pumps for home heating is a clear advantage for Crayfern Homes, and a session at Daikin UK's Woking training centre gives staff the background to maximise the potential.

SPECIFICATION

Current developments are seeing Daikin Altherma Low Temperature split systems in larger properties and Daikin Altherma Monobloc heat pumps in more compact homes.

Typical of a Crayfern top-end development is a group of 8 houses at Wield Lane in the mid-Hampshire village of Medstead. The stylish properties feature underfloor heating downstairs, with conventional radiators in the upstairs rooms.

All 8 houses have 16kW Daikin Altherma LT split Systems. The systems are set to deliver water at 35oC. When needed, the leaving water temperature automatically steps up to 45oC for the radiators and towel rails and 48oC for the 300-litre hot water cylinder.

BENEFITS

Crayfern's construction director John Curry says heat pumps have a double benefit in newbuild properties: they help developers comply with official requirements for low-carbon homes, and they give homeowners the ongoing convenience of low-cost, energy-efficient space and water heating.

"We'd probably still be using gas boilers if we hadn't been pushed by the planning system. The Daikin heat pumps are a much more environment-friendly solution. They also avoid the cost of connecting to the gas network, which can be considerable." John Curry, Construction Director.

BUILDING REGULATIONS POLICY SUPPORT

Policy 1: Maximum flow temperature of 55ºC in heating system installations in new build and retrofit

The deployment of low-carbon heat can be aided through some specific changes to the building regulations through the Part L review. Firstly, all heating system installations in new build should be built to a maximum flow temperature of 55ºC. Doing so will mean that homes are 'renewable heat ready', ensuring the efficient performance of heat pumps or any heating technology that is installed now or later. Even if gas boilers are installed, it would mean that these systems run more efficiently by enabling them to condense more consistently than at higher flow temperatures. It would also mean the retrofit cost of putting in a low-carbon system in the future would be minimised as the distribution systems necessary would already be in place. This technology agnostic approach reiterates previous recommendations of other organisations in the past and would 'future proof' new buildings to allow low-carbon heat to be deployed.

To truly futureproof these homes, new builds should be encouraged to operate at even lower flow temperatures, 45ºC for example. The main reason being that at higher temperatures the practice of installing microbore pipework is more common, which can limit future options. The majority of heat pumps require larger bore (22-28mm) pipework. High temperature systems operating with the smaller pipework should be used for hard to treat buildings exclusively, not new builds.

This can be encouraged through factors such as hydraulic connections throughout the homes to allow for lower temperature systems.

The Government has also decided to consult on existing domestic buildings. In such buildings, the same arguments for a maximum 55ºC flow temperature apply. At the time of heating system replacement in existing buildings, regulation should ensure that the newly installed system is able to operate at a maximum flow temperature of 55ºC. This will significantly aid the shift to low-carbon heating at the same time as improving the efficiency of any heating system that is put in place in these existing properties.

Analysis indicates the benefits of a lower flow temperature for both heat pumps and gas boilers. The results show that for a heat pump, changing from a flow temperature of 70 to 55ºC improves the efficiency by almost 24%, while for a gas boiler the improvement between the same two temperatures accounts for around 2%.[33] With this gain in efficiency, there are operational cost savings to be had for the consumer and also to the overall lifetime of the heating system. Consumers would save almost £300 per year in fuel bills and save about 2500 kgCO_2 during the overall lifetime of the heating system. Even though the efficiency gain for the gas boiler is relatively lower than that of a heat pump, consumers would still save £15 per year in fuel bills and 870kgCO_2 during the overall lifetime of the technology.

Policy 2: Ensure the delivery of the Future Homes Standard in 2025

The Government's review of Building Regulations will be vital to the realisation of the Future Homes Standard. The Future Homes Standard will mean that the installation of fossil fuel heating systems in new homes will be prevented by 2025 and all new homes after this point will also have "world-leading levels of energy efficiency".[34] BEIS anticipate that heat pumps will play a major role in delivering low carbon heat for homes built to this standard. It is therefore vital that the policies are put in place now that will allow the supply chain to develop alongside the efforts of industry so that this ambition can be realised. The HPA fully supports the Future Homes Standard and believes it is paramount that it is delivered.

Policy 3: End the 'freezing' of Building Regulations by closing current loopholes

The current Building Regulations review must pave the way for the Future Homes Standard to happen. Without suitable changes now, the Future Homes Standard is unlikely to be achieved. This is because of the considerable lag that there currently is between changes in building regulations and homes actually being built to this standard. At present, planning permission to a certain building regulation iteration can be granted, after which building work must 'commence' within three years.[35]

The definition of commencement of work here can be minimal, with little work of actual substance carried out, meaning that housebuilders can carry out a small amount of work to lock-in the planning permission. This is particularly pertinent across whole sites, where despite only starting the works on some of the buildings, the regulations imposed can apply to all homes to be built on that site; this delays the implementation of any new building regulations.

Part L must change to reflect this loophole in a couple of ways. Firstly, the definition of commencement must be raised such that irrevocable work has been carried out, such as the foundations already being laid for an individual building, regardless of it being part of a site development. The commencement allowance of three years must also be tightened to two years to speed up the process of implementation of building regulation changes. At the same time, a 5-year time limit should be put in place for completion of building projects, unless a 'special exemption' is granted where a developer can demonstrate that achieving this deadline is not possible.

This time limit which mirrors the regulation updates makes sense, even though it will not usually be perfectly synchronized. The Building Regulations are updated every 5 years so allowing an implementation period of the same length is logical. This measure will ensure developments keep at most to the previous iteration of regulation and not any further behind.

Without these changes, previous trends have shown housebuilders will build to outdated standards. The three biggest housebuilders, Persimmon, Taylor Wimpey and Barratt, in the UK built 62%, 52% and 47%, respectively, of their homes in 2018 to standards that pre-dated the 2013 building regulations [36] resulting in substantially higher emissions than if they had been built to the most recent version.

Policy 4: Significantly tighten the energy efficiency requirements in the 2020 Building Regulations

The Future Homes Standard aims to deliver world leading levels of energy efficiency alongside the deployment of low-carbon heat. Regardless of the heating system installed, emissions can be lowered by reducing the energy demand for heating in homes through the tightening of energy efficiency standards.

The 2020 Building Regulations offer a crucial intervention point to set these standards on a route to ensure that world leading levels can be reached by 2025. Without the changes in this iteration of the regulations, the supply chain may have insufficient time to develop as well as skills of installers to adjust. The 2020 Building Regulations should therefore tighten energy efficiency requirements to reduce carbon emissions from the notional home as much as possible.

Indeed, analysis conducted for the Impact Assessment for the consultation on these regulations shows the preferred option to be that of the more significant carbon reduction. By tightening the carbon standards through a combination measures, including higher levels of fabric efficiency standards, to a 31% reduction on current levels rather than a 20% reduction, there will be an additional £6324 million in energy savings for an extra building cost of £4880 million. Furthermore, coupled with additional carbon and air quality savings, the total net benefit to society for the 31% reduction is £585 million. It is expected that some developers will choose the least costly route to meeting these standards, which means putting low-carbon heat in now alongside higher fabric standards.[37]

Policy 5: Ensure new builds have suitable electricity supply connections

New builds must also be 'future proofed' by considering the potential power supplies that will be needed for the property. With an expected increase in the deployment of electric vehicles (EVs) and the charging needs that this will bring, added to by the deployment of electric heating through heat pumps, homes will likely require a greater power supply from the electricity grid.

Building Regulations must therefore make sure that these higher expected demands can be met by providing enough electricity power when the home is built. Doing so will mean that there are no power limitations in these homes that may otherwise prevent the use of EVs or heat pumps.

Policy 6: Require the installation of hot water cylinders in new builds

Building Regulations need to require space to be made available for the shift to renewable technologies from the outset. We must not continue to build a legacy which can't easily be adapted in the future, as this only defers costs which will be greater later on.

One crucial aspect of this is new builds having a requirement for the installation of hot water cylinders, which support both heat pumps and the utilisation of other forms of renewable heat, such as solar thermal, and facilitate demand-response flexibility through load-shifting capability.

By accommodating hot water cylinders in homes through legislation, property developers will be able to plan their layouts accordingly and ensure that this important aspect of low-carbon heating is provided. As already shown, new build homes offer the cost-effective deployment of heat pumps and this is including the cost of a hot water cylinder. [4]

Policy 7: Revise the permitted volume of outdoor units (Permitted Planning)

The current volume size of the HP outdoor units allowed under Planning Permitted Development (PPD) rules has not kept up with industry changes and actually works counter to other requirements of PPD, such as producing low noise units which are often larger to accommodate bigger, slower moving fans and additional acoustic treatment.

There has been significant industry progress in reducing the noise from units in recent years among other innovate measures being introduced (see Case Study 3). The current 0.6m^3 allowed should be raised to 0.75m^3, in both new build and retrofit, to allow lower noise units and heat pumps which have additional equipment inside such as low noise circulation pumps, which reduces plant space requirements inside the property. It would also have the added benefit of improving the efficiency of heat pumps to further reduce carbon emissions from this already carbon saving technology.

There is a strong argument to even remove the volume restriction as the noise level restriction acts as a backstop to larger units with higher capacities. This is due to the noise that would emanate from large compressors and or larger fans required. With the fans, eventually there is a diminishing return in making the fan slower but larger, because the tip speed increases and that can cause noise. By having the noise limits in place, the size of the unite itself is limited and no manufacturer is going to make the casing any bigger than it actually needs to be.

[4] See Appendix for further details

LOCATION: LEICESTERSHIRE

PROJECT:
NEW-BUILD HOME

PREVIOUS FUEL:
N/A

TECHNOLOGIES:
AIR SOURCE HEAT PUMP ✓

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

THE PROJECT

This new build home was built to standards far exceeding the current requirements from building regulations.

With the space heating energy requirement being lower than the hot water requirement, any heating system installed has to be able to cope with hot water production as the dominant load.

The high levels of insulation and air tightness characteristics leant themselves towards the installation of a heat pump.

SPECIFICATION

The new Ecodan QUHZ ASHP was well-suited, it has been specifically designed with new-build standards of insulation and lower heating loads in mind and means the Fox family receives hot water whenever they need it.

The QUHZ model also offers exceptional noise-levels with a whisper-quiet 41.2 dB(A) at 1.5m from neighbouring properties, making it ideal for almost any new build scenario.

The renewable heating includes automatic in-built energy monitoring, using Mitsubishi's MELCloud, internet-based system, which allows for full control and monitoring from anywhere in the world.

BENEFITS

The application of the Ecodan QUHZ has helped this home achieve an A rating on the EPC. The low flow temperatures supplied to the underfloor system and radiators together with hot water on demand from the thermal store will ensure high efficiency and low running costs.

"We were delighted to work with [Mitsubishi] to deliver a system which achieves exceptional energy efficiency. We clock the hot water to come on at intervals to meet our needs. The heat pump runs at night and we are very impressed with how quiet it is." Jon Fox, Property Owner.

REGULATION OF HEAT IN EXISTING HOMES

For the net zero target to be met, the fossil fuel component used for heating will need to be all but phased out by 2050.[39] This represents a significant shift in consumer behaviour and with a typical gas boiler having a lifetime of around 15 years, this leaves a deadline for preventing the replacement of these systems by 2035 at the absolute latest. Indeed, this is recognised by the CCC who advise that there should be "regulation by 2035 at the latest to ensure all heating system replacements are low-carbon." [40]

This shift in consumer behaviour will require a period of transition to allow for a steady change in heating consumption. To do so will require a firm commitment from Government to end the use of polluting fuels by a certain date and a period of incentivisation prior to this. This will allow the development of the supply chain to adapt to reach a level where demand can be met once the ban on these fuels comes in. The Government have already partially recognised this with a proposed consultation on regulations to set out a framework that will allow innovation, infrastructure and long-term decisions to be taken by industry.[41]

The ban on fossil fuels should not pick winners but should guarantee that the use of heating fuels that are not compliant with the net zero target is prevented. This can be achieved by banning the replacement of certain heating systems if they have carbon emissions, from the delivered energy, above a certain threshold by various cut-off points.

Policy 8: An emissions standard for delivered heat

The HPA propose that 3 firm thresholds are implemented immediately, with the potential for interim targets to be set between these dates. These limits will require the 'delivered' energy for heating to be below a certain carbon intensity. This is calculated by dividing the carbon intensity of the fuel by a fixed, predetermined efficiency of the heating technology. The proposed values would apply to any replacement systems and are:

1. Less than **220gCO_2e** per kWh of delivered energy by 1st January **2025**
2. Less than **170gCO_2e** per kWh of delivered energy by 1st January **2030**
3. Less than **110 gCO_2e** per kWh of delivered energy by 1st January **2035**

These limits would ensure that low-carbon heating methods can only be installed after 2035, but this could come through any fuel type or heating technology provided that emissions are low enough. It would mean that installations requiring the pure use of heating oil and LPG would not be possible after 2025, matching the Government's ambition in the Clean Growth Strategy to phase out fossil fuels off the gas grid during the 2020s.[42]

It would mean though, that biofuels could be developed and blended into the supply. For example, with the 2025 proposed level, oil would need a blend with around a 30% bio element[43] and LPG with approximately a 10% bio proportion.[44] These contributions would then need to increase in 2030 and again in 2035. These levels would also allow natural gas with the current blend of biogas up to 2030, after which point a greater blend of biogas or hydrogen would be necessary.[45]

Among others, heat pumps offer a solution that can already meet all of these thresholds and so provide a known technology that can be used as a replacement to the methods that do not meet these levels.

Using DEFRA's latest carbon intensity of the electricity grid of 256gCO_2e/kWh[46] for an air-source heat pump (ASHP) with an efficiency of 280%, the delivered energy would result in emissions of 91gCO_2e/kWh of delivered heating energy and a ground-source heat pump (GSHP) with an efficiency of 320% would result in emissions of 80gCO_2e/kWh of delivered heating energy. This is well below even the proposed 2035 threshold. This is before even considering the inevitable drop in the carbon intensity of the grid with increased renewable generation looking ahead.

Indeed, BEIS estimate that the carbon intensity of electricity will have fallen to 41gCO_2e/kWh by 2035,[47] which with the same heat pump efficiencies (although likely to improve by this date) results in delivered energy emissions of 15gCO_2e/kWh for the ASHP and 13gCO_2e/kWh for the GSHP. These figures clearly highlight the huge carbon savings that heat pumps can already and will further achieve in the future compared to the majority of historically typical installations.

TAXATION AND SPENDING POLICY

Policy 9: An RHI successor scheme using an upfront financial incentive

The Need for Financial Incentives

The Government must confirm its commitment to decarbonising heat following the end of the Renewable Heat Incentive (RHI). A successor policy must be put in place to maintain support for low-carbon heating and to give the confidence that this is the route being taken.

This financial support should come in the form of an upfront grant that is paid when scrapping a fossil fuel system in replacement of a heat pump. The grant will help in overcoming one of the main barriers for heat pump uptake in the upfront cost, rather than the current RHI structure of payments over a 7-year period, which only benefit those who are 'able-to-pay'.

Initially, off-grid fossil fuel scrappages offer the largest gains in terms of emission reductions and would help government to deliver its ambition in the Clean Growth Strategy to phase out fossil fuels off the gas grid during the 2020s.[48] The subsidy support should therefore follow the RHI to complement the regulatory ban (Policy 7) on these high carbon fossil fuels by offering the scrappage to oil boilers initially. Some of the oldest oil boilers can be relatively easily repaired, through a relatively cheap replacement of the pilot light, which is normally the component that fails; this means that without the encouragement of a scrappage scheme, there is less motivation to replace the unit and emissions will remain high and dirty, augmented by a pilot light constantly burning.

In addition, a scrappage scheme for the highest polluting fuels, such as oil boilers, initially offers the chance for lessons to be learned and applied to help the roll out of low-carbon heating on the gas grid. This is a low-regrets action that can create a huge amount of carbon savings.

The grant could be used in a variety of ways, for example, using the money to 'lock-in' the infrastructure for low carbon heating in these homes by paying for the removal and recycling of oil tanks, the upgrading of emitters and some of the cost of installation, or by directly going towards the cost of the heat pump unit and installation.

Economics of a Scrappage Scheme

With starting grant levels of £4000 for ASHPs and £6000 for GSHPs, we would expect to see an uptake of around 34000 replacements in the first year of the scheme, taking a 'generalised cost of heating' approach.[49] This is based on the option for locking-in the low-carbon heat infrastructure above (see infographic below). It would mean spending similar to the yearly spend on domestic RHI (~£130m in 2019 /20[50]) and as the market develops and consumers become more accustomed to the use of heat pumps, this grant level could be adjusted each year to encourage both early uptake but also allow budgetary control.[5]

Although heat is often seen as one of the harder areas of the economy to decarbonise, a scrappage scheme in this form offers a cheap route to decarbonisation. The marginal abatement cost for the government would be estimated at £28/tCO_2e. This offers carbon savings at a price far lower than many other proposed schemes. The RHI, for example, is estimated to have had an abatement cost of £142/tCO_2e[51] and is below the potential cost for converting off-gas properties' residual demand to bioLPG at £41/tCO_2e.[52]

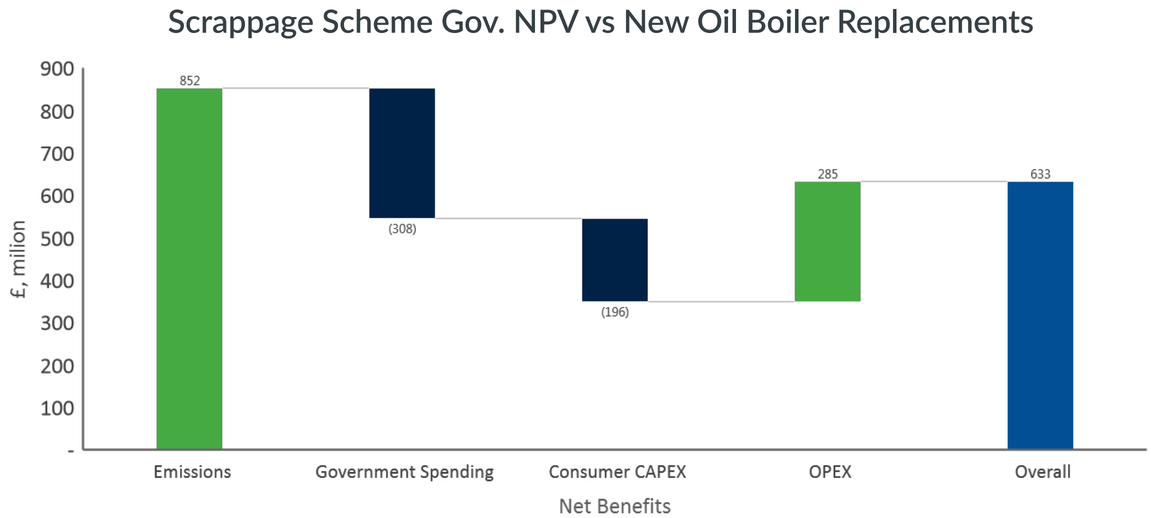


Figure 9: Scrappage Scheme Net Present Value Costings (see Appendix for further details)

The proposed scrappage scheme would also yield considerable air pollution reductions. Oil boilers, especially older and more inefficient systems, emit considerable amounts of NOx, SOx and particulate matter (PM), whereas heat pumps do not emit any of these locally as there is no burning of fuel required. This can lead to considerable air pollution reductions locally with the installation of heat pumps. Under the scrappage scheme, approximately 12,000 tNOx would be saved up to 2050, saving society around £129 million (NPV) in health costs as a result of the avoided air pollution. This is on top of the substantial reductions in carbon that are realised.

Governance and operation of a scrappage scheme

There has been a previous success of boiler scrappage schemes from which lessons should be taken through to the implementation and design of this scheme. In 2010 the Department of Energy and Climate Change (DECC) offered a £400 voucher for the upgrade from an old boiler to a new boiler, with uptake being significant. This success was due to several contributing factors that should be carried through to this RHI successor scheme. Firstly, there was a high profile prime-ministerial launch that gained significant public interest which was then passed on through word-of-mouth. Consumer satisfaction was also extremely high, largely due to the ease of application and approval through the online portal that was used. These success factors should certainly be replicated with the responsibility falling to the consumers themselves, installers and manufacturers to find the suitable replacements; in the 2010 scheme, demand and enquiries far exceeded expectations, showing the strong interest that an upfront grant can generate.

This financial support should be a minimum and help the Government to gather evidence on levels of uptake and how the scheme should be administered. It is not only these oil boilers that will need to be replaced in order to meet net zero, and although further incentivisation may not be needed down the line, government should be ready to extend this scheme to potentially all heating systems that are not compliant with reaching net zero by 2050. With the complementary regulation on emission intensities in place, these policies will act as a cornerstone to the decarbonisation of heat.

CWM HESGEN, ABERGEIRW, WALES

NIBE

PROPERTY:

ISOLATED HOLIDAY WELSH COTTAGE

PREVIOUS FUEL:

OIL BOILER

TECHNOLOGIES

GROUND SOURCE HEAT PUMP ✓

THE PROJECT

Few of us can imagine the remote location of this traditional Welsh holiday cottage situated on a working sheep farm high in the mountains in Gwynedd.

Rhun Jones, owner of Cwm Hesgen, sought to install a renewable source of heating to replace an old oil boiler.

The 1700s farm cottage has been sympathetically enhanced to create a holiday cottage where people really can escape from it all. It commands stunning views and now thanks to a NIBE Ground Source Heat Pump enjoys plentiful heating and hot water for guests to enjoy.

SPECIFICATION

This was specified with the help of experienced renewable energy installers Hafod Renewables. Two F1245 12kW Ground source Heat Pumps along with a 300 litre UKV buffer tank were enough to generate heating and hot water for the property as well as a drying room in an adjacent outbuilding to support the working farm.

With plenty of land surrounding the property they were able to install the collector loops laterally which only took two days thanks to the geology, which was wet clay, perfect for digging and laying the pipes. The old boiler and 1000 litre oil tank were then removed, installing new radiators to maximise the efficiencies of the system and creating a bespoke plant room for the property.

BENEFITS

The old oil boiler was circa 80% efficient and used fuel with a very heavy carbon footprint. The new heating system is 350% more efficient and the fact that the system gets 75% of the electrical requirements to run the heat pump via Mr Jones' hydro system means over 8 tonnes of CO^2 per annum will be saved – the equivalent of taking five diesel cars off the road each year. The projected income from the installation of the system is £60,000 with accompanying RHI payments.

"I would like to think that Cwm Hesgen can be an example to other holiday cottage owners, particularly those in off grid locations, that installing a renewable heating and hot water system is the responsible thing to do. I really do think that the figures and statistics speak for themselves and with the renewable installer market growing accessibility is becoming easier and more straightforward."
Rhun Jones, Owner.

LOCATION: DORSET

LG Electronics

PROJECT:
FAMILY HOME

PREVIOUS FUEL:
OLD OIL BOILER

TECHNOLOGIES:
AIR SOURCE HEAT PUMP ✓

THE PROJECT

Mr and Mrs Letts were using a 20-year old oil boiler requiring regular maintenance and very expensive to run. They needed an installation that could cope with the hot water demands when all of the family were home.

The home already had some underfloor heating and solar PV, complementing the installation of the high temperature heat pump well.

They were currently using an expensive immersion heater to heat a second shower.

SPECIFICATION

The model chosen was the popular Therma V range of air to water heat pumps from LG that can deliver hot water at up to 80°C.

The LG High Temperature unit is ideal for combining with hot water cylinders or thermal stores and has already been successfully linked with other renewable technologies including solar PV as in the case of the Lett's home.

BENEFITS

Mr and Mrs Letts saw lower running and maintenance costs. The home is no longer using an immersion heater for a second shower on top of the hassle removed from the avoided oil fuel deliveries. This is on top of the huge carbon savings that can be achieved. A conservative estimate would show that within 7 years a saving of £8260 will be achieved from the decision to switch.

"We are on a pension and were keen to invest in a system that would deliver the heat and hot water we needed, but that didn't see us needing to manoeuvre too much. We wanted to make savings and keep our costs down." Mr Letts, Property Owner

Policy 10: A rebalancing of the taxes placed on electricity and gas to reflect carbon content

The taxes placed on electricity must represent the associated carbon emissions on a basis that is equal to other fuel types. The UK currently has one of the highest ratios of the gas to electricity across Europe, sometimes known as a 'spark gap', with the price of electricity being close to four times that of gas per kWh.[53] This is in a large part due to the taxation placed on electricity above that of gas (see Figure 10). Levelling the playing field to accurately reflect the emissions of each fuel would see this spark gap close and help to incentivise the electrification of heat.

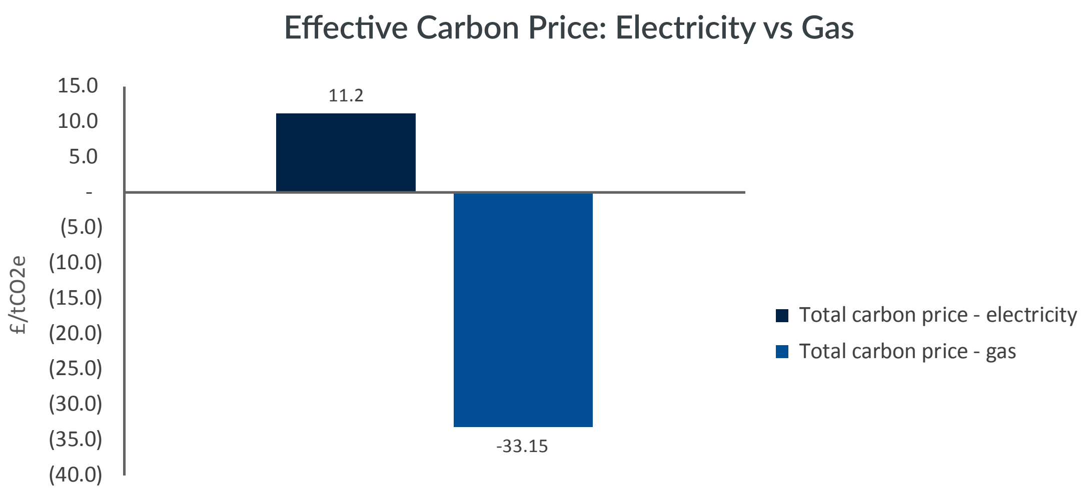


Figure 10: Effective Carbon Price - Electricity vs Gas (Calculations based on Energy Systems Catapult and DEFRA[54])

The current environmental and social levies placed on electricity create perverse incentives that do not encourage switching to lower carbon alternatives.[55] These levies are used to pay for domestic supply programmes, such as the Feed-in-Tariff and Energy Company Obligation, and are much less for gas since as there is no equivalent to support for renewables investment. These levies are therefore working counter to their purpose, through the relative encouragement of higher long-term emission fuels in the use of gas over electricity. According to OFGEM, the environmental and social obligation costs represent 20.44% of an electricity bill,[56] whereas for gas the same proportion is 1.6%. [57]

Instead, the environmental and social costs should be moved away from energy bills and into general taxation. This would see the marginal cost of heat pump operation fall below that of a gas boiler and encourage the uptake of low carbon heat. It would also allow the carbon content of the fuels to be fairly reflected and allow for the decarbonisation of the electricity supply to be considered in the future.[58] Schemes must not counteract each other and run in parallel to promote the same message. Multiple issues can be tackled through policies that reduce energy use, use high efficiency systems and minimise emissions vie the use of renewable technologies. At the very least, the environmental and social costs should be more evenly distributed between gas and electricity bills.

> *“[Net zero] is only credible if policy to reduce emissions ramps up significantly”. The Committee on Climate Change, Net Zero Report.*

CONCLUSION

Heat pumps are a technology that offer huge carbon savings immediately. This contribution to decarbonising the economy is essential when there is no time to waste in avoiding the worst consequences of the climate crisis.

The UK Government has committed to a net zero target by 2050 and now must deliver on this by implementing policies to ensure that the necessary changes are made. Despite the UK being the first major economy to legislate such a target, the UK lags behind many economies in terms of the deployment of low-carbon heat through the use of heat pumps. A combination of government support through policy changes and Industry efforts will reverse this trend and encourage the long-term growth of a healthy heat pump market to significantly reduce emissions from heating.

There are upcoming policy decisions that are a key opportunity in making sure that the UK doesn't fall further behind and instead is seen as a leader for this progression to provide a clear signal to Industry towards the support of low-carbon heat. There is strong evidence to suggest that the deployment of heat pumps makes most sense in homes off the gas grid as well as new build properties.

By creating growth in these areas, the path will be set to allow Industry to help the scaling up of production and installer numbers to a level that makes the transition to also decarbonising homes on the gas grid far easier. The ongoing Building Regulations Review and the upcoming regulatory framework consultation are fundamental to setting this path in motion and providing a clear signal that the decarbonisation of heat will be happening. With the right changes as recommended through the 10 key policy asks in this document implemented, the government can be confident that the decarbonisation of heat will be set on the path to achieving the reduction needed for net zero.

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Appendices

Appendix 1: Potential Numbers of Installers

The potential number of installers were calculated based on the numbers from the deployment trajectory. Assuming that 6 working days would be needed to install a heat pump in a new build that has been constructed to allow 55oC flow temperatures, 8 working days are needed in retrofit homes and 3 working days are needed to replace heat pumps with a new heat pump. Each installer is assumed to work for 200 days per year. These are rough estimates based on what the HPA believes to be reasonable assumptions intended to give an idea towards the number of installers that might be needed but offer no warranty or assurance as to future accuracy or completeness.

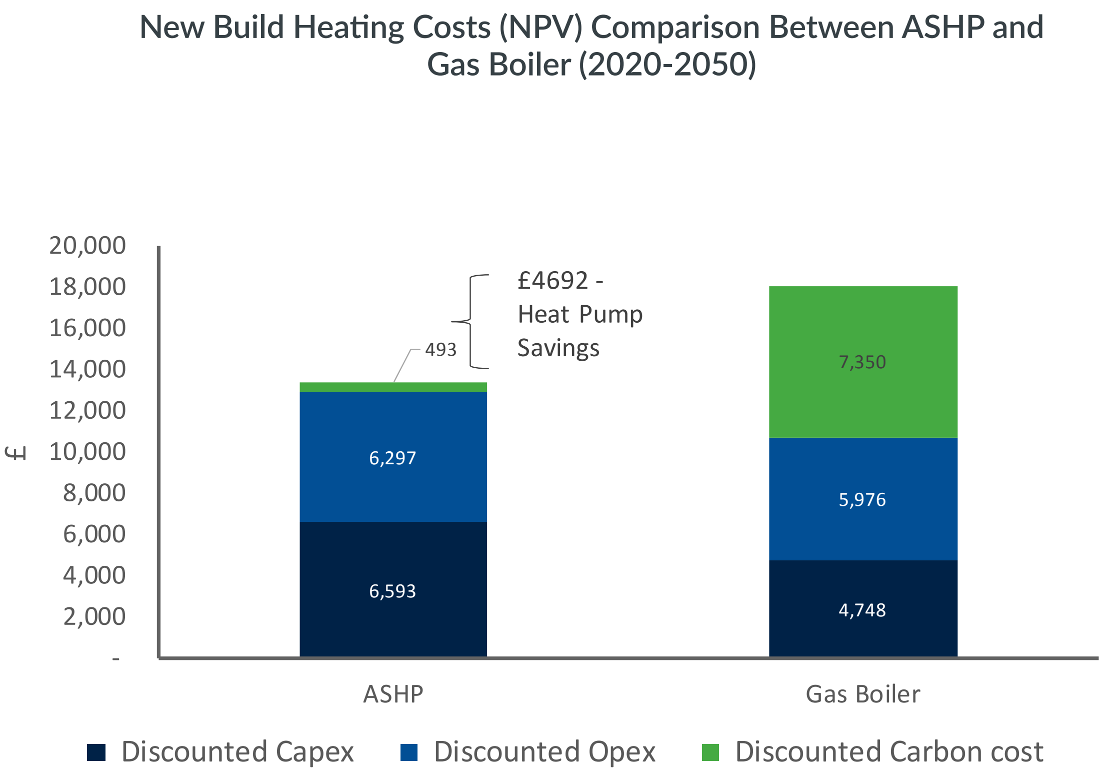
Appendix 2: New Build Analysis

A Net Present Value (NPV) analysis has been carried out to provide evidence of the cost effectiveness of heat pumps and the benefits they would bring by using them as a heating technology in new build homes. The calculations span from 2020 to 2050.

The heat pump data used for the HPA's analysis comes from recent quotes for new build installations for the housing type modelled. First-hand information has been fed to the HPA for the sake of analysis, allowing the use of up to date data to give as accurate a picture of the current situation as possible.

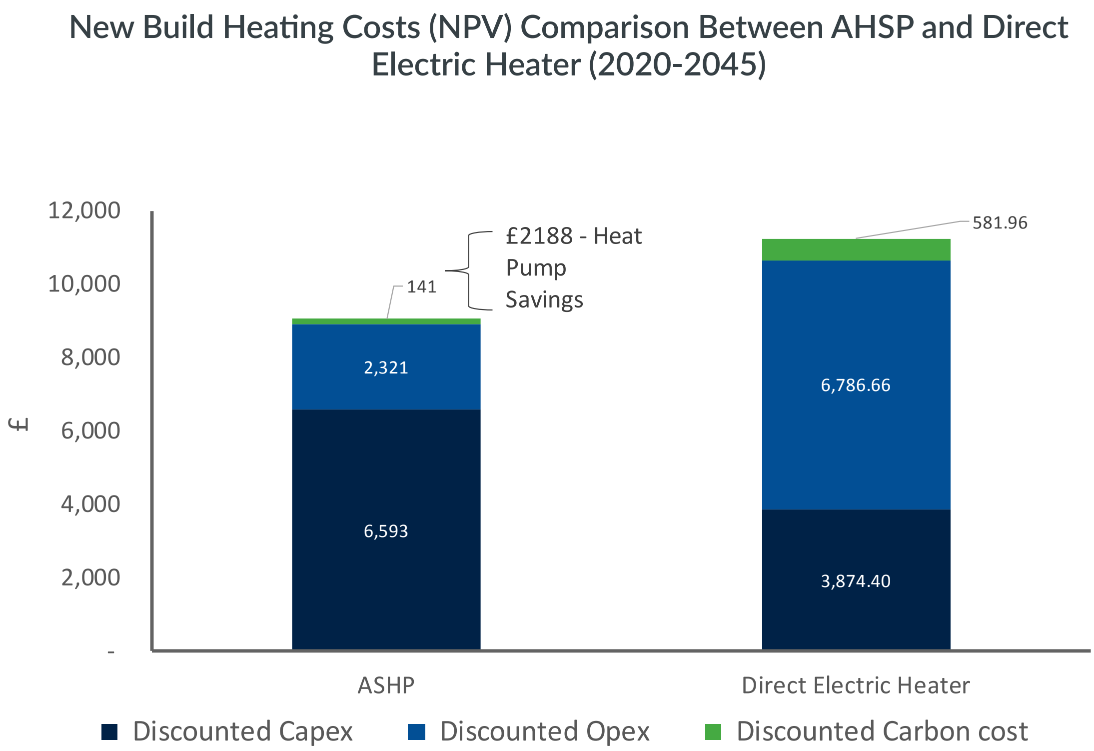
When comparing gas boilers with heat pumps, the investment decision for ASHPs is favourable, presenting a lower cost for this technology. For instance, the total cost NPV for the gas boiler is £18074, while for the ASHP is £13383.

Finally, heat pumps result in a cost-effective option compared to gas boilers, they show lower operational costs and significantly lower carbon costs. The total discounted costs accounted in the NPV analysis for each technology can be seen in the Figure below.



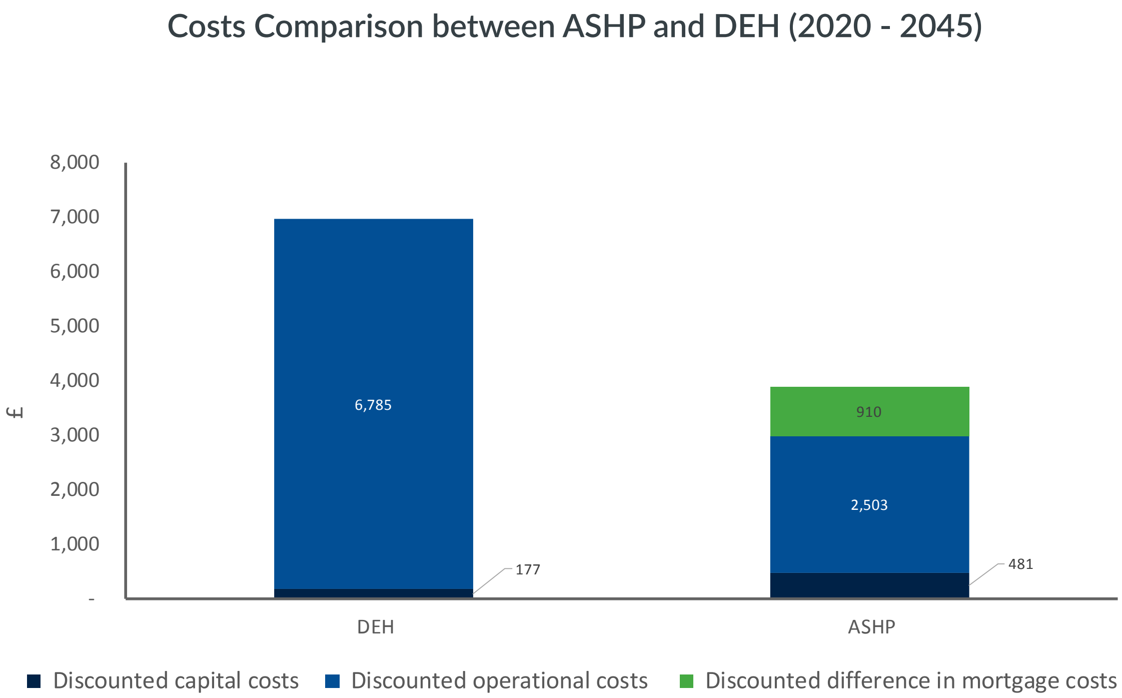
Appendix Figure 1: New build heating costs (NPV) comparison between ASHP and Gas Boiler (2020-2050)

The second new build analysis that has been carried out compares direct electric heaters and heat pumps. As in the gas boiler's case, an NPV analysis was chosen as the best methodology to assess the cost-effectiveness of the technology. Due to the differences of efficiency of the technologies and the usage of the same fuel, the results show a net benefit for the heat pumps. An average new build semi-detached house demand has been considered in this case, although it may be that direct electric is more suitable to smaller housing types. In this case, ASHPs result in final savings of around £2200. This difference between the two technologies is mainly explained by the high fuel bills faced by the direct electric heater as a result of the lower efficiency. The total NPV for the two cases in the selected timeline is £9054 for the ASHP and £11243 for the direct electric heater, as shown in the Figure below.



Appendix Figure 2: New build heating costs (NPV) comparison between AHSP and Direct Electric Heater (2020-2050)

In order to analyse the added value of heat pumps for consumers in particular, an additional analysis considers the additional costs in yearly mortgage rates to be faced in case of the installation of a heat pump in a new build, instead than a direct electric heater. As it can be seen in the following chart, even if a slightly higher mortgage fee may be paid every year (the calculations show an additional £115 per year), the overall lower operational costs to burden with a heat pump would lead to high fuel bills savings for consumers.



Appendix Figure 3: Costs Comparison between ASHP and Direct Electric Heating (2020 - 2045)

The levelised costs of energy for each heating technology have also been considered, referring again to a new build detached house heating demand. This is the cost per MWh of heat provided. The results show that ASHPs will become cost-effective from 2021 in new builds, showing the lowest LCOE (0.096 £/kWh) between the 3 technologies considered. Already in 2019 in new builds, the only competitive technology against ASHP is gas boilers, whose cost, due to projected social cost of carbon increasing over time and potential favourable economies of scale for heat pumps, increases up to 2050. Direct electric heaters present a much higher levelised cost due to the net difference in efficiency and compounded by the absence of potential performance improvements.

Appendix 3: Data Tables

The Carbon Savings from Heat Pumps in 2019

Oil boiler	Value	Assumptions	Sources
Design Efficiency	0.88		Ofgem
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.25		DEFRA
LPG boiler	**Value**	**Assumptions**	**Sources**
Design Efficiency	0.92		BEIS
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.21		DEFRA
Natural gas boiler	**Value**	**Assumptions**	**Sources**
Design Efficiency	0.92		BEIS
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.18		DEFRA
Direct electric panels	**Value**	**Assumptions**	**Sources**
Design Efficiency	1		
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.26		DEFRA
Wood fire	**Value**	**Assumptions**	**Sources**
Efficiency	0.17		DECC
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.02		DEFRA
Air Source Heat Pump	**Value**	**Assumptions**	**Sources**
Design Efficiency	3.40		BEIS
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.26		DEFRA
Ground Source Heat Pump	**Value**	**Assumptions**	**Sources**
Design Efficiency	3.70		BEIS
COP/SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.26		DEFRA

Air Source Heat Pump Projected 2050	Value	Assumptions	Sources
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.03		BEIS
Ground Source Heat Pump Projected 2050	**Value**	**Assumptions**	**Sources**
Carbon Intensity of Fuel $kgCO_2e/kWh$	0.03		BEIS

NPV Analysis and LCOE

Air Source Heat Pump	Value	Assumptions	Sources
Carbon Intensity of Fuel ($kgCO_2e/kWh$)	Projected each year up to 2050		BEIS
Efficiency SPF	3.2 for space heating 2.2 for water heating	It is assumed a 5% increase per year in the efficiency between 2018 and 2028	Currie and Brown
Fuel cost (£/kWh)	Fuel cost (£/kWh)		BEIS
Capital costs (£)		Capital costs use first-hand HPA data and are thus confidential.	
O&M cost (£)		Maintenance costs use first-hand HPA data and are thus confidential.	
Lifetime (years)	18		Currie and Brown

Gas boiler	Value	Assumptions	Sources
Carbon Intensity of Fuel ($kgCO_2e/kWh$)	0.184		BEIS
Efficiency COP/SPF	0.92		Boiler Plus
Capital costs (£)	4914	It includes the cost of the boiler, sundries and gas connections	Currie and Brown
Fuel cost (£/kWh)	0.04442		BEIS
O&M cost (£)	100		Currie and Brown
Lifetime (years)	15		Currie and Brown

Direct Electric Heaters	Value	Assumptions	Sources
Carbon Intensity of Fuel ($kgCO_2e/kWh$)	Projected each year up to 2050		BEIS
Efficiency COP/SPF	1		Assumption only
Capital costs (£ per heater)	190	Assumed looking at current average market prices	
Fuel cost (£/kWh)	0.18158		BEIS
O&M cost (£)	0	No significant O&M cost considered	
Lifetime (years)	20	Assumed looking at current average market values	

Mortgage Analysis

Semi-detached House	Value	Assumptions	Sources
Average house price (£)	223275	Considering the average new build price, an estimation of a new build property price has been calculated	House Price Index
Average house size (m2)	90		Floor Space in English homes
Average deposit amount (%)	15	Calculated as an average across different sources	
Average mortgage interest rate (%)	2.2	Calculated as an average of 5 years period interest rate across different mortgage types	Statista
Average mortgage period (years)	25	Calculated as an average across different sources	
Heating technologies costs		For consistency, the same costs and assumption of the NPV analysis, regarding the heating technologies, have been used in this analysis.	

Scrappage Scheme Analysis

Demand	Value	Assumptions	Sources
House Heat Demand (kWh/year)	16086		Ecuity calculations
New oil boiler	**Value**	**Assumptions**	**Sources**
Design Efficiency COP	As above in carbon savings analysis		
Carbon Intensity of Fuel ($kgCO_2e/kWh$)	As above in carbon savings analysis		
Oil NOx ($kgCO_2e/kWh$)	0.0003		EEA
Capital Costs (£)	3519	Ecuity calculations based on ECO 3	ECO3
Fuel Price		Fuel prices taken from Sutherland Tables and projected using percentage change in BEIS' projections.	BEIS

Lifetime (years)		As above in NPV analysis	
Social cost of carbon (£/tonne)	Projected up to 2050		BEIS
Social cost of NOx (£/tonne)	13950		DEFRA

Old oil boiler	Value	Assumptions	Sources
Efficiency	0.6		Boiler Hut
COP			
Carbon Intensity of Fuel $kgCO_2e/kWh$		As above in carbon savings analysis	
Oil NOx ($kgCO_2e/kWh$)	0.0003		EEA
Capital Costs (£)	1350	.	NNFCC
(oil tank removal and recycling)			
Fuel Price		Fuel prices taken from Sutherland Tables and projected using percentage change in BEIS' projections.	
Lifetime (years)		As above in NPV analysis	
Social cost (£/tonne) of carbon	Projected up to 2050		BEIS
Oil tank			
Capital Costs (£)	1000		Oil Tank Plus
Lifetime (years)	20		OFTEC

Air Source Heat Pump	Value	Assumptions	Sources
Design Efficiency	3.4		BEIS
SPF			
Carbon Intensity of Fuel $kgCO_2e/kWh$	Projected yearly up to 2050		BEIS
Capital Costs (£)	6970	Cost assumed to go down by 20% CCC by 2030	BEIS
Fuel Price		Fuel prices taken from Sutherland Tables and projected using percentage change in BEIS' projections.	
Lifetime (years)		As above in NPV analysis	
Social cost of carbon (£/tonne)	Projected up to 2050		BEIS

Ground Source Heat Pump	Value	Assumptions	Sources
Design Efficiency SPF	3.7		BEIS
Carbon Intensity of Fuel $kgCO_2e/kWh$	Projected yearly up to 2050		BEIS
Capital Costs (£)	10840	Cost assumed to go down by 20% CCC by 2030	BEIS
Fuel Price		Fuel prices taken from Sutherland Tables and projected using percentage change in BEIS' projections.	CCC
Lifetime (years)	20		BEIS
Social cost of carbon (£/tonne)	Projected up to 2050		

Radiator	Value	Assumptions	Sources
Capital cost (£)	90		BEIS

Flow Temperature Analysis

Demand	Value	Assumptions	Sources
Space Heating (kWh)	11050		Hybrid Heat Pump Study
Water Heating (kWh)	1950		Hybrid Heat Pump Study

Gas boiler	Value	Assumptions	Sources
Efficiency COP/SPF		Changes according the flow temperature	SAP
Carbon Intensity of Fuel ($kgCO_2e/kWh$)	0.1840		BEIS
Carbon cost (£/tCO_2e)	69		BEIS
Fuel Price (£/kWh)	0.04578		BEIS
Lifetime (years)		As above in NPV analysis	

Air Source Heat Pump	Value	Assumptions	Sources
Efficiency COP/SPF		Changes according the flow temperature	CCC
Carbon Intensity of Fuel ($kgCO_2e/kWh$)	Projected up to 2050		BEIS
Carbon cost (£/tCO_2e)	Projected up to 2050		BEIS
Fuel Price (£/kWh)	0.185		BEIS
Lifetime (years)		As above in NPV analysis	

Disclaimer

This paper was commissioned by the Heat Pump Association. The work was overseen by the Heat Pump Association with analytical, writing and design support from Ecuity Consulting LLP (Ecuity). While Ecuity considers the data and analysis included in this report to be reasonable based on current information, Ecuity offers no warranty or assurance as to accuracy and completeness. Details of the principal sources used are set out within the document.

Any recommendations or positions taken in this report are the responsibility and reflect the views of the Heat Pump Association and not of Ecuity.

CONTACT

W: heatpumps.org.uk

T: 0118 940 3416

E: info@heatpumps.org.uk