CIPHE The Chartered Institute of Plumbing and Heating Engineering

What are the implications of the notable change in central heating systems for the UK housing stock?

How will home owners cope with the minefield that central heating installation/design is set to become?

What are the facts surrounding heat pumps and hydrogen, and what will the cost implications be?

The future of home heating

A consumer guide

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Introduction

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Introduction

A recent report by Energy Guide showed that home heating accounts for around 38% of all gas used in the UK.[1] In 2017, every household in the UK produced around 2.7 tonnes of CO_2 annually[2] just from their home gas/oil/solid fuel heating appliances, and when you consider that there are some 30 million homes in the UK, that's an awful lot of carbon dioxide being released into the atmosphere. Not surprising then, that home heating has been targeted as one of the areas where a major change is required to help with the UK governments commitment to achieve net zero emissions by 2050.

We took our first steps into achieving the net zero goal in June 2022, when the much-anticipated changes to the Building Regulations were implemented. These changes immediately forced construction companies to build dwellings that reduced the CO_2 emissions by some 31%.[3] This paved the way for more radical updates to the Building Regulations which are set to be implemented by 2025.

From 2025 all new-build dwellings will be required to reduce CO_2 emissions by a whopping 75–80%.[4] This, as we shall see later, falls into the remit of *The Future Homes Standard*. Homes of the future will need to be zero-carbon ready, with fossil fuel installations, such as natural gas and liquid petroleum gas (LPG), prohibited with a visible shift towards low/zero-carbon alternative heat sources.

But what are the implications of this notable change in central heating systems for the rest of the UK housing stock? How will homeowners cope with the minefield that central heating installation/design is set to become? What are the facts surrounding heat pumps and hydrogen, and what will the cost implications be?

The Future Homes Standard

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The Future Homes Standard

Under the UK government's *The Future Homes Standard*, it is proposed that natural gas and LPG gas boiler installations in all new-build homes will be prohibited by 2025. The document tells us that:

*'The Prime Minister's ten-point plan for a green industrial revolution noted that, as well as increasing the energy efficiency of our buildings, we will need to move away from heating our homes with fossil fuels in order to meet our net zero target. The Building Regulations will continue to set a performance-based standard rather than mandating or banning the use of any technologies. However, to ensure that new homes are zero carbon ready, we intend to set the performance standard of the Future Homes Standard at a level which means that **new homes will not be built with fossil fuel heating, such as a natural gas boiler.'***[5]

The precursor to this has already been implemented with the introduction of the new *Approved Document L: Conservation of Fuel and Power*, which came into force in June 2022.

What the Building Regulations say

Approved Document L: Conservation of Fuel and Power Vol 1: Domestic Dwellings

Under the new Document L, the heating flow temperature of hydronic heating systems must not exceed 55°C. This applies to **all** new central heating system installations whether those installations are in new-build dwellings or complete replacement systems in existing dwellings (not including replacement boilers/appliances only). The message here is crystal clear; all new systems whether in new-builds or complete replacement systems in existing properties, must be low-carbon-heat-source-compatible, and that means heat pumps.

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But there is another statement in the 2021 government publication *Heat and Buildings Strategy* that is all too often missed:

"Ultimately, Net Zero will mean gradually, but completely, moving away from burning fossil fuels for heating. This is why we are setting the ambition of phasing out the installation of new natural gas boilers from 2035." [6]

So, from 2035, there will be no gas boiler installations of any sort, new, replacement or otherwise!

Whilst many of the proposed changes can be reasonably easily implemented in new build properties, *Approved Document L* will have far reaching implications for the existing housing stock and the retrofit market.

The choices

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The choices

So, how does the homeowner cope without natural gas and LPG as their source of heating, and what will become of all those millions of gas boilers (and gas fires) in the coming years? Simply put, what are the choices that the consumer has when it comes to heating their home?

One thing is for sure. We can only reach net zero by stopping the use of fossil fuels in our homes and in this respect that means embracing renewable energy in a way that the homeowner has never had too before. The problem is that embracing renewable/sustainable energy will come with a hefty price tag that many will not be able to afford, even with government subsidies!

Let us take a look at some of the alternatives to natural gas and LPG.

The following discusses technology that is currently available and/or likely to be available in the near future:

- Hydrogen gas
- Heat pumps
- Hybrid systems
- Biomass
- Electric boilers
- Electric storage heaters

CHOICE ONE:
Hydrogen

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CHOICE ONE

Hydrogen

An alternative fuel to natural gas (CH_4) under consideration for heating is hydrogen (H_2). Hydrogen is a non-toxic, highly flammable gas. It is the most abundant element in the universe. Its only combustion products are water vapour (H_2O) and nitrogen oxide (NOx), neither of which are long-staying greenhouse gases.

However, pure hydrogen is an unstable element and only exists naturally on earth in rare circumstances in limited quantities in underground deposits for which there are no current extraction proposals. All hydrogen therefore must be manufactured. Several methods exist to do this, all of which use energy.

Some, such as electrolysis of water and catalytic reform of natural gas, are well-established and understood, whilst others remain at theoretical, prototype or demonstration project stage.

Once produced, hydrogen can be used in those boilers designed for its use for combustion, similar to the way natural gas and LPG are used presently. Many of the UK's boiler manufacturers have active product developments under way, and several have produced both prototypes for 100% hydrogen boilers, and established product development to modularise gas boilers so they can be converted to 100% relatively cheaply (so-called 'hydrogen-ready') at some future stage should the fuel become available in sufficient quantities at a fuel price that makes it a viable choice for consumers.

Current boiler technology will also function with up to 20% hydrogen blended into natural gas (80% CH_4–20% H_2 blend), and this reduces the CO_2 content of the gas when it is combusted.

Technology developments are also underway by many manufacturers to allow for the use of 100% pure hydrogen. While the latter seems a very attractive proposition when produced by electrolysis because at the point of use it contains no local carbon and therefore has no greenhouse gas (GHG) emissions, it has some issues that must be overcome before it becomes a viable alternative to natural gas and LPG.

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In particular, for hydrogen to be a true zero carbon solution, as with other fuels such as electricity, the greenhouse gas impact, and particularly the carbon intensity of how it is produced, as well as its likely price competitiveness as a fuel, will be key to whether it becomes a viable long-term solution.

There are four classifications of hydrogen:

Black hydrogen

Using black coal or lignite (brown coal) in the hydrogen-making process, these black and brown hydrogen are the absolute opposite of green hydrogen in the hydrogen spectrum and the most environmentally damaging. Just to confuse things, any hydrogen made from fossil fuels through the process of 'gasification' is sometimes called black or brown hydrogen interchangeably.

Grey hydrogen

Grey hydrogen is produced by separating the hydrogen from natural gas (CH_4). It uses a principle called 'steam methane reforming', which separates the carbon from the gas leaving behind the hydrogen. This is the most common method of hydrogen production. Unfortunately, it is not very 'enviro-friendly' as produces 9.3kg of uncaptured CO_2 for every kilogram of hydrogen (H_2) produced.[7]

Blue hydrogen

This again uses steam methane reforming to separate the carbon dioxide from the hydrogen, only with this process, the carbon dioxide is captured and stored (Carbon Capture and Storage — CCS). This type of hydrogen is often referred to as 'carbon neutral' since the carbon is not released to atmosphere. However, some experts say that because around 10% to 20% of the CO_2 cannot be captured and is subsequently released into the atmosphere, 'low carbon' would be a more accurate description.[8]

Green hydrogen

This process uses clean electricity from renewable sources such as wind power, solar or nuclear generation. In this process, the water is separated into two atoms of hydrogen (H_2) and one atom of oxygen (O) using the electrolysis process.[9] Provided green energy sources are used to generate the electricity required for electrolysis to take place, this is a totally carbon free method of producing hydrogen. The downside is that it takes vast amounts of electricity to produce it, hence it only makes up 0.1% of all hydrogen production. However, this figure is expected to rise exponentially in the future.

Several other colour categories also exist in the way hydrogen can be classified, depending on the precise production method — for example from nuclear power or solar, but the key to them all is that hydrogen can

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only be produced using an external energy source, and so the carbon intensity of that source becomes the key factor in defining hydrogen's role in decarbonisation across a wide range of applications, including heating.

The problem with hydrogen

There are also some technical considerations for the use of hydrogen that need to be addressed before we can begin to use it as we do natural gas today:

Hydrogen has a specific gravity of 0.08. Compare that to 0.8 for natural gas and 1.0 for air and it can be seen that hydrogen is a lot lighter than air. Around fourteen times lighter. This means that hydrogen is a very searching gas and will find leaks in pipework that other gases, like natural gas, will not. What this all means is that, if the existing natural gas pipe infrastructure in the UK is used to transport hydrogen, we must be absolutely sure it will be gas tight against the hydrogen (It also means that any escaping gas is likely to float off into space, hence the reason there is no natural hydrogen on Earth). It will undoubtedly mean that some of the existing pipework infrastructure will have to be replaced. More research and demonstration projects are needed to establish the extent to which the existing connection pipework and terminal equipment are suitable for hydrogen, or the extent to which they will need to be replaced.

Hydrogen has no odour. It is odourless and colourless. So, a way has to be found to add an odour to it for leak detection purposes. The same is true of natural gas. That too has no odour to it and so the chemical mercaptan is added to give it a distinctive 'rotten egg' aroma for leak detection purposes.

Hydrogen burns with virtually no flame[10] and so there are some safety concerns with regard to flame detection especially around the National Grid and, of course, in the home. How would we know, for instance, that a cooker hob was on if we cannot see the flame?

Some experts also argue that there is an increased risk of nitrogen oxide (NOx) pollution[11] when combusting hydrogen, and while NOx is not a greenhouse gas, it can produce health issues like asthma and respiratory problems. More research is needed in this area, particularly into the effect of direct emissions of NOx directly into the home from cooker burners, which are presently higher for hydrogen than for natural gas.

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The diagram shows efficiency using a given amount of low carbon electricity in delivering heat for buildings

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The price of the fuel is currently unknown. There will be efficiency losses from whatever production method is used for the hydrogen — any process used to produce hydrogen will not be able to produce as much stored energy in the hydrogen as the energy put into the process. Therefore, if natural gas or electricity are used as the primary means for hydrogen production, the hydrogen will always be more expensive per unit of energy than the original source fuel.

Field trials

There were proposals for several trials of pure hydrogen and hydrogen/natural gas mix powered boilers[12] across the UK:

An experimental installation of 150 boilers running a blend of natural gas with 20% hydrogen was concluded at Keele University in Staffordshire. The appliances operated perfectly with no adverse effects on the appliances.

The Hy4Heat trial in Northumberland was planned to run 100% hydrogen appliances proving the safety of hydrogen conversion of homes and gas networks.

A 100% hydrogen trial was also planned by the gas supplier Cadent for the Cheshire village of Whitby.

A 300-home trial that is set to commence this year (2024) in Fife in Scotland. Here 300 homes will be connected to 100% hydrogen using new pipe work. This is due to go live in the second half of 2024.

Manufacturers say that the cost of a hydrogen boiler will be roughly the same as a natural gas/LPG appliance.

Opposition to the hydrogen field trials

Significant public opposition to the proposed trials at both Whitby and Redcar has led to the cancellation of both projects.

Whitby, known as ‘Hydrogen Village’, was chosen as a major hydrogen trial site, along with Redcar in the north-east of England for potential of converting to 100% hydrogen gas. These two trials would have had the potential to reach 2,000 appliances. However, residents fear that they are being made, as one resident put it, ‘lab rats’ for a technology that will be discarded in time. The residents are questioning the practicality of using hydrogen and the true cost to residents.[13]

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The main opposition is not to the gas itself. Residents[14] say:

- **They do not have freedom of choice in the trial.**
- **Fuel costs will not continue to be subsidised and hydrogen is three times more expensive than natural gas.**
- **There are only a limited number of suppliers of hydrogen.**
- **Hydrogen is the smallest molecule making it much more prone to leakage.**
- **Hydrogen needs four times the pressure of natural gas in pipework not designed for such pressures.**
- **No public consultation with the residents.**
- **No independent support for residents.**

The issues raised appear to be in conflict with what has actually been stated by participating companies and more research is required to get to the real issues surrounding this trial. It may be simply a case of misinformation surrounding hydrogen as a fuel. Whether hydrogen is eventually considered safe enough for use in dwellings, only time will tell, but its initial use looks promising.

Hydrogen — in conclusion

We must remember that hydrogen is not available yet to domestic customers, and neither National Grid nor the Committee on Climate Change forecast it being so until well after 2035. The production constraints of adequate volume, competitive price, and sufficiently low carbon, all need significant progress before hydrogen appliances can deliver on the potential for them to become a feasible mass market option for home heating in the UK.

The trials in the field would have been a good start in demonstrating practical application and consumer use and acceptance, but more research and development in the technology, as well as significant changes in policy to address fuel availability and price, is needed before hydrogen can be considered to be a viable mass market option for future heating.

CHOICE TWO: Heat pumps

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CHOICE TWO

Heat pumps

The idea behind heat pumps is not new. The technology has been around for many years in parts of Europe, but it is only very recently that heat pumps have started to make their mark here in the UK. But what are they and how do they work? And why are they proving so controversial?

What is a heat pump and how does it work?

Basically speaking, a heat pump is a device that takes energy from the outside environment and converts it into heat for the dwelling and hot water system. It uses electricity to run the various components — the compressor, a fan and circulating pumps etc — to transfer the heat into either a buffer tank or a heating system[15] using a process called the 'vapour compression refrigeration cycle'. It is exactly the same process that works in the refrigerator in your kitchen, but in reverse. Instead of giving off cold, it gives off heat.

The heat pump uses four main components:

The compressor

Heat pumps contain a refrigerant. The refrigerant is the chemical that transfers the heat from the environment via the vapour compression refrigeration cycle, into the heating system. The refrigerant is a vital part of the system, which, in various stages of the cycle, is either in a liquid state or a gaseous state. At the beginning of the cycle, the refrigerant is a low temperature gas, and this passes through to the compressor, where is compressed. The act of compression raises the pressure and temperature of the refrigerant gas. This pressurised and hotter gas then moves to a condenser The heated refrigerant is then passed through to the condenser.

The condenser

The condenser is a heat exchanger where the heat contained in the high pressure refrigerant gas is transferred into the water in the heating system or buffer tank for onward circulation throughout the heating system, heating the home and/or the hot water storage cylinder.

This loss of heat from the refrigerant to the heat distribution system causes the refrigerant to condense back into a liquid.

From here, the refrigerant passes through to the expansion valve.

The expansion valve

The expansion valve releases the pressure on the refrigerant, which immediately expands, instantly turning the refrigerant liquid back into a refrigerant gas. In the process, this creates a big drop in temperature to create cold the same way it does in a refrigerator. From here the cold, low pressure refrigerant liquid/gas mix is passed through to another heat exchanger, the evaporator.

The evaporator

Here the low temperature refrigerant enters as a liquid/gas mix where it begins to absorb heat from its higher-temperature surroundings. This evaporates any remaining liquid back into a gas. From here the low temperature gas is passed through to the compressor and the process begins all over again.

The cycle works more efficiently with the heat pump running for longer periods unlike traditional heating systems with gas or oil boilers, that use intermittent cycles, only coming on at certain times of the day. Heat pumps use weather monitoring controls, called ‘weather compensation’ to control the output of the heat pump based on the external temperature conditions, and load compensation to modulate operation according to the heat demand of the property. Weather compensation has been an option on combination boilers since 2018.

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How efficient are heat pumps?

Heat pumps can be the most efficient type of heat source for central heating installations provided the heat pump is matched to a suitable heat distribution system that allows for it to operate efficiently. Heat pumps work best in an ideal situation where all of the necessary heat loss calculations have been carried out correctly for every room that requires heat, and the emitters (radiators or under floor heating) can impart sufficient heat at the lower operating temperatures that allow for heat pumps to operate at their most efficient. Where the building has been insulated to a very high standard, the heat loss will be lower, and therefore the emitter sizes likely to be smaller. This is no different for condensing gas boilers when used with low temperature heating.

A condensing gas boiler is incapable of capturing the heat carried the combustion flue gas unless the water returning to the boiler is below 55°C. For peak operation efficiencies of 93%–94%, this return temperature needs to be at 40°C or lower. If a heating system is therefore already specified to allow for a boiler to operate at these peak efficiencies, it will almost certainly be 'heat pump ready'—meaning that little or no additional upgrades to radiators or other emitters will be needed for a heat pump to operate efficiently.

It is not uncommon for a well-designed and installed heat pump, whose heat distribution system is correctly specified, to operate at between 350% and 400% efficient for an air source heat pump, and higher for ground or water source. This means for every 1 kW of electrical energy used to power the heat pump, 3.5–4 kW of usable heat can be transferred from the outside into the building. The ratio of heat transferred to electrical energy used is known as the Coefficient of Performance or CoP.

How does this actually work?

Let's say that a 12 kW air source heat pump has been installed in a property. The electrical input of the heat pump is only 3 kW. In this instance, the heat pump has a Seasonal Coefficient of Performance (SCoP)[16] of 4, meaning It is 400% efficient.[17] This figure, of course, is theoretical, calculated, and would depend on other factors, such as:

- The suitability of the building's heating system, and particularly whether it can impart sufficient heat at the low operating temperatures already necessary for peak boiler efficiency performance.
- The environmental factors i.e., outside temperatures etc throughout the year.
- The loads on the heat pump.

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The number of occupants of the building.

The hot water demand (if applicable) and its interplay with heating demand

The controls and the correct set up of weather compensation and set-back temperatures.

The consumer's understanding of how to use a heat pump and how this may be different to the way they previously used a boiler.

Every heat pump has a data sheet explaining exactly what the expected CoP is, but this will not necessarily explain what the running costs/efficiency of the heat pump will be. For this, we need to look at the Seasonal Coefficient of Performance or SCoP.

The SCoP is the measure of the heat pump over a full year considering the fluctuations and variations of outdoor temperatures based on the factors mentioned above and the average external temperatures that the heat pump is likely to experience. The installer must calculate this as part of the design process and share it with the customer.

What types of heat pumps are available?

There are several types of heat pump:

Air source

An air source heat pump takes heat energy from the outside air and transfers it to the water in a central heating system or hot water system. They are the most popular heat pump type in the UK and can work effectively even when the outside temperature is as low as minus 20°C. There are two types of air source heat pump:

Air to water — these are used to heat the water in central heating systems using either underfloor heating or wet radiator/convectors and can be either monobloc or split unit types.

Air-to-air — these use the heat from the environment to heat the air in a building via ductwork and fans in a similar way to air conditioning.

Ground source

These work in a very similar way to air source heat pumps but use a buried network of pipes called a 'ground collector' to extract the heat from the below the surface of the ground and transfer it into the buildings heating system. The pipes are buried about 1.5m underground and contain a mixture of water and antifreeze that absorbs the heat, which

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is then transferred through the evaporator, into the refrigerant. Here the vapour compression refrigeration cycle generates more heat as previously described by compressing the refrigerant to generate more heat.

Because the ground is at a fairly constant temperature all year round, ground source heat pumps are generally more efficient than air source types. Shallow ground loop systems require sufficient ground area to bury the collector, and the amount of area required will depend on the heat demand of the property served. Bore hole systems overcome this constraint but require drilling to typical depths of between 60m and 100m.

Water source

These are very similar to ground source heat pumps, except that the collector is placed in a source of water such as a lake, river, or ground water. There are two kinds of water source heat pumps:

Closed loop — this is a closed pipe or collector placed into the water to collect the heat energy.

Open loop — this is when the water is taken out of the source and passed across the evaporator before being returned to its source.

Can heat pumps be a direct boiler replacement?

This depends on how the heating system into which a heat pump is being fitted is already set up, and in each case the full room by room heat loss calculation that a qualified and competent installer should perform even when installing a condensing boiler, will provide the necessary information as to whether ancillary changes to radiators and / or other components is necessary.

If the heat pump is replacing a condensing boiler, functioning in high efficiency mode with return temperatures consistently below 55°C all year, it is likely a correctly-sized heat pump will operate efficiently with minimal changes to the system.

However, if a heat pump is being used to replace a boiler that is operating consistently above 55°C return temperature because any changes needed to radiators and pipework for efficient boiler operation were not made when that boiler was installed, then there may need to be considerable upgrades to that customer's heating system for a heat pump to be able to operate efficiently, unless it is a high temperature heat pump or a hybrid system. It is important however to note that this is not a unique property of installing a heat pump. Whilst a boiler may be able to mask the inefficiencies of failing to make the necessary changes to the heat distribution system to allow it to operate efficiently, it

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will do so by operating in non-condensing mode for much of the time, still resulting in considerable loss of efficiency and therefore higher fuel bills and carbon emissions from that property.

Why?

For us to be able to understand the answer to this question, we have to go back to the start of this article and look again at the 2022 version of *Approved Document L: Conservation of Fuel and Power*. This tells us that the flow temperature of any **new** heating system **cannot** exceed 55°C for all heat sources.

Approved document L states:

5.10 Where a wet heating system is either:

1. *newly installed, or.*
2. *fully replaced in an existing building, including the heating appliance, emitters and associated pipework*

all parts of the system including pipework and emitters should be sized to allow the space heating system to operate effectively and in a manner that meets the heating needs of the dwelling, at a maximum flow temperature of 55°C or lower.

Most existing heating systems in the UK were originally designed to work on a flow temperature from the boiler of 75°C to 80°C, with a return temperature of 60°C It was only after the introduction of the condensing boiler that flow/return temperatures needed to be reduced to increase system efficiency.

During that time, many properties still had single-glazed windows, uninsulated cavity walls and much lower amounts of loft insulation than today. Over time, some properties may have switched to double-glazed windows and have improved insulation and draught-proofing. However, there are cases the central heating radiators and pipework have remained as originally installed. This would mean the heat loss characteristics of many rooms would have substantially fallen compared to when the system was first installed. Therefore (for example) a radiator previously operating at 80°C/60°C flow/return may sometimes now operate at lower temperatures and still meet the new, reduced heat demand of that room.

A condensing gas boiler operates at peak efficiency when the return temperature is below 55°C.

Therefore, the only way to establish — for both condensing boilers and heat pumps — whether existing radiators are appropriately sized, is to conduct a room by room heat loss calculation to determine the size of radiator required for each room to be heated to

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comfortable temperature. The installer will then need to check to see if the incumbent radiators are suitably sized or need to be replaced with the correctly sized radiator. If this step is not completed, you have a high risk of the heat pump not being able to warm the room to required temperatures.

If an installer installed a heat pump with a maximum flow temperature of 55°C into a dwelling where the worst performing radiator required a flow temperature of 75°C to 80°C there would not be sufficient enough heat generated to provide the comfort levels expected/required by the consumer. This would be a poor installation that would fall short of the industry's standard, however competent installers should assess the room heat loss, existing radiator output and associated pipe size to understand the suitability of the existing system. It may only require the updating of one or two radiators to ensure efficient operation. If this protocol is not followed, then there is a risk that the heat pump will not operate at its maximum efficiency with increased running costs.

For new systems, first-time central heating or new-build, the suitability of heat pumps is easier to design-in, but the same approach applies. In every case a room by room heat loss calculation and correct sizing of radiators and pipework will lead to the most efficient operation and the lowest cost for the consumer. Given the low temperature requirements of condensing boilers, there is little difference in this regard between boilers and heat pumps.

Hot water demand and heat pumps

Around 70% of British homes use a combination boiler or 'combi' as their source of hot water.[18] Combination boilers heat the hot water supply 'on demand' when a hot tap is opened. There is no storage capacity. Heat pumps cannot provide instantaneous hot water supply and therefore a hot water cylinder is required, or alternative source of hot water.[19]

If a heat pump is replacing a combination boiler as the heat source for the central heating and hot water supply, the customer will also need a hot water storage system for the building's hot water demand, adding further costs to an already costly installation. It also brings the problem of where the hot water cylinder is going to be sited, as many dwellings no longer have an airing cupboard.

But there is another, more important issue surrounding hot water supply, and that is the temperature of the hot water itself.

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Some heat pumps work on a maximum flow temperature of 55°C and use an additional heating element to raise the water temperature to 60°C/65°C, once per week to comply with the legionella protection provisions of The Water Supply (Water Fittings) Regulations.[20] High temperature heat pumps operating with R290 refrigerant can have flow temperatures up to 75°C.

Insulation requirements

The first step for any consumer in reducing their energy bills or seeking to reduce their carbon emissions should be to take all cost-effective insulation and draught-proofing measures. This should be the case regardless of the choice of heating system. A better insulated home will have a lower heat demand, and this will mean a lower cost heating system regardless of whether a heat pump or a boiler is chosen.

However, there is considerable misinformed commentary that a heat pump can only work well in a well-insulated home. This is incorrect.

A correctly sized heat pump can meet any heat demand, provided that the radiators and other ancillary components are sized correctly in each room so that they can meet the heat loss requirements at temperatures that allow the heat source (heat pump or boiler) to operate at its best efficiencies. The same is also true for a condensing boiler if it is to operate in high efficiency mode for the majority of the time — the only difference being that a boiler can mask any inability to heat the room efficiently by operating at a higher temperature — less efficiently and therefore at greater cost, whereas a poorly-sized heating system and badly specified heat pump may not be able to provide adequate heat in the first place.

Anyone considering having a new heating installation should seek expert advice about insulating their home.

The older the building is, the higher its heat demand is likely to be, and therefore the more likely that its original central heating system will have been sized to accommodate a non-condensing boiler. If the building has not been subsequently retrofitted with energy efficiency measures, the combination of continued high heat loss and heat emitters compatible only with high operating temperatures will likely mean more of the system needs to be changed for either a heat pump or a modern condensing boiler to operate efficiently.

The following table shows the u-values of homes built to the building regulations stretching back 50 years.[21]

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U-Values over the last 50 years

Component	The Building Regulations 1972	The Building Regulations 1976	The Building (Second Amendment) Regulations 1981	The Building Regulations 1991	The Building Regulations 1991	The Building Regulations 2000	The Building Regulations 2000	The Building Regulations 2010	The Building Regulations 2010	The Building Regulations 2010	The Building Regulations 2010
	AD F 1972	**AD F 1976**	**AD F 1981**	**AD L1 1992**	**AD L1 1995**	**AD L1 2002**	**AD L1A 2006**	**AD L1A 2010**	**AD L1A 2013**	**AD L1A 2016**	**AD L Vol 1 2023**
External wall	**1.7**	**1**	**0.6**	**0.45**	**0.45**	**0.35**	**0.35**	**0.3**	**0.18**	**0.18**	**0.18**
Ceiling	1.42	1	0.6	0.45	0.45	0.25	0.25	0.25	0.13	0.13	0.13
Floor	1.42	0.6	0.35	0.25	0.25	0.25	0.25	0.2	0.13	0.13	0.11
Window	n/a	5.7	5.7	5.7	3.3	2.2	2.2	2	1.4	1.4	1.2
Door	n/a	5.7	5.7	5.7	3.3	2.2	2.2	2.2	1.4	1.4	1.0
SAP							2005	2009	2012	2012	2022
Pressure testing							10	10	5	5	5

AD = Approved Document of the Building Regulations

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These are the key elements of a building that are used during heat loss calculations. It shows that all of the u-values have reduced, meaning that our homes are much better insulated now than they were 50 years ago, and if we compared these figures against even earlier buildings, then it would soon become clear that work on insulating existing buildings is absolutely essential. Take a look for example, at the heat loss from external walls.

Based upon the Building Regulations, in 2023, an external wall will lose only 10% of the heat it did 50 years ago in 1972, because of the design of the wall, the materials, and the insulation the wall contains. Looking at the table, we could say that homes built under *Approved Document L1A 2013* would probably be heat pump ready (but advice should be sought to be absolutely sure). Before this date, as the figures show, some work on insulating the building will be required to bring the heat loss from the property down to where a heat pump is a viable alternative to a boiler.

In some cases, where the walls are of solid wall construction, like Victorian terrace housing for example, as much as £15,000[22] may need to be spent on upgrading the insulation to reduce the property's heat loss to levels more consistent with more recent construction standards. There is also the question of how the wall is insulated. Insulating older buildings can either be done by cladding on the outside (not an option for listed buildings where the outside of the building cannot be altered) or by adding insulation on the inside, which reduces the size of the room and may cause problems with interstitial condensation if not designed and installed correctly.[23] Some insulation internally may require a moisture barrier of some description to prevent interstitial condensation from occurring. In such examples, whether opting for a heat pump or a condensing boiler, upgrades to the heat distribution system such as changes to radiators and pipework to allow for efficient operation, may be less expensive than some of the higher cost insulation measures, and in both cases a professional assessment should be done of the heat loss characteristics of every room to provide the consumer with full information on the options available to them.

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In June 2021, the Department of Business, Energy and Industrial Strategy (BEIS) recognised that up-front cost is presently a barrier to widespread adoption of heat pumps:

> **Air source heat pumps are priced between £7,000 and £14,000 while ground source heat pumps, which get heat from holes drilled into the ground, cost from £15,000 to £35,000, with installation prices driven up further by the limited number of trained installers.[24]**
>
> **Heat pumps will play a crucial role in decarbonising how we heat our homes and buildings and helping to eliminate our contribution to climate change. We will achieve our goal of installing 600k heat pumps a year by 2028 through targeted regulation, working with industry and financial support, all of which will be set out in our upcoming Heat and Buildings Strategy.**
>
> **The Heat and Buildings Strategy will be published in due course and will include targeted regulatory, market-based, and public investment measures to incentivise low-carbon heat systems, which will help bring down costs.**
>
> *Build* magazine, June 2021

Heat pumps — in conclusion

There are still some challenges with the government's policy to place heat pumps, at least in the foreseeable future, at the heart of heat decarbonisation. As fossil fuel boilers have to be phased out in order to meet the UK's legally binding carbon reduction targets, there may well be properties where a heat pump is not the right appliance to install, or where hybrid heat pumps are appropriate instead as an interim measure.

According to UK government's own statistics, there are seven million terraced houses in the UK, most of which were built in the 19th century, making them the most popular house type in Britain and almost all are of solid wall construction.[25] The upgrades needed for such properties are not dissimilar for heat pumps as those required for an *efficiently performing* condensing boiler. In both cases cost-effective home insulation upgrades should be the first step because this will both reduce the peak heating requirements and increase the likelihood that the existing heating system can work at the lower temperatures needed for either heat pumps or condensing boilers to operate efficiently without the need for extensive replacement of parts of the central heating system itself. For those properties where it is more difficult or prohibitively costly to achieve a lower heat demand through energy efficiency measures alone, more of the central heating system is likely to need changing.

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This is the case both for heat pumps and if a condensing boiler is to operate efficiently, and it remains to be seen if these properties can be brought into the 21st century at a price that is affordable to the general public.

For new build properties, where the heating design for the house can be tailored to suit a heat pump installation. Modern building regulations require insulation levels that reduce the overall heat loss considerably compared to older properties, meaning negligible difference in cost between the radiators suitable for a heat pump and those suitable for an efficiently operating condensing boiler. Underfloor heating, which can allow for operating temperatures to be reduced even further, is also usually easier and cheaper in new build. However, the volume of new build homes each year means that they only represent a fraction of the UK housing stock.

Providing heat pumps to terrace housing may prove problematic.
Edith Avenue, Moss Side, Manchester

In conclusion, the sizing of the heat emitters is critical to the efficient operation of heat pumps, but this is also the case for condensing boilers to operate efficiently. In many cases, existing emitters may be adequate because those originally designed for high temperature operation were servicing the much higher heat demands that existed before measures such as double glazing and cavity wall and loft insulation were rolled out to the mass market. The key to ensuring either a boiler or a heat pump is fit for purpose is for a room by room heat loss calculation to be correctly performed every time an existing boiler is removed so its replacement is sized correctly, and any ancillary changes to the rest of the system made to ensure the consumer gets the most efficient performance out of whichever replacement they chose.

The good thing is that heat pump technology is improving all the time, with new models being much quieter than their predecessors, giving better outputs with even greater SCoPs. Heat emitter technology also continues to improve with better heat outputs for a smaller surface area, and much more aesthetic designs bringing heating truly into the 21st century.

CHOICE THREE:

Hybrid systems

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CHOICE THREE

Hybrid systems — bivalent heat pump systems

Sometimes called a 'dual fuel' system, a hybrid system uses two heat sources, usually an air or ground source heat pump and a gas or oil condensing boiler to heat the home and the hot water supply.[26] They are usually installed in properties that have a requirement for peak heat demand that cannot be met cost-effectively using low operating temperatures, or where a single heat source, such as a heat pump, cannot provide enough heat to consistently warm the property.

We must remember that a heat pump works much better and more efficiently in the 40°C–45°C temperature regime. The vast majority of homes that were constructed before the 1960s are sometimes not very well insulated and there are still lots of properties out there that still do not even have cavity wall insulation. For many older properties, the only upgrades they have had are double glazed windows and doors, and many still lack decent loft insulation.

The Energy Saving Trust suggest that large properties where 'insulating is either impractical or too expensive', may benefit from a hybrid system.[27] This is especially true where the heating demand exceeds 14kW, as this is the largest heat pump that can be installed on a domestic single phase electricity supply, but it must be borne in mind that a heat pump on its own MAY NOT provide savings on the combined gas and electricity bill in every situation. It may be possible to upgrade the electricity supply to a three phase supply to allow the installation of more than one heat pump, but generally upgrading to a three-phase electricity supply proves too costly at between £3,000 to £15,000.[28]

How do hybrids work?

A hybrid heating system uses controls to switch between heat sources depending on which is the most economical to run at the time. Like all heat pumps and weather-compensated boilers, it monitors the outside temperature conditions. When the temperature

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outside drops below the point the heat pump can maintain reasonable efficiencies, the boiler will provide supplementary heat as required. The temperature at which this happens will depend on the size of the heat pump, the required flow temperature and, in well-optimised systems, take account of the difference in the customer's retail price paid for gas and electricity respectively. A properly calibrated control system will ensure the boiler is only used when it is cost effective to do so, taking account of the above parameters.

There are two likely configurations for hybrid systems:

Using the boiler to 'top up' the system during very cold weather when the heat pump cannot cost-effectively supply the heat required to warm the property, or a top up of temperature of the hot water to 60°C is required for sterilisation of the hot water storage cylinder.

Separation of heating from hot water demand. By doing this, it may be possible to install a combination boiler so that a hot water storage cylinder installation is not required, but the system can still benefit from a boiler heating 'top up' if necessary.

What are the pros and cons of hybrid systems?

The majority of existing heating systems installed in the UK prior to condensing boilers becoming mandatory in 2005 were designed for a water temperature of 75°C with an external design temperature of -3°C with heat emitters sized accordingly. They were designed to be 'intermittent' in operation. In other words, coming on for, say two hours in a morning and four hours in an evening. They are not 'on' 24/7. During the 'off' periods, the house would then gradually lose heat throughout the day until the temperature is around 5°C below a comfortable temperature of 21–22°C. Some controls are designed to initiate the heating system if the house falls below 15°C. This is known as the 'set back' temperature, and the boiler will keep the property at this temperature until it is timed to come on and warm the house up to 21°C again.

Installing a heat pump with its maximum temperatures of around 45°C on a system whose emitters still require 75°C would unlikely be able to provide sufficient heating, causing the consumer to use less efficient forms of heating being used to supplement the heat shortfall, leading to more carbon being emitted in the long run.

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There will be times, however, when the outside air temperature is higher that the design temperature of -3°C. At these times, the desired room temperature can be achieved using the heat pump alone with very little in the way of efficiency loss. If the heating system was initially sized correctly, then external temperatures around 7°C will allow the heat pump to be effective with the existing heat emitters with no costly upgrades.

One of the major advantages of a hybrid system as a stepping stone to future decarbonisation options is that it can allow for installation of a heat pump without the immediate need to make alterations either to the existing system/hot water system or the fabric of the property itself. Indeed, it is possible a heat pump could be installed that, once fabric improvements are eventually made, will mean the boiler component of the system subsequently no longer runs or can be removed, but without the consumer having to incur all the up-front cost of those improvements at the start.

Another significant advantage is the use of heat pumps in conjunction with combination boilers. With a hybrid system, a heat pump can be used for the majority of space heating without the immediate need to install a hot water storage system — which could be added at a later date when required or when more affordable. A heat pump and a combi boiler on can be used on the same system, making use of the instantaneous hot water side of the combi, meaning that costly and space encroaching hot water storage systems are not required. With this arrangement, the heat pump would heat the property while the outside temperatures aren't too cold, but heating is still required, utilising the combi boiler to heat the property during cold spells weather and initially using the combi to service hot water needs.

All this, with very few modifications to the property, adds up to a win-win[29] situation:

- Better energy efficiency
- Lower heating bills
- Reduced carbon footprint for the property

On the downside:

- The system is not totally renewable with some reliance on fossil fuels.
- Higher up front costs when compared to a standard boiler replacement.

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Controlling hybrid systems

Modern hybrid controls allow for the heat pump to be the prime heat source with the boiler picking up the heating requirement when the temperature outside dictates that the heat pump is no longer the most cost efficient heat source.

Typically, hybrid systems will have the following controls as a minimum:

- An external weather sensor to monitor external temperatures.
- An internal temperature controller to control the internal temperatures.
- The ability for a central controller to control both the heat pump and the boiler.
- For the controller to have required time and temperature control, and be left to decide and optimise running times.

Hybrid system costs

The cost of installing a hybrid system varies considerably and depends on the following factors:

- Is the existing boiler is sufficient?
- Will both a new heat pump and a new boiler be required?
- Is stored hot water is required or is a combination boiler is being considered?
- Where is the heat pump being installed in relation to the position of the boiler?

The heat pump should be able to provide the heating needs for the property around 70% of the time and in most cases this will require a heat pump of around 6 kW output.[30] If a condensing combination boiler is also being installed, then a 30 kW model should be adequate to provide heating and good hot water flow (the advice of a professional should be sought regarding appliance sizes). Considering the purchase of two new appliances and installation costs on to an existing system with adequately sized heat emitters, the cost of a hybrid system could be in the region of £8,000 to 10,000, and possibly more if an unvented hot water storage cylinder is required.

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Hybrid systems — in conclusion

Potentially, in the short term, a hybrid system *may* be the answer to many people's prayers, especially where it is impractical or unaffordable either to upgrade emitters or to improve insulation to achieve the lower flow temperatures that allow heat pumps to perform at their best. The 55°C maximum flow temperature, as dictated by *Approved Document L vol. 1 Domestic Properties*, does not apply since only the appliances are being replaced. However, we must be mindful of the government's ambition for 2035 that and the no further gas boiler installations will be permitted.

Hybrid systems may well have a place — they can buy the consumer time and allow them to spread the cost of any energy efficiency improvements and other heating system upgrades that might be needed to allow for heat pumps to perform to their best efficiencies. This means making a home fully heat pump ready can be completed at a steadier pace, over a period of years not weeks or months, spreading the cost and helping with family finances, while, all the time, saving money on heating bills.

Hybrid Heating Europe — a vision is a document written in 2021. It details some crucial points about hybrids that should be considered by anyone looking at upgrading their heating system in the very near future.[31] It says:

Hybrid systems offer lower and more spread out investment and a lower cost heating bill

Investment in hybrid heating can be relatively modest, especially if the existing boiler is being used.

They require no immediate deep renovation measures.

They can significantly reduce energy bills

They allow a gradual more measured building renovation

Hybrids offer 'the best of both worlds' by keeping the technology we know, whilst dipping our toe into the technology of the future. They offer a method of paving the way to a fully heat pump system, whilst pacing the way in which we do it.

CHOICE FOUR:
Biomass fuels

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CHOICE FOUR

Biomass fuels

What is biomass?

Biomass is a biological material that originates from living or recently living organisms. When used as a fuel for electricity generation or heat production, the term 'biomass' usually refers to plant materials such as wood, grasses, crops, and food wastes.[32] It is not a zero-carbon fuel, simply because the raw materials that make the biomass fuel are derived from organic life and all life on Earth is based on carbon. When they are combusted, they release carbon dioxide. In theory, Biomass can be said to be carbon neutral because it only releases the carbon dioxide that the plant/tree has taken in during its lifetime. However, in reality, biomass is a *low* carbon fuel because of the carbon emissions associated with its extraction, processing into fuel and transportation to the end user.[33]

The types of biomass appliances

For the domestic market, there are two types of appliances:

Biomass boilers

These can provide both whole house heating and a plentiful supply of hot water. There are two basic types:

Log boilers — stoked by hand, these are available in outputs ranging from 20kW to 50 kW.

Pellet boilers — automatic fuel feed is generally incorporated into the design of pellet boilers via a pellet hopper or a worm screw taking the pellet fuel direct to the fuel bed. Pellet boilers, generally, have outputs ranging from 8 kW to 30 kW.

Wood burning stoves

Generally speaking, these provide space heating for individual rooms up to 7 kW. Wood burning stoves generally burn logs, but some are available that will burn pellets also (pellet stoves are eligible for the

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governments Renewable Heat Incentive scheme). Models are available that will provide some hot water. They are around 60% to 80% efficient.

Biomass boilers are best suited to 'off-gas grid' situations where they are the ideal replacements for oil, LPG and solid fossil fuel (coal) boiler installations. There are, currently, 1.1 million such installations in the UK.[34]

In towns and cities, biomass is not such an attractive prospect. Many local governments prohibit the use of certain fuels based on their emissions and air quality regulations in force.[35] However, providing the boiler being installed is on the Exempt Appliances List, then there is no reason that a biomass boiler cannot be installed in a city, providing there is ample space for fuel storage and access for fuel deliveries. In these instances, planning permission may be required, so advice should be sought from your local planning office.

Biomass boiler installation costs

Biomass boilers are expensive. According to some sources, installing a biomass boiler could cost around £12,000.[36] In some instances, the installation could be as much as £19,000. However, biomass is a renewable energy source and, as such, government schemes are available to mitigate some of the cost.

The Renewable Heat Incentive (RHI) provides financial support of between £2,000 and £3,500 each year for a period of seven years. This rebate amounts to between £14,000 and £24,500 (12.2p per kWh). There are caveats, of course, insomuch that the installation must be MCS approved (MCS currently only covers installations up to 45kW).

The environmental cost of biomass

Researching the environmental impact of biomass brings a plethora of websites, many extolling the virtues of burning biomass, others bemoaning the cost to the environment. The fact of the matter is, whether we like or loathe biomass, we are burning a carbon based material that releases carbon dioxide as a by-product of producing heat into the atmosphere. On top of this, other solid airborne particulates are also released, such as fly ash and other volatile organic compounds.[37]

Consider the following analogy — if a 100-year-old tree dies, it will fall to the ground and decompose releasing slowly into the atmosphere 100 years' worth of CO_2 that the plant absorbed as part of the photosynthesis process. It may take as long as 90 years for the tree to fully rot away.[38] In this way, the CO_2 the tree holds is released slowly over the time it takes for the tree to fully decompose, allowing time for the CO_2 to be reabsorbed into the surroundings.

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When we combust the tree, the CO_2 is released in the time it takes for the tree to burn, releasing the same amount of CO_2 quickly, producing a glut of CO_2 that will take years to be reabsorbed by other trees and plants. This is known as the carbon debt[39] and adds exponentially to the parts per million (ppm) of CO_2 currently in the atmosphere (currently 423.06ppm).[40]

Deforestation is another issue surrounding biomass. Not all of the UK's needs for biomass can be satisfied using wood waste and other surplus timber sources. Some will undoubtedly come from mature trees due to deforestation, especially the forests of Canada.[41] Deforestation leads to habitat loss, loss of eco-systems, soil erosion, loss of soil nutrients and a decrease in water resources.

Many scientists argue that this is the environmental cost of using biomass as a form of energy.

Is the combustion of biomass harmful to humans?

The combustion of biomass can impact local air quality, especially in those areas where air quality is already a concern. This can contribute to health problems.[42] Burning any type of wood releases microscopic particles of soot (known as particulate matter or PM) and gases, such as carbon dioxide (CO_2), carbon monoxide (CO), and nitrogen oxides (NOx) into the air, which can accumulate.

According to the Energy Saving Trust, the biggest concern surrounds traditional log stoves, especially when these are used inappropriately.[43] Emissions can penetrate directly into the home creating an unhealthy environment whenever the stove door is opened for cleaning and refuelling.

The recommendations are:

- Use reputable companies to install your stove and flue system.
- Use only dry wood to ensure that complete combustion of the fuel talks place.
- Have the flue swept regularly to ensure that pollutants are drawn away from the living space.

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Generally, emissions from pellet boilers are lower than those from wood burning stoves, and because boilers are housed in separate boiler rooms, there is less chance of emissions entering the living space. It must be realised, however, that there are emissions with all forms of biomass appliance. Because of this, the implications of investing in a biomass system must be considered with care, especially in areas where poor air quality is already an issue.

Biomass systems — in conclusion

It is obvious that biomass has a place in the UK home heating strategy, especially for those systems installed in the more remote areas of the UK where the emissions from biomass combustion may be less of an impact of air quality or the environment. In its Biomass Policy Statement, the Department for Business, Energy, and Industrial Strategy (BEIS) states:

Biomass has a role in decarbonising certain properties, such as off gas grid homes that are unsuitable for heat pumps or where there are no other alternatives, and where appropriate mitigations can be set in place to minimise air quality impacts.

It continues:

We recognise that not every home off the gas grid will be suitable for a low temperature heat pump, and these will require an alternative low carbon heating solution that is consistent with the pathway to net zero and wider government objectives on environmental sustainability and air quality. We anticipate in most of these cases, high temperature heat pumps and solid biomass will be suitable alternatives.

Department for Business, Energy, and Industrial Strategy (BEIS)

CHOICE FIVE:

Electric boilers

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CHOICE FIVE

Electric boilers

Electric boilers have been on the market for some years and are a good solution for small sized heating/hot water systems up to 12 kW (for single phase electricity supply) and 24 kW (for three-phase electricity supply).

Unlike gas boilers, electric boilers only use electricity to heat the radiators and hot water storage (combination models, supplying instantaneous hot water, are available).[44]

The downside to electric boilers is the fact that they are only suitable for small/medium properties because of the limitations with the domestic electricity supply to most dwellings.

How do they work?

Electric boilers work in much the same way as a gas boiler but uses electricity instead of carbon dioxide producing gas/oil. They are 100% efficient and, provided the electricity supply is generated using green technology, they are classed as a zero carbon technology. They work by heating water via an electrical element inside a heat exchanger. The heated water is then pumped around the heating system in exactly the same way as a gas/oil boiler. Thermostats control the temperature of the water. There are several different types[45] of electric boiler:

Direct acting

The simplest form of electric boiler. These heat water on demand just like a combi boiler.

Storage electric boiler

These take advantage of stored water either built into the unit or in a separate storage vessel. Cheap rate electricity can be used to heat the water over night. These models are larger and more expensive than direct acting types.

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Electric Combined Primary Storage Units (CPSUs)

These hold lots of water which they can heat very quickly. Seldom found in domestic properties and are more suited to the commercial sector.

Dry core storage boilers

These work quite differently from normal electric boilers insomuch that the use cheap rate economy 7/10 electricity during the night to store heat in thermal bricks held in the boiler in much the same way as an electric storage heater. The difference here is that the heat in the bricks is used during the day to heat radiators and hot water storage vessels.

The pros and cons of electric boilers

An attractive feature of electric boilers is that there are no emissions of any sort at the dwelling, and when comparing efficiencies with gas boilers, fewer units of energy are required to produce the same amount of heat. Another attractive feature is the lack of moving parts, which drastically reduces the risk of boiler breakdown.

Electric boilers are very quiet in operation and can virtually be placed anywhere in the home without the fear of noise. There is also no need for an external wall as there is no flue to worry about.

On the downside, electric boilers are expensive to run, relying solely on electricity supply. Electricity is generally more expensive than gas per kW/h.

Although more efficient than gas boilers, electric boilers are less efficient than heat pumps. However, they are less expensive buy and install and will still benefit from a well-insulated home as this will lower the output of the boiler required.

It must also be remembered that they are not suitable for large dwellings with a high heat demand.[46]

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Electric boilers — in conclusion

As gas boilers are phased out over the next 12 years or so, electric boilers will have a part to play in their replacement, of that there is little doubt. They have several qualities[47] that make them attractive gas boiler replacements:

For any home that is not suitable for heat pump installation because of, say, a lack of outdoor space, then electric boilers may be a good alternative.

Installations in flats and apartments where gas appliance would be difficult to install and maintain.

Off-grid installations as replacements for oil and LPG boilers.

For those customers looking for a zero carbon option but cannot afford heat pump technology.

Running costs can be offset by the use of solar photovoltaic (PV) panels during the day and may further be assisted by domestic battery storage.

Clearly, at the present time, gas boilers are much cheaper to run than electric boilers and are available in greater outputs, but this may not always be the case. As gas supplies dwindle and the UK government shifts from all types of fossil fuels, an alternative to heat pumps for home heating must be allowed to be available from a choice perspective, and electric boilers might be the way forward for many UK households. The 100% efficiency and zero carbon tag must surely make them an attractive proposition for those households whose finances are tight. It may still be the case that some insulation of existing properties to bring the heat loss into a reasonable regime, thus lowering the output of the boiler required. Even so, based purely on purchase costs and installation costs, electric boilers are worth a second look. However, it will be the running costs of electric boilers that will probably dissuade people from considering them,[48] and the decision to install one must be made with eyes wide open.

CHOICE SIX:

Electronic storage heaters

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CHOICE 6

Electric storage heaters

Electric storage heaters store heat generated by the use of cheap night electricity. The heat is stored in special heat retaining ceramic or clay bricks and released during the day to warm the room. They are designed specifically for those properties that have either Economy 7 or Economy 10 electricity meters installed. These give a much cheaper rate of electricity during certain overnight hours (usually midnight to 7am[49] but these times can vary depending on summer/winter clock times).

Provided the electricity supplier offers Economy 7, anyone can switch by contacting their provider.[50]

How many heaters would I need?

Generally speaking, if storage heaters are replacing wet radiators, then the same amount of heaters would be needed as there are radiators. These should only be installed by a competent electrician as they would need to be connected to two circuits. The other factor that should be considered is the weight of storage heaters as some models can be extremely heavy.

Electric storage heater cost

Storage heaters vary massively in price. Some basic models can cost as little as £150 but up-to-date versions can cost £500 plus. The more expensive they are, the more efficient they are, and this means that they are cheaper to run. However, it must be remembered that installation costs vary, and the installation alone could cost up to £1,000 per room.[51]

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Estimates for the running costs of electric storage heaters vary wildly with some estimates approaching £70 per calendar month for a single heater. However, the website electricheatingcosts.com gives the following figures for popular sized storage heaters:

Running costs of popular storage heaters, based on an example off peak electricity cost of 5.5 pence per unit (kw/h)

850w (0.85kw) storage heater = £0.327p per seven-hour period (33p per day when charged on Econ 7 at night)

1700w (1.7kw) storage heater = £0.654p per seven-hour period (66p per day when charged on Econ 7 at night)

2550w (2.55kw) storage heater = £1.249 per seven-hour period (£1.25p per day when charged on Econ 7 at night)

3400w (3.4kw) storage heater = £1.309 seven-hour period (£1.31p per day when charged on Econ 7 at night)

Obviously, it is always better to check with the electricity supplier beforehand and seek their advice. There may be other alternative tariffs that they are offering which brings the cost down further. They may even have their own purchase and installation scheme.

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How efficient are electric storage heaters?

According to EDF Energy, modern night storage heaters are 100% efficient because all of the electricity used is generated into usable heat,[52] and like electric boilers, provided the electricity comes from renewable sources, they are completely zero carbon. Older heaters are not so efficient and anyone with older storage heater models should consider upgrading to make the most of the electricity being used.

Modern heaters contain sophisticated controls making the release of the heat into the room much more economical and targeted. Controls such as automatic charge control, thermostat and programmer literally control the heater without any user input, except for slight adjustments where necessary. Other controls include:

Input dial

This controls the amount of electricity used and, therefore, how much heat is available for use.

Output dial

This controls the release of the heat. The higher it is set, the faster the heat will be used.

Boost

This is generally optional on some heaters. It must be remembered that using the boost during the day will result in full tariff electricity being used — and that is very expensive!

Electric storage heaters — in conclusion

Electric storage heaters have been around for many years and really came into public consciousness in the mid 80s and Economy 7 housing. Here, well insulated timber framed houses were built with no gas supply and just electricity for cooking, hot water (Economy 7 cylinders with double thickness polyurethane insulation and top/bottom immersion heaters) and electric storage heaters for the household heating needs. They proved to be expensive properties to run.

Now, with the advent of sourcing gas heating alternatives, storage heaters are once again being considered for whole house heating.

There are some good, efficient models on the market and a well-insulated property may well benefit from a storage heater installation. Again, as with electric boilers, the zero carbon tag may appeal to some people, but it should always be remembered about the running costs.

Conclusion

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Conclusion

Choosing a heating system used to be so easy! If you lived in a town or city, gas was nearly always the first choice. Readily available and piped right to the door, gas was always there, always reliable. Very rarely did it go wrong and when it did, there were any number of plumbers and gas engineers ready and willing to affect a repair, 24 hours a day, seven days a week.

But times change. Soon, and maybe within our lifetime, gas boilers will slowly become a thing of the past, confined to the history books as the UK releases its grip on fossil fuels. And slowly, as those boilers breakdown or simply become obsolete, we must choose a new source of heat to ensure our homes remain healthy and thermally comfortable.

For some people, that choice is going to be a hard one. There are so many conflicting stories, so many contradicting experts and, as it turns out, not enough qualified engineers. The UK government has a vision that 600,000 heat pumps a year should be fitted by 2028. It is a vision that they hope the UK population will share.

Yet the general public remain too confused to choose. Should I go for a heat pump? Should I wait for Hydrogen? Are hybrids all they are hyped up to be? The questions just bring more unanswered questions. The net effect, of course, is that the 600,000 heat pump installation dream will be just another missed target.

Sense and sensibility dictates that we should be choosing heat pumps. The UK government certainly thinks so. Their efficiencies alone are hard to ignore but so are the costs of insulating the home to a degree where a heat pump becomes viable, especially when there are other less expensive heating methods on the market.

And so, it comes down to one question. Are heat pumps the right choice for your heating solution? This is the choice only the homeowner can make. Times change, and that's a fact! And if we are to embrace a zero-carbon future, so must we.

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