Department for
Business, Energy
& Industrial Strategy

Improving Boiler Standards and Efficiency

Boiler efficiency, hydrogen-ready boilers, and the role of hybrid systems

Closing date: 21 March 2023

December 2022

Any enquiries regarding this publication should be sent to us at:
domesticboilersconsultation@beis.gov.uk

Contents

General information

Why we are consulting

To set out policy proposals and invite stakeholder views on plans to ensure newly installed gas boilers are performing as efficiently as possible, the case for requiring all newly sold boilers to be 'hydrogen-ready' to facilitate a potential switch to hydrogen heating in future, and the potential role of hybrid heat pump-gas boiler systems in the medium and longer-term, to support decarbonisation objectives.

Consultation details

Issued: [13 December 2022]

Respond by: [21 March 2023].

Enquiries to: Gas Boiler Policy Team

Please do not send responses by post to the Department.

Email: domesticboilersconsultation@beis.gov.uk

Consultation reference: Improving Boiler Standards and Efficiency

Audiences:

This consultation will be of interest to stakeholders operating in the heat sector, business representative bodies, households, and those with a wider interest in the UK's net zero ambition.

Territorial extent:

Great Britain. However, the Northern Ireland Protocol Bill was introduced by HMG in Parliament on 13 June 2022. The Bill proposes the creation of a dual regulatory regime in Northern Ireland, which will allow businesses selling products in Northern Ireland to choose between meeting UK or EU rules (or both). Once the NIP Bill has passed through the Parliamentary process and is in force, proposals on energy-related products could encompass the whole UK. This may, however, require amending Ecodesign legislation to extend regulation making powers to Northern Ireland.

How to respond

Respond online at: https://beisgovuk.citizenspace.com/heat/improving-boiler-standards-and-efficiency

Or if you are unable to respond using Citizen Space:

Email to: domesticboilersconsultation@beis.gov.uk

Please do not send responses by post to the department. When responding, please state whether you are responding as an individual or representing the views of an organisation.

Your response will be most useful if it is framed in direct response to the questions posed, though further comments and evidence are also welcome.

Confidentiality and data protection

Information you provide in response to this consultation, including personal information, may be disclosed in accordance with UK legislation (the Freedom of Information Act 2000, the Data Protection Act 2018 and the Environmental Information Regulations 2004).

If you want the information that you provide to be treated as confidential, please tell us, but be aware that we cannot guarantee confidentiality in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not be regarded by us as a confidentiality request.

We will process your personal data in accordance with all applicable data protection laws. See our privacy policy.

We will summarise all responses and publish this summary on GOV.UK. The summary will include a list of names or organisations that responded, but not people's personal names, addresses or other contact details.

Quality assurance

This consultation has been carried out in accordance with the government's consultation principles.

If you have any complaints about the way this consultation has been conducted, please email: beis.bru@beis.gov.uk.

Executive summary

There are around 30 million buildings in the UK[1] responsible for approximately 30% of our emissions.[2] The vast majority (79%) of these emissions result from heating, making up 23% of all UK emissions. As such, meeting net zero will require almost all buildings to fully decarbonise.

The Heat and Buildings Strategy[3] set out the government's intention to phase out the installation of new and replacement natural gas boilers from 2035 to ensure that almost all domestic heating systems used in 2050 are low-carbon.

Each year up to 1.7 million domestic-scale natural gas boilers are installed in the UK. Even with increasing heat pump deployment, we expect a minimum of 10 million further domestic gas boiler installations between 2025 and 2035.[4] This represents a significant target population for furthering two objectives:

1. Reducing domestic gas consumption to lower consumer bills and carbon emissions, and improve our energy security: by ensuring new boilers meet the highest standards of efficiency.
2. Preparing for the energy transition: ensuring new boiler installations prepare the ground for the future transition of homes to low-carbon heating, including for a potential hydrogen conversion and exploring the role of hybrid heating systems.

This consultation seeks views from consumers, installers, and manufacturers on our proposals to meet these two objectives. Our proposals are in three parts, focused on

- improving in-home boiler performance
- proposing a requirement that all new domestic sized gas boilers be 'hydrogen-ready'
- further exploring the role of hybrid heating systems combining a gas boiler and electric heat pump

The consultation is principally focused on domestic-scale natural gas boilers with a capacity of 45kW or less. However, we are also seeking views on whether it is appropriate to extend these

[1] Office for National Statistics (2020), 'Households projections for England', Table 401, (https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/householdprojectionsforengland), and
BEIS (2020), 'Non-domestic National Energy Efficiency Data-Framework' (https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020) based on 2018 data.
[2] BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019', (https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019) and National statistics Energy Consumption in the UK (ECUK), (https://www.gov.uk/government/statistics/energy-consumption-in-the-uk) last updated 2021.
[3] BEIS (2021), 'Heat and Buildings Strategy', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1044598/6.7408_BEIS_Clean_Heat_Heat___Buildings_Strategy_Stage_2_v5_WEB.pdf.
[4] See Impact Assessment published alongside this document. In a scenario where a decision is taken to roll-out hydrogen for use in domestic heating this figure is likely to be higher, as hydrogen-ready boilers (initially fitted to burn natural gas) will continue to be deployed widely throughout the period.

proposals to boilers sized up to 70kW. This would extend the scope of the proposals to include a larger number of systems installed in non-domestic buildings.

Our expectation is that the proposals outlined in this consultation will principally affect existing homes currently connected to the gas grid. Under the Future Homes Standard, to be introduced from 2025, we expect low-carbon heating technology, such as heat pumps and heat networks, to become the primary heating technology in new-build homes.

Raising efficiency, reducing bills

Previous government policies have aimed to improve the efficiency of gas boilers, thereby supporting consumer bill savings and reducing carbon emissions. This consultation continues in the same vein as previous regulatory improvements, including the introduction of the requirement for gas boilers to be condensing models from 2005[5] and the introduction of the Boiler Plus Standards in England in 2018.[6]

The consultation proposes new requirements that reflect recent technological developments and will help ensure consumers are getting the greatest potential out of the condensing boilers in their homes. These include proposals to:

- reform boiler controls standards
- tackle boiler oversizing, particularly in combination boilers
- bring system and regular boilers within the scope of expanded requirements
- improve the minimum standards for hot water tanks
- develop installer skills and seek ways to improve heating system design, commissioning, and maintenance

These policies are expected to improve the in-home performance of the average newly installed natural gas boilers by up to 6%. This will ensure boilers can deliver at, or as close as possible to, their lab-tested efficiency levels. However, we acknowledge that homes across the country are diverse, and savings will vary from household to household. Our proposals, which we intend to introduce from 2025, are set out in detail in Chapter 1: Boiler efficiency.

[5] Department of Trade and Industry (2003), 'Energy white paper: Our energy future – creating a low carbon economy', https://www.gov.uk/government/publications/our-energy-future-creating-a-low-carbon-economy, and Office of the Deputy Prime Minister (2005), 'The Building Act 1984 Amendments to Approved Document L1: Conservation of fuel and power in dwellings', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/11433/133115.pdf.
Exemptions were set out in Office of the Deputy Prime Minister (2005), 'Guide to the condensing boiler installation assessment procedure for dwellings', https://www.absolutelofts.com/pdf/Guide_to_the_Condensing_Boiler.pdf.

[6] BEIS (2017), 'Heat in Buildings: Boiler Plus Final Policy and Consultation Response', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651853/Boiler_Plus_final_policy_and_consultation_response.pdf.

Enabling a transition to hydrogen heating

The consultation proposes to mandate that from 2026 onwards all new domestic-scale gas boilers sold are to be 'hydrogen-ready'. The government's view is that there is a strong case for the introduction of hydrogen-ready boilers as standard from this date, provided that these boilers can meet all relevant regulatory standards, that they can reach price parity with existing gas boilers if deployed market wide, and assuming that a single market-wide definition can be agreed.

Hydrogen-ready boilers are boilers that are initially installed to burn natural gas but can be easily converted by a gas engineer in future to operate on hydrogen. The deployment of hydrogen-ready boilers from the mid-2020s is expected to deliver significant benefits should hydrogen later be rolled-out in the gas grid, by reducing the costs associated with scrapping natural gas-only boilers before the end of their useful life. This is expected to hold even in the case of a partial grid conversion. Mandating hydrogen-ready boilers will give industry the confidence to prepare supply chains to ensure the benefits of the potential transition are maximised.

At this stage, there is no guarantee that any hydrogen-ready boilers will ultimately be converted to run on hydrogen gas. However, the UK Hydrogen Strategy[7] set out the crucial role hydrogen will play in helping to decarbonise industry, heavy transport, and power. The government continues to work with regulators, industry, and others to develop the evidence base necessary to take strategic decisions in 2026 on the role of hydrogen for heating buildings. Alongside this work, the production of low-carbon hydrogen will also be crucial for realising any large-scale hydrogen grid conversion or construction. In the British Energy Security Strategy,[8] the government doubled its ambition for UK hydrogen production to up to 10GW by 2030, with at least half of this from electrolytic hydrogen. In addition, support for new low-carbon hydrogen production is available through the Net Zero Hydrogen Fund and hydrogen business model, with the aim to have up to 2GW of production capacity in operation or construction by 2025.

Given that there is no guarantee that a hydrogen-ready boiler will be converted to burn hydrogen, the government needs confidence that consumers will not face a premium for their purchase. Based on a price promise made by industry, the government expects the upfront costs of hydrogen-ready boilers to reach price parity with those of existing natural gas boilers once they match the current levels of production. As part of this consultation exercise, we are seeking to further our understanding of how this will be achieved. In addition, we expect that hydrogen-ready boilers will be able to meet minimum efficiency standards and other relevant regulatory standards. The proposals in Chapter 1: Boiler efficiency are designed to be fuel

[7] BEIS (2021), 'UK Hydrogen Strategy', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf.
[8] BEIS and Prime Minister's Office, 10 Downing Street (2022), 'British Energy Security Strategy', https://www.gov.uk/government/publications/british-energy-security-strategy.

neutral, meaning they are expected to support optimal boiler operation whether the boiler is running on hydrogen or natural gas.

The role of hybrid heat pumps

This consultation will also consider the specific role of hybrid heating systems, consisting of a heat pump and gas boiler, in decarbonising our homes and buildings, focusing on their role in the 2020s and 2030s. Hybrid systems may represent an important technology on the path to net zero, combining the combustion technologies familiar to consumers with an efficient heat pump element.

Deployment of hybrid heat pumps could support the growth of the heat pump supply chain and reduce dependence on natural gas, while continuing to significantly reduce emissions compared to natural gas boilers. However, appropriate safeguards are needed to ensure that the contribution of the low-carbon heat pump within hybrid systems is maximised, and that the deployment of hybrid systems supports wider government strategic objectives.

The consultation outlines the government's thinking on the role of hybrids within the existing target to reach 600,000 heat pump installations per year by 2028,[9] detailing the conditions required to support the inclusion of hybrids within this overall deployment. Beyond this, the consultation outlines the government's hope that hybrid systems may be able to play an even more substantive role, potentially becoming the new minimum energy performance product from 2028. The consultation seeks stakeholders' views on the potential for technological developments and large-scale cost reductions in technologies such as compact hybrids (and other new innovative technologies) to support the potential widespread deployment of hybrids, including any further increases to minimum standards.

Implementation and scope

The government is seeking to implement the proposals in this consultation through product standards by updating the Ecodesign and Energy Labelling regulations.

Product standards were previously set and controlled by the European Union (EU). Following the UK's exit from the EU, existing Ecodesign and Energy Labelling legislation was retained in domestic law and continues to apply. The powers to update Ecodesign and Energy Labelling requirements have been transferred to the Secretary of State allowing the government to maintain its own requirements for energy-related products in Great Britain. The Northern Ireland protocol currently means that EU Ecodesign and Energy Labelling requirements continue to apply in Northern Ireland. However, on 13 June 2022 the Northern Ireland Protocol Bill (NIP Bill) was introduced by HMG in Parliament. The Bill proposes the creation of a dual regulatory regime in Northern Ireland, which will allow businesses selling products in Northern

[9] Prime Minister's Office, 10 Downing Street (2020), 'Ten Point Plan for a Green Industrial Revolution for 250,000 jobs', https://www.gov.uk/government/news/pm-outlines-his-ten-point-plan-for-a-green-industrial-revolution-for-250000-jobs .

Ireland to choose between meeting UK or EU rules (or both). Once the NIP Bill has passed through the Parliamentary process and is in force, we may have the ability to apply any update to Ecodesign and Energy Labelling as a result of this consultation to take effect across the whole UK including Northern Ireland. This may, however, require amending Ecodesign legislation to extend regulation making powers to Northern Ireland.

Given the technical nature of this consultation, a glossary of terms is included in Annex A.

A full list of the questions posed in this consultation is included in Annex B.

Chapter 1: Boiler efficiency

Introduction

It is the government's understanding that there is a gap between lab-tested, advertised efficiencies of gas boilers and what is delivered in the home.[10] We believe there is more that can be done to improve the in-home performance of natural gas boilers. The policies set out below are expected to overlap to improve the in-home performance of the average newly installed natural gas boilers by up to 6%, which is estimated to provide a £30 bill saving per year for the average household.[11] This will ensure boilers can deliver at or as close as possible to their lab-tested efficiency levels.

The following section sets out the context within which our proposals have been developed, and the current Boiler Plus Standards which came into force in England in 2018. The Department published an interim review of the current Boiler Plus Standards last year which sought to assess their impact and test options to go further with boiler standards.[12] In addition, a call for evidence on energy-related products was published in 2020 collecting evidence on what more can be done to improve boiler efficiency, followed by the Energy-related Products Policy Framework from November 2021.[13] Building on this, the Context section also sets out our understanding of some of the challenges impacting the performance of boilers.

This understanding, alongside ongoing engagement with the industry, has been used to formulate our proposals, which are outlined in detail below. In summary our proposals are:

- To introduce revised requirements for controls installed with boilers, to ensure boilers and controls are communicating in order to modulate boiler output and to deliver lower flow temperatures
- To address boiler oversizing in combination boilers through wider modulation ranges, allowing them to efficiently meet the space heating demands of homes throughout the heating season
- To apply the new standards to all boiler types
- To improve heating system design and maintenance requirements

[10] GASTEC for the Energy Saving Trust (2009), 'In-situ monitoring of efficiencies of condensing boilers and use of secondary heating', https://www.gov.uk/government/publications/in-situ-monitoring-of-efficiencies-of-condensing-boilers-and-use-of-secondary-heating-trial-final-report-2009, and
VHK for the European Commission (2019), 'Review Study existing ecodesign & energy labelling SPACE HEATERS & COMBINATION HEATERS',
https://www.vhk.nl/downloads/Reports/2019/VHK%20569%20Boilers%20Task%204%20final%20report%20July%202019.pdf.

[11] We estimate bill savings of around £30 per year in the typical household using a natural gas boiler. This figure is based on Green Book gas prices (June 2021), which do not take into account the current energy price rises. These savings will vary overtime as gas unit prices change.

[12] BEIS (2021), 'Boiler Plus: initial policy review', https://www.gov.uk/government/publications/boiler-plus-initial-policy-review.

[13] BEIS (2021), 'Energy-related Products Policy Framework', https://www.gov.uk/government/publications/energy-related-products-policy-framework.

- To gather evidence on the ways to better record real world boiler performance and information provided to the consumer

Context

The Boiler Plus Standards

The Boiler Plus Standards were introduced in 2018 in England through an amendment to Approved Document L[14], the statutory guidance to Part L of the Building Regulations. They were intended to ensure all households in England had a reasonable level of choice and control over their heating to enable them to achieve comfort and efficiency. For all types of gas boilers installed into existing dwellings, the standards required:

- A new minimum efficiency standard of 92%
- The installation of boiler interlock
- Time and temperature controls to be installed at the same time as the new boiler, if not already present and working.

In addition, combination boilers were required to be installed with an additional energy efficiency measure. The energy saving technologies that can be used to comply are:

- Load compensation
- Weather compensation
- Smart controls (with automation and optimisation)
- Flue Gas Heat Recovery (FGHR)

Boiler Plus Review

The Boiler Plus Review, published last year, found that Boiler Plus had been successful in ensuring the removal of the boilers with the lowest tested efficiency from the market. The standards may also have led to a significant increase in the installation of the additional measures fitted alongside combination boilers, as anticipated.

The review flagged several potential barriers and opportunities to go further with regulations. Some participants suggested that a lack of monitoring and oversight of the additional measures fitted alongside gas combination boilers may have undermined the standards' impact. Consumer engagement with, and understanding of, the standards and the products they were receiving as a result appears to have been very limited, which may also have limited their effectiveness, especially in terms of the benefits delivered by certain types of smart controls. The review found that there was often little consideration given to which additional measure would be more beneficial in any given case, either by the installer or consumer.

[14] DLUHC (2018), 'Conservation of fuel and power: Approved Document L', https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l.

The controls on the market were also found to vary widely, with a broad range of functionalities, impacting the benefit offered to consumers. Furthermore, there are various operational protocols in use in technology across industry, affecting how well controls are able to communicate with and control the boiler, potentially limiting their benefits.

The review also found there does not appear be any technical barriers preventing all gas boilers, including regular and system boilers, from being fitted with controls that lower flow temperatures produced by the boiler. It also suggested that more could be done to ensure installers are better equipped to design, commission and maintain the heating system within which a boiler operates. In addition, the call for evidence on energy-related products sought views on proposals for how boiler cycling might be limited through improved boiler modulation, with respondents suggesting that wider modulation should be combined with appropriate modulating controls.

Challenges impacting boiler performance

Flow temperatures

The key factor in determining the efficiency of a condensing boiler is the temperature of the water returning to the boiler (the 'return temperature'). The lower the return temperature the more efficient the boiler operation. This, in turn, will require a lower flow temperature (the temperature of the water leaving the boiler). Running at lower temperatures is likely to mean that radiators may not feel as hot to touch but this does not necessarily mean homes will not be as warm. It may take slightly longer but the heating system will still reach the temperature set on the thermostat and it will result in a more efficient use of the system.

The gap between laboratory tested and in-home efficiency is often because the flow and return temperatures are too high, limiting boilers' potential to condense. This was one of the key issues the original Boiler Plus Standards were aiming to address by encouraging take-up of controls that lower flow temperatures.[15] However, due to limited functionality or interoperability, we are concerned that installed controls are not always delivering lower temperature systems.

To start to achieve higher efficiencies, the return temperature needs to be equal to or below the 'dew point' temperature of approximately 55°C (the temperature below which the flue gas needs to be cooled, in order to allow the water vapour to condense and additional latent heat contained within it to be captured). However, to achieve the higher efficiencies advertised, boilers need to operate at as low a temperature as possible, below this level of 55°C, for the majority of the year.

Boilers are tested in a steady-state (continuous operation) at two flow and return temperatures: 1) full load, 80-to-60°C flow to return temperatures and 2) part load, 50-to-30°C flow to return

[15] BEIS (2017), 'Heat in Buildings: Boiler Plus Final Policy and Consultation Response', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651853/Boiler_Plus_final_policy_and_consultation_response.pdf.

temperatures.[16] Tested boiler findings shows that the improvement in the efficiencies of the average boiler when operating at part load, at lower temperatures, as opposed to full loads are between 8-10% percentage points.[17]

The reasons for boilers running at higher temperatures than optimal for efficiency is often linked to the size of the heat emitters in a property and the property's energy efficiency. Traditionally, central heating systems have been designed to operate at flow and return temperatures of 80-to-60°C.[18] However, these high flow temperatures would only be required when outside temperatures are very cold, sustained at sub-zero levels of approximately -2°C or -3°C.

BEIS research found that around 50% of homes have heat emitters adequately sized to provide thermal comfort at a flow temperature of 55°C on an average winter day, with outside temperatures at around 4°C.[19] As such, there is a significant opportunity to improve boiler efficiency by supporting systems to operate at these lower temperatures for the vast majority of the year.

Previous Domestic Building Services Compliance Guides advised that boiler return temperature should be set at 55°C.[20] This would imply the boiler has flow temperatures set at or about 75°C if the system has been set up and balanced correctly. Many installers who took part in the Boiler Plus Review stated that they follow manufacturer guidance for setting flow temperature, and a review of literature suggests that many manufacturers advise setting the flow temperatures at or around 75°C. Updated Building Regulations' guidance now requires all new and replacement full heating systems – including the appliance, radiators and piping – to be designed to operate to 55°C degrees or lower, where possible.[21]

The flow and return temperature of the boilers can be influenced by the type of control used. A simple boiler control combining a timer and thermostat is only able to control the room temperature by switching the boiler on and off (cycling) when a desired set temperature has been reached. Boilers combined with these controls would only operate at a flow temperature set by the installer unless this has been subsequently adjusted by the consumer. Even in these cases the boiler will do some modulation of its output, however this is unlikely to be optimised for efficiency as it will not adjust the flow temperature. Simple controls also result in high boiler cycling and resultant inefficiencies.

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[16] BRE (2011), 'Changes to the treatment of heating and hot water systems with boilers in SAP 2012', https://www.bre.co.uk/filelibrary/SAP/2012/STP11-B09_BoilerChanges.pdf.
[17] Young, Bruce; Shiret, Alan; Hayton, John; Griffiths, Will, for BRE (2013), 'Design of low-temperature domestic heating systems: Design of low-temperature domestic heating systems', https://www.brebookshop.com/samples/327257.pdf.
[18] Recent updates to Building Regulations now require new and replacement heating systems to be installed to operate at a maximum flow temperature of 55°C.
[19] BEIS (2021), 'Domestic heat distribution systems, evidence gathering: final report', https://www.gov.uk/government/publications/heat-storage-and-distribution-systems-hds.
[20] HM Government (2013), 'Domestic Building Services Compliance Guide', and DLUHC (2018), 'Amended Approved Document L1B and Domestic Building Services Compliance Guide', https://www.gov.uk/government/publications/amended-approved-document-l1b-and-domestic-building-services-compliance-guide.
[21] DLUHC (2021), 'Approved Document L, Conservation of fuel and power, Volume 1 : Dwellings', https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l.

More advanced controls, including Boiler Plus compliant weather and load compensation, can modulate the boiler's output (see below for details) and lower the flow temperature of the water leaving the boiler based upon the internal temperatures (in the case of load compensators) or external temperatures (in the case of weather compensators) or both to reach a temperature set on a thermostat.

Additional factors

Other factors, including the degree of modulation and boiler cycling, installation practices and the maintenance of the whole heating system, impact efficiency.

Modulation and boiler cycling: Boilers are at their most efficient when they only use the energy required to meet the demands of a property. Typically, domestic hot water demand, especially in the case of combination boilers, requires more energy than that required to meet space heating demands. Boilers address this by modulating their output to reflect the space heating demands of a property and do as little work as possible. Boiler modulation is the ability of a boiler to 'turn down' its output. If a typical, 30kW combination boiler is installed into a home but only 10kW of heat is required for the next hour to maintain temperatures, the boiler can modulate its output to 1/3 of its total output to only use the 10kW required.[22]

Cycling occurs when the boiler switches on and off to maintain a set temperature like an older non-modulating boiler. More combination boilers are oversized, to an extent, which means they are not able to modulate their output to the space heating demand of a property. Therefore they cycle more than they should to maintain the room temperature, impacting efficiency and stress on the boiler, leading to wear and tear.

Installation, commissioning, and maintenance: Correct commissioning and installation of a boiler is key to the system being operated efficiently and maximising the transfer of useful heat throughout the home. Hydraulic balancing, for instance, has an important role in ensuring the gap between the flow and return temperature is correct. The lack of regular system maintenance for the boiler and the heating system also means that boiler and system performance is likely to degrade over time, as suggested by the National Energy Efficiency Data.[23]

[22] Heat Geek (2018), 'What is boiler modulation and boiler cycling?', https://www.heatgeek.com/what-is-boiler-modulation/.
[23] BEIS (2021), 'National Energy Efficiency Data-Framework (NEED) report: summary of analysis 2021', https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-report-summary-of-analysis-2021.

New boiler standards and technology

Reforming boiler control standards

The Boiler Plus Review found that smart controls were the most common way of complying with the Boiler Plus Standards, with load compensators being the second most common. However, the Boiler Plus Review and engagement with industry has suggested both smart controls and load compensators can represent a broad range of products, operating in different ways and with the potential to deliver varied consumer benefits.

Among smart controls, a key distinguishing factor is their 'optimisation' functionality. The Boiler Plus consultation response proposed that at a minimum, smart controls should be able to "calculate how long it takes the property to reach the desired comfort level, and time the system's operation to minimise the amount of work required." The expectation was that boiler modulation would be the way controls met this criterion. However, we are aware that not all smart controls sold offer this functionality and some appear to be prevented from delivering this functionality due to limited interoperability with boilers, including as a result of the range of different operational protocols used.

The Boiler Plus Review also revealed concerns over the installation of Time Proportional and Integral (TPI) controls, which some respondents saw as a low-quality alternative to load compensators.[24] TPI controls are a device, or feature within a device, which maintains the temperature inside the building by cycling the boiler on and off in a ratio that is proportional to the difference between the required and measured temperatures inside the building.[25] We understand some smart controls on the market meet their optimisation functionality in this fashion. However, the original Boiler Plus consultation response and Policy Clarification documents were clear that TPI controls are not a way of complying with the standards.[26, 27] This was partly to reflect the additional wear and tear on the boiler that stems from the increased boiler cycling caused by TPIs.

The variation in the functionality of smart controls and instances of TPIs installed instead of true load compensators may have led to significant numbers of controls being installed that do not necessarily provide the efficiency gains anticipated by the original Boiler Plus Standards. We are seeking to correct this by simplifying and clarifying the requirements for controls installed alongside a gas boiler.

[24] BEIS (2021), 'Boiler Plus: initial policy review', https://www.gov.uk/government/publications/boiler-plus-initial-policy-review.
[25] BRE, prepared for BEIS (2017), 'Evidence Gathering – Compensation and TPI Heating Controls', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/648337/heating-controls-compensation-tpi-bre.pdf.
[26] BEIS (2018), 'Boiler Plus: New standards for domestic boiler installations from April 2018', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718569/Boiler_Plus_Factsheet_v3.pdf.
[27] BEIS (2017), 'Heat in Buildings: Boiler Plus Final Policy and Consultation Response', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651853/Boiler_Plus_final_policy_and_consultation_response.pdf.

To do so, we propose to draw on the existing temperature control classes specified in the Energy Labelling Regulations for energy labels, of packages of space and combination heaters of temperature controls and solar devices.[28] The regulations define a range of control classes (ranging from Class I to Class VIII) and provide clear definitions, which are displayed on control manufacturer guidance, specification material, manuals and installation guidance.

Our intention is that new gas boilers are sold and fitted with Class VI controls. Therefore, we propose to require new gas boilers to be placed on the market with Class VI gas boiler controls.[29] Class VI controls are weather compensators and room sensors for use with modulating heaters, including gas boilers.[30] This definition allows for controls to include both weather and load compensation functionalities, or just controls with advanced weather compensation. This proposal will ensure a consistent base functionality for heating controls that will ensure they all can enhance boiler performance when in operation.

It is the government's understanding that many internet-enabled smart controls would meet this classification if combined with the correct boiler, without any changes. Controls more 'traditional' in appearance can meet this classification with weather information collected via an outdoor sensor which is fitted at the installation. A correctly installed outdoor sensor also ensures the most accurate weather information is collected. The reason for not requiring 'smart' functionality as a default is to reflect different consumer needs and preferences. It is expected that smart devices will remain the most popular due to their significant consumer appeal, in part through useful functionalities which can reduce gas consumption such as geolocation.

The internal sensor on the Class VI control will help to ensure consumer comfort by gathering and monitoring the temperature inside the building rather than solely leaving the boiler output to the weather. In addition, smart thermostats, which can learn the characteristics of a building and how long it takes to heat specific rooms, will act in a similar way and also may mean some load compensating functionality can be utilised.

Class VI controls are widely available and retail at similar price points to controls from lower classes. As controls of lower classes are available at similar price points, it is the government's understanding that the control class is not driving the price point, but other additional features. Therefore, it is not anticipated that this proposal will raise the overall cost of boiler controls and new boiler installations. However, we are interested to hear views as to whether there will be any resulting price increase or reduction.

Question 1: Do you agree that all gas boilers should be placed on the market with controls that meet Energy Labelling Class VI? Yes/No. Please expand on your views.

[28] 'Commission Delegated Regulation (EU) No 811/2013', https://www.legislation.gov.uk/eur/2013/811.
[29] For guidance regarding placing products on the market, see:
BEIS, 'Placing manufactured products on the market in Great Britain', https://www.gov.uk/guidance/placing-manufactured-goods-on-the-market-in-great-britain, last updated November 2022.
[30] A full definition is provided in Annex A: Glossary.

The government is exploring whether gas boiler controls sold separately should also be in scope of our proposal. We are interested to hear views as to whether it is preferable to require all gas boiler controls on the market to meet Class VI.

Question 2: Do you think we should require all gas boiler controls to meet Energy Labelling Class VI, irrespective of whether they are placed on the market with a gas boiler?

Zonal controls

Zonal heating divides a property into different zones, usually defined by separate rooms. These controls enhance performance in the same way as other compensating controls by lowering flow temperatures. Zonal heating allows each zone to be individually controlled, for example with different set temperatures in different zones, to meet consumer needs. In the existing temperature control classes, zonal controls fall within Class VIII, defined as: *Multi-sensor room temperature control, for use with modulating heaters: An electronic control, equipped with 3 or more room sensors that varies the flow temperature of the water leaving the boiler dependent upon the aggregated measured room temperature deviation from room sensor set points*.

We are interested to hear views as to whether Class VIII controls should be allowed as an alternative route to compliance, meaning boilers could be sold with either Class VI or Class VIII controls.

Question 3: Should Energy Labelling Class VIII controls be allowed as an alternative route to compliance? Yes/No. Please expand on your views, including which boiler systems or property types are most suitable for these controls.

Control communications

Effective modulation of boiler output to improve efficiency requires effective communication between the control and boiler. However, there are different operational protocols in use across the heating industry and as a result limited interoperability is a barrier to some controls, such as Class VI and Class VIII, being able to offer the full functionality they are designed to deliver. Therefore, in addition to proposing boilers should be sold with a Class VI control, the government is seeking further evidence as to whether open protocols are also necessary to ensure effective functionality of Class VI controls and that the proposal delivers as expected. If the government mandated open protocols, boilers would need to be sold with a Class VI control and an open protocol adaptor or run using open protocols.

‘Open protocols’ allow controls and boilers produced by different manufacturers to communicate with each other, allowing interoperability. Some manufacturers produce boilers that allow for open protocols whereas others only sell boilers which use closed protocols, meaning only their branded controls can fully operate with their boilers.

The original Boiler Plus consultation response suggested that open protocols could develop organically within the market and be a market led solution.[31] In countries like the Netherlands open protocols communication, such as OpenTherm, are commonplace. However, four years after the implementation of the Boiler Plus Standards, open protocols do not appear to have become the norm in the UK.

The government is aware of Class VI controls on the market that when paired with a boiler using a closed protocol become a different control class and operate in an on/off fashion, cycling the boiler. We understand that affordable adaptors are required to make boilers with closed protocols communicate with controls that use open protocols.

Question 4: a) Is it necessary to mandate that all available boilers and controls use open protocols? Yes/No. Please expand on your views. b) Is an appropriate route for achieving this through a government mandate that boilers are sold with open protocol adaptors? Yes/No. Please expand on your views.

Flue Gas Heat Recovery

Flue Gas Heat Recovery (FGHR) systems are one of the additional measures that can be installed alongside combination boilers to comply with the Boiler Plus Standards. FGHR systems are distinct from the other three additional measures as they are not a form of control, but an additional unit attached to, or integrated within, a boiler. FGHR systems are primarily, if not always, fitted alongside combination boilers.

FGHR systems work by recovering heat from waste flue gases to preheat the cold water entering the boiler. This reduces the energy needed to warm up the water to the required temperature. FGHR systems provide efficiency gains principally for domestic hot water production and not for space heating. Therefore, gas reduction from FGHR systems will vary depending on the actual and relative hot water demand of a property, the volume of thermal storage and the extent of hot water and space heating demand overlap.

There are a variety of FGHR systems available. Passive FGHR (PFGHR), are the most widely available version of the technology. FGHR systems which include thermal stores might be the most effective version in reducing gas consumption.

According to BEIS commissioned research,[32] FGHR systems realise the most significant savings when boilers operate at higher flow temperatures, as in these cases there will be more wasted flue gas heat compared to a boiler operating at lower flow temperatures. Therefore, it is our expectation that FGHR systems will have the greatest impact in homes with a high hot water demand and in systems operating at higher flow temperatures. This can often mean

[31] BEIS (2017), 'Heat in Buildings: Boiler Plus Final Policy and Consultation Response', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651853/Boiler_Plus_final_policy_and_consultation_response.pdf.

[32] BEIS (2021), 'Review of the methodology for Flue Gas Heat Recovery in the Standard Assessment Procedure – final report', https://www.gov.uk/government/publications/review-of-the-methodology-for-flue-gas-heat-recovery-in-the-standard-assessment-procedure-final-report.

savings are greatest when FGHR systems are fitted alongside a larger combination boiler, for example those above 35kW. However, in such cases, it may be more appropriate to install system or regular boilers, given their better capacity to manage high hot water demands. Overall, we are keen to understand how and where FGHR systems can best play a role and whether they can reduce combination boiler sizing by producing hot water more efficiently.

The policies outlined in this consultation are intended to support flow temperature reduction and limit wasted heat output. By supporting increases in boiler condensing, with systems operating at lower temperatures, this will be achieved in part through modulating controls and with more appropriate modulation ranges (see below). If the circumstances above are true, it may mean that it is not complementary to add FGHR systems to our other proposals, as it would undermine the impact of the FGHR system.

Manufacturers who took part in the Boiler Plus Review found the introduction of the standards has had a limited impact on the sales of FGHR systems. This was put down to their higher capital cost versus the other additional measures. The increase in sales of these systems was driven by the installation of integrated units often in the new build market, which are not in scope of the Boiler Plus Standards as these apply only to existing dwellings. The review also found significant variation of installers' knowledge of FGHR systems. Installers who were familiar with FGHR systems were of the view that when the system is not integrated into the boiler, they are more expensive than other Boiler Plus options and can be cumbersome to install.[33]

While cost may be a barrier to deployment, evidence suggests there is potential for significant cost reductions on Passive FGHR systems, mainly through increased volume of manufacturing.[34] The government would welcome current views on what cost reduction potential exists for these appliances.

Question 5: a) Should FGHR systems be required as an alternative or additional requirement to Class VI controls, for example, alongside larger combination boilers over 35kW? Yes/No. Please explain your answer. b) If so, should this be limited to certain types of FGHR systems, for example, limited to inbuilt Passive FGHR systems with thermal storage? Yes/No.

Boiler oversizing

Selecting an appropriately sized boiler is key to ensuring it can meet the needs of a property, both for space heating and for domestic hot water provision. Selecting a boiler which is oversized for space heating increases the likelihood of boiler cycling and consequential

[33] BEIS (2021), 'Boiler Plus: initial policy review', p.39, https://www.gov.uk/government/publications/boiler-plus-initial-policy-review.
[34] Delta Energy & Environment Ltd. & Enertek International Ltd, prepared for BEIS (2016), 'Evidence Gathering: Passive Flue Gas Heat Recovery Technologies', https://www.gov.uk/government/publications/evidence-gathering-passive-flue-gas-heat-recovery.

reductions in efficiency and wear and tear on the boiler, meaning it may require earlier replacement.

Boiler sizing is almost always informed by the installer at the point of replacement. Combination boilers are by far the most common boiler type sold in the UK, making up around 80% of the market.[35] These deliver hot water instantly and therefore do not require a hot water tank. It is the hot water demand that largely informs the size of the combination boiler selected, given the power needed to provide instantaneous hot water. However, this does mean boilers are significantly oversized for the space heating demand of homes. Typically, homes with a larger hot water demand are best suited to system boilers, while those with lower hot water demand and space heating loads are suited to combination boilers.

The Cambridge Housing Model (CHM),[36] models an average house based on the 2011 English Housing Survey,[37] to estimate energy use. Using the CHM, it is estimated that approximately 6kW output is required to meet the space heating demand for the average house at temperatures down to approximately -2°C.[38] However, the government understands most combination boilers sold are 24kW or over, on the surface suggesting boilers are significantly oversized for space heating needs.

All modern condensing boilers can modulate to some degree and operate at a percentage of their full output. This is the chief way of tackling the cycling that results from oversizing. In combination with a control, boiler modulation reduces the need for the boiler to cycle and allows it to operate in a "steady state" fashion. This depends in part on the boiler's modulation range – the ratio between the maximum and minimum output. (For example, a 36kW capacity combination boiler with a 1:6 modulation range can modulate down to 6kW capacity.) The energy-related products call for evidence found many respondents thought wider modulation boilers would be helpful to increase overall heating system efficiency.[39]

The recent update to Building Regulations and associated guidance,[40] which took effect from June 2022, sets a standard that combination boilers should be able to modulate down to the heating demand of the property. While this is an important step, the space heating demand of the property is usually established assuming sub-zero temperatures, which can be as low as -4°C.[41] Therefore, in milder temperatures and average winter temperatures of 4°C the boiler is likely to be still oversized for heating and boiler cycling may still occur. To support boiler modulation and enhance the benefits delivered by controls, we propose all domestic-scale (≤ 45kW) gas-fired combination boilers should be capable of modulating their heat output down to

[35] HHIC (2021), 'Boilers bounce back as consumers invest in home renovation', https://www.hhic.org.uk/news/boilers-bounce-back-as-consumers-invest-in-home-renovation.
[36] BEIS (2010), 'Cambridge Housing Model', https://www.gov.uk/government/publications/cambridge-housing-model-and-user-guide.
[37] DLUHC (2013), 'English Housing Survey', https://www.gov.uk/government/collections/english-housing-survey.
[38] 'Space heating operation of combination boilers in the UK: The case for addressing real-world boiler performance'. Bennett, G., Elwell, C. and Oreszczyn, T (2018), 'Building Services Engineering Research and Technology', 40(1), pp.75-92.
[39] BEIS (2020), 'Energy-related Products: Call for Evidence', https://www.gov.uk/government/consultations/energy-related-products-call-for-evidence.
[40] DLUHC (2021), 'Approved Document L, Conservation of fuel and power, Volume 1 : Dwellings' https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l.
[41] BSRIA (2011), 'Rules of Thumb', https://www.bsria.com/doc/rQV5xn.

10% of their maximum output without on/off cycling, while operating at least the same useful efficiency as when tested part-load. We understand that there are many boilers already on the market that offer modulation ratios of 1:10, with a range of price points. We understand many boiler manufacturers' top-of-the-range models have this specification, however, cheaper models are also available and the top end models include additional product features not related to modulation that drive a higher cost. Mandating a high modulation range is anticipated to create economies of scale and help support cost reductions for this added functionality.

We are also considering whether the minimum output level should be capped, so that smaller combination boilers are not required to modulate down to extremely low output levels as a result of the 1:10 modulation requirement. For example, a cap set at 3kW would mean a 24kW boiler only needs to modulate down to this level, and thus achieve a modulation range of 1:8. We expect this would support the deliverability of the requirements for smaller boilers while still ensuring smaller boilers can modulate down more effectively to meet the space heating demand of a property. This could ensure smaller systems remain widely available, thus avoiding any unintended contribution towards boiler oversizing as a result of the proposals.

Question 6: Do you agree that all domestic-scale gas combination boilers should be able to modulate to 10% of their maximum output without on/off cycling? Yes/No. Please expand on your views.

Question 7: Should minimum boiler outputs be capped, and, if so, at what level? Please expand on your views.

System and regular boilers

The original Boiler Plus consultation[42] determined that the Boiler Plus Standards should only apply to combination boilers for two key reasons.

Firstly, available FGHR systems were deemed incompatible with system and regular boilers. Five years on this situation appears to remain largely the same. Given that hot water is stored with system and regular boilers rather than provided on demand, the Boiler Plus Review suggested that there would be little benefit from combining FGHR systems with system and regular boilers. However, the government would welcome views on this topic.

Secondly, and more importantly, there were concerns over the potential risk of legionella bacteria, if the advanced boiler control options were extended beyond combination boilers. Legionella bacteria can typically multiply in stored water where temperatures are between 20 and 45°C.[43] Legionella build-up can be prevented completely by running an anti-legionella cycle of 60°C on a regular basis. However, due to the potential for each of the three control

[42] BEIS (2018), 'A future framework for heat in buildings: call for evidence', https://www.gov.uk/government/consultations/a-future-framework-for-heat-in-buildings-call-for-evidence and BEIS (2016), 'Consultation Document: Heat in Buildings consultation', https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat.
[43] HSE (2021), 'What is Legionnaires' Disease?', https://www.hse.gov.uk/legionnaires/what-is.htm.

options to modulate the boiler output and lower the boiler flow temperature below 60°C, there was a concern that inclusion of regular and system boilers could increase the risk from Legionella bacteria.

The Boiler Plus Review re-examined this issue. It found that some manufacturers are confident they have addressed any potential legionella risks by making modifications to enable independent modulation of a separate space heating circuit, enabling low flow temperatures within this circuit while providing fully effective legionella control in the hot water circuit. Other manufacturers felt they would need to undertake some further technical development work to address the risk.

The government is also aware of the availability of heating controls that have anti-legionella programmes built into them, which can ensure anti-legionella cycles take place. In some cases, this will require the control to be able communicate with the thermostat on the cylinder through an open protocol.

In addition, installation manuals set out that the legionella risk can be avoided by making simple changes to the water piping valves and/or using appropriate controls that can differentiate between water provided for hot water use and space heating. This may include practices such as the removal or adaptation of older ‘S’ and ‘Y’ plan systems and the replacement with domestic hot water priority piping design, including ‘X’ and ‘W’ plan piping. We understand this may have the added benefit of enhancing consumer comfort.

The effective management of the risk posed by legionella bacteria is also essential for other low temperature heating systems, like heat pumps, that depend on stored water for hot water provision and similar solutions to those outlined above are used for these technologies.

Given these various solutions, the review concluded that there does not appear to be any technical barriers to setting a requirement for system and regular boilers to have controls that lower the flow temperature for space heating, though, the controls installed alongside such boilers may be required to have specific anti-legionella cycle functionality built in.

Finally, while system and regular boilers can often have a smaller thermal output than combination boilers, as they are not required to provide instantaneous hot water, it is possible to purchase larger system and regular boilers with outputs significantly in excess of the typical heat demand of a property. As such, we are also proposing to apply the modulation requirement outlined above to system and regular boilers.

Question 8: Do you agree that we should extend the revised requirements to include system and regular boilers? Yes/No. Please expand on your views.

Question 9: What additional installer training, if any, would be needed to support system and regular boiler inclusion in these requirements?

Question 10: Do you agree that the minimum modulation range should apply to system and regular boilers? Yes/No. Please expand on your views.

Question 11: What role, if any, can FGHR systems have with system and regular boilers?

Tested boiler efficiency

The proposals above are focused on improving the in-home performance of boilers. However, to be sold on the market and to inform energy labelling, boilers will still need to meet minimum energy performance standards demonstrated through laboratory testing. The minimum performance standard is currently 92% ErP for natural gas boilers.

Despite the assumed gap between tested efficiencies and in-home efficiency, minimum energy performance standards are an important tool in removing the least efficient systems from the market, driving improvements and encouraging further innovation. In addition, tested performance standards are expected to continue to form the basis of the ErP efficiency ratings and the scores used in the SAP Product characteristics which feed into calculating EPC scores (SEDBUK).[44]

Market surveillance has revealed that boilers with tested efficiencies of 93% or 94% are available for purchase. Therefore, the government is seeking views on whether to raise minimum performance standards to 93 or 94%, in addition to the above proposals focusing on in-situ efficiency.

Question 12: Should the tested minimum energy performance standard for a domestic sized gas boiler be increased to a) 93% or b) 94%? Please explain your answer.

Question 13: What real-world efficiency benefits might be realised by such an increase to minimum energy performance standards?

Question 14: What risks or disbenefits might arise from such an increase to minimum energy performance standards?

Hot water storage

The Heat in Buildings call for evidence and consultation posited that reducing the losses from hot water cylinders represented the most significant opportunity for improving the efficiency of system and regular boilers.[45] At the time the Boiler Plus Standards were introduced in 2018, Ecodesign regulations required any newly installed storage tank to achieve an efficiency rating of D or above. This was subsequently raised to a minimum rating of C. Cylinder insulation and

[44] Boiler efficiency is calculated in two slightly different ways 1) SEDBUK, is used as part of the product characteristic databases within the Standard Assessment Procedure (SAP) model used to develop EPCs. The second metric is the Energy-related Products (ErP) metric, which is used to determine the grading on the boiler's energy label. The main distinction between the two labels is the primary energy factor and the weighting given to operation at full and part load.

[45] BEIS (2018), 'A future framework for heat in buildings: call for evidence', https://www.gov.uk/government/consultations/a-future-framework-for-heat-in-buildings-call-for-evidence and BEIS (2016), 'Consultation Document: Heat in Buildings consultation', https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat.

cylinder thermostats (the latter of which are a standard in Approved Document L: volume 1.) [46] can have a significant impact on fuel consumption and comfort in homes using hot water cylinders.

The Energy-related Products Policy Framework set out broad proposals for these products. One proposal outlined involved setting a higher minimum efficiency of B for cylinders and we are keen to seek views on this proposal here.

Given low-carbon solutions such as standalone heat pumps also require hot water cylinders, the government is keen to understand if increasing the minimum efficiency to B would also increase the likelihood these cylinders were suitable for use as part of heat pump systems in the future, thereby reducing replacement costs.

Question 15: Do you agree that the government should set a requirement for all cylinders to have a minimum efficiency rating of B? Yes/No. Please expand on your views.

Question 16: What additional measures may be required to ensure that cylinders are future-proofed for use alongside heat pumps?

Installer skills

Improving system maintenance

BEIS has commissioned research on the heating and cooling installer workforce, which will be published in due course. This will inform the government's understanding of the existing workforce and how the government can support greater apprenticeship uptake. Department for Education statistics show that there are currently 6,590 apprentices enrolled in the Plumbing and Domestic heating Apprenticeship,[47] the majority of whom enrolled in the 2021/22 academic year.

Heating systems that are better designed and maintained deliver more efficient heating and higher comfort levels to consumers. The domestic heating distribution system research highlighted the importance of completing correct commissioning practices when installing a new appliance, including hydraulic balancing, and flushing the system to remove sludge.[48] Not doing so can limit the amount of useful heat transferred by the radiators into the home and increase gas consumption by having to run a heating system longer and at higher temperatures. Regularly servicing heating systems can also ensure that a heating system is still working optimally throughout a boilers lifespan. However, it is clear from the research that heating distribution system maintenance is not happening on an annual basis as

[46] DLUHC (2021), 'Approved Document L, Conservation of fuel and power, Volume 1: Dwellings', https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l.
[47] Department for Education (2022), 'Apprenticeships and traineeships: Academic Year 2021/22', https://explore-education-statistics.service.gov.uk/find-statistics/apprenticeships-and-traineeships.
[48] BEIS (2021), 'Domestic heat distribution systems, evidence gathering: final report, https://www.gov.uk/government/publications/heat-storage-and-distribution-systems-hds.

recommended, and there are also concerns expressed by industry that annual boiler servicing is also not happening consistently.[49]

The original Boiler Plus Standards made clear that hydraulic balancing was an expected practice to be completed following the installation of a replacement boiler. It is a practice that ensures the temperature difference between the inlet and outlet of each radiator is consistent throughout the property. Thereby reducing the risk of over or under heating rooms by ensuring each room meets the set point temperature at the same time. The Heating and Hotwater Industry Council's (HHIC) Benchmark Commissioning Checklist requires installers to check the heating system is correctly balanced, and if not, to rebalance the system.[50] The Benchmark is listed in Approved Document L (the statutory guidance to Part L of the Building Regulations) as a checklist for showing that commissioning of the system has been carried out satisfactorily. Boiler warranties are often tied to the completion of the Benchmark checklist and if not completed by the installer, as well as an annual boiler service, the warranty may be invalid should a consumer make a claim.

Hydraulic balancing can be completed by either a manual or automated means. Responses to the original Boiler Plus consultation noted the difficulties around adding a requirement for hydraulic balancing to Approved Document L (the statutory guidance to Part L of the Building Regulations) without adequate information collection to support enforcement. Respondents also noted this expected practice was often not undertaken due to the additional time taken, we assume this would be due to the time taken to complete this manually. However, we are aware the time required to complete balancing and other processes may be reduced and simplified with the availability of new technologies, and therefore be easier for installers to do.

The government is keen to understand how to ensure correct commissioning takes place and whether more information should be recorded a time of installation to demonstrate this. At the same time, we are also interested to understand how these practices might be made more efficient.

In addition, we are seeking views on how regular heating system servicing, going beyond normal recommended gas checks,[51] can be encouraged or whether it should be mandatory. We are also seeking views on whether the appropriate regularity of servicing for heating distribution systems should be on annual basis as is currently recommended and what practices should be specified.

Updated Building Regulations' guidance now requires all new and replacement wet heating systems (including the heating appliance, emitters and associated pipework) to be designed to operate to 55°C degrees or lower, where possible.[52] This will deliver significant benefits to condensing boiler efficiency and prepare homes for switching to low temperature heating

[49] BEIS (2021), 'Domestic heat distribution systems, evidence gathering: final report, https://www.gov.uk/government/publications/heat-storage-and-distribution-systems-hds.
[50] Heating and Hotwater Council, 'Benchmark Commissioning & Warranty Validation Service Record' https://www.hhic.org.uk/uploads/5D9B41557255E.pdf, last updated 2019.
[51] Normal gas boiler servicing includes safety checks, removing all the casing to check the main boiler components are working and cleaning boiler parts such as the heat exchanger.
[52] DLUHC (2021), 'Approved Document L, Conservation of fuel and power, Volume 1 : Dwellings', https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l.

appliances like heat pumps. We are seeking views as to how to ensure that gas boiler installers have the relevant skills to meet this Building Regulation requirement, for example by making low temperature heating system training mandatory for gas installers by incorporating this into regular Gas Safe Registration renewal and entry training.

Question 17: a) What additional information can be collected or recorded by installers to ensure full commissioning for boiler installations take place, for example, should heat loss calculations be recorded? b) What available technologies can be used to speed up this process, including more time-consuming practices like hydraulic balancing?

Question 18: How can regular heating system servicing be encouraged, what practices should be included and what are the potential benefits and costs consumers should expect?

Question 19: **Should low temperature heating system training be mandatory for gas boiler installers to help ensure Building Regulations are met? Yes/No. Please expand on your views.**

Real world performance monitoring

The Energy-related Products Policy Framework[53] set out the possibility of requiring all new heating appliances to make real time efficiency information available to consumers. This information has the potential to assist consumers in improving the efficiency of their system by encouraging regular boiler and heating system maintenance and servicing and have a helpful role in bill management.

Real world efficiency monitoring will rely on collecting the percentage of useful energy transferred into heat and displaying this on the boiler console. Some stakeholders suggest that implementing this could be simple and entail monitoring the return temperature of water flowing to the boiler and using this to generate displayed real-time efficiency information. However, other stakeholders have concerns about how accurate such devices would be and who is responsible for acting upon it. The government would welcome views on this and the feasibility of pursuing this policy.

Question 20: What appropriate technological solutions currently exist or could be developed for collecting and displaying real-time efficiency information? Please explain your answer.

[53] BEIS (2021), 'Energy-related Products Policy Framework', https://www.gov.uk/government/publications/energy-related-products-policy-framework.

Implementation

Timing

This consultation proposes that changes relating to in-home boiler efficiency are implemented from 2025. However, we are keen to understand views on whether any of the individual requirements should be introduced over a longer timeframe, and the relative costs and benefits of alternative options.

Regulatory vehicle

The original Boiler Plus Standards were implemented using an update to the statutory guidance Part L of the English Building Regulations. The government's intention is to use product standards to implement the technologically focused proposals set out above, through Ecodesign legislation.

Product standards were previously set and controlled by the European Union (EU). Following the UK's exit from the EU, Ecodesign and Energy Labelling legislation was retained in domestic law. The powers to update Ecodesign and Energy Labelling requirements have been transferred to the Secretary of State. The Office for Product Safety and Standards (OPSS), part of the Department for Business, Energy and Industrial Strategy, is the appointed Market Surveillance Authority for Ecodesign Regulations in Great Britain and will provide oversight for implemented proposals.

Our position throughout this chapter has been that the proposals are focused on boilers of a domestic-scale of 45kW or lower. However, we are also seeking views on whether it is appropriate to extend these proposals to boilers sized up to 70kW. This would extend the scope of the proposals to include a larger number of systems installed in non-domestic buildings and also ensure that homes with higher hot water and heating demand do not avoid the regulations by purchasing larger boilers.

Final policy design will be confirmed in the government's response to this policy document and a consultation on draft Ecodesign and Energy Labelling legislation, which will follow this winter. This consultation will consider other space heating technology and include considerations of the circular economy and resource efficiency.

As set out in BEIS's Energy-related Products Policy Framework, it is important to embed circular economy principles in design so that products, components, and constituent materials remain in circulation for longer, and we can increase the resource efficiency of our economy. This involves products being designed to be more durable, repairable, and recyclable, as well as making use of recycled content. Benefits are in reduced product lifecycle emissions, reduced impacts on nature, contribution to an increase in our resource security and creation of jobs in this country. We are currently considering material resource efficiency options in relation to boilers as well as other space heating technology, including hybrid systems considered later, and, as necessary, will set these out separately in the future consultation.

Question 21: Do you agree that the proposals for new boiler and hot water tank product standards should be applied to new boiler installations from 2025? Yes/No. Please expand on your views.

Question 22: a) Could the proposals be applied to new boiler installations earlier to help lower bills for consumers sooner? Yes/No. Please expand on your views. b) What additional steps or refinements may be required to support an earlier implementation date?

Question 23: What are your views on the cost implications of the various proposals for the average boiler installation? Please expand on your views.

Question 24: Do you agree that the government should use Ecodesign legislation to implement the proposals? Yes/No. Please expand on your views.

Question 25: What are your views on extending the regulations to cover all gas boilers up to 70kW? Please expand on your views.

Chapter 2: Hydrogen-ready boilers

Introduction

This chapter of the consultation proposes the introduction of new standards which would require all new domestic-scale (≤ 45kW) natural gas-fired boilers to be hydrogen-ready from 2026.

The government proposes to proceed with requiring that all newly installed domestic-scale natural gas boilers be hydrogen-ready, on the assumption that the following conditions can be met:

a) Hydrogen-ready boilers can satisfy regulatory requirements once converted to operate on 100% hydrogen gas which includes performance and safety.
b) Price parity with natural gas boilers will be achieved when hydrogen-ready boilers reach natural gas only boiler sales totals.
c) A single market-wide definition of hydrogen-ready boilers is agreed, which ensures that products meeting this definition can prepare homes for possible 100% hydrogen conversions.

The main benefit of such a requirement would be to prepare homes for a potential gas grid conversion to hydrogen. The Climate Change Committee's Sixth Carbon Budget Report also supported such a requirement on this basis.[54] The deployment of hydrogen-ready boilers from 2026 would reduce the scrappage costs and disruption associated with the replacement of natural gas boilers before the end of their useful life at the point of grid conversion. This section considers issues including the expected costs of such systems, their performance, conversion kits and the skills required for installation.

Context

Unlike natural gas, hydrogen does not release CO2 when burned, though emissions can still occur through the production process. Low-carbon hydrogen therefore has the potential to decarbonise several UK sectors, including heavy industry, heavy transport, power and potentially heating, as an alternative to natural gas. In the recently published British Energy Security Strategy, we committed to doubling our UK ambition for hydrogen production to up to 10GW by 2030, with at least half of this from electrolytic hydrogen. Support for new low-carbon hydrogen production is now available through the Net Zero Hydrogen Fund and hydrogen

[54] Climate Change Committee (2020), 'The Sixth Carbon Budget -The UK's path to Net Zero', https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf.

business model, with the aim to have up to 2GW of production capacity in operation or construction by 2025.[55]

Replacing natural gas with 100% hydrogen is not yet an established option for decarbonising heating in buildings at scale. The government is working with industry, regulators and others to deliver a range of research, development and testing projects to assess the feasibility, costs and benefits of using 100% hydrogen for heating. As set out in the Ten Point Plan for a Green Industrial Revolution, this work includes a pioneering programme of community trials, with the government supporting industry to deliver a neighbourhood-sized and a village-sized trial by 2025. The local trials and planning work, together with the results of a wider research and development and testing programme, will enable strategic decisions in 2026 on the role of hydrogen for heat decarbonisation.[56]

This work will build on the previous research supported by the government, including the Hy4Heat hydrogen innovation programme which began in 2017 and concluded at the end of March 2022. The Hy4heat programme was a key first step in investigating the safety and feasibility of using 100% hydrogen for heat in the home and included the development of prototype hydrogen-compatible heating appliances such as gas fires, cookers and boilers, the development of hydrogen gas meters, a safety assessment for a range of domestic building types of standard construction (e.g., terraced, detached and semi-detached housing) and technical standards and studies.

As with other proposals focused on improving in-home boiler performance, this consultation principally considers the case for requiring that natural gas boilers with a capacity ≤ 45kW be required to be hydrogen-ready, on the basis that this is the largest capacity of combination boiler that is typically installed in homes. However, as with the other proposals, we are interested to understand whether this should be extended to 70kW, thereby capturing significant segments of the smaller non-domestic property market as well as preventing any sale of oversized boilers that would not need to meet the new regulations into the domestic market.

The government is developing a position with regard to commercial gas boilers greater than 70kW. Commercial prototype hydrogen-ready boilers are still undergoing development. For larger boilers for industrial applications, the government is also developing its position and monitoring market activity, including some demonstrations funded by our net zero innovation portfolio.[57] A call for evidence on ‘enabling or requiring hydrogen-ready industrial boiler equipment’ ran from December 2021 to March 2022. We have published the government

[55] BEIS and Prime Minister’s Office, 10 Downing Street (2022), ‘British Energy Security Strategy’, https://www.gov.uk/government/publications/british-energy-security-strategy.
[56] BEIS, Prime Minister’s Office, 10 Downing Street, The Rt Hon Alok Sharma MP and The Rt Hon Boris Johnson MP (2020), ‘The Ten Point Plan for a Green Industrial Revolution’, https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution.
[57] These competitions include two Industrial Fuel Switching competitions: https://www.gov.uk/government/publications/industrial-fuel-switching-competition and https://www.gov.uk/government/publications/industrial-fuel-switching-to-low-carbon-alternatives.

response to this call for evidence today. This information may form the basis for further consultations on proposals for industrial boiler equipment.[58]

Mandating hydrogen-ready boilers

The government proposes to proceed with requiring that all newly installed domestic-scale natural gas boilers be hydrogen-ready, on the assumption that the following conditions can be met:

a) Hydrogen-ready boilers can satisfy regulatory requirements once converted to operate on 100% hydrogen gas which includes performance and safety.
b) Price parity with natural gas boilers will be achieved when hydrogen-ready boilers tend to natural gas only boiler sales totals.
c) A single market-wide definition of hydrogen-ready boilers is agreed, which ensures that products meeting this definition can prepare homes for possible 100% hydrogen conversions.

The introduction of hydrogen-ready boilers as standard is expected to have significant benefits in the case of any future conversion of the gas grid to hydrogen. It will maximise hydrogen-ready boiler deployment levels ahead of any grid conversion, thereby minimising the number of potentially stranded assets. A regulatory approach also provides market certainty for industry to make investment decisions and convert supply chains and for installers to gain relevant hydrogen-ready boiler installation skills. In combination, high levels of deployment and market certainty will also minimise upward pressure on the cost of boilers.

A hydrogen-ready mandate from 2026, informed by the results of the consultation, is separate to – but aligns with – the wider strategic decisions to be made in 2026, following the neighbourhood-sized and village-sized trials. We are proposing that a decision to require gas boilers to be hydrogen-ready should be made before broader strategic decisions on hydrogen for heating, so that the mandate can be implemented in 2026 and deliver the aforementioned benefits.

If all three conditions are met, it is the government's view that the mandate constitutes a low-regrets action in terms of impacts to consumers, whether their hydrogen-ready boiler is converted or not, as they will not face additional upfront purchasing costs.

The case for requiring all new domestic gas boilers be hydrogen-ready is informed by previous regulatory changes in the heating industry. This includes the requirement for gas boilers to be condensing models, introduced in 2005 by setting higher minimum efficiency standards. Despite condensing gas boilers being a mature technology, their deployment across the housing stock remained very low. This remained the case despite government incentives through grants in the 1990s and the attractiveness of the potential bill reductions offered by

[58] BEIS (2021), 'Enabling or requiring hydrogen-ready industrial boiler equipment: call for evidence', https://www.gov.uk/government/consultations/enabling-or-requiring-hydrogen-ready-industrial-boiler-equipment-call-for-evidence.

condensing boilers due to their higher efficiency. The uptake of this technology remained low until a regulatory change was announced and introduced.[59]

The government is keen to hear views on the opportunities and challenges presented by requiring that all newly installed domestic-scale natural gas boilers be hydrogen-ready from 2026. We are also interested in hearing any alternative proposals on how to implement a hydrogen-ready boiler mandate, while meeting our three proposed conditions for ensuring low-regrets impacts for consumers.

Question 26: What opportunities and challenges would requiring all newly installed domestic-scale natural gas boilers to be hydrogen-ready from 2026 present? Please provide evidence and reasoning to support your answer.

The sections below set out our current understanding versus the assumptions listed above and other issues related to the successful roll-out of hydrogen-ready boilers. The evidence gathered will be considered alongside the findings from the multiple research projects carried out on behalf of the government including the Hy4Heat programme. The Hy4Heat innovation programme has demonstrated that it is technically feasible to produce domestic-scale hydrogen-ready boilers[60] that meet standards of performance and safety equivalent to the standards applied to natural gas boilers.

Hydrogen-ready boiler costs

As set out above, a key factor enabling the government to mandate hydrogen-ready boilers is that they can reach cost-parity with natural gas only boilers by the time that they are required as standard.

Strategic decisions on the role of hydrogen for heating will be taken in 2026. As such there is no guarantee that hydrogen-ready boilers will be converted to operate on hydrogen.

For the introduction of hydrogen-ready boilers as standard to be considered advantageous, their upfront costs must reach parity with those of existing natural gas boilers when deployed market-wide. The public price promise made by boiler manufacturers and industry body representatives provides welcome assurance in this regard.[61] In this section, we set out the findings of previous government funded research on appliance costs and are seeking to further understand how price parity might be achieved.

The upfront cost of an installed boiler is comprised of the price of the boiler and the price of the labour time required to install it. The average cost of a boiler installation is approximately

[59] N.Eyre (2020), 'The story of condensing boiler market transformation – a briefing note for BEIS'.
[60] BEIS (2022), 'Hy4Heat Report: Final Progress Report', https://www.hy4heat.info/s/Final-Final-Report.pdf.
[61] EUA (2021), 'New report tracks true cost of green energy switch'. https://eua.org.uk/new-report-tracks-true-cost-of-green-energy-switch/.

£2,600.[62] This cost can vary significantly depending on the type and size of boiler purchased. Other works completed alongside the installation, including system maintenance works and fitting any new controls, will also influence cost.

It is anticipated that any upfront cost increases from hydrogen-ready boilers will be due to product costs, as the time required to fit hydrogen-ready boilers is expected to remain the same as natural gas boilers. BEIS commissioned research by Frazer-Nash from 2018, estimated the retail price of hydrogen-ready boilers was likely to be 10% to 20% more than natural gas boilers, while average installation costs were likely to remain the same. However, these production costs assumed a degree of ongoing dual production.[63] Additionally, further development of prototype hydrogen-ready boilers has occurred since the report was published in 2018.

Research carried out by Element Energy suggested that the hydrogen-ready boiler prices will tend towards the natural gas boiler prices as production volumes increase over 100,000 units per manufacturer per year[64], but would be significantly more expensive below these levels. The research concluded that hydrogen-ready boilers could reach cost parity with natural gas boilers when produced at scale but presented cases where costs could be higher. Taken together, these previous projects suggest that for costs to be kept as low as possible, hydrogen-ready boiler sales need to reach mass-market levels, and therefore support the case for introducing hydrogen-ready boilers as a market-wide standard.

The government welcomes the price promise made by manufacturers that if hydrogen-ready boilers were made mandatory they could be retailed at the same costs as natural gas only boilers. We are aiming through this consultation process to confirm how this will be achieved. In addition, we are also seeking to understand whether and how this can be achieved by smaller manufacturers, and to gather installer and consumer views regarding the expectation of price parity.

In addition, the government is also seeking to understand if manufacturers would look to sell hydrogen-ready boilers in advance of a government mandate and what potential costs early adopter consumers could face. The price promise is expected to protect consumers following a mandate, but the government is interested in the appropriate consumer protections which can be offered to consumers in advance of this.

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[62] BEIS analysis estimates the average cost of a boiler as £2,600 using Delta EE cost data for boiler installations and averaging this data across data for all gas heating dwellings in Great Britain using the National Household Model.
Delta Energy and Environment, prepared for BEIS (2020), 'The Cost of Installing Heating Measures in Domestic Properties', Table 2, https://www.gov.uk/government/publications/cost-of-installing-heating-measures-in-domestic-properties and
BEIS (2017), 'National Household Model', https://data.gov.uk/dataset/957eadbe-43b6-4d8d-b931-8594cb346ecd/national-household-model.

[63] Frazer-Nash Consultancy, prepared for BEIS (2018), 'Logistics of Domestic Hydrogen Conversion', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760508/hydrogen-logistics.pdf.

[64] Element Energy on behalf of BEIS (2018), 'Hydrogen Supply Chain Evidence Base', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760479/H2_supply_chain_evidence_-_publication_version.pdf.

Question 27: If made mandatory, can hydrogen-ready boilers match the cost of current natural gas boilers? Yes/No. Please provide evidence and reasoning to support your answer.

Question 28: Do you anticipate the installation of a hydrogen-ready boiler to take the same time as a natural gas boiler replacement? Yes/No. Please expand on your views.

Question 29: a) For early adopters of hydrogen-ready boilers, in advance of a government mandate, can consumers expect to pay more for hydrogen-ready boilers? Yes/No. Please expand on your views. b) What protection can be put in place to support consumers?

Hydrogen-ready boilers – definition

There is no standardised definition of a hydrogen-ready boiler. A clear definition is required to provide clarity for industry, to give consumers confidence in the product they purchase and to ensure that boilers sold as 'hydrogen-ready' are compatible with any future conversion of the grid from natural gas to hydrogen.

This consultation is focused on hydrogen-ready boilers that can run on 100% hydrogen gas following a simple conversion process, such as the prototype models developed as part of the Hy4Heat programme. Once a definition is finalised and transferred into regulations, it will only be possible to place a hydrogen-ready boiler on the market that meets this definition. This will mean that boilers that can use a 20% hydrogen blend cannot be advertised or sold as 'hydrogen-ready'. The definition will be enforced by the Office for Product Safety and Standards.

Underpinning standards and certification – PAS4444 and UKCA marking

The PAS 4444:2020+A1:2021 specification[65] was developed to be used primarily on the Hy4Heat programme but with the aim that it forms the basis for widescale standardisation of hydrogen-fuelled appliances. The specification provides principles for manufacturers regarding the safety testing and functionality of hydrogen-fuelled and hydrogen/natural gas dual-fuelled or converted appliances, including boilers, cookers, and fires.

The PAS 4444:2020+A1:2021 specification will be used in the neighbourhood-sized and village-sized trials of 100% hydrogen for heating. It also expected to form the basis of the testing process a hydrogen-ready boiler might go through in both natural gas and hydrogen mode, as well as the conversion kit. Completing these tests may be a step to:

[65] British Standards Institute, 'PAS 4444:2020+A1:2021 Hydrogen-fired gas appliances', https://standardsdevelopment.bsigroup.com/projects/2021-00131 - /section.

- ensuring that the boilers and conversion kits can meet the essential requirements set out in the Gas Appliance Regulations (GAR)[66]
- receiving the certification for a UK Conformity Assessed (UKCA) marking,[67] needed to sell the product on the UK market

Therefore, regardless of any final definition used in regulations, the government will expect a hydrogen-ready boiler to undergo the testing process set out in PAS 4444:2020+A1:2021.

Definitions

The Heating and Hot Water Industry Council has developed the following definition for hydrogen-ready boilers, in collaboration with their members: *A boiler of any type (Regular, System or Combination) that "out of the box" is ready to be connected to the Natural Gas Network and following a conversion and re-commissioning process in situ, can then operate safely and efficiently, maintaining equivalent comfort levels and providing a sufficient supply of heating and hot water using hydrogen.*[68]

The government has drawn upon the industry's proposal to develop the definition planned for use in regulations, set out below. The proposed definition is seeking to more clearly define the time expected to convert a boiler, the availability of conversion kits and the performance of the product and to add clarity about when a hydrogen-ready boiler could be defined as 'low-carbon'.

Ease of conversion: We understand a conversion kit, containing necessary replacement parts, will be required to convert hydrogen-ready boilers. The government is clear that only boilers that have been designed specifically to facilitate a simple and quick conversion to run on 100% hydrogen should be considered compliant with regulations. Speed of conversion is the main way hydrogen-ready boilers can support hydrogen being rolled out across the gas network. Gas boilers that may require costly, significant changes to convert to hydrogen should not be considered hydrogen-ready. The prototype hydrogen-ready boilers developed through

[66] OPSS (2022), 'Regulation 2016/426 and the Gas Appliances (Enforcement) and Miscellaneous Amendments Regulations 2018: Great Britain', https://www.gov.uk/government/publications/gas-appliances-enforcement-regulations-2018/regulation-2016426-and-the-gas-appliances-enforcement-and-miscellaneous-amendments-regulations-2018-great-britain#:~:text=Regulation%20(EU)%202016%2F426,2016%2F426%20in%20the%20UK, 'Regulation (EU) 2016/426 of the European Parliament and of the Council', https://www.legislation.gov.uk/eur/2016/426/contents, and 'The Gas Appliances (Enforcement) and Miscellaneous Amendments Regulations 2018', https://www.legislation.gov.uk/uksi/2018/389/contents.

[67] On 14 November 2022, the Government placed legislation before Parliament providing that, until 11pm on 31 December 2024, gas appliances which have been independently conformity assessed by an EU Notified Body and 'CE' marked or independently conformity assessed by a UK Approved Body and 'UKCA' marked can be placed on the Great Britain market. From 11pm on 31 December 2024 only appliances which have been independently conformity assessed by a UK Approved Body and UKCA marked can be placed on the Great Britain market. However, activities taken towards CE marking before 11pm on 31 December 2024 will count towards UKCA marking, and any certificates issued by an EU Notified Body as part of that conformity assessment process will be valid until the certificate expires, or until 11pm on 31 December 2027, whichever is sooner. Further information is available at: https://www.gov.uk/guidance/ukca-marking-conformity-assessment-and-documentation.

[68] Heating and Hotwater Council (2022), 'Hydrogen Appliances', https://www.hhic.org.uk/uploads/62CFE776309E6.pdf.

Hy4Heat can be converted in around 2 hours. The Hydrogen Supply Chain Evidence Base (2018) suggested that boilers could be converted even more quickly, in as little as an hour.[69] The government is keen to hear views on if and how conversion times could be reduced to this level.

Efficiency: The government's view is that hydrogen-ready boilers should continue to meet minimum efficiency standards when operating with natural gas or hydrogen. A working definition used in the Hy4Heat programme referenced prototype boilers being optimised for use of hydrogen. However, as set out in Chapter 1: Boiler efficiency, the government is clear about the need to maintain and improve the performance of natural gas boilers, ahead of a possible hydrogen conversion. Hydrogen-ready boiler performance is considered in more detail in the following section – Tested hydrogen-ready boiler performance.

Low-carbon ready: Hydrogen-ready boilers cannot be considered low-carbon when operating in natural gas mode and this will need to be clearly stated in any materials accompanying or referring to the boiler. It should remain clear to consumers purchasing hydrogen-ready boilers, including in communications from manufacturers, retailers and installers, that hydrogen-ready functionality provides no assurance that low-carbon hydrogen will be available within the lifetime of the appliance, and the appliance will need to be converted to actually run on hydrogen. The government is introducing the Low-Carbon Hydrogen Standard,[70] to ensure government supported hydrogen production delivers genuine carbon savings.

Taking the above considerations into account, we propose to base a definition in future regulations on the following:

A domestic hydrogen-ready boiler is a gas boiler of any type (Regular, System or Combination) that "out of the box" is ready to be connected to the Natural Gas Network and is technically prepared to be converted, normally within 2 hours, into a safe boiler that can use 100% hydrogen as a fuel and maintains the minimum energy efficiency performance standard. Conversion kits will be supplied by the boiler manufacturer if and when hydrogen conversion is confirmed in the area where the boiler is installed.

Question 30: Do you agree with the proposed basis for a definition for hydrogen-ready boilers? Yes/No. Please expand on your views.

Tested hydrogen-ready boiler performance

Hydrogen-ready boilers are expected to meet all the new standards described in Chapter 1: Boiler efficiency, including requirements related to controls, modulation ranges and

[69] Element Energy on behalf of BEIS (2018), 'Hydrogen Supply Chain Evidence Base', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760479/H2_supply_chain_evidence_-_publication_version.pdf.
[70] BEIS (2022), 'The UK Low Carbon Hydrogen Standard: Government response to consultation', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1076448/uk-low-carbon-hydrogen-standard-government-response.pdf.

improvements in overall system design and maintenance. These proposals are expected to enhance the performance of the boiler regardless of fuel type.

Hydrogen-ready boilers will also need to meet minimum energy performance standards through laboratory testing, when operating in both natural gas and hydrogen modes. That hydrogen-ready boilers can meet minimum energy performance standards is important for two reasons. Firstly, given there is no guarantee of hydrogen conversion, especially for the first wave of hydrogen-ready boilers installed, performance needs to be maintained when burning natural gas. Secondly, when operating using hydrogen, it is crucial that these boilers can do so efficiently, given the energy required to produce hydrogen.[71]

Our understanding is that hydrogen-ready boilers can meet the 92% ErP efficiency standard when burning natural gas. We are aware that the primary energy factor for hydrogen will affect the final ErP efficiency of the boiler when operating in hydrogen mode. For the purpose of this consultation, we are seeking to understand what ErP efficiency ratings could be achieved, assuming the primary energy factor for hydrogen remains the same as for natural gas. Primary energy factors for space heating technologies are being considered through wider work on energy-related products.

Chapter 1: Boiler efficiency considers the option of increasing tested efficiency standards to 93% or 94% ErP. We would therefore also welcome views on whether hydrogen-ready boilers could meet such increased tested efficiency standards, when operating in both natural gas and hydrogen modes.

Question 31: a) Do you agree that domestic-scale hydrogen-ready boilers should continue to meet 92% ErP efficiency? Yes/No. Please expand on your views. b) If ErP efficiency standards for gas boilers were raised to 93% or 94%, as set out in question 12, could hydrogen-ready boilers meet this increased standard, when operating using both natural gas and hydrogen? Yes/No. Please expand on your views.

Hydrogen-ready boilers and air quality

The transition to low-carbon heating will need to take into account the air quality and public health impacts of different technologies. Natural gas boilers produce nitrogen oxide (NOx) emissions through fuel combustion. This would also be the case for hydrogen-ready and hydrogen boilers.

Limits on NOx emissions from fossil fuel boilers are applied through Ecodesign requirements. Ecodesign requirements for NOx emissions (expressed in nitrogen dioxide) came into force in September 2018 and require that fuel boilers (space heaters and combination heaters using gaseous fuels) do not exceed 56 mg/kWh fuel input in terms of

[71] We are introducing a Low Carbon Hydrogen Standard, to ensure hydrogen production supported by Government delivers genuine carbon savings.

gross calorific value.[72] These requirements were agreed by the United Kingdom when part of the European Union and were retained into domestic law following the UK's exit from the EU.

To support air quality benefits, government's intention would be to ensure NOx emission limits apply to boilers running on hydrogen. Hydrogen-ready boilers will need to meet relevant NOx emission standards when running on hydrogen.

Some early prototypes of hydrogen boilers, developed through the Hy4Heat hydrogen innovation programme, produce less NOx emissions than Ecodesign limits, with NOx emissions of less than 25 mg/kWh.[73] To improve air quality, we are interested to hear views as to whether NOx emission limits could be set for hydrogen-ready boilers running on hydrogen gas at a level lower than 56 mg/kWh.

Question 32: Could hydrogen-ready boilers meet lower nitrogen oxide emission limits, when running on hydrogen gas? Please provide evidence and reasoning to support your answer.

Scope

The government is planning to introduce a hydrogen-ready boiler mandate from 2026 based on the assumptions set out above. This would mean that all gas fired boilers within a specific size cap, focused on boilers used for domestic purposes, would have to meet this requirement. The starting position is that this should apply to all boilers ≤ 45kW. It would apply to all gas boiler types – regular, system and combination. All proposals on boiler design set out above would also apply to hydrogen-ready boilers. Like the energy efficiency proposals, we intend to introduce this appliance focused requirement through the forthcoming update to Ecodesign regulations.

It is anticipated that industry will need at least a 3-year lead-in time to convert all their boiler ranges to hydrogen-ready models.[74] On this basis we assume implementation from 2026 will provide all parts of the industry with sufficient lead-in time to prepare supply chains.

As noted above, following the UK's exit from the EU, powers to update and introduce Ecodesign and Energy Labelling requirements have been transferred to the Secretary of State. We propose using this legislation to introduce and mandate the requirement for boilers to be hydrogen-ready.

[72] The National Archives (2018), 'Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for space heaters and combination heaters, Annex II, Division 4', https://www.legislation.gov.uk/eur/2013/813/annex/II/division/4#.
[73] Worcester Bosch (202X), 'Hy4Heat | Hydrogen-Ready Wall-Mounted Gas Boilers', p.2, https://www.hy4heat.info/s/Bosch-HyLife.pdf.
[74] Frazer-Nash Consultancy, prepared for BEIS (2018), 'Logistics of Domestic Hydrogen Conversion', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760508/hydrogen-logistics.pdf.

Question 33: Do you agree that any requirement for domestic gas boilers to be hydrogen-ready in 2026 should be made through an update to UK Ecodesign legislation? Yes/No. Please expand on your views.

Question 34: Would you support increasing the scope of the hydrogen-ready mandate to include gas boilers with capacity of up to 70kW in 2026 or at a later date? Yes/No. Please expand on your views.

Conversion – parts management

Hydrogen-ready boilers will run on natural gas when initially installed. To be converted to operate using hydrogen, they will require conversion kits, containing necessary replacement parts, including burners.

Boiler conversion parts and kits need to be properly stored to be maintained correctly. Hydrogen-ready boilers installed in the first years following their introduction are unlikely to be converted earlier than the middle to late 2030s. As such, the conversion components will not be required for many years.

There are three options we have considered for managing the provision of conversion kits:

1. They are provided to the consumer at the initial point of installation, either separately or placed within the boiler casing
2. They are produced by the manufacturer at the same time as the boiler and stored until they are required for conversion
3. They are only produced and supplied by manufacturers when boilers are due for conversion, potentially through a bill of materials

The government's preference is for option 3. Both options 1 and 2 would increase wastage by producing parts that may not be required, leading to increased costs and in-built carbon emissions. There are also other factors which make options 1 and 2 less desirable.

Firstly, it is not reasonable to require consumers to be responsible for such vital equipment that may never be used and could potentially be lost or mishandled or stored incorrectly. This also removes any need to confirm or guarantee the safe transfer of component parts from household to household in the case of moving properties.

Secondly, it is not reasonable to expect manufacturers to hold significant volumes of conversion kits in storage. There are expected to still be issues related to the correct storage of conversion kits and associated costs for manufacturers to absorb stemming from increased production and storage.

Option 3 requires conversion kits only to be produced and provided at the point or just ahead of any local grid conversion once such conversions are confirmed. This position places responsibility for kits and component parts with manufacturers and suppliers.

In this scenario a further consideration is whether appropriate records would need to be kept, for example on the models and serial numbers of boilers and where these have been installed. Such record keeping would assist in ensuring the correct conversion kits could be produced and distributed at the time of conversion.

Information regarding boiler installations is currently gathered through the Gas Safe self-notification process, which includes the location of the boiler, the type, manufacturer, and model. In addition, industry led schemes, such as the HHIC's Benchmark Commissioning Checklist, contain more information than is collected through Gas Safe. This includes boiler serial number which is likely to be critical for ensuring conversion kits align with boiler models.

Question 35: Do you agree that hydrogen-ready boiler conversion kits should only be supplied when a hydrogen grid conversion of an area has been confirmed? Yes/No. Please expand on your views.

Question 36: Do you agree that information regarding the location and model of the hydrogen-ready boiler needs to be collected in an easily accessible format for manufacturers and networks to ensure a smooth future hydrogen conversion and roll out? Yes/No. Please expand on your views.

Conversion – additional works and maintenance

Where a hydrogen-ready boiler is installed, this does not necessarily mean that the property is fully ready to be heated using hydrogen. BEIS is working with industry, regulators and others to deliver a range of research, development and testing projects, including community trials, to assess what additional changes, if any, may be required to homes to make them suitable for using hydrogen gas.

The Hydrogen Skills and Standards for Heat programme will produce enabling standards and installer guidance for the installation of new hydrogen pipework and to repurpose existing natural gas installations for use with hydrogen. This programme will support the community village trial to produce critical evidence to inform strategic decisions on the role of hydrogen for heating in 2026.

Hydrogen-ready boilers are expected to have a similar lifespan to natural gas boilers of up to 15 years. The government is keen to support efforts to ensure this, as it will give the first generation of hydrogen-ready boilers installed the greatest possible chance to be converted to a hydrogen fuel. We understand that regular boiler servicing is already linked to many warranties, and we are keen to understand whether this will be adequate for hydrogen-ready boilers. We would also welcome views as to whether regular servicing of hydrogen-ready boilers should be made mandatory to ensure the appliance and key components are maintained.

Question 37: Building on question 18, we welcome views as to whether the change to hydrogen-ready boilers is likely to mean the government should look to strengthen the amount of regular maintenance required on boilers throughout their life span, given the

need to ensure their fitness for hydrogen conversion can be preserved? Please expand on your views.

Installer skills

Ensuring there is a suitably skilled workforce is crucial to ensure the safe installation of new hydrogen appliances. As part of the Hy4Heat programme, Energy & Utility Skills (EUS) were commissioned by BEIS to develop and deliver a Hydrogen Competency Framework. The Hydrogen Competency Framework established a series of sequential components designed to ensure any work to install and maintain new hydrogen appliances will be completed safely, to the highest standards, and will only be carried out by competent Gas Safe registered engineers.

The outputs of the design development stages of the Hydrogen Competency Framework were the following:

1. A **Comparative Analysis** of hydrogen and existing hydrocarbon gases
2. A **Skills Matrix** that translates the analysis into skills, knowledge and understanding
3. An Interim **Hydrogen Technical Standard** that defines acceptable parameters and requirements for hydrogen installation work
4. A **Hydrogen Training Specification** that will enable training course consistency and facilitate industry recognition
5. An independent **Hydrogen Assessment Module** that will facilitate the addition of a hydrogen competence category on the Gas Safe Register

Following on from this, the BEIS funded Hydrogen Skills and Standards for Heat programme will help define the required criteria to safely repurpose existing natural gas equipment for hydrogen and to train a workforce of competent hydrogen gas installers. EUS and the Institution of Gas Engineers and Managers (IGEM) are working together to deliver the guidance and training requirements for installers.

IGEM will use the latest information from industry to update the Hydrogen Reference Standard for low pressure hydrogen utilisation. Following the update, two full enabling standards will be produced covering considerations for gas installers for domestic and non-domestic scenarios (up to light industrial sites). The standards will cover both installing new gas pipes and repurposing existing gas infrastructure in a building.

EUS will codify both the IGEM domestic and non-domestic enabling standards into competency frameworks and training specifications to facilitate the training of a competent workforce for trials. They will produce Accredited Certification Scheme (ACS) assessment criteria and Approved Code of Practice (ACoP) assessment modules for both enabling standards, working with industry to ensure there is a clear path for existing competent engineers to train for hydrogen installations. This module is expected to be completed in 2023.

Question 38: Do you agree that installers should be required to complete a module in hydrogen training prior to being permitted to fit hydrogen-ready boilers? Yes/No. Please expand on your views.

Chapter 3: Hybrids

Introduction

A hybrid heat pump system is a heating system that combines an electric heat pump with another heat generation technology. Specific controls are often used to manage how the component technologies operate together. For the purposes of this consultation, a "hybrid heat pump" is used to describe a system combining a heat pump and gas boiler.

The market for hybrid heating systems is rapidly developing. A range of products are now available to consumers – ranging from heat pumps installed alongside pre-existing boilers (retrofit hybrids) to separate boiler and heat pump products sold as a package (packaged hybrids). Integrated and compact hybrid heat pumps consist of a heat pump and natural gas boiler integrated within a single unit.[75] Existing compact hybrid heat pump models have a small heat pump[76] and do not include an outdoor unit. In the future, hydrogen-ready hybrid heat pumps – combining an electric heat pump with a boiler capable of hydrogen combustion – may also become available.

The deployment of hybrid heating systems in the 2020s and 2030s could support the growth of the heat pump supply chain, particularly in building types less suitable for a low temperature heat pump, while significantly reducing gas consumption and emissions compared to natural gas boilers. However, significant carbon savings from hybrid systems are dependent on factors including system design, a building's thermal characteristics and consumer behaviour. Appropriate safeguards are therefore needed to ensure that the contribution of the heat pump element within the hybrid system is maximised, and to ensure deployment supports wider government objectives.

Strategic context

The Heat and Buildings Strategy acknowledged that hybrids could play a transitional role in the 2020s and 2030s and that it remains too early to rule hybrid systems in or out of the 2050 energy mix. This is in part due to the ongoing consideration of the potential role of hydrogen for heating.[77] By 2050, the combustion element of any hybrid system would need to be supplied with a low-carbon fuel to be compatible with net zero.

The Net Zero Strategy sets out three illustrative potential scenarios for decarbonising the UK's heating sector that would be consistent with our net zero by 2050 trajectory – reflecting

[75] Element Energy, prepared for BEIS (2017), 'Hybrid Heat Pumps study – final report', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700572/Hybrid_heat_pumps_Final_report-.pdf.
[76] Generally, 2 – 4 kW.
[77] BEIS (2021), 'Heat and Buildings Strategy', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1044598/6.7408_BEIS_Clean_Heat_Heat___Buildings_Strategy_Stage_2_v5_WEB.pdf.

different technological mixes.[78] The following sections consider these three illustrative scenarios, and the possible role for hybrids in each scenario.

The high electrification scenario

The illustrative high electrification scenario sees little to no role for hydrogen heating in buildings. In this scenario, the government would continue to rapidly grow the heat pump market beyond the current target of 600,000 installations per year by 2028 to up to 1.9 million per year from 2035, with around 11 million homes using heat pump systems in 2035 alongside around 2 million using low-carbon heat networks.[79] In this scenario, hybrid heating systems would have no role in 2050, as they would lock consumers into continued use of natural gas or other combustion fuels.

In this illustrative scenario, hybrid heat pumps could have a potentially significant transitional role during the 2020s and 2030s, acting as a stepping-stone for householders in the journey from traditional heating systems to standalone heat pumps and more energy efficient homes. During this period, hybrids could also support the transition required in the electricity network by reducing peak demand versus a scenario where only standalone heat pumps are deployed.

The high hydrogen scenario

The illustrative high hydrogen scenario sees hydrogen as a feasible and preferrable route for the decarbonisation of most of the UK's buildings. In this illustrative scenario, by 2035 around 4 million homes will be using low-carbon hydrogen, 7 million will be using heat pumps and 2 million using heat networks – with a total of 13 million homes using low-carbon heating.[80]

Here hybrids combining heat pumps and hydrogen combustion boilers might have a role as a transitional technology in some homes and buildings. Deployment of hybrids in some circumstances over the 2020s and 2030s could allow continued ramp up in the decarbonisation of heating over that period – as the low-carbon hydrogen economy grows. There may also be some continued use of hybrids up to 2050 and beyond which would provide additional flexibility and choice to consumers in how they heat their homes.

The dual energy system scenario

The illustrative dual energy systems scenario has both hydrogen and electrification as safe and feasible options for heating the UK's buildings. This recognises that, given the differences in the UK's housing stock, it is plausible that no one type of low-carbon heating source will be

[78] BEIS (2021), 'Net Zero Strategy: Build Back Greener', https://www.gov.uk/government/publications/net-zero-strategy.
[79] BEIS (2021), 'Net Zero Strategy: Build Back Greener', p.141, https://www.gov.uk/government/publications/net-zero-strategy.
[80] BEIS (2021), 'Net Zero Strategy: Build Back Greener', p.141, https://www.gov.uk/government/publications/net-zero-strategy.

preferable for all buildings. This scenario could arise from most or all of the gas grid being converted to low-carbon hydrogen, but with different consumers making different choices between use of hydrogen or electrification technologies. Alternatively, there could only be partial conversion of the gas grid, or partial connection of homes to the hydrogen grid, with decisions taken based on geographical and built environment factors.[81]

In this illustrative scenario, there could be widespread consumer demand for hybrid systems that utilise a mix of both energy sources. For some consumers, hybrids could act as a stepping-stone to either technology – allowing consumers to upgrade to standalone heat pump or hydrogen system at the end of the life cycle of their hybrid heating systems.

Policy context

The government recognises that in each of the above scenarios, hybrids could play a transitional role in the 2020s and 2030s in existing on-grid homes. To support assessment of this role, the government has actively prioritised collecting further data on the in-situ performance and use of hybrid heat pumps on the gas grid, through the Electrification of Heat Demonstration project,[82] which has installed 153 hybrid systems.[83] The government has also supported the deployment of hybrid systems through the recently closed Domestic Renewable Heat Incentive[84] and the ongoing Sustainable Warmth Fund[85] and Energy Company Obligation.[86]

Beyond this, the government has recently consulted on a market-based mechanism for low-carbon heat,[87] (the mechanism) which will run from 2024 to at least 2028. The mechanism, alongside other policies, will support the installation of ~400,000 heat pumps per year by 2028 in existing homes, including on the gas grid. The government response to the consultation confirmed plans to include hybrids in the mechanism, subject to assurances that consumers can be confident that their installations are high-performing and low-carbon.[88] A further consultation on the scheme's detailed design is planned before a definitive decision is reached on exactly how different hybrid installations will be treated within its incentives and rules.

[81] BEIS (2021), 'Net Zero Strategy: Build Back Greener', p.142, https://www.gov.uk/government/publications/net-zero-strategy.
[82] BEIS (2020), 'Electrification of Heat Demonstration Project', https://www.gov.uk/government/publications/electrification-of-heat-demonstration-project-successful-bids.
[83] Energy Systems Catapult (2021), 'Electrification of Heat Demonstration Project – Heat Pump Installation Statistics', https://es.catapult.org.uk/report/electrification-of-heat-installation-statistics/.
[84] Ofgem, 'Domestic Renewable Heat Incentive', https://www.ofgem.gov.uk/environmental-and-social-schemes/domestic-renewable-heat-incentive-domestic-rhi.
[85] BEIS (2021), 'Sustainable Warmth Competition', https://www.gov.uk/government/publications/sustainable-warmth-competition-successful-local-authorities.
[86] Ofgem, 'Energy Company Obligation', https://www.ofgem.gov.uk/environmental-and-social-schemes/energy-company-obligation-eco.
[87] BEIS (2021), 'A market-based mechanism for low carbon heat', https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat.
[88] BEIS (2022), 'A market-based mechanism for low carbon heat – summary of responses received and government response', https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1074284/government-response-clean-heat-market-mechanism.pdf.

From 2028, there are several possible levers, such as Building Regulations and products standards (Ecodesign and Energy Labelling), that could be used to continue to increase hybrid deployment on the gas grid. The recently published Energy-related Products Policy Framework set out several options for space heating appliances, including raising the Minimum Energy Performance Standards (MEPS) to improve the efficiency of existing technologies such as boilers and heat pumps, and looked at whether minimum standards could help drive the shift towards lower carbon technologies.[89] One of the illustrative options involved raising MEPS for heating appliances, such as gas boilers, to above 100%.[90] Such a minimum standard could be met by the widespread adoption of hybrid heat pumps, with the incorporation of heat pumps within or alongside boiler appliances.

For buildings off the gas grid, the government recently consulted on proposals to phase out the installation of heating systems using high carbon fossil fuels in homes off the gas grid in England from 2026.[91] We expect heat pumps will be the primary technology for decarbonising off-grid buildings – as evidence shows they are widely deployable and consistent with net zero emissions as the electricity grid decarbonises. We recognise that not all off-grid households will be suitable for a heat pump – and these properties will require an alternative low-carbon heating solution. If hybrid heat pumps are to play a long-term role, the fuel used by the boiler element of the system must be consistent with net zero.

The government is currently analysing the feedback we have received to this consultation and will issue our response in due course. This response, when published, will set out the government's latest thinking on the potential role for hybrid heat pumps and sustainable biofuels off the gas grid.

This document therefore focuses specifically on the potential role for hybrids in existing homes on the gas grid. The remainder of this chapter will consider the potential pros and cons of widespread deployment of hybrids both in the period from now to 2028, as we work towards 600,000 heat pump installations per year, and beyond this point.

Hybrids within heat pump deployment to 2028

This section considers the extent to which the government should actively promote hybrid installations by including them in the target for 600,000 annual heat pump installations by 2028, specifically in the on-grid retrofit sector.

In line with our proposals in Chapter 2: Hydrogen-ready boilers, the gas boiler element of newly installed hybrid heat pumps should, from 2026 onwards, be required to be hydrogen-ready, meaning the hybrid could be easily converted to run on hydrogen gas at the point of any

[89] BEIS (2021), 'Energy-related Products Policy Framework', https://www.gov.uk/government/publications/energy-related-products-policy-framework.
[90] BEIS (2021), 'Energy-related Products Policy Framework', p.44, https://www.gov.uk/government/publications/energy-related-products-policy-framework.
[83] BEIS (2021), 'Phasing out the installation of fossil fuel heating in homes of the gas grid', https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid.

grid transition. Initially though, hybrids deployed on grid are likely to be combinations of natural gas boilers and heat pumps.

Hybrid heating systems can, however, provide a good level of thermal comfort to a wide range of buildings and act as a stepping-stone between combustion boilers and standalone heat pumps. Some forms of hybrid systems, where sufficiently similar to standalone heat pumps, can also support the development of the heat pump supply chain and installer base. There are therefore good reasons to allow hybrids to play a significant role within on-grid retrofit deployment.

For hybrids to be incentivised through the market-based mechanism, the government will need assurances that they will support the policy's overarching objectives of achieving substantial near-term carbon savings and building the heat pump supply chain, particularly in relation to heat pump manufacturing and installer skills.[92] This may mean the mechanism needs to differentiate between different types of hybrid system.

This section considers the possible actions that might be taken to help ensure that hybrid deployment supports decarbonisation objectives, that consumers have sufficient choice when buying new heating technologies and that hybrid installations occur only in suitable buildings.

Low-carbon operation

Significant emission reductions from hybrid systems are dependent on the design and use of the system, and whether these factors support a high utilisation rate for the heat pump element, and therefore support the low-carbon operation of the overall system.

High heat pump utilisation rates (e.g., where the heat pump meets 80% of annual space heating output) may be technically possible for hybrids in the majority of on gas grid homes. However, we are not aware of hybrid trials to date which demonstrate consistent achievement of this level of heat pump utilisation.

We propose the low-carbon operation of hybrid systems could be supported through a combination of measures. We believe utilising Ecodesign and Energy Labelling standards to determine a minimum heat pump contribution for hybrid systems could be an effective way to provide for low-carbon operation and could support consumers to choose the most appropriate hybrid heating systems for their homes. This would be accompanied by the use of optimised smart controls and installation standards to ensure maximum low-carbon operation. A fuller discussion on Ecodesign, Energy labelling and smart controls follows below.

We recognise that changes to the relative prices of gas and electricity may also bring about natural behaviour change in how consumers utilise their hybrid systems, providing an incentive to maximise use of the heat pump element. In this way, actions to rebalance costs could support the low-carbon, heat pump-led operation of existing and newly installed hybrid systems. The government is seeking to 'rebalance' the costs placed on energy bills away from

[92] BEIS (2021), 'A market-based mechanism for low carbon heat', p.17, https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat.

electricity to incentivise electrification across the economy and accelerate a shift away from volatile global commodity markets over the decade. This will also ensure heat pumps no longer face the current market distortions and are comparatively cheap to run over time. We will publish our proposals on how to do so in due course, considering overall system impacts and limiting the impact on bills, particularly for low-income consumers.[93]

The above measures may have less effect on the operation of some sorts of hybrid system than others. In particular, hybrid systems consisting of a heat pump installed alongside a pre-existing gas boiler (retrofit hybrid systems) will not be captured by the Ecodesign and Energy Labelling proposals set out below. Similarly, it will take time for such measures to come into effect and there may be weaker drivers for the low-carbon operation of system in the meantime.

Ecodesign and Energy Labelling

Hydronic space heating systems are currently regulated under Ecodesign and Energy Labelling regulations which set the relevant MEPS and establish a tiered labelling system for all systems, based on efficiency. Seasonal Space Heating Energy Efficiency (SSHEE, $\eta_{s,h}$)[94] is the metric used to set MEPS in Ecodesign regulation and to set the energy efficiency classes included on each product's energy label. The SSHEE value of any space heating product reflects the products performance under laboratory test conditions and does not necessarily reflect real world, in-situ performance of products.

The current labelling system establishes tier classes for hydronic heating products between A+++ and D, with heat pumps and other highly efficient technologies at the top of the scale and less efficient technologies, such as older combustion systems, at the bottom. The Energy-related Products Policy Framework, proposed re-scaling the existing energy label classes, by reducing the overall number of rating classes, removing classes for products now below established minimum standards, reclassifying the top class of products to A, and keeping this top-class empty, to begin with, to allow room for innovation.[95]

Ecodesign and Energy Labelling could be used to regulate packaged and integrated hybrid heating systems – that is, where both heat generating elements are sold together.

We therefore propose:

1. Establishing a minimum SSHEE value that any space heating product must meet in order to be classified as a hybrid heating system. For example, this might mean establishing a minimum SSHEE value of 125% for hybrid heating systems.

[93] BEIS and Prime Minister's Office, 10 Downing Street (2022), 'British Energy Security Strategy', https://www.gov.uk/government/publications/british-energy-security-strategy.
[94] SSHEE is the ratio between the space heating demand for a designated heating season, supplied by a space heater and the annual energy consumption required to meet this demand, expressed in %.
[95] BEIS (2021), 'Energy-related Products Policy Framework', p.37, https://www.gov.uk/government/publications/energy-related-products-policy-framework.

2. Using Ecodesign to establish the minimum heat pump contribution for hybrid heating systems (e.g., 40% of the seasonal space heating energy output).
   There are a number of methods for establishing the heat pump contribution to a hybrid system including:

   - 'the separate method', which determines the efficiency of the heat pump and the fossil fuel boiler separately
   - 'the combined method', which calculates the efficiency of the heat pump and boiler as one complete connected appliance – including the air supply, flue ducting etc. – with the boiler and heat pump measured as operating together.

   Both methods include a 'bin method', which tests the heat pumps' performance at different ambient temperatures and then calculates the seasonal energy efficiency based on the climate in which the hybrid will be used.

3. Using the Energy Labelling system to distinguish between hybrid systems, creating a tiered system, whereby systems with higher SSHEE ratings receive a higher label class. The exact tiers and threshold values will be established as part of wider work to re-structure the labelling classes, outlined above.

Using Ecodesign and Energy Labelling in this way will allow for distinction between hybrid systems that are designed to be more or less heat pump led at the point of sale. Energy Labelling proposals, for all hydronic space heating technologies, will be explored and developed through several stakeholder engagement opportunities outside of this consultation. We will explore this issue further through our work on UK Ecodesign and Energy Labelling standards for space heaters and consult further in due course.

Question 39: What is a reasonable minimum SSHEE value for hybrid heat pumps? Please provide evidence and reasoning to support your answer.

Question 40: What is a reasonable minimum seasonal heating output, from the heat pump, for a hybrid system? Please provide evidence and reasoning to support your answer.

Smart controls

Using smart controls alongside hybrid heating systems can enable effective interoperation of the heat pump and boiler elements of the system. Smart controls can be used to optimise the operation of the system to minimise running costs, maximise carbon abatement, provide demand side response services or achieve a balance of multiple objectives. They can do so by varying operation in response to a range of inputs, including variable fuel price signals, real-time information on weather and temperature, system learning of the building's thermal efficiency and the consumer's inputted heating needs.

Smart controls can implement a number of control strategies such as peak shifting/preheating and dual operation to maximise heat pump usage and the overall efficiency of the system, assuming that the hybrid system is physically capable of achieving these outcomes (i.e.,

correctly designed, sized and installed).[96] One or a combination of these control strategies can be implemented through smart controls to reach a set minimum SSHEE and/or an annual space heating output contribution from the heat pump unit.

The recently published consultation on Smart and Secure Energy Systems (SSES)[97] outlined plans to encourage the uptake of smart electric space heating appliances, including proposals to mandate the smart functionality for domestic electric heating appliances, which would apply to the heat pump element of a hybrid heat pump. The consultation seeks to gather views on the devices in scope, the requirements for smart functionality and the benefits or implications for consumers and industry.

The government acknowledges that specific smart control standards maybe required for hybrid heating systems – for example, control standards for hybrids would need to consider the communication between the boiler and the heat pump unit and resulting interoperation.

Ahead of introducing the smart mandate, the government will engage stakeholders and consider the relevant next steps, including whether a further consultation is required, before taking powers.

Question 41: Do you think specific smart controls standards, that go beyond those for smart heat pumps, are needed for hybrid heating systems? Yes/No. Please expand on your views.

Question 42: Do you think other measures are required to support low-carbon operation of hybrid heating systems? Please expand on your views.

Supporting consumer choices

As heat pump deployment increases, more consumers will be considering the choice between traditional gas boilers, heat pumps and hybrid systems. The Electrification of Heat Demonstration Project has shown that heat pumps are suitable for most of the UK's housing stock.[98] However, this does not mean that all homes are heat pump ready today.

It is our view that heating installers will play a significant role in advising consumers on the appropriate low-carbon heating solution for their home. Therefore, they should have a complete understanding of the trade-offs associated with installing a standalone heat pump versus hybrid heating system, and the benefits of future-proofing a heating system by ensuring

[96] The controls' achievement of heat pump led operation can also impacted by conditions external to the hybrid heating system, such as weather conditions and user preferences.
[97] BEIS (2022), 'Delivering a smart and secure electricity system: the interoperability and cyber security of energy smart appliances and remote load control', https://www.gov.uk/government/consultations/delivering-a-smart-and-secure-electricity-system-the-interoperability-and-cyber-security-of-energy-smart-appliances-and-remote-load-control.
[98] Energy Systems Catapult (2021), 'All housing types are suitable for heat pumps, finds Electrification of Heat project', https://es.catapult.org.uk/news/electrification-of-heat-trial-finds-heat-pumps-suitable-for-all-housing-types/.

a standalone heat pump appliance could be installed in place of a hybrid appliance in future. Installer skills are considered further in the section below – Installer skills.

The availability of independent advice is also key to supporting consumers in making appropriate choices and we will continue to work with industry to explore means for the provision of such information. The government's recently published 'Check if a Heat Pump is Suitable for Your Home' tool[99] will support consumers in making choices between various heat pump options, including hybrids.

Question 43: What further measures can the government and industry take to support consumer choices and ensure hybrids are installed where most appropriate?

Installer skills

Installers will be a key intermediary for homeowners – supporting them to make the appropriate choices between low-carbon heating systems and will be essential in ensuring systems and controls are installed to a high standard, allowing efficient operation.

Hybrid deployment must therefore be supported by adequate skills within the installer workforce and by appropriate installation standards. Furthermore, to support the longer-term electrification of heating, this deployment must contribute to the development of a skilled heat pump installer base.

The government understands there is significant cross-over between the skills required to install most types of hybrid systems and those required to install standalone heat pumps, such that installers of hybrid systems should be capable of transitioning to installing standalone heat pumps. However, installers may need to acquire additional skills to make this transition, such as those related to installing hot water tanks as part of systems or sizing a heat pump system which can meet the peak heating requirements of a home. Therefore, it is the government's view that hybrid training should provide installers with all the competencies required to install a standalone heat pump. This includes the competency to design and install any further equipment or make any required amendments to the home, including radiator changes or installing a hot water cylinder.

The government is currently working with industry to update both the existing Plumbing & Domestic Heating Technician apprenticeship standard, as well as the Minimum Technical Competencies (MTCs) for individuals to participate in competent person schemes, which allows installers to self-certify certain types of building work against Building Regulations.[100] This review will consider hybrid heating systems and provide a clear minimum expectation for

[99] The 'Check if a Heat Pump is Suitable for Your Home' tool is available at: https://www.heat-pump-check.service.gov.uk/.

[100] To be registered with a competent persons scheme (CPS), installers need to demonstrate that they meet the relevant MTC criteria. These criteria define the competence requirements for CPS organisations and individuals working directly on work for which self-certification is required under the Building Regulations.

the skills, knowledge, experience, and behaviours that a heat pump installer should have to be regarded as competent.

Our current understanding is that the skills required to install a compact hybrid do not overlap with the skills required to install a non-compact hybrid system or standalone heat pump. Existing compact hybrids can be installed by a Gas Safe engineer and require standard gas boiler servicing and dusting/vacuuming of the heat pump evaporator, to ensure maximum operational efficiency.

Question 44: Do you agree that installers of hybrid heating systems should develop all of the skills required to install standalone heat pumps, to be considered competent to install hybrid systems (excluding when installing a compact hybrid)? Yes/No. Please expand on your views.

Installation standards and guidance

Upholding high standards of installation across industry will be crucial to ensure that the desired carbon benefits are achieved by hybrid systems, and consumer confidence in low-carbon heating technologies is maintained. The experience of early adopters of technologies like hybrid heating systems will ultimately help shape consumer views on these and other technologies, including standalone heat pumps.

Both hybrid systems and standalone heat pumps are expected to comply with Building Regulations – through this we expect installers to have a good understanding of different available heating solutions, their efficiencies and sizing, so that they can provide good quality advice to consumers. Installers wishing to self-certify that their hybrid installations comply with Building Regulations must ensure that the heat pump installation, of a hybrid system, is notified to an appropriate competent person scheme, in addition to notifying the gas boiler installation to the Gas Safe Register.

Members of competent person schemes are expected to put work right where it is found not to comply with the Building Regulations. The government will review the current conditions of authorisation for competent person schemes (including the Gas Safe Register) and consider whether the existing protections associated with these schemes are sufficient.

Beyond this, it is unclear to what extent current standards effectively capture the relevant requirements for the proper installation of all hybrid systems and whether wider deployment of hybrids in the on-grid retrofit market will require the development of specific hybrid installation standards.

Question 45: Do you think there is sufficient guidance available on ensuring that hybrid installations comply with appropriate regulations e.g., Gas Safety Regulations and Building Regulations? Yes/No. Please expand on your views.

Question 46: Do you have suggestions on how the relevant standards regimes (e.g., Building Regulations, competent person schemes) should be expanded or altered to adequately cover hybrids systems? Please expand on your views.

Flexibility

Hybrid heating systems can switch between using electricity, gas, or a combination of both, to meet consumer needs and in response to other signals. Smart controls could, for example, be set to use the gas boiler when electricity demand is high and to utilise the heat pump when electricity demand is lower.

If replicated across widespread deployment of hybrids, the potential reductions in peak electricity demand, delivered by such a control strategy, could reduce the need for additional generation capacity and the expansion of the electricity grid. There could also be some carbon savings from exercising such flexibility, by avoiding electricity generation from less clean sources during peak times.[101]

However, smart-enabled heat pumps are also able to operate flexibly by taking advantage of periods of reduced electricity demand, using methods such as pre-heating in advance of set periods and heat storage. As such, the network cost benefit of installing hybrids in place of standalone smart-enabled heat pumps may be limited.

Furthermore, BEIS electricity networks modelling, to be published as part of the forthcoming Electricity Networks Strategic Framework, shows that the network's planned capacity is sufficient to comfortably cater for the deployment of standalone heat pumps up to the targeted level of 600,000 in 2028. As such, it is probable that there is little significant benefit from the electricity demand flexibility provided by hybrids up to 2028 and there is no compelling case for deployment of hybrid heating systems from their potential network flexibility benefits.[102]

Question 47: Do you agree with our assessment of the significance of the flexibility benefits provided by the deployment of hybrids, in the time frame until 2028? Yes/No. Please expand on your views.

Hybrid deployment beyond 2028

The government has set the ambition to end the sale of new and replacement natural gas only boilers from 2035. The government is focused on growing the market for heat pumps by reducing costs and improving consumer experience, for example through shorter installation times. We are also assessing the case for hydrogen heating through consumer trials and growing the market for heat networks.

[101] This should be offset with the carbon emitted at the consumers' end if boiler element was used instead.
[102] However, there is a chance that some areas could require larger than expected levels of reinforcement before 2028 with this target. This is due to a large degree of uncertainty around the level of network utilisation in the Low Voltage (LV) distribution network, which is currently not widely monitored.

Within this framework, the government is hopeful hybrid systems may be able to play a substantive role beyond 2028 in the transition to low-carbon heating.

There is the potential that hybrid systems, and in particular compact hybrids, could become the new minimum standard for products on the market. This would reduce consumer energy bills, improve our energy security, and reduce carbon emissions. One policy option for achieving this would be requiring that from 2028 (or potentially an earlier date) all newly installed natural gas boiler installations must be accompanied by an electrical heat generation element or other renewable or low-carbon system. Our Energy-related Products Policy Framework, published in November 2021, proposed using product legislation to raise the MEPS of space heating appliances to above 100%, which would effectively achieve this outcome.[103] We are also aware of similar recent proposals in other European markets.

An alternative role that hybrids could play beyond 2028 is in a pathway where hydrogen plays a significant role in heating. Consumers on a hydrogen grid could have the option of a hybrid system as an alternative to a hydrogen boiler or a heat pump. In this instance, there could be a more enduring role for hybrids as they would be compatible with reaching net zero by 2050.

Mass deployment of hybrids

The potential benefits of widespread deployment of hybrids from 2028 are significant – reducing consumer bills, improving our energy security and supporting emissions reductions towards our carbon budgets and net zero.

For example, if compact hybrids were to become the new minimum standard for products, this would in effect see an efficiency increase from the 92% current gas boilers can achieve, or potentially 93% to 94% as suggested earlier, to potentially above 130%. This would be a substantial improvement in efficiency for consumers and, combined with actions to rebalance the costs placed on energy bills referenced above, could see consumer energy bills reduce significantly as a consequence.

Similarly, such a large improvement in efficiency would mean that we will need less energy to heat our homes and buildings, and we will be less dependent on volatile fossil fuel prices. In turn, this will significantly increase our energy security.

Mass deployment of hybrids would also deliver large reductions in emissions compared to the continued deployment of natural gas boilers up to 2035, contributing to our near-term carbon budgets. Our Impact Assessment (published alongside this document) suggests this could be up to 30.4 MtCO2 in the Carbon Budget 6 period (2033 – 2037), compared to a scenario based on improving boiler efficiency and mandating hydrogen-ready boilers alone.[104]

Many consumers will move directly to heat pumps, but hybrid systems could act as a stepping-stone for some consumers to migrate to fully low-carbon heating technologies. This is

[103] BEIS (2021), 'Energy-related Products Policy Framework', https://www.gov.uk/government/publications/energy-related-products-policy-framework.
[104] See Impact Assessment published alongside this document.

particularly the case for those consumers that would otherwise be installing a standard gas boiler. Even with strong growth in the heat pump market, we expect 10 million or so gas boilers to be installed between 2025-2035.

A significant role for hybrids from 2028 would also contribute towards the continued growth of the heat pump supply chain and support growth in UK manufacturing of low-carbon appliances and upskilling of the installer base.

From the late 2020s onwards, the flexibility benefit of hybrids – based on their ability to switch between fuel sources – may become more significant, as more of the economy becomes electrified.

However, the mass deployment of hybrids involves significant unknowns – including those related to the availability of sufficient skilled installers and the level of potential for further technological development – and the government is keen to work with industry to further understand these.

The deployment of hybrids, in advance of a switch to hydrogen on the gas grid, would also require further innovation and technology development such as hydrogen-ready hybrid systems, which are currently unavailable.

The role of compact hybrids

We are particularly interested in views from stakeholders on the potential for technological developments and large-scale cost reductions in technologies such as compact hybrids, and other new innovative technologies, to support the widespread deployment of hybrids.

Compact hybrids – consisting of a heat pump and a natural gas boiler within a single unit and without an outdoor unit – have the potential to deliver the benefits of mass hybrid deployment explored above. While there is currently only one compact type in the UK and deployment is limited to trials, the government is keen to gather more information on these systems to support decisions on their longer-term potential. We would be minded to support the wider roll-out of such systems, perhaps through revised minimum standards, as set out above, if assurances can be gained that such systems will not impose significant additional upfront or running costs on consumers, will be suitable for a wide-range of UK homes and can meet suitably high standards of efficiency and carbon abatement. In this case, we would expect a wider range of products from multiple manufacturers to become available.

It is our understanding that current models of compact hybrids can reach ErP efficiencies of over 130%, which is far higher than gas boilers. However, we would welcome views on the standards of energy efficiency and low-carbon operation hybrids might achieve with further innovation and investment.

We understand compact hybrids may also be suitable for a range of housing types in the UK, as they do not require external space or space for a hot water tank. However, further technological developments may also be required, to make compact hybrids smaller and

lighter to allow them to be more widely suited to the UK housing stock. We would welcome views on the achievability of such aims.

While mass deployment might provide an opportunity for significant cost reductions through economies of scale, the scale and rate of such deductions are still unclear. We would welcome views on whether the costs of owning and running a compact hybrid system are likely to reach parity with those for gas boilers, and the conditions required to realise such cost reductions.

The government is keen to develop its position in this space in the coming years, to provide the market with the certainty to make necessary investments and the time to ramp up production as may be necessary. Stakeholder views gathered through this consultation will form a key plank in further developing this position.

Question 48: Do you agree with our current understanding of risks and benefits of widespread deployment of hybrids from 2028? Yes/No. Please provide evidence and reasoning to support your answer.

Question 49: What levels of energy efficiency and carbon-intensity may be achievable for compact hybrids or other hybrid technologies with further innovation and investment? Please provide evidence and reasoning to support your answer and please specify to which types of hybrid system your answer refers.

Question 50: What further technological developments can be expected from compact hybrid systems, or hybrids of other types, to support the widespread roll out of hybrids across the UK building stock? Please provide evidence and reasoning to support your answer and please specify to which types of hybrid system your answer refers.

Question 51: What scale of cost reductions is possible for compact hybrids, or hybrids of other types, and what are the conditions required to deliver such cost reductions? Please provide evidence and reasoning to support your answer and please specify to which types of hybrid system your answer refers.

Equality Act 2010

Under the Public Sector Equality Duty, the government must take steps to understand how policies will affect different groups in society in different ways, with a particular focus on removing or minimising disadvantages suffered by people due to the following protected characteristics: age; gender reassignment; being married or in a civil partnership; being pregnant or on maternity leave; disability; race including colour, nationality, ethnic or national origin; religion or belief; sex; and sexual orientation. Warm homes and thermal comfort play a crucial role in maintaining our health and wellbeing. Evidence suggests that in homes with a lower level of thermal comfort elderly, pregnant and disabled groups may be particularly affected and at an elevated risk of negative health outcomes.

The government's proposed policy for boiler heating controls allows compliance with either a smart control or a more traditional non-smart control to ensure those without a smart device, particularly likely to include the elderly, can use the heating control to its full functionality.

Question 52: Do you have views on whether, and to what extent, the policy proposals here might disproportionately impact upon certain types of consumer, with a particular focus on those in groups with protected characteristics? Please provide evidence and reasoning to support your answer.

End of Consultation

This is the end of the consultation on Improving Boiler Standards and Efficiency.

Question 53: Do you have any further views to make on our proposals that are not already captured in your responses to the previous consultation questions?

Annex A: Glossary

The following terms are used throughout the consultation.

Term	Definition
Bivalent hybrid	A bivalent hybrid is one where the heat pump is combined with an additional, or existing heat source, such as a gas boiler. In this consultation, bivalent is used as a catch all term for standard hybrid systems which include separate indoor and outdoor units for the gas boiler and electric heat pump. This does not include integrated or compact hybrids (see below).
Boiler cycling	Boiler cycling causes the boiler to repeatedly turn on and off during a heating period. This can occur for a number of reasons such as the boiler system replicating a lower output in order to maintain a desired room temperature.
Boiler interlock	Boiler interlock refers to a wiring arrangement that ensures the boiler is switched off when there is no demand for space heating or water heating. For a combination boiler this can be achieved simply by having a room thermostat. For a system or a regular boiler, the controls need to be wired such that the boiler and pump will turn off when neither the space heating nor the hot water cylinder requires any heat input.
Boiler modulation	Boiler modulation is a boilers ability to dynamically reduce its output from its maximum output. This allows boilers to use less energy by using a lower output to meet the desired room temperature.
Combination, system and regular boilers	There are three main types of gas boiler used in domestic properties: • Combination boilers, also known as combi boilers, combine both water heating and

	central heating in a single unit. They provide hot water directly at the time that it is required, rather than it being stored in a separate hot water tank or cylinder. • A system boiler heats hot water in advance, storing hot water in a separate hot water tank or cylinder. The hot water tank is fed directly from the mains water supply rather than a cold-water storage tank. • A regular boiler is fed by a cold-water storage tank (usually in a loft or attic) resulting in lower heat distribution system pressures. Hot water is heated in advance and stored in a separate hot water tank or cylinder, from which it is released when needed (i.e., independently of the boiler being fired).
Competent person scheme (CPS)	A scheme for installers which indicates competence and allows the installer to self-certify their work against the Building Regulations.
Condensing boiler	Condensing boilers collect the latent heat from the water vapour created during combustion of natural gas. In a non-condensing boiler, this water vapour is expelled to the atmosphere through the flue without reclaiming the available energy. Condensing boilers are more efficient than non-condensing boilers. Since 2005, condensing boilers have been mandatory to install in the UK.
Ecodesign and Minimum Energy Performance Standards (MEPS)	Ecodesign is the legislative framework for setting the Minimum Efficiency Performance Standards (MEPS) for energy-related products, including for space heating appliances. Ecodesign aims to phase out the least efficient energy-related products from the market through these standards.

	The Boiler Plus Standards set the new minimum performance standard for domestic gas boilers in English homes to 92% ErP.
Definition of temperature control classes (IV, VI and VIII) for energy labels for packages of space and combination heaters, temperature controls and solar devices, as stated in the Energy Labelling Regulation[105]	Class IV - TPI room thermostat, for use with on/off output heaters: An electronic room thermostat that controls both thermostat cycle rate and in-cycle on/off ratio of the heater proportional to room temperature. TPI control strategy reduces mean water temperature, improves room temperature control accuracy and enhances system efficiency. Class VI - Weather compensator and room sensor, for use with modulating heaters: A heater flow temperature control that varies the flow temperature of water leaving the heater dependent upon prevailing outside temperature and selected weather compensation curve. A room temperature sensor monitors room temperature and adjusts the compensation curve parallel displacement to improve room comfort. Control is achieved by modulating the output of the heater. Class VIII - Multi-sensor room temperature control, for use with modulating heaters: An electronic control, equipped with 3 or more room sensors that varies the flow temperature of the water leaving the heater dependent upon the aggregated measured room temperature deviation from room sensor set points. Control is achieved by modulating the output of the heater.
Flow temperature and return temperature	The flow temperature is the temperature that the water is heated to in the boiler and then travels to heat emitters via the distribution pipework. Boilers are more efficient when operating at lower flow temperatures.

[105] 'Commission Delegated Regulation (EU) No 811/2013', https://www.legislation.gov.uk/eur/2013/811. Only three classes of heating control have been defined and used throughout this consultation. Further information on all eight heating control classes is available at: https://energy.ec.europa.eu/document/download/c61475ba-4419-4ed9-9e00-033b6a926c55_en?filename=GuidelinesSpaceWaterHeaters_FINAL.pdf.

	The return temperature is the temperature of the water after it leaves the heat emitters and returns to the boiler, this temperature is highly influential in determining the efficiency of the boiler and whether it condenses or not.
Flue Gas Heat Recovery (FGHR)	FGHR systems recover heat from waste flue gases to preheat the cold drinking water entering the combi boiler, lowering the amount of energy needed to warm the drinking water up to the required level. This means that the effectiveness of FGHR does not depend on householders using it in certain ways or making any sort of adjustments to their behaviour. Some FGHR systems use electricity to power them, while others (known as Passive FGHR) do not.
Heat emitter	A heat emitter is a product that gives out (emits) heat, including radiators. Heat emitters are used by heating systems to create warm conditions in specific spaces, remote from the central heating appliance.
Hybrid heating systems and hybrid heat pumps	A hybrid heating system combines two or more technologies to provide heat and hot water to a building (e.g., an electric heat pump with another heat generation technology). Specific controls are often used to manage how the component technologies operate together. For the purposes of this consultation, a “hybrid heat pump” is used to describe a system combining a heat pump and gas boiler.
Hydraulic balancing	Hydraulic balancing is a process to ensure, through valve restriction setting, that a suitable flow of heating system water passes through each radiator in the system. When a central heating system is properly balanced, radiators will heat up throughout the house at the same rate, accounting for the pressure losses in pipework that may reduce flow to

	radiators further from the boiler. If the system is out of balance, higher flow rates may reach closer radiators than others in the home resulting in uneven and inefficient heating of the home.
Hydrogen-ready boiler	A boiler that is initially designed to run on natural gas and after a simple and quick conversion process can run on 100% hydrogen gas.
Hydronic space heating system	A hydronic space heating system (wet system) is when a heating appliance produces hot water which is distributed around the property to heat emitters.
Integrated and compact hybrid	Integrated and compact hybrid heat pumps consist of a heat pump and natural gas boiler integrated within a single unit. Existing compact hybrid heat pump models consist of a small heat pump and do not include an outdoor unit.
Load compensation	A load compensator is a device that measures the gap between the internal temperature of the home and what the controller is set to, then modulates the temperature and/or output of the boiler output so that it is hot enough to provide the extra heat needed. This allows the boiler to operate in condensing mode for more of the time, lowers the chance of overshoot of room temperature, thus saving more fuel than just standard time and temperature control.
Modulation ratio	A boiler's modulation ratio is the maximum output compared to the minimum output. A boiler with 24kW heat output and a minimum heat output of 4kW has a modulation ratio of 1:6.
Operating protocols	Operating protocols are the communication systems utilised between boilers and heating controls. Open protocols should enable any boiler or heating control manufactured by different companies to work different.

	OpenTherm is the most common example. Closed protocols mean only a control made by the same manufacturers will be able to follow interact and affect the boiler.
Room thermostat	A central or room thermostat allows consumers to set their preferred temperature in their home. If the heating is turned on, the boiler will send hot water to the radiators such that the temperature on the thermostat is reached and then maintained, but not exceeded. Without a thermostat or any other heating controls, the boiler will keep heating the home until the heating is switched off, thereby using far more energy, and resulting in higher bills.
Smart controls	Smart controls are products that let consumers remotely control their home temperature via a tablet, smartphone or desktop computer. To comply with Boiler Plus, if a smart control includes load or weather compensation, it does not require automation and optimisation. Automation is where the device automatically controls the heating system output in response to programmed demand or occupancy detection (for example using the GPS on the users' smartphones). Optimisation means that the device works out what time it should switch the boiler on so that it gets to the temperature on the thermostat at the chosen time, while using the least amount of energy.
Space heating demand	Space heating demand is the amount of heat input required to heat a property to the required temperature at a given outdoor temperature.
Space heating energy efficiency (SSHEE or $\eta_{s,h}$)	Space heating energy efficiency is the ratio between the space heating demand for a designated heating season, supplied by a space heater and the annual energy

	consumption required to meet this demand, expressed in %. This is the metric used to set MEPS in Ecodesign regulation and to set the energy efficiency classes on energy labels.
Time proportional and integral (TPI) control	TPI controls are a device, or feature within a device, which maintains the temperature inside the building by cycling the boiler on and off in a ratio that is proportional to the difference between the required and measured temperatures inside the building.
Timer	A timer allows consumers to set the heating to come on at specific times of the day to meet their routines without daily action on their part. Some systems have a 24-hour timer, which allows consumers to set the heating to switch on and off at the same time each day. More advanced timers, or timer functions within a programmable or smart thermostat, allow for different times to be set on different days, for example to reflect varying weekday and weekend routines.
Weather compensation	Weather compensation interacts intelligently with the boiler to provide just enough heat to keep the home warm, by adjusting the temperature and/or output of the boiler to account for changes in the weather. Operating at a lower temperature makes the boiler more efficient. Weather compensators can be an external sensor feeding weather data back to the boiler, or digital products using weather data from the internet.

Annex B: Consultation questions

1. Do you agree that all gas boilers should be placed on the market with controls that meet Energy Labelling Class VI? Yes/No. Please expand on your views.

2. Do you think we should require all gas boiler controls to meet Energy Labelling Class VI, irrespective of whether they are placed on the market with a gas boiler?

3. Should Energy Labelling Class VIII controls be allowed as an alternative route to compliance? Yes/No. Please expand on your views, including on which boiler systems or property types are most suitable for these controls.

4. a) Is it necessary to mandate that all available boilers and controls use open protocols? Yes/No. Please expand on your views. b) Is an appropriate route for achieving this through a government mandate that boilers are sold with open protocol adaptors? Yes/No. Please expand on your views.

5. a) Should FGHR systems be required as an alternative or additional requirement to Class VI controls, for example, alongside larger combination boilers over 35kW? Yes/No. Please explain your answer. b) If so, should this be limited to certain types of FGHR systems, for example, limited to inbuilt Passive FGHR systems with thermal storage? Yes/No.

6. Do you agree that all domestic-scale gas combination boilers should be able to modulate to 10% of their maximum output without on/off cycling? Yes/No. Please expand on your views.

7. Should minimum boiler outputs be capped, and, if so, at what level? Please expand on your views.

8. Do you agree that we should extend the revised requirements to include system and regular boilers? Yes/No. Please expand on your views.

9. What additional installer training, if any, would be needed to support system and regular boiler inclusion in these requirements?

10. Do you agree that the minimum modulation range should apply to system and regular boilers? Yes/No. Please expand on your views.

11. What role, if any, can FGHR systems have with system and regular boilers?

12. Should the tested minimum energy performance standard for a domestic sized gas boiler be increased to a) 93% or b) 94%? Please explain your answer.

13. What real-world efficiency benefits might be realised by such an increase to minimum energy performance standards?

14. What risks or disbenefits might arise from such an increase to minimum energy performance standards?

15. Do you agree that the government should set a requirement for all cylinders to have a minimum efficiency rating of B? Yes/No. Please expand on your views.

16. What additional measures may be required to ensure that cylinders are future-proofed for use alongside heat pumps?

17. a) What additional information can be collected or recorded by installers to ensure full commissioning for boiler installations take place, for example should heat loss calculations be recorded? b) What available technologies can be used to speed up this process, including more time-consuming practices like hydraulic balancing?

18. How can regular heating system servicing be encouraged, what practices should be included and what are the potential benefits and costs consumers should expect?

19. Should low temperature heating system training be mandatory for gas boiler installers to help ensure Building Regulations are met? Yes/No. Please expand on your views.

20. What appropriate technological solutions currently exist or could be developed for collecting and displaying real-time efficiency information? Please explain your answer.

21. Do you agree that the proposals for new boiler and hot water tank product standards should be applied to new boiler installations from 2025? Yes/No. Please expand on your views.

22. a) Could the proposals be applied to new boiler installations earlier to help lower bills for consumers sooner? Yes/No. Please expand on your views. b) What additional steps or refinements may be required to support an earlier implementation date?

23. What are your views on the cost implications of the various proposals for the average boiler installation? Please expand on your views.

24. Do you agree that the government should use Ecodesign legislation to implement the proposals? Yes/No. Please expand on your views.

25. What are your views on extending the regulations to cover all gas boilers up to 70kW? Please expand on your views.

26. What opportunities and challenges would requiring all newly installed domestic-scale natural gas boilers to be hydrogen-ready from 2026 present? Please provide evidence and reasoning to support your answer.

27. If made mandatory, can hydrogen-ready boilers match the cost of current natural gas boilers? Yes/No. Please provide evidence and reasoning to support your answer.

28. Do you anticipate the installation of a hydrogen-ready boiler to take the same time as a natural gas boiler replacement? Yes/No. Please expand on your views.

29. a) For early adopters of hydrogen-ready boilers, in advance of a government mandate, can consumers expect to pay more for hydrogen-ready boilers? Yes/No. Please expand on your views. b) What protection can be put in place to support consumers?

30. Do you agree with the proposed basis for a definition for hydrogen-ready boilers? Yes/No. Please expand on your views.

31. a) Do you agree that domestic-scale hydrogen-ready boilers should continue to meet 92% ErP efficiency? Yes/No. Please expand on your views. b) If ErP efficiency standards for gas boilers were raised to 93% or 94%, as set out in question 12, could hydrogen-ready boilers meet this increased standard, when operating using both natural gas and hydrogen? Yes/No. Please expand on your views.

32. Could hydrogen-ready boilers meet lower nitrogen oxide emission limits, when running on hydrogen gas? Yes/No. Please provide evidence and reasoning to support your answer.

33. Do you agree that any requirement for domestic gas boilers to be hydrogen-ready in 2026 should be made through an update to UK Ecodesign legislation? Yes/No. Please expand on your views.

34. Would you support increasing the scope of the hydrogen-ready mandate to include gas boilers with capacity of up to 70kW in 2026 or at a later date? Yes/No. Please expand on your views.

35. Do you agree that hydrogen-ready boiler conversion kits should only be supplied when a hydrogen grid conversion of an area has been confirmed? Yes/No. Please expand on your views.

36. Do you agree that information regarding the location and model of the hydrogen-ready boiler needs to be collected in an easily accessible format for manufacturers and networks to ensure a smooth future hydrogen conversion and roll out? Yes/No. Please expand on your views.

37. Building on question 18, we welcome views as to whether the change to hydrogen-ready boilers is likely to mean the government should look to strengthen the amount of regular maintenance required on boilers throughout their life span, given the need to ensure their fitness for hydrogen conversion can be preserved? Please expand on your views.

38. Do you agree that installers should be required to complete a module in hydrogen training prior to being permitted to fit hydrogen-ready boilers? Yes/No. Please expand on your views.

39. What is a reasonable minimum SSHEE value for hybrid heat pumps? Please provide evidence and reasoning to support your answer.

40. What is a reasonable minimum seasonal heating output, from the heat pump, for a hybrid system? Please provide evidence and reasoning to support your answer.

41. Do you think specific smart controls standards, that go beyond those for smart heat pumps, are needed for hybrid heating systems? Yes/No. Please expand on your views.

42. Do you think other measures are required to support low-carbon operation of hybrid heating systems? Please expand on your views.

43. What further measures can the government and industry take to support consumer choices and ensure hybrids are installed where most appropriate?

44. Do you agree that installers of hybrid heating systems should develop all of the skills required to install standalone heat pumps, to be considered competent to install hybrid systems (excluding when installing a compact hybrid)? Yes/No. Please expand on your views.

45. Do you think there is sufficient guidance available on ensuring that hybrid installations comply with appropriate regulations e.g., Gas Safety Regulations and Building Regulations? Yes/No. Please expand on your views.

46. Do you have suggestions on how the relevant standards regimes (e.g., Building Regulations, competent person schemes) should be expanded or altered to adequately cover hybrids systems? Please expand on your views.

47. Do you agree with our assessment of the significance of the flexibility benefits provided by the deployment of hybrids, in the time frame until 2028? Yes/No. Please expand on your views.

48. Do you agree with our current understanding of risks and benefits of widespread deployment of hybrids from 2028? Yes/No. Please provide evidence and reasoning to support your answer.

49. What levels of energy efficiency and carbon-intensity may be achievable for compact hybrids or other hybrid technologies with further innovation and investment? Please provide evidence and reasoning to support your answer and please specify to which types of hybrid system your answer refers.

50. What further technological developments can be expected from compact hybrid systems, or hybrids of other types, to support the widespread roll out of hybrids across the UK building stock? Please provide evidence and reasoning to support your answer and please specify to which types of hybrid system your answer refers.

51. What scale of cost reductions is possible for compact hybrids, or hybrids of other types, and what are the conditions required to deliver such cost reductions? Please provide evidence and reasoning to support your answer and please specify to which types of hybrid system your answer refers.

52. Do you have views on whether, and to what extent, the policy proposals here might disproportionately impact upon certain types of consumer, with a particular focus on those in groups with protected characteristics? Please provide evidence and reasoning to support your answer.

53. Do you have any further views to make on our proposals that are not already captured in your responses to the previous consultation questions?

Next steps

We want to engage with stakeholders operating in the heat sector, business representative bodies and households on the policy proposals set out in this consultation. Their input is essential for shaping the proposals' final design.

This consultation will close on 21 March 2023, after which responses will be analysed and we expect to provide a response to this consultation in 2023.

Building on responses from this consultation, the government plans to consult on draft Ecodesign and Energy Labelling legislation next year.

This consultation is available from: https://www.gov.uk/government/consultations/improving-boiler-standards-and-efficiency

If you need a version of this document in a more accessible format, please email domesticboilersconsultation@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.