



# ELECTRIFICATION OF HEAT



# 1.

## Introduction

For over half a century the UK has been reliant principally on natural gas to heat its homes and buildings. However, the greenhouse gas emissions associated with heating these buildings (excluding Industry) were responsible for 20% of the UK's emissions in 2019.<sup>1</sup>

The Government's Ten-Point plan for a Green Industrial Revolution<sup>2</sup> and Clean Growth Strategy<sup>3</sup> highlight that it is increasingly evident that using natural gas or other fossil-fuels for heating buildings must be phased out as the UK aims to achieve its legally binding climate change commitments.

Decarbonising heat is recognized as perhaps the greatest challenge to achieving the UK net zero target<sup>4</sup> and will involve fundamental change, not just to the energy sector and grid infrastructure, but will also involve households engaging with hitherto unfamiliar technologies and products, and potentially adapting their behaviour and lifestyle.

Given the heterogeneity of the UK's building stock and diversity of heat demand, it is likely that we will require a mix of technologies to decarbonise the sector, but the electrification of heat will be a crucially important part of the solution.

Currently some 8% of households in the UK heat their homes electrically, with the majority of these using a combination of storage and panel convector heaters, but the Government's ambition to install 600,000 heat pumps per year by 2028, ensures that heat pumps will play a decisive role now and in the future.

<sup>1</sup> BEIS 2021 Final UK Greenhouse gas emissions

<sup>2</sup> <https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>

<sup>3</sup> <https://www.gov.uk/government/publications/clean-growth-strategy>

<sup>4</sup> CCC 2019 C

<sup>5</sup> EHPA European Heat Pump Market and Statistics report 2021

<sup>6</sup> EHPA European Heat Pump Market and Statistics report 2021

<sup>7</sup> BSRIA 2020 Heat pump market analysis ([www.bsria.com/UK](http://www.bsria.com/UK))

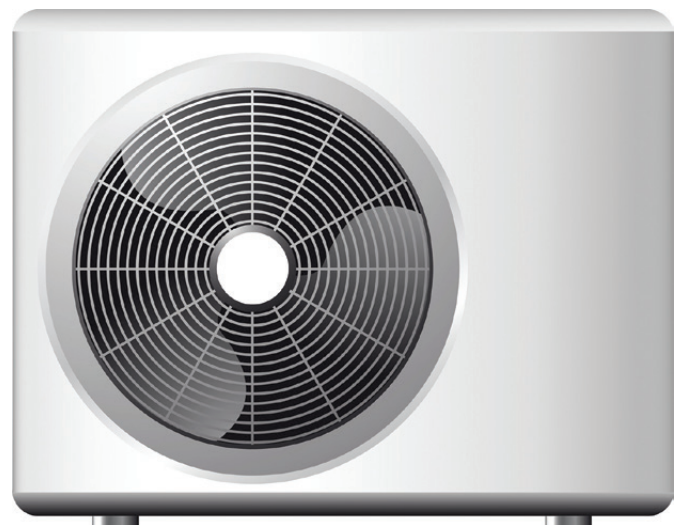
# 2.

## Heat Pump Market

The established heat pump market size in the UK totals approximately 260,000<sup>5</sup> units in operation, which is less than 1% of all installed heating systems, and heat pumps account for a very small proportion of new space heating systems installed, with some 36,000<sup>6</sup> installed in 2020 which nevertheless represents an 11% increase over 2019 and is double the number that was fitted in 2016.

The overwhelming majority of heat pumps sold in the UK (87%) are 'Air-to-Water', which suits the requirements for the older, poorly insulated, typical UK housing stock, in that this heating system provides more inertia and radiant heat than the 'Air-to-Air' units which are the most popular type throughout the rest of the globe, (mainly because they are reversible).

Of the 32,000 heat pumps sold in 2019, the majority (62%) were retrofit applications with the remaining 38% used in new buildings<sup>7</sup> For comparison, in the same year only 8% of UK boiler sales were destined for new-builds and 86% for refurbishment or replacement. Of these over 80% were "distress purchases" due to a failed boiler.



# 3.

## The Challenges

The Government is calling on the Heat pump Industry to increase annual sales by a factor of 17 within 7 years, and to increase the market by this order of magnitude in such a short period of time presents some significant challenges:

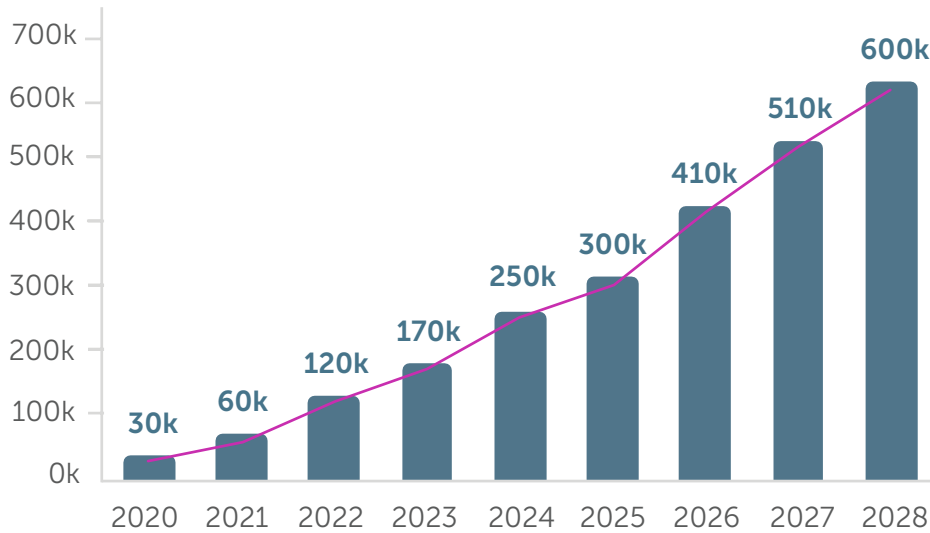


Figure 1: Illustrative ramp up of heat pump deployment

Source BEIS

### Supply Chain Constraints

BEIS commissioned research in November 2020<sup>8</sup> to identify the capabilities of the UK Heat pump supply chain to respond to the expected increase in volume.

This report identified that since the majority of heat pumps sold in the UK are manufactured by international businesses that these manufacturers were very confident they could increase supply into the UK market, through both importing and domestic manufacture, by a minimum of 25-30% year-on-year for the next 15 years. However, the decision to manufacture in the UK would be based on economic considerations, the most important of which is confidence in long term market growth, supported by long-term policy.

<sup>8</sup> BEIS Heat pump manufacturing supply chain research Project November 2020

<sup>9</sup> BSRIA 2020

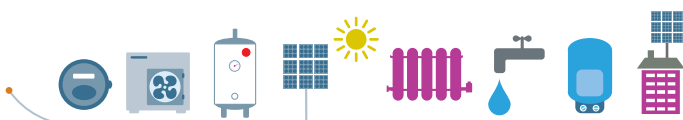
<sup>10</sup> UKERC 2021

<sup>11</sup> BEIS

### Installer Constraints

The number of trained heat pump installers (ground source and air-source) is very low at an estimated 1,800,<sup>9</sup> as compared to 130,000 fossil-fuelled boiler installers.<sup>10</sup>

It is estimated that the industry will need another 30,000 installers by 2028<sup>11</sup> to meet the expected demand for heat pumps. Industry is investing in new training capacity to meet this demand, but is reliant on Government to provide long term policy certainty to attract installers to retrain from fossil-fuel installations.





**Government must make a long-term policy commitment to support the Heat pump Industry and needs to develop a public information campaign which will extend to installers to raise awareness of the decarbonisation of heat and the transition to Heat pump programme.**

### Installation Standards

Currently only an estimated 30% of heat pump installations are undertaken by an accredited installer, as MCS standards or equivalent are only mandatory for Government support schemes. This leaves the other 70% of installations at risk of being subject to inconsistent quality standards from untrained and non-accredited installers with the potential concomitant effect of the industry gaining a poor reputation.

MCS and Industry have responded to this challenge by updating existing technical standards and revising existing commissioning and servicing records, and working towards a single integrated digital commissioning sheet.



the system requirements for low temperature operation. Therefore, Industry has seen fit to develop a new standardised suite of low temperature heating system and heat pump training courses, which will serve the needs of both new trainees and experienced fossil-fuel trained installers who wish to retrain, the latter of whom will need to service the bulk of the heat pumps installed over the next 10 years.

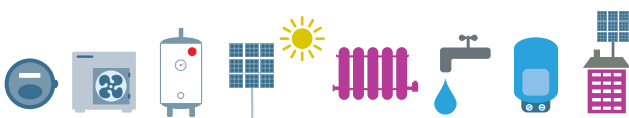
Heat pump education considerations also need to go beyond the installer, to designers, planners and architects who are involved at the fundamental scheme design stage.

**Government must take whatever steps are necessary to ensure that all heat pumps are installed to the same standard, but with the minimum administrative burden on the installer.**

### Inconsistent Training

There has been a variety of heat pump training courses with different service providers working to different standards, resulting in variable quality, and there has been a concern that there is not enough focus on low carbon heating, with little emphasis placed on heat loss calculations, hydraulic balancing and the need to address

**Government will need to collaborate with Further Education Institutions and help Industry engage with them to ensure there is a focus on low carbon heating training to establish and maintain the high standards and rapid deployment growth in heat pump installation that is required.**



## Implications for Networks

By 2050 it is estimated that electricity could provide over half of the UK's final energy demand as internal combustion engine cars are displaced by EVs and oil and gas are displaced by electricity for heating our homes.

That could mean that electricity demand doubles from today's rate to nearly 700 TWh.<sup>12</sup>

This change will necessitate a very different approach, and not just because the electrical infrastructure will need to support the deployment of clean energy technologies, but also because it will have changed from a centralised supply system largely based on fossil fuel generation, when supply largely follows demand, to a system where demand will be satisfied as much by local solutions, as by nationally organised and operated systems, but with the added complication of higher amounts of intermittent renewable generation which will require integrated management of both supply and demand in order to maintain system stability.

The significant role played by Heat pumps in the decarbonisation of heat will inevitably lead to issues of peak electrical demand during the winter as the demand on the energy systems would previously have been managed by the gas grid. It is crucial therefore that the DNOs have accurate visibility and notification of where heat pumps have and will be installed on the Network. This information is essential to inform network design and operation, as well as ensuring DNOs can design a safe and reliable connection for their customers.

Currently only around 17% of heat pump connections<sup>13</sup> are notified to the DNO, meaning that in the last year alone over 29,000 heat pumps will have been connected somewhere in the country, without notification, and are therefore not accounted for.

Industry and the ENA have recognised the need to streamline the application process to ensure that being able to connect to the Network is a straightforward process for installers, principally

by developing the ENA database but there are still further refinements to be made to minimise delays in application approvals.

**Government must conduct research amongst installers to identify why they do not notify, rather than assume that the hurdle is the application process, and thereby adapt the strategy for dealing with the issue accordingly. Government must also minimize the connection costs which can frequently be prohibitive and ensure that charges are equitable and consistent.**

## Flexibility

To ensure that we can integrate heat pumps at scale onto the Grid, whilst still maintaining the balance of electricity supply and demand and minimising the amount of generation needed to meet our demands, we require a smart flexible energy system.

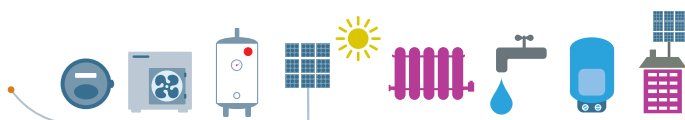
The principal barriers for the development of a smart heat pump system are the meters, the storage capacity of the heat pump, and communication protocols, as well as demand side flexibility restrictions imposed by the heat pump in normal operation.

The Heat pump will communicate with a central control system, and to do that it must be able to react to dynamic responses to external signals such as time-of-use tariffs and although the communications protocol and scope might still be undecided, it is assumed that a smart heat pump controls system will have to meet, as a minimum, the criteria for Smart Readiness Level 3.<sup>14</sup>

<sup>12</sup> BEIS 2020 Energy White paper page 42

<sup>13</sup> BEIS 2021

<sup>14</sup> Delta EE (2014) Review of Smart Ready Products UK



**Government must ensure smart technologies are appropriately recognised in SAP, and explore how to convince the consumer of the value of flexibility and support them to provide flexibility to the grid and reduce their energy bills in a meaningful way , as well as protecting them with embedded cybersecurity.**

### Low Consumer awareness

Perhaps the greatest challenge of all is to convince the householder of the value of a low carbon heating system, and the benefits it brings to the wider community and society overall.

Lack of awareness of the need for decarbonisation is surprisingly high with 32% of the respondents in a recent BEIS UK PAT survey thinking that they had not heard of “Net Zero,”<sup>15</sup> yet in the same survey 79% of the public supported the need for renewable energy.

Nevertheless, the combination of the latest widely reported IPCC report (August 2021) in which they announced that the window to deliver the “deep emissions cuts needed to prevent the worst impacts of the climate crisis is closing rapidly” and the incidence of deadly heatwaves, floods, and storms experienced around the world in July and August this year (2021) appears to have raised levels of UK public concern about the environment. According to the August 2021 Ipsos Mori Issues Index nearly a third of people (32%) said climate change, the environment and pollution were a major issue for Britain, putting it second only to the pandemic as a key concern<sup>16</sup>.

Although UK consumers might express a new-found level of concern for the environment, few perceive heat pumps to be one of the solutions.

Heat pumps are not a new technology, the basic chemistry behind the product was first demonstrated in the 1750s, and the first working heat pump was devised in Austria in 1855. There are an estimated 220m heat pumps operating globally, and yet only 30% of the UK population have heard of an air source heat pump.<sup>17</sup>

From the installer’s perspective there is a perception that the consumers who do know of the technology, not only think that Heat pumps are too expensive, but also don’t know enough about the benefits of the technology to request to have one installed, or agree to having one fitted if suggested by the installer.<sup>18</sup>

To counteract this level of ignorance by creating a compelling sales proposition for low carbon heating delivered nationally is challenging, time consuming and expensive.

The UK Heat pump Industry is small by National and International standards and although manufacturers and brands will continue to shoulder most of the burden of promotional spend for this category, this expenditure will only be in line with sales budgets, which will raise awareness levels only incrementally over time. To build awareness levels to achieve the sales volumes anticipated by 2028 will require very significant up-front resources to be expended over a protracted period.

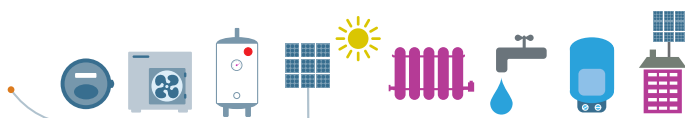
**Government must increase consumer awareness of heat pumps so that householders can begin to plan for changes to their heating systems and should also follow the CCC advice to fully embed net zero in all policy areas, as well as working with consumer organizations to promote heat pumps.**

<sup>15</sup> BEIS Public Attitude Tracker Survey March 2021

<sup>16</sup> <https://www.ipsos.com/sites/default/files/ct/news/documents/2021-08/issues-index-august-2021-charts.pdf>

<sup>17</sup> BEIS Public Attitudes survey Tracker Wave 32

<sup>18</sup> BEIS Social Research with installers of heating systems in off gas grid areas of England and Wales May 2021





## High costs of a heat pump system

The BEIS commissioned research with heating system installers of May 2021<sup>19</sup> cited the largest obstacle to take-up of heat pumps was the installed cost (64% of respondents).

This is not particularly surprising as the average installed cost of an air-to-water heat pump is around £10,000 as compared with the average price of a replacement gas boiler of between £3-4000.<sup>20</sup>

Although it is expected that as heat pump volumes grow over the next few years, the economies of scale will ensure some cost reductions, the reality is that in such a mature market the likelihood of further reductions in the cost of raw materials and components is low.

The principal driver of lower costs will come from the increase in the number of installers available giving rise to a more competitive installation cost.

Although Government can do little to affect the unit cost of a heat pump, other Government policy interventions can help to offset this cost (see below).

## Historical Policy Stimuli

### RHI

Over the last decade the Government has introduced a range of policies to promote renewable heating technologies such as heat pumps. The most significant of these was the Renewable Heat Incentive scheme which has now been extended to March 2022 ahead of the launch of the Clean Heat Grant scheme.

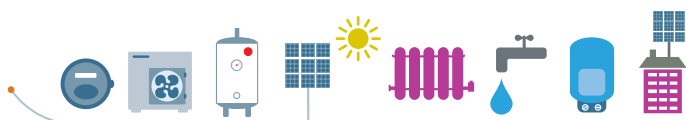
Uncertainty surrounding the future of the RHI was cited as a barrier to the more rapid growth of the market although reforms to the scheme helped to reduce uncertainty latterly.

## The Green Homes Grant

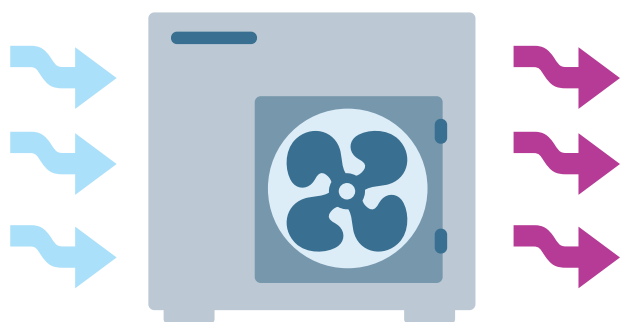
The Green Homes Grant which came into effect in November 2020 was perceived to have been launched too quickly and too late in the season, to be overly bureaucratic, and with unachievable deadlines. Consumers had difficulty understanding which home technologies were appropriate for their home, as there was not enough information about the different products available and the benefits they would deliver. Consumer protections were compromised often leading to unresolved disputes with installers, and installers complained about delayed payments. The scheme closed earlier than planned, achieving only about 10% of the target to improve 600,000 homes in 6 months and many builders with order books that were suddenly depleted.



<sup>19</sup> BEIS Social research with installers of heating systems in off gas grid areas of England and Wales May 2021  
<sup>20</sup> Boilerguide 2021



For future schemes Government needs to work in collaboration with Industry and Consumer bodies to avoid the scheme being mired in a mix of red tape and lengthy delays, with enough notice being given to enable the trade to gear up effectively with appropriately trained manpower to deliver the level of service expected and needed by householders who wish to improve their homes. The scheme must look beyond the short term and be a long-term policy to give Industry and householders confidence to plan and budget for their home improvements. Most importantly, any scheme must be supported by ensuring that householders have access to easily understandable and unbiased advice on the most appropriate technologies for their home, and a clear understanding of the advantages, features and benefits these technologies will bring.



## Policy Options to Support uptake

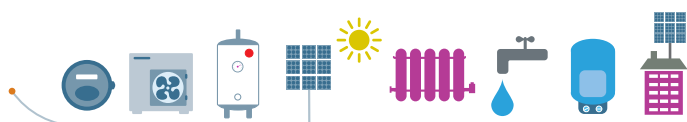
To achieve the level of heat pump uptake desired to ensure effective decarbonisation of heat by 2050 without significant policy intervention seems implausible.

The current consumer proposition with high installed system costs relative to gas boilers and without substantially lower running costs, is not strong enough to tempt the mass market to change their established heating systems without policy intervention, and relying on consumer led schemes, such as the RHI and the Clean Heat Grant will not be sufficient.

### Government needs to supplement these incentives with :

- Stamp duty rebates to encourage the installation of heat pumps either before or after the sale of a house
- Tax reductions such as VAT free purchase of the heat pump and ancillaries and/or installation costs
- Facilitating the easy access of Private finance
- Carbon taxes to incentivise the shift away from fossil fuels
- Re-evaluation of the relative costs of energy. Currently domestic electricity prices carry a much higher share of the environmental and social obligation costs than gas<sup>21</sup> which is counterintuitive because of the rapidly falling carbon intensity of electricity, and the requirement to incentivise householders to choose an electric heating system. The distribution of these costs must be re-evaluated

<sup>21</sup> <https://www.ofgem.gov.uk/energy-advice-households/costs-your-energy-bill>





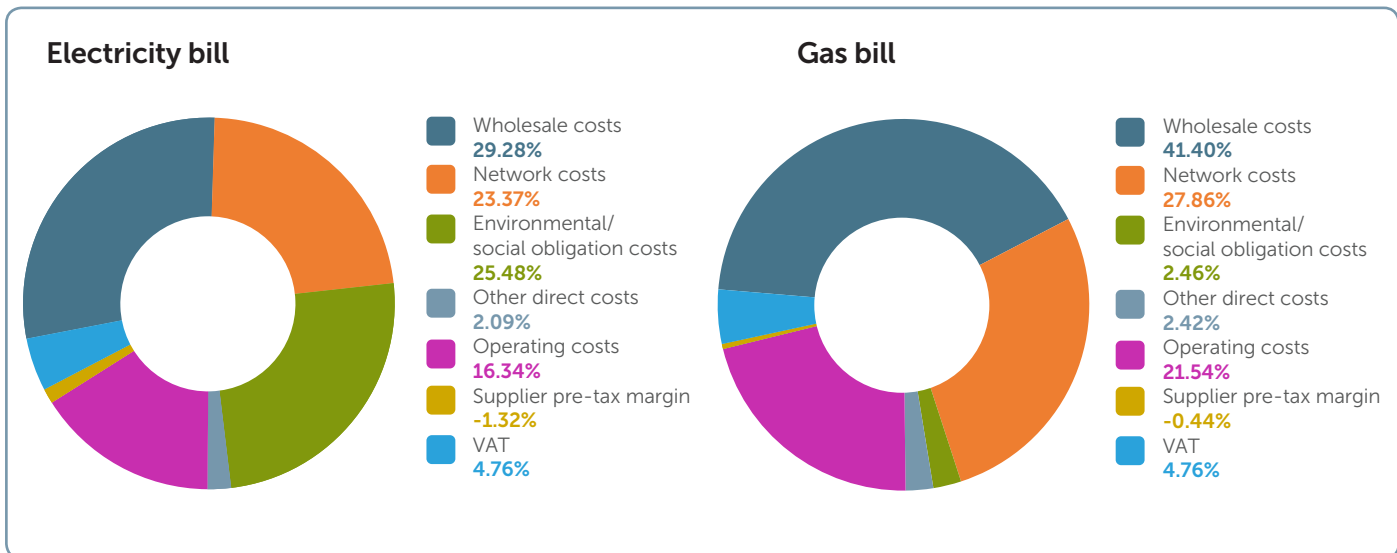


Figure 2: Domestic Fuel cost breakdown.

Source - Ofgem 2021.

## Other considerations

### Reversible Heat pumps

It is technically possible to provide the facility for most heat pumps to cool as well as heat, and this dual function is utilised most frequently in Continental Europe and explains the popularity of such a system in that region.

In the UK the Government has historically been concerned that if this facility was available routinely on a national scale, then it would increase The UK's energy consumption and carbon emissions significantly, and therefore UK policy has been to ensure housebuilders utilise passive design and ventilation measures to cool properties, and cooling with heat pumps has not been allowable under permitted development rules.

Nevertheless, a recent study by Loughborough University and BRE<sup>22</sup> found that 4.6 million homes in the UK are currently affected by overheating, a trend which will only get worse, and consideration of future cooling requirements will need to form part of the UK government's decarbonisation plans.

It may be prudent therefore to consider enhancing the value of the UK heat pump proposition by encouraging the use of reversible heat pumps used in conjunction with underfloor

emitters, for properties that also have Solar PV and battery storage which can offset the load on the grid with local generation.

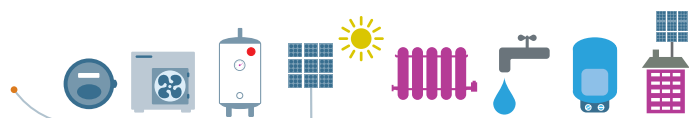
It may also be environmentally and economically viable, given the enhanced insulation levels and reduced space heating requirements for small, new-build flats and apartments to use reversible Air-to air heat pumps for heating and cooling as the building fabric will provide the inertia required to ensure temperature stability. It is noticeable that in Finland, Sweden and Norway, countries which have very well insulated properties, long winters and humid climate conditions, reversible air-to-air heat pumps represent between 50 and 80% of sales. In Finland, which last year installed 102,000 heat pumps, of which 82,000 were reversible air-to-air units, nearly one third of homes are fitted with heat pumps.<sup>23</sup>

### Domestic Hot water heat pumps

Another technology that is extremely popular in countries such as France, Japan and growing elsewhere, is the Domestic Hot Water heat pump. This product, most frequently fitted in conjunction with electric resistance space heating or larger homes with fossil fueled boilers, used in conjunction with Solar PV, can provide a near zero cost and emissions solution for hot water all year round, as well as acting as a thermal battery.

<sup>22</sup> <https://www.lboro.ac.uk/news-events/news/2021/july/over-4.6-million-homes-experience-overheating/>

<sup>23</sup> EHPA European Heat Pump Market and Statistics report 2021



## Electric resistance heating

The most significant “other” low carbon heating system that has been highlighted in the Government’s thinking is electric resistance heating, which has been around for more than a century, has been sold on a daily basis in electrical wholesalers throughout the Country for almost as long, is the second most common means of home heating after natural gas, and yet been frequently overlooked in the long-term planning process.

Although this type of heating, most commonly represented by storage heaters, panel convectors and electric radiators, is less efficient than heat pump technology, the carbon emissions on a CO<sup>2</sup>/kWh basis of this system are still lower than natural gas, and with an increasing amount of renewable generation coming onstream on a weekly basis, the carbon intensity of this fuel will continue to drop for some time to come.

Despite this type of heating being referenced as an appropriate solution variously by the CCC, and Element Energy, there has been a reluctance in Government to promote this technology as an alternative to heat pumps because of the perceived operating costs of these systems and the potential strain on the electricity grid at peak times if system take-up is high.

However, this concern may be misplaced, as the most frequent application for electric resistance heating in the UK is in small flats and apartments with nearly 25% of all flats in England and 35% in Scotland using the technology. Of the 1.8 million households using this type of heating in the UK, the most common size of home is between 50-75m<sup>2</sup> in floor area and since the insulation levels of the most modern homes mean that they are almost hermetically sealed, and, as demonstrated by a recent BEIS report<sup>24</sup> the space heating demand, and therefore operating costs are frequently low, as are the capital costs. Consequently, the space requirements needed, and upfront costs of a heat pump system for such a property, are frequently difficult to justify by the sometimes-marginally lower running costs achieved over resistance heating, and therefore it is frequently not a practical solution.

## What can we learn for other Countries?

Scandinavian countries have some of the highest per capita penetration levels for heat pumps. This is partly due to regulation banning oil boilers, a very low carbon electricity supply grid and the lure of lower running costs than direct electric heaters. Latterly laws requiring high standards of efficiency for new buildings and growth in the new building sector have had a positive impact also, but many other factors impinge on the marketplace.

**The most significant factors affecting sales of heat pumps across Europe would appear to be:**

- A low carbon electricity supply grid
- Banning of fossil fuel boilers
- A fuel price ratio ( electricity v gas) in favour of electricity
- Beneficial Government policies
- Stringent building standards and building tradition
- Customer preference for heating type
- The need for cooling
- Growing construction sector
- Tax deductible labour costs

## Conclusion

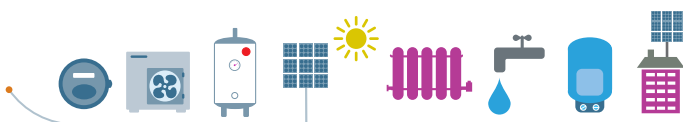
Clearly if we maintain the growth rate of heat pumps in the UK over the last three years it will be insufficient to decarbonise our heating by 2050, and yet the Government is relying principally on this technology to be the major tool to achieve that goal.

Industry has shown that it has the capability and desire to overcome the challenges it faces in delivering that target, but Government must demonstrate that as a critical component of UK energy policy, the decarbonisation of heat will be supported by a stable, long term policy environment and address the distorted price mechanism that currently still favours the use of fossil fuels.

<sup>22</sup> <https://www.lboro.ac.uk/news-events/news/2021/july/over-4.6-million-homes-experience-overheating/>

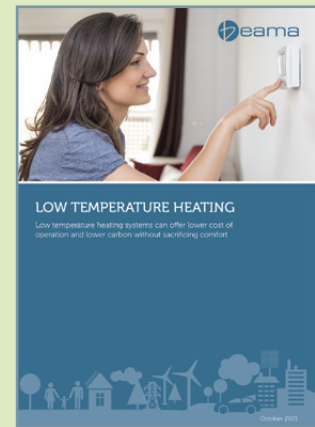
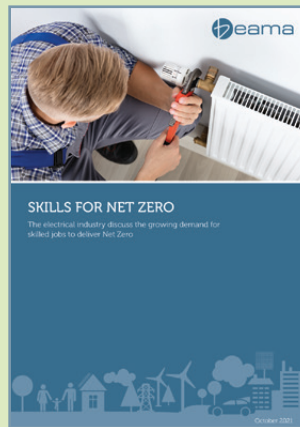
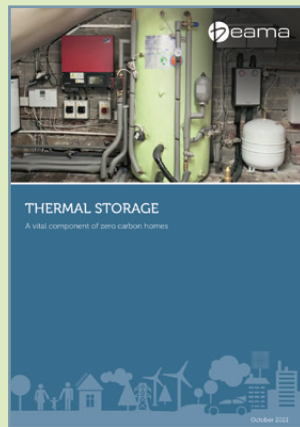
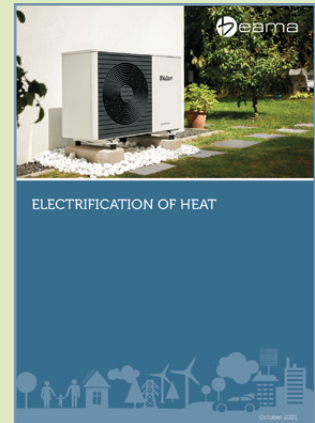
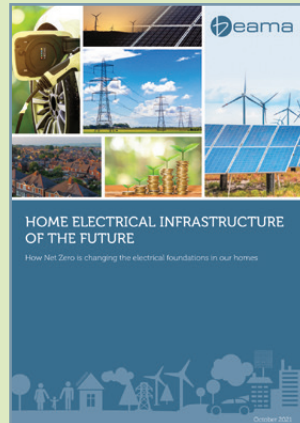
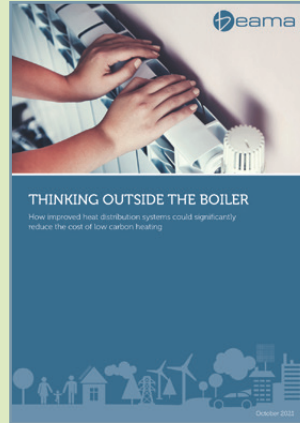
<sup>23</sup> EHPA European Heat Pump Market and Statistics report 2021

<sup>24</sup> <https://www.gov.uk/government/publications/cost-optimal-domestic-electrification-code>



To read more, download the  
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Main report and white papers

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