

Residential Heating: The journey to **Net Zero**

Up to

70%

of EU homes'
energy use results
from heating



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Overview

Following the first Danfoss whitepaper, The Challenge of Net Zero for the Heating Sector, this companion document focuses on key drivers and potential pathways to a carbon neutral future for residential heating in both the new build and renovation sectors.

With a primary focus on the UK, it looks at how legislation and possible Government-backed schemes and incentives can assist in achieving this target and explores a selection of current and future technologies in the bid to move home heating towards the ultimate goal of Net Zero by 2050.

**90% of the energy
used for heating
Europe's homes and
buildings currently
comes from fossil fuels**





Background

Drawing on expert industry data, the first white paper considered the reasons why heating is considered one of the biggest challenges to bringing all gas emissions to Net Zero by 2050 – a goal set by UN member countries in the 2015 Paris Agreement at COP21. To illustrate the challenge, figures compiled by the not-for-profit organisation, Euroheat & Power, indicated that heating homes and buildings accounts for more than 50% of all carbon emissions in Europe. Furthermore, industry research estimated that around 90% of the energy for this sector currently comes from fossil fuels. In the light of this data, making the transition to more sustainable energy sources is clearly going to be a massive challenge for the heat supply chain. It will require an unprecedented step change – or what might even be described as a revolution – to displace our reliance on carbon-emitting fuels to heat our homes. There's no doubt that there needs to be a radical shift in the energy system and a scaling-up of alternative energy sources if we are to achieve Net Zero in residential heating.

A report from the Committee on Climate Change (CCC), which provides advice to the UK Government on building a low-carbon economy, acknowledges that major infrastructure decisions need to be made in the near future and quickly implemented to achieve the 2050 deadline. On a positive note, the report references some of the large-scale transitions that have been successfully achieved in the UK before, such as the natural gas switchover in the 1970s or the switch to digital broadcasting in the 2000s.

In addition to these examples, in 2005 the UK heating industry undertook a huge programme to switch the 1.4m boilers installed each year to more efficient, condensing models. Whilst this was a step in the right direction, to achieve carbon-neutral heating in 30 years' time the energy industry must now take much bolder action. It has to fully embrace low-carbon technologies, such as heat pumps, district heating and low-carbon gases, and reduce overall demand for energy through improved efficiency.

Drivers

Heat, and residential heating in particular, has been identified as a 'difficult' area to decarbonise, mainly because of the high energy requirements and the wide distribution of emissions points (such as the gas boilers in individual homes). However, we know that the technology needed to warm our homes without producing carbon dioxide already exists – so emissions from domestic heating could be completely eliminated now – but of course it's not that simple. Getting from where we are now to where we need to be on the roadmap to carbon neutrality will have wide-reaching economic and societal impacts. It will affect energy providers and associated stakeholders, housebuilders and developers, property owners, national and local government planning and policy makers, the heating industry itself and, of course, consumers.

Minimising the cost and disruptive impact of transitioning will be key to achieving Net Zero. An increase in public and private investment in sustainable energy infrastructure and distribution networks will be essential; while behavioural economics could also play a role in understanding consumer attitudes towards their energy use. Getting Government to commit public funds to green energy infrastructure amid the economic impact of the Covid-19 pandemic is likely to be a further challenge. As the UK faces its deepest recession on record it will need significant market and policy drivers if carbon neutral housing is to become a reality by 2050.

According to the Committee on Climate Change homes, both new and existing, account for 20% of greenhouse gas emissions in the UK. Among the policies seeking to drive residential heating towards Net Zero in the UK are the proposed Future Homes Standard, SAP methodology, Building Regulation Part L (and F), and Boiler Plus.

Current situation in EU homes



48 – 69%
of the total home energy use in EU homes accounts to heating.



500 million
radiators in EU homes are still fitted with uncontrolled radiator valves.



250 million
radiators in EU homes with TRVs older than 20 years.

Saving potential in EU homes



29 MtCO₂
greenhouse gas emissions reduced every year which is equivalent to the emissions of 15 million cars.



12 bln EUR
is the amount of money EU citizens can save on the energy bills per year.



160 TWh
could be saved per year in EU homes.



18%
average energy savings potential across EU homes.

“ Getting Government to commit public funds to green energy infrastructure amid the economic impact of the Covid-19 pandemic is likely to be a further challenge. ”



Future Homes Standard

Due to be introduced in full in 2025, the Government's Future Homes Standard (FHS) focuses on new-build dwellings as the first step towards decarbonisation of heat. It anticipates that the installation of heat pumps will play a major role in delivering low carbon heat for homes built to the FHS. Heat pumps come with the same low-carbon benefits as direct electric heating, but can deliver heat much more efficiently, which can help to overcome the affordability and grid-resource constraints typically associated with direct electric heating.

However, taking the UK as an example, the installation of heat pumps would have to be stepped up considerably over the next thirty years to achieve Net Zero. New build homes offer an opportunity to kick-start this process, particularly in the light of the Government's plan to ban the installation of fossil-fuel heating systems, primarily gas and oil boilers, in any new build dwellings from 2025.

Whilst FHS is seen as a good starting point not everyone is convinced it goes far enough. At present, housebuilders can build homes to the standard in force when they start work on a development, even if new standards are introduced before it is finished. Some are calling for Government to take action now and, if necessary, incentivise housebuilders and developers to future-proof planned developments or those currently under construction. Ensuring they are FHS-ready, rather than waiting for new standards to come into force, will avoid the cost and disruption of retrofitting homes in, say, 20 years' time.

Implementing this more forward-thinking approach will require a greater focus on the design of heating systems, such as ensuring installations are designed for the lower temperature operation of sustainable energy solutions, including heat pumps and District Energy Networks (DEN). This may be in the form of fitting over-sized radiators with a larger surface area to take account of lower boiler heat output, or the use of hydronic underfloor heating where feasible.

Heating installations in new homes could also be designed to make it easier to swap to hydrogen-compatible boilers, for example, in the future. Whilst it addresses some of the issues for new homes, FHS in its current form does not take account of the millions of gas (and oil boilers) being used to heat existing UK homes.

This is a major challenge in achieving Net Zero and will require a huge overhaul in residential heating systems to be compatible with sustainable energy solutions, whether that's hydrogen gas, heat pumps, or connecting communities to new district heat networks.

Needless to say, the least disruptive, and costly, options are likely to be the most attractive to this market. These might include hydrogen boilers that could use existing pipework, or air source heat pumps (combined with electric radiators) rather than ground source versions that require pipes to be buried underground.

“Some are calling for Government to take action now and incentivise housebuilders and developers to future-proof planned developments.”



SAP

SAP (Standard Assessment Procedure) was first introduced in 1995 to assess and compare the energy and environmental performance of buildings to make sure that any new developments will not only meet Building Regulations but also all energy and environmental policy initiatives. Although not being used in an official capacity as yet, the latest version (SAP 10) was released alongside the Government's proposed changes to Part L and is helping designers plan their new housing specification in readiness for the new regulations, which are likely to treat sites using electric heating systems – especially heat pumps – more favourably.

Looking further ahead, in April 2020 the SAP Industry Forum (used by Government to gain feedback about potential policy options relating to SAP) published its final report on what the priorities should be for the development of SAP 11 and beyond. It covers key areas where it anticipates future technologies will be key in the energy use of a home, which include domestic hot water and heating, overheating and cooling. Whatever the next version includes, any changes to SAP will need to update the methodology to ensure it better reflects the greening of the grid and the growing use of renewable energy.



The FHS incorporates proposals for revising Part L and Part F to encourage faster implementation of the new energy efficiency requirements.



Building Regulations

The Future Homes Standard incorporates proposals for revising Building Regulation Part L and Part F, including making them easier to navigate, together with changes to transitional arrangements to encourage faster implementation of the new energy efficiency requirements.

However, some industry experts, including the Chartered Institution of Building Services Engineers (CIBSE), have concerns that the proposals for Part L 2020 do not represent the necessary 'meaningful and achievable step' towards zero carbon.

They also feel the timeline and content of the FHS is not ambitious enough and believe Government should deploy FHS now, rather than wait till 2025. Early certainty about the content and implementation of this standard might help drive market leaders to adopt it early, and incentives could be introduced to further promote early adoption.



Boiler Plus

(Addendum to Building Regulation Part L)

Launched in April 2018, Boiler Plus encourages energy efficiency by mandating requirements for domestic heating systems when these are updated. As the name suggests, the focus is on gas combi boiler performance, which is currently set at a minimum of 92% ErP. The ErP Directive aims to phase out poorly performing products across a range of product groups to reduce carbon emissions across Europe. To further increase efficiency, Boiler Plus requires all those fitting combi boilers to include one of the following in their system:

- » **Flue gas heat recovery systems**
- » **Weather Compensation**
- » **Load Compensation**
- » **Smart controls featuring automation and optimisation functions**

The Boiler Plus policy was delivered collectively through the platform of the Heating and Hotwater Industry Council (HHIC). The Council believes that mandating certain controls, such as programmable timers and modern thermostats, has encouraged innovation within the industry and raised consumer awareness of the various options for enhancing the efficiency of their heating system. However, we know that many professional installers were already fitting the technology specified in Boiler Plus, so was it simply catching up with existing industry practice?

There is a broad range of opinions regarding Boiler Plus, with some feeling that it went too far and others suggesting it didn't go far enough. Progress is, of course, a moving target and standards need to be continually reviewed to keep pace. As far as Boiler Plus is concerned, there are a number of areas that could be extended, such as applying the standards beyond the combi boiler market and making them mandatory for new-build heating systems and system boiler installations as well as the replacement market.

Extensions could also include annual boiler servicing, to help ensure boilers are working at optimum efficiency and safety, and installation best practice such as hydraulic balancing. Despite being a vital factor in heating efficiency and consumer comfort, only 18% of the 750 UK installers who responded to the Boiler Plus consultation claimed to undertake system balancing as a standard practice. Although Boiler Plus did not include mandatory system balancing, the policy document did state that it might seek to enforce this at a future date, and advised installers who are not familiar with this practice to address this particular skills gap.



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Options

In its first white paper, The Challenge of Net Zero for the Heating Sector, Danfoss considered a variety of potential solutions for making the necessary step change in the way we heat our homes. These ranged from short-term measures that are available now to longer-term solutions and future technologies. With the focus on residential heating in this companion document, Danfoss takes a look at some of the options for new and existing homes. This includes a growing role for clean electricity generation and low carbon gases such as hydrogen and the development of heat networks for distributing and connecting homes to sustainable energy sources.



Gas boilers

According to the non-profit organisation and think-tank, Energy and Climate Intelligence Unit, around 80% of UK homes are heated with natural gas - a higher dependency than many other countries. This is mainly due to the development of North Sea reserves, which are now dwindling - another reason to decarbonise the UK's heat supply. Under FHS, the Government has committed to phasing out the installation of high carbon fossil fuel heating in new properties from 2025. Until then, however, many more domestic gas boilers will no doubt be fitted.

In its report on reaching Net Zero in the UK, the CCC highlights the needs for extensive changes, including the potential development of a hydrogen economy to service demands from industrial and domestic sectors, including residential heating. On paper, hydrogen-compatible domestic boilers could offer a relatively inexpensive replacement for the millions of existing gas boilers in people's homes.

There are, however, many practical and technical considerations associated with transitioning UK domestic properties from natural gas to 100% hydrogen, including adapting the existing gas grid to run on a low carbon gas like hydrogen. Converting existing homes would require, at the very least, a survey of pipework condition and potentially unsuitable legacy materials. This could be minimised for homes currently under construction if they were designed to be hydrogen-ready. When, or perhaps that should be if, this technology does become a reality, a Government-backed scrappage scheme might be a useful way to incentivise householders to swap their existing gas boiler for a hydrogen appliance.



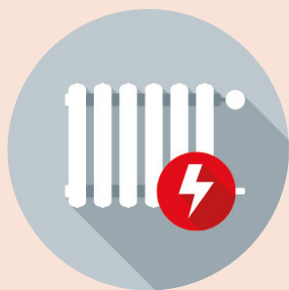
Electrification

In the UK there are an estimated four million households without access to mains gas. As the electricity grid becomes greener with increased use of renewables, such as wind and solar, it seems likely that electric heating will become one of the cleanest heat sources in the move towards Net Zero. Domestic electric heating options include:

Heat pumps

Heat pumps are among the UK Government's preferred low carbon solutions. Although heat pumps still have some impact on the environment as they need electricity to run, an Air Source Heat Pump (ASHP) will typically produce around 3kW thermal energy for every 1kW of electrical energy consumed - and there is the potential to use solar thermal technology and solar PV arrays. In addition, the heat that the pumps extract, whether that's from the air, ground, or water is constantly being renewed naturally. To explore the role of electrification, and heat pumps specifically, in low carbon housing, the Electrification of Heat Demonstration Project (part of the Government's Energy Innovation Programme) will install and monitor hundreds of innovative heat pump systems across a representative range of housing archetypes, with the majority on the gas grid. The project is expected to run until March 2022.

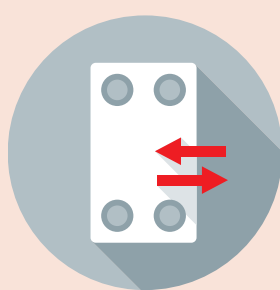




Electrical Underfloor Heating and Electric Radiators

Combining electrical floor heating, such as the DEVI system from Danfoss, with a renewable energy source like solar power cells is a strong alternative to other environmentally-friendly heating solutions, particularly for new homes with a high degree of insulation and low energy consumption.

When used with renewable energy, modern electric radiators can also offer a sustainable heating solution, with zero emissions. And as more energy is produced by green methods, smart electric radiators that can be programmed to reduce wasted energy by controlling exactly when and where the heating is active, could become an efficient and eco-friendly option for some homes. As a further benefit, both electrical underfloor heating and electric radiators are easy to install, providing a low level of disruption when fitted in an existing property.



Heat Networks

Heat networks, sometimes referred to as district heating, are a distribution system that takes heat from a centralised source and delivers it to a number of different buildings, such as a housing development. Developing heat networks is part of the Government's plans for delivering low carbon heat to new homes in the future, particularly in cities and high density areas.

According to the FHS Clean Heating policy, heat networks offer the potential for phased decarbonisation as new technologies can be added to the system with little disruption to individual households. Heat networks provide a unique opportunity to exploit large scale, renewable and recovered heat sources that cannot be accessed at an individual building level. They also provide system benefits such as thermal storage to reduce energy demand at the grid at peak times.

It is estimated by the CCC that around 18% of UK heat will need to come from heat networks by 2050 if the UK is to meet its carbon targets cost-effectively. For its part, Danfoss has developed End-to-End solutions for District Energy Networks (DEN). A complete package can be provided to optimise heat transfer and system control from the energy source at one end of the network through to end-user level. Solutions include variable speed drives for efficient pump control, bespoke building connections featuring advanced heat exchangers, an extensive range of control components, and ultrasonic energy meters for accurate billing of energy consumption and system diagnostics.

In addition, Danfoss substations provide a complete building connection for DEN, including balancing and controls. And as domestic heating moves away from individual gas boilers, Danfoss solutions offer easy to install Heat Interface Units (HIU) that deliver low return temperature and high user comfort to residential buildings served by a district heating system.



Heating Controls

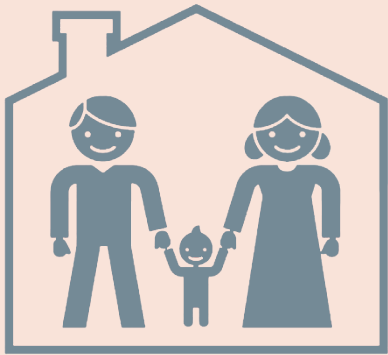
Irrespective of the heating technologies the next generation of zero carbon homes will be using, the overarching requirement for effective control and hydronic balance will still exist to maintain optimum system efficiency and consumer comfort.

Indeed, heating controls are among the key elements of efficient building design when calculating SAP. Installing modern electronic controls to regulate the temperature in individual rooms, and which can be programmed to suit individual lifestyles, is proven to reduce domestic energy consumption. The advanced functionality of many of these devices, such as 'open window' and 'delayed start' bring further energy saving benefits, helping to provide affordable warmth for households facing fuel poverty.

Modern heating controls represent a granular (or front line) approach to reducing domestic energy consumption in the home. Programmable devices, including devices that can be controlled via a smartphone app, provide a highly efficient and convenient interface between end-users and the heat source, whatever that may be. Unlike basic on/off timers, the latest electronic controls can be programmed to maintain the most energy efficient temperature, whilst also ensuring the heat source operates at optimum efficiency. Low carbon systems such as heat pumps, for example, work more effectively if allowed to run continuously, rather than being switched on and off. Heating can now be better controlled by today's more sophisticated controllers over a 24-hour period, and not just in response to outside temperatures. New controls, like Danfoss ICON™ and TPOne-S, allow users to access their heating when away from home and adjust the schedules to suit their individual requirements.

To complement the energy-saving benefits of fitting modern heating controls, hydronic balancing of HVAC systems is essential to ensure a system runs as efficiently as possible both in terms of energy consumption and indoor comfort. However, industry research suggests that this practice is too often overlooked. Whatever products are used, correct installation and commissioning will always be key to creating a system that works to the design specification and meets the user's expectations.

Benefits achieved by making simple changes



Homeowners

- Reduce their energy consumption and gain better control over it
- Save money
- Improve comfort and better indoor climate
- Reduce risk of mold, fungus and improve health conditions
- Reduce their environmental impact



Installers

- New business opportunities
- Increased sales potential (electronic and smart TRVs)



Housing Associations

- Reduce the energy bills and heating costs
- Pays back quickly
- Contribute to energy efficiency and reduce environmental impact

Challenges and opportunities

In compiling this series of white papers, Danfoss aims to highlight not only the many challenges of achieving Net Zero in the UK but also the opportunities. These include innovation in heating technologies, advancements in dwelling design and modern methods of construction such as modular building, as well as greater investment in green energy infrastructure that will bring new employment opportunities. Indeed, a report by the Local Government Association predicts more than a million new jobs could be created in England's low-carbon and renewable energy economy by 2050, from clean electricity generation for homes and businesses to manufacturing of wind turbines, installing solar panels and heat pumps.

Those involved in the installation and maintenance of domestic heating systems will be at the front line of this green energy revolution and are being urged to adapt their skills sooner rather than later before their 'bread and butter' jobs, such as fitting and servicing a natural gas boiler, are consigned to history. And as for the next generation, a career in heating and plumbing is likely to look very different from now. Training will be key to ensuring that tomorrow's students and apprentices learn the skills and knowledge they will need to deliver cleaner, greener heating for the homes of the future.

Covid-19 and the future

Few can argue that achieving a well-managed transition to low carbon, and ultimately zero carbon housing, will bring a raft of benefits, from better physical health to an improved environment and, crucially, reduced exposure to the impacts of climate change. But achieving this transition could now be facing an unexpected complication – Covid-19.

According to figures compiled by the CCC, in order to achieve Net Zero the UK needs to achieve an average emissions reduction of around 15.5 MtCO₂e per year over the next 30 years. Whilst this is similar to the 16 MtCO₂e achieved in 2019 the figures do not allow for the impacts of the Covid-19 pandemic in 2020. Given the economic downturn caused by this unprecedented public health crisis, many are now asking if the roadmap to 2050 is still on course. Whatever the answer to that question may be, it is clear that Government policies and priorities in the coming months, and years, will be crucial to keeping the UK's domestic climate ambitions – and a zero carbon future for residential heating – alive.

More than a million new jobs could be created in England's low-carbon and renewable energy economy by 2050.

For more information on how Danfoss is getting ready for Net Zero click below or contact us at Danfoss Heating UK:

[Learn more about the challenge of Net Zero in the heating sector](#)

[Consider yourself an energy-efficiency ambassador? Take a quiz to see how much you learned!](#)

[Check out the Installer Hub - making every day in Installer Life simpler](#)

[London Underground air is recycled to heat up local homes](#)

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[Record savings on central heating consumption, in family house, Køge, Denmark](#)

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