Quick guide to low carbon heat

Market overview

The majority of CO_2 emissions from homes in the UK come from burning fossil fuels for heat - in a typical home between 75% and 90% of CO_2 emissions come from providing space and water heating[1]. Over 22 million UK homes are heated by gas boilers; oil boilers are more common in rural homes; and direct electric or electric storage heating are common in both rural and urban flats.

In contrast, only a very small proportion of UK homes currently have a form of low carbon heating with fewer than 270,000 heat pumps installed as of 2021 (less than 1% of homes)[2]. However, the market for low carbon heat is expected to grow substantially. The Committee on Climate Change (CCC) estimate that 19 million heat pumps will need to be installed in UK homes by 2050[3] and the government has set a target to install 600,000 heat pumps a year by 2028. Under the Future Homes Standard, the installation of gas boilers in new homes is banned from 2025 and government has also signalled its intention to ban the installation of new gas boilers in existing homes from 2035[4].

Low carbon heating options for homes

Heat pumps

Are the primary low carbon technology available to replace fossil fuel boilers. Heat pumps produce between 2 and 4 units of heat for every unit of electricity used, meaning they have much lower CO_2 emissions and lower running costs than other forms of electric heating[5]. Heat pumps work most efficiently in homes with lower flow temperature heating systems which is typically achieved through some combination of lower temperature distribution systems (such as underfloor heating or large radiators) and energy efficient thermal fabric or a building fabric with good thermal mass. To achieve this some existing properties may require upgrades to either the thermal fabric or the heat distribution system, or a combination of both. However recent studies have shown that, with good system design, heat pumps can work efficiently in all UK house types[6]. Weather compensating controls on heat pumps regulate flow temperatures according to external temperatures meaning that flow temperatures can be kept to a minimum enabling heat pumps to operate at good year-round efficiency. Many latest generation heat pumps can deliver higher flow temperatures than previous models, equivalent to gas boilers where required, offering the possibility of direct gas boiler replacements[7] but it is important to note that low temperature system design will always deliver higher efficiency and lower running costs. The Government's Net Zero Innovation Portfolio is funding the up to £60 million Heat Pump Ready programme to test how domestic heat pumps can be made more accessible, deployable and attractive to the consumer[8].

All heat pump installations must comply with Building Regulations. Heat pumps should be installed by a qualified installer with suitable expertise to ensure the system is designed, installed, commissioned and controlled to its full potential. The Microgeneration Certification Scheme (MCS) is an independent certification scheme for microgeneration products that currently certifies over 1,450 heat pump installers on the MCS database. MCS Certification (or equivalent) is required by all Government grant schemes for installations under 45 kW such as the Boiler Upgrade Scheme (BUS). The Boiler Upgrade Scheme provides upfront capital grants to cover part of the cost of replacing fossil fuel heating systems with a heat pump (or biomass boiler). Grants are available for £5,000 towards an air source heat pump, or £6,000 towards an eligible ground source heat pump installation[9].

High heat retention (HHR) storage heaters and electric storage boilers

Electric storage heating can enable customers to benefit from lower cost and lower carbon electricity. The ability to store electricity at times of excess supply means storage heat could play a crucial role in a low carbon energy system. Older model electric storage heaters are often associated with poor levels of comfort, but modern HHR storage heaters give customers much greater control[10]. Centralised electric storage boilers are also now available that can directly replace gas boilers in wet central heating systems[11]. Storage heat can be well suited to smaller

homes and flats that may lack suitable space for heat pumps. To avoid high running costs, storage heat should only be used with a lower 'off peak' or variable rate tariff. Storage heaters should be installed by a suitably qualified electrician. Storage heat is not covered by the MCS scheme.

Biomass boilers and room heaters

Depending on how the wood pellet or log fuel is sourced and transported, biomass boilers and stoves can represent a low carbon heating option. Biomass can sometimes offer low running costs although fuel prices vary significantly across the country. Wood burning stoves are a popular source of secondary heat in homes. However, concerns over air pollution in urban areas limit their mass market uptake. Biomass boilers are relatively higher maintenance than fossil fuel boilers and their overall contribution to UK net zero targets is expected to be small. There are over 150 biomass boiler installation companies listed on the MCS database.

Solar water heating

There are three primary ways to harness solar power to contribute to water heating:

- Solar thermal panels
- Solar PV panels connected to an immersion heater,
- Solar PV panels connected to a heat pump.

In all three cases, a hot water cylinder or other thermal store is required as the vessel for storing hot water. These technologies can typically cover the majority of hot water demand in summer, and typically between 20% - 60% of hot water demand throughout the year[12]. Where solar PV is already installed, using the renewable electricity to provide hot water via an immersion heater or heat pump can help maximise the on-site use of generated energy, reducing running costs. Solar PV and Solar thermal installers can be found on the MCS database. Solar technologies generally do not contribute to space heating load.

Green gas and hydrogen heating

Green gases are renewable or low carbon gases that may be able to be used in place of methane in boilers. However, currently less than 1% of gas comes from biomethane. Whilst there is much speculation about the potential for hydrogen to displace methane, in practice there are significant economic and production challenges that would need to be overcome for hydrogen to be considered a viable option for homes. It is currently not possible to purchase a hydrogen only boiler nor access hydrogen fuel for domestic heat[13].

Table 1: Indicative installation costs and savings for low carbon heat technologies

	Installation cost (before grant[14])[15]	Potential cost of heating distribution system upgrades[16]	Grants[17]	Heating cost per year[18][19]	tCO_2 emissions per year[20]
Gas boiler	£3,200 - £5,200	£0 - £6,400	£0	£1,720 - £1,930	3.3 – 4.0
Oil boiler	£3,970 - £5,950	£0 - £6,400	£0	£1,880 - £2,200	5.1 – 6.4
Direct electric (no water heating)	£1,290 - £2,880	£0	£0	£5,100 - £5,670	2.1 – 2.4
Air Source Heat Pump[21]	£10,445 - £17,309	£0 - £6,400	£5,000	£1,500 - £2,040	0.6 – 0.9
Ground Source Heat Pump[22]	£15,750 - £22,689	£0 - £6,400	£6,000	£1,460 - £1,890	0.6 – 0.8
Electric storage (no water heating)	£1,890 - £6,100	£0	£0	£1,880 - £4,690[23]	2.1 – 2.7
Biomass boiler	£12,000 - £24,000	£0 - £6,400	£5,000	£1,235 - £3,210	0.4 – 1.1

References and notes

[1] Ofgem (2023) 'Average gas and electricity use explained' **https://www.ofgem.gov.uk/information-consumers/energy-advice-households/average-gas-and-electricity-use-explained**
[2] BEIS (2022) 'Public Attitudes Tracker Spring 2022: Figure 3.1 Main Method of Heating Home' **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1082718/BEIS_PAT_Spring_2022_Heat_and_Energy_in_the_Home.pdf**
[3] Committee on Climate Change (2019) 'Net Zero Technical Report' **https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf**
[4] BEIS (2021) 'Heat and Buildings Strategy' **https://www.gov.uk/government/publications/heat-and-buildings-strategy**
[5] Energy Systems Catapult (2022) 'Electrification of Heat Demonstration Project' **https://es.catapult.org.uk/project/electrification-of-heat-demonstration/**
[6] Energy Systems Catapult (2022) 'Electrification of Heat Demonstration Project' **https://es.catapult.org.uk/project/electrification-of-heat-demonstration/**
[7] Vaillant (2022) 'A Leap Forward' **https://www.vaillant.co.uk/downloads/aproducts/r290/r290-leaflet-final-aw-1604751.pdf**
[8] HM Government (2023) 'Heat Pump Ready Programme: successful projects' **https://www.gov.uk/government/publications/heat-pump-ready-programme-successful-projects**

[9] HM Government (2023) 'Apply for the Boiler Upgrade Scheme' **https://www.gov.uk/apply-boiler-upgrade-scheme?_ga=2.23541821.647605493.1686142406-768009580.1686142406&_gac=1.186935002.1686143757.CjwKCAjw1YCkBhAOEiwA5aN4AXhj0q9TPO-LhhrU-LwSyHUrwNOv_3z02iUVGfORMB_k7sVxCSUwFhoCOxcQAvD_BwE**
[10] Element Energy (2019) 'Evidence Gathering for electric heating options in off-gas homes' (**https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831079/Electric_heating_options_in_off-gas_grid_homes.pdf**)
[11] Example: 'Tepeo Zero Emission Boiler' **https://tepeo.com/thezeb**
[12] Energy Saving Trust 'Solar Water Heating' **https://energysavingtrust.org.uk/advice/solar-water-heating/**
[13] BEIS 'Heat and Buildings Strategy' **https://www.gov.uk/government/publications/heat-and-buildings-strategy**
[14] Delta EE (2018) 'The Cost of Installing Heating Measures in Domestic Properties' **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/913508/cost-of-installing-heating-measures-in-domestic-properties.pdf** adjusted for VAT and inflation using 'Bank of England Inflation Calculator' **https://www.bankofengland.co.uk/monetary-policy/inflation/inflation-calculator?number.Sections%5B0%5D.Fields%5B0%5D.Value=3660&current_year=105.921916666667&comparison_year=126.447**
[15] Technology costs vary significantly by region, brand, company and the specific circumstances of each home. These should be treated as an indicative guide only and do not represent and minimum or maximum figure for real world costs.
[16] Includes potential installation of new pipework, radiators, pumps.
[17] More generous grants are available in Scotland. Details available on Home Energy Scotland website.
[18] Assumes a heat demand of 15,000 kwh per year, based on an Ofgem Medium user.
[19] Assumes October 2022 price cap unit rates of £0.34 for electricity and £0.104 for gas.
[20] UK Government (2022) 'Greenhouse gas reporting: emissions factors' **https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022**
[21] Assumes efficiency range of 250% - 350%.
[21]Assume efficiency range of 270% - 370%.
[22] Assumes off-peak electricity tariffs between £0.13 and £0.25 per kWh.

carbontrust.com

+44 (0) 20 7170 7000

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