Department for
Business, Energy
& Industrial Strategy

HEAT IN BUILDINGS

The Future of Heat: Domestic buildings

December 2016

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The Future of Heat: Domestic buildings: Domestic buildings

The consultation and Impact Assessment can be found on the BEIS section of GOV.UK:

HEAT IN BUILDINGS

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

Ministerial foreword

We are committed to secure, clean and affordable energy supplies. Upgrading how we heat our homes and businesses is an essential part of our plan to keep heating bills as low as possible and cut emissions.

The energy we use to heat our homes and businesses currently accounts for around 5% of average household expenses, almost half of our energy consumption and a third of all carbon dioxide emissions. We need to cut bills and carbon in this part of the economy, while ensuring people maintain the same level of comfort in their homes and buildings. One of the best ways to cut bills and carbon is to cut energy use itself, and that is why improving household heating systems and better use of heating controls is an important part of our energy policy. This consultation proposes ways to drive performance of heating systems up and bills down, giving households the benefit of products and standards in line with today's technical capabilities.

The Government has taken effective action in this area over the last 20 years and we want to build on this further. In the 1990s, the UK set minimum performance standards for boilers replacements. In 2005, UK Building Regulations guidance was amended to set new performance standards for boiler replacement. This dramatically increased the sale of efficient boilers, bringing down costs and cutting carbon.

The proposals set out in this consultation could transform the way people use energy in their homes by giving them greater choice, greater control, and tangible savings on their energy bills. These measures are critical to putting the consumer at the heart of energy policy.

BARONESS NEVILLE-ROLFE DBE CMG

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General information

Purpose of this consultation

This consultation asks for views on options for raising domestic boiler standards. The Government is also seeking evidence on the costs and benefits of wider domestic central heating system performance improvements.

Issued: 8 December 2016

Respond by: 27 January 2017

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Territorial extent:

This consultation comprises specific proposals relating to domestic heating systems in England, and a wider call for evidence relating to possible further work across the United Kingdom.

How to respond

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.
We encourage respondents to make use of the online e-Consultation platform to respond to this consultation wherever possible as this is the Government's preferred method of receiving responses. This platform can be found at https://beisgovuk.citizenspace.com/heat/heat-in-buildings-online-consultation. However, responses submitted in writing or by email to the postal and email addresses above will be accepted.

Additional copies:

You may make copies of this document without seeking permission. An electronic version can be found at https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat.

Other versions of the document in Braille, large print or audio-cassette are available on request. This includes a Welsh version. Please contact us at the above details to request alternative versions.

Confidentiality and data protection

Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the access to information legislation (primarily the Freedom of Information Act 2000, the Data Protection Act 1998 and the Environmental Information Regulations 2004).

If you want information that you provide to be treated as confidential, please say so clearly in writing when you send your response to the consultation. It would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded by us as a confidentiality request.

We will summarise all responses and place this summary on the GOV.UK website. This 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 consultation process (as opposed to comments about the issues which are the subject of the consultation) please address them to:

Email: enquiries@beis.gov.uk

Executive summary

Our homes and buildings are central to our daily comfort and wellbeing, and the ability to keep ourselves warm and control our comfort is fundamental to our quality of life. The course of action set out in this consultation seeks to transform the way consumers engage with their heating systems. We want to give all consumers, whatever their circumstances, greater choice over their heating technology and greater control over the space in which they live than ever before, bringing new ways to reduce their energy bills and costs of living.

At the same time our proposals make a valuable contribution towards our ambitious targets to reduce emissions of greenhouse gases by 2050. Buildings account for a fifth of all carbon dioxide emissions. Policies on heat and energy efficiency will be crucial to meeting the fourth and fifth Carbon Budgets.[1]

With this consultation we are seeking views from consumers, installers and manufacturers on a range of measures and policy options that can:

- Keep energy bills as low as possible;
- Ensure the UK has a secure and resilient energy system;
- Reduce carbon emissions cost-effectively at home; and
- Avoid unreasonable upfront costs for consumers which could discourage home improvements.

The focus of this consultation is on domestic heating. Work on the non-domestic market is on-going, and we are calling for evidence on this sector separately.

Domestic boiler standards

Each year in England about 1.2 million boilers are installed in our homes.[2] This represents 1.2 million opportunities to give consumers greater control to reduce energy bills, improve household comfort across the country for all and reduce the carbon intensity of domestic heating.

We propose changes to the minimum requirements that apply when a boiler is installed to:

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[1] CB4:2023 – 2027, CB5: 2028 - 2032

[2] Commercial sales data indicates there are 1.5m replacement boilers installed each year in the UK, 96% are gas boilers and 86% of gas connections are in England (2014 Subnational statistics) this gives approximately 1.2m boiler replacements per year.

- Ensure all households have a reasonable level of control to enable them to optimise comfort and efficiency in their home; and
- Drive the market for the highest performing boilers and send a signal to industry that we are committed to reducing the amount of energy and carbon used in buildings;

We propose to raise the minimum standard for boilers in England into line with today's technical capabilities to drive performance up and bills down. Technology has continued to develop and advance since the existing standards were set, and we must keep standards high to create long term confidence in England as a place to do business. At the same time, in order to help people take full control over their household heat supply, we are proposing to require time and temperature controls to be included with every domestic boiler installation in an existing home in England. This will give all households the means to optimise comfort and save energy.

We are also considering a role for weather compensation in all new boilers in existing homes. These devices allow the boiler to use only as much energy as is really necessary for the desired level of comfort, meaning households will pay for less fuel than they would otherwise.

In this consultation we are seeking views on these proposals, with a view to implementing them as soon as possible. We are also seeking views and evidence on a further range of technologies, which may be incorporated into our proposals if the evidence shows their energy and money saving potential and that they do not place unreasonable costs on consumers. These additional technologies tend to be better suited to different circumstances, so a robust understanding of each technology is needed to ensure standards offer choice and protection from rising energy bills, rather than becoming a burden.

Information and advice

Reliable and impartial advice can be key to ensuring everyone is empowered to make the choices that we propose to offer them. We would like to receive views on how the provision of advice to consumers can be improved.

A call for evidence: future opportunities

In Chapter 3 we include a call for evidence to help us develop additional opportunities in the short and long term.

Domestic heating systems

We are seeking evidence to help explore the costs and benefits for a range of measures that are already used to greater or lesser extent to improve the performance of heating systems:

- Hydraulic balancing;
- Return water temperatures and radiator sizing; and
- Internal system cleanliness.

Targeting buildings off the gas grid

The Government will need to consider how to reduce the use of coal and oil in buildings, and how best to promote a transition away from high fossil fuel heating over the coming decades. We need to consider which kind of policy interventions could support this change, and how to ensure such changes are aligned with our industrial strategy and an economy that works for everyone.

Innovative solutions

The low carbon industry is a growing economy in which big ideas should thrive. Innovative solutions can produce new or improved technologies, novel business models can make currently expensive products pay for themselves and help consumers meet their bills. We need innovative solutions, and in the UK we have an engaged and proactive industrial sector, and an academic community that is at the cutting edge of innovative design. We wish to hear from these and all sectors about new ways of thinking for the future that will help to build a thriving economy for all.

Introduction

1.1. The way we heat our homes is intrinsic to comfort and quality of life: consumers now tend to heat more rooms in their homes and to higher temperatures than at any time in history.[3] Elderly people, in particular, are more vulnerable to health problems as a result of lower than average room temperatures,[4] a trend which is likely to have a greater impact on heat demand as the population ages. Action is needed to empower households to take control of their heating, now and in the long term.

1.2. At the same time, domestic buildings in the UK account for around a third of our energy consumption[5] and15% of all carbon dioxide emissions.[6] Hitting the UK's 2050 carbon reduction target is likely to require eliminating nearly all of the heat-related emissions from buildings. While it is important to improve the energy efficiency of our buildings and reduce the amount of energy used, we know that to make a real difference we also need a change in where our heat comes from.

1.3. Almost 80% of domestic heat is currently generated by gas, the majority of which is now imported from overseas.[7] In rural areas people are more likely to use heating oil, while electricity is an important heat source for many in those urban areas not connected to the gas network, such as apartment blocks. The UK housing stock varies widely from solid wall Victorian terraces, through mid-twentieth century tower blocks to modern new-build properties; each of these has significantly different thermal characteristics.

1.4. Our approach to the move towards low carbon heat must accommodate these differences, and they must centre on what the consumer wants: low costs and low bills. At the same time we must avoid unreasonable upfront costs for consumers which could discourage home improvements.

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[3] Mavrogianni et al, 'Historic Variations in Winter Indoor Domestic Temperatures', 2011

[4] Marmot Review Team, The Health Impacts of Cold Homes and Fuel Poverty, 2011 Provides evidence linking low temperatures in homes to with a range of health impacts from minor infections to serious respiratory and cardiovascular condition (e.g. COPD), which can prove fatal. www.instituteofhealthequity.org/projects/the-health-impacts-of-cold-homes-and-fuel-poverty

[5] Energy consumption by the domestic sector accounted for 29% of final energy consumption in the UK in 2015, ECUK (2016) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/541163/ECUK_2016.pdf

[6] Carbon emissions from the residential sector accounted for 12% of 2014 UK Greenhouse gas emissions, Department of Energy and Climate Change (2016) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/496946/2014_Final_Emissions_Statistical_Summary_Infographic.pdf

[7] Gas usage accounted for 77% of energy consumption for space heating in the domestic sector (excl. lighting and appliances) in 2013, Table 1.04, ECUK (2016): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/541168/ECUK_Tables_2016.xlsx

1.5. The role for gas boilers is likely to continue for the foreseeable future - this means that there is a clear case for increasing their performance and efficiency. This is where we can really make a difference now – where the technology has the potential to improve further, scale up and to compete in a global market without subsidy.

1.6. Where our heat comes from should not be looked at in isolation, but hand in hand with how much heat we use. Policies to cut carbon from heating must be complementary with policies that encourage energy efficiency in the home. The ultimate aim should be for Government to set a clear framework that enables markets to deliver these goals. This requires setting long-term, transparent signals for the market, giving the confidence to invest and innovate, improving the performance of products and bringing down costs to consumers. The proposals in this consultation are designed to align with this vision.

1.7. In this consultation we have identified opportunities for immediate progress that can be made to reduce emissions in homes. It also includes a call for evidence to support future policy development.

1.8. We have been working closely with industry stakeholders to develop new policy options. We will continue to work with stakeholders alongside this consultation to test and refine our proposals and ensure that any potential changes are implemented smoothly.

Boiler standards and supporting technologies

2.1. Each year in England about 1.2 million boilers are installed in our homes, either for the first time in that property or to replace an older boiler.[8] This represents 1.2 million opportunities every year to support consumers by helping to reduce energy bills, improve household comfort across the country and reduce the carbon intensity of domestic heating. These outcomes can be achieved through a combination of changes in fuel or technology, through insulation to reduce the amount of heat needed or through changes in the way households use their heating system.

2.2. Over the coming decades we would like to see the role for low and zero carbon heating technologies continue to grow in a way that is affordable and accessible to householders. For now, natural gas boilers remain the most efficient and the most cost effective way of heating homes on the gas grid. With an on-going role for natural gas into the 2030s it is right to consider all opportunities to drive down emissions from this sector and establish long term confidence for markets to invest. Our proposals aim to ensure that consumers continuing to use fossil fuel boilers stand to benefit from:

- Increasingly efficient boilers;
- Greater control over their heating system; and
- Better practices, standards and maintenance to optimise the performance of their whole heating system, not just the boiler.

2.3. This chapter sets out proposals for higher standards for domestic fossil fuel boilers that run on natural gas, oil and liquid petroleum gas (LPG). Emissions from fossil fuel boiler central heating systems depend upon many factors that differ from household to household across the country. We propose changes to the minimum requirements that currently apply when a new boiler is installed, or where a boiler is replaced in existing domestic buildings in England. Through the improvements identified in this chapter we aim to:

- Drive the market for the highest performing boilers and send a signal to industry that we are committed to reducing the amount of energy and carbon used in buildings;

[8] Commercial sales data indicates there are 1.5m replacement boilers installed each year in the UK, 96% are gas boilers and 86% of gas connections are in England (2014 Subnational statistics) this gives approximately 1.2m boiler replacements per year.

- Ensure all households have a reasonable level of choice and control to enable them to achieve comfort and efficiency without increased bills; and
- Support manufacturers and installers and facilitate exports by aligning the metric for minimum standards with the European Energy Related Products Directive (ErP).[9]

2.4. To achieve these aims this consultation presents proposals for new minimum requirements for:

- Boiler performance
- Control of space heating
- Weather compensation

Scope

2.5. Buildings Regulations are devolved matters, so these proposals relate to England only.

2.6. Current requirements for domestic boilers are different for gas and oil-fired heating systems. As with gas, oil boilers are likely to continue to play a role for a limited period. We believe that raising the standards for oil boilers will benefit those households who are still reliant on them, without locking them into oil indefinitely.

2.7. Existing requirements are also in place for electric heating, solid fuel heating, community heating and a range of other heating systems. These are not in scope for this chapter.

Timing and Implementation

2.8. To date minimum requirements associated with domestic boilers have been set out in Part L of the Building Regulations: 'Conservation of Fuel and Power'. Guidance on how to comply with these requirements is provided through Approved Document L1B[10] and the 'Domestic Building Services Compliance Guide', which set out the minimum efficiency for a boiler and the minimum level of control.[11]

2.9. The proposals set out in this chapter may be implemented through changes to the existing Building Regulations framework. We would seek to introduce the changes on the common commencement date of October 2017 with a three month period

[9] On 23 June, the EU referendum took place and the people of the United Kingdom voted to leave the European Union. It will be for the next Prime Minister to begin negotiations to exit the EU, and until exit negotiations are concluded, the UK remains a full member of the European Union and all the rights and obligations of EU membership remain in force. During this period the Government will continue to negotiate, implement and apply EU legislation.

[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516018/BR__PDF__AD_L1B_2013_with_2016_amendments.pdf

[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/453968/domestic_building_services_compliance_guide.pdf

before they came into effect to allow time for the market to make any necessary adjustments. Exemptions would continue to apply as set out in the 'Guide to the Condensing Boiler Installation Assessment Procedure for Dwellings'.[12]

2.10. This is the same approach that Government took in 2005 which required gas boilers to be high efficiency products, and oil boilers from 2007. These requirements resulted in the UK becoming a market leader in condensing boiler technology, helping it exploit export markets. The cost of the more efficient condensing boilers dropped rapidly following the introduction of the new standards, falling below the cost of non-condensing alternatives within twelve months. It is thought that this change reduced average household bills by around £95 a year, and in 2009 condensing boilers are estimated to have saved £800 million in fuel costs across the UK.

Consultation Question	
1.	Is a three month coming into force period sufficient?

[12] http://www.idhee.org.uk/ExceptionsGuide.pdf

Boiler Performance

2.11. Advances in boiler technology mean that when older boilers are replaced, substantial efficiency improvements can be expected from newer equipment. Existing minimum installation standards are already high, and manufacturers now design for maximum efficiency and durability.[13] This is an example of the innovation and initiative that makes the UK gas boiler market one of the largest and most valuable in the world.

2.12. Currently the efficiency of a domestic gas boiler should be at least 88%, calculated using a standard model known as 'SEDBUK 2009'.[14] For oil boilers the minimum varies: 88% in the case of system boilers and 86% for combination boilers.

2.13. Since setting these standards, the performance of boilers sold in the UK has continued to improve through innovation and competition on the global stage. After the 2005 standards were set the market share of highly efficient condensing gas boilers tripled in two years, and tripled again in the three years after that.[15] Condensing boilers continue to dominate the market for both gas and oil-fired domestic heating systems, and the market continues to grow.[16]

2.14. As of April 2016, all boiler manufacturers in the UK have started using a new model for calculating performance, the Energy Related Products methodology (ErP). It is in use across the EU and enables the UK market to trade effectively with Europe.[17] We propose to bring the performance requirements for boiler performance in England into line with the ErP methodology and set the minimum standard at 92%.

2.15. The relationship between the ErP methodology and other industry metrics is set out in the Technical Annex, along with further details of the proposed 92% minimum standard.

Consultation Questions

2a.	Do you agree the minimum standard for domestic boilers in England should be changed to 92% ErP?
2b.	If not, what ErP rating is appropriate for each fuel type, and are there risks?
2c.	What can be done to further improve the efficiency of a boiler beyond 92% ErP and what are the technical and cost implications for the industry and the consumer?

[13] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/453968/domestic_building_services_compliance_guide.pdf
[14] 'Seasonal Efficiency of Domestic Boilers in the UK'
[15] English Housing Survey 2014-15
[16] BSRIA Domestic Boilers Market Report, Socrates Christidis, 58359/64 May 2015
[17] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52014XC0703(01)&from=EN

Control of space heating

2.16. Heating controls are a vital part of any central heating system. Effective use of controls can help minimise energy consumption by ensuring each room is at the right temperature for comfort, while avoiding overheating.

2.17. Inadequate heating controls can lead to wasted energy and create potential heating problems, such as rooms being too hot or cold. Many households struggle to achieve comfort or currently need to choose between comfort or affordability. Many others may not be aware of such issues in their home if comfort needs are being met, but may be paying more than necessary for the warmth they need.[18] We wish to give all households the necessary tools to put them in control of their comfort and wellbeing while reducing bills and benefiting the environment.

2.18. Consumer research shows around a third of society make a conscious effort to manage how much energy they use, for instance by turning thermostats down, turning heating off when they go out and down in rarely used rooms. Another third of society put more emphasis on ensuring their heat demands are met, or meeting the needs of others in the property, for instance by preheating empty homes or rooms to avoid waiting for them to warm up when needed.[19] However, less than half our homes are properly equipped with sufficient controls to enable households to achieve the level of comfort they want or avoid wasting energy unnecessarily.[20]

2.19. Heating controls can also help improve the performance of low and zero carbon heating technologies.[21] It is important that today's standards reflect not only current needs but potential future long term options for heating, to enable secure market investment. The existing requirements for heating controls distinguish between new systems where a boiler (plus radiator and pipes) is installed throughout an existing home, and boiler replacement where a new boiler is installed into an existing system. New *systems* should be provided with independent time control, a room thermostat (or programmable thermostat) and individual radiator controls.[22] The same is not required for when a new boiler is installed in existing systems, causing installers to differ in their advice to householders, which is why so many homes across the country are at a disadvantage.[23]

2.20. To remove uncertainty in the existing requirements and to ensure households continue to benefit from heating controls when other upgrades are made to their

[18] http://www.which.co.uk/reviews/boilers/article/boiler-controls-and-thermostats
[19] ETI Heat Consumer Insights (2015)
[20] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277552/FINALHow_heating_controls_affect_domestic_energy_demand_-_A_Rapid_Evidence_Assessment.pdf
[21] http://www.energysavingtrust.org.uk/sites/default/files/reports/TheHeatisOnweb(1).pdf
[22] It is also possible to use a timer and individual networked radiator controls, but the combination set out above is more common.
[23] Faye Wade, Michelle Shipworth & Russell Hitchings (2016): How installers select and explain domestic heating controls, Building Research & Information, DOI: 10.1080/09613218.2016.1159484

heating we propose to extend the existing requirement for heating controls to include the following whenever a boiler is replaced, rather than only applying to new systems:

- All households to be provided with control over the time the heating system is on for and the temperature of their homes.

2.21. For many heating engineers these requirements will remain consistent with their existing practices, but households that have not benefitted in the past will be given the potential to increase the comfort and/or improve their control over their heating bills.

2.22. To ensure these requirements do not place undue burden on households we are not proposing to extend this to mandate inclusion of thermostatic radiator valves (TRVs) at the current time. While TRVs have the potential to dramatically improve the performance of domestic heating systems the cost of installation quickly escalates in properties with a large number of radiators. Therefore whether or not to install TRVs should be a choice for consumers, to avoid adding additional burdens upon households.

2.23. Further information can be found in the Technical Annex.

Consultation Questions

3a.	Do you agree that functional timers and thermostats should be a mandatory system component when a boiler is installed?
3b.	Will increased demand lead manufacturers to diversify designs to make it easier for consumers to find a product that suits their needs?
3c.	What would be the advantages and disadvantages of mandating that all relevant heating system components be capable of communicating using an open communication protocol (e.g. OpenTherm)?
3d.	Do consumers engage effectively with installed timers and thermostats to maximise efficiency?
3e.	Please provide any additional information to support your answers to questions 3a-3d. In relation to question 6, what evidence is there to indicate how engaged consumers are, and to what extent does usability present a problem for any consumers, and particularly vulnerable and disabled persons?

Weather compensation

2.24. Weather compensators are devices that measure the temperature outside the building to ensure the boiler does not work as hard when the weather is mild as it does on very cold days. This results in less fuel being consumed for the same level of comfort.

2.25. Weather compensation is already a mandatory requirement in some countries such as Germany[24], but there is no equivalent requirement in England. However, current guidance does carry supplementary information about weather compensation being one example for achieving desirable low return water temperatures.[25]

2.26. We are considering the role of weather compensation as part of the mandatory requirement in the UK. The Technical Annex sets out how such a requirement could be set out, if it is found to benefit consumers.

2.27. As an individual product weather compensators can be purchased currently for £40-£115, with an average cost of £80. As seen in 2005, this additional cost is likely to fall very quickly once regulations have been set. In the interim, our work with consumers has revealed that 65% of consumers would rather pay more upfront for their next boiler if it meant lower bills, so that they spend less in the long run.[26] Based on current prices, consumers are expected to recover the additional £80 spent within the lifetime of their boiler.

2.28. Through this consultation we wish to test our assessment of the deliverability and impact of weather compensators as a constituent of boiler installation. We would like to hear from manufacturers about the technical potential for this technology in the future, and from installers about their confidence in installing weather compensators and setting compensation curves. We would also like to see any evidence of circumstances under which weather compensation is not a practical option.

Example 1:

Phil, a Gas Safe registered heating engineer was called in for routine boiler replacement in a two-bedroom flat. After inspecting the system and talking to the customer, Phil recommended an appropriately sized boiler that Phil was familiar with and knew to be reliable.

The new boiler had a built in clock timer, and Phil found that the flat didn't have a functional thermostat. Phil explained to the customer that this is now a

[24] Verordnung über energiesparenden Wärmeschutz und energiesparende Anlagentechnik bei Gebäuden (Energieeinsparverordnung - EnEV) - Regulation on energy- saving thermal insulation and energy-saving systems engineering for Buildings (Energy Saving Ordinance - EnEV).

[25] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/453968/domestic_building_services_compliance_guide.pdf

[26] https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat

requirement and offered a choice between a basic device for setting the temperature or a programmable thermostat with more versatility. The customer was not clear on the difference, so Phil explained that the programmable thermostat would allow them to schedule the boiler to switch on and off automatically, and different temperatures at different times as desired. The customer said that they were unlikely to set a schedule as they felt more comfortable switching their heating on and off whenever they needed it.

Phil also installed a weather compensator. The flat was on the fourth floor making it impractical to attach an external sensor, so Phil chose a weather compensator that uses data from the internet rather than a sensor. The device was designed with automatically adjusting compensation curves, so Phil did not need to set this manually.

Phil charged £2,450 for the installation, including the boiler, a £50 basic thermostat and a £100 weather compensator.

Consultation Questions

4a.	Do you agree that weather compensation should be a mandatory system component when a boiler is installed in a domestic building in England?
4b.	Are boiler installers qualified and confident to install weather compensators and set compensation curves?
4c.	Please provide evidence to support your answers to questions 4a and 4b. In answering, please consider: • What technical factors have the greatest influence on effectiveness? • The impacts on energy savings and costs of different types of device, e.g. sensor-based or internet-based • The significance of different types of boiler burner control • Specific circumstances in the home that might make a difference
4d.	What alternative solutions can minimise return temperatures in response to variations in heat demand? Please provide technical details of how alternatives might work, alongside details of expected impact on heating system performance, equipment supply and installation labour costs.

Going further

2.29. To maximise the environmental benefits of this policy and benefits to consumers, we also want to explore more ambitious ideas for decarbonisation. While the technologies identified in this section would have potential benefits for some consumers, we are still gathering evidence about costs and the overall societal benefits they may offer. It is essential that policy options are designed to support consumers and do not add unnecessary burdens or unreasonable upfront costs for consumers. By building our evidence base through this consultation and through direct contact with a range of experts we can assess the suitability of these options, to implement only if there is sufficient evidence for doing so.

2.30. The technologies listed below have potential to drive down emissions and bills significantly, however they each tend to be better suited to different household circumstances or preferences. By empowering consumers to choose the technology that best meets their preferences and needs we can maximise the benefits for all.

2.31. In this scenario, consumers would choose at least one of the following to install alongside a new boiler, unless one or more are already in place and working:

- Passive flue gas heat recovery systems (PFGHR)
- Zonal control or independent radiator control such as Thermostatic Radiator Valves (TRVs) throughout the property
- Time Proportional Integral controls (TPIs)
- Automated optimisation

2.32. These technologies have been identified as having the greatest potential, currently, to improve the performance of household heating systems without imposing excessive burden on consumers or the industry. Each technology is well established with an existing supply chain that can respond to increased demand if this policy option was implemented. We need to better understand the extent to which installers are able to help consumers identify the right technology for their circumstances, and the extent to which they are confident to install each technology in the list. Alongside this consultation we will engage directly with installers to better understand the feasibility of this option.

2.33. There are other technologies and measures that also have potential to play an important role in reducing emissions from gas and oil central heating systems. Some of these are addressed in Chapter 3. We welcome views on the applicability of these measures, as well as any others.

2.34. Between half and two thirds of households already have TRVs on every radiator, according to sources such as the 2013 English Household Survey. As such, these households would have already met the requirement, though some may choose to adopt an additional measure to benefit from further reductions to their fuel bills. In other households we would expect installers to discuss the technical options with their customers in the same way they currently do regarding boilers and controls,

and to assist householders in selecting the option that will bring the greatest benefit to their household.

Example 2:

Jas was called to repair a boiler in a two bedroom semi-detached house. On inspection Jas saw that the boiler would need to be replaced.

Jas presented the customer with a choice of two different boilers. The customer's preference was an efficient model that did not include a built in timer. Jas found that a separate mechanical timer and thermostat were in use in the house.

Jas explained to the customer that all boiler installations now need to include efficiency measures. Jas recommended a leading brand of smart control with a built in weather compensator. Even though some controls were already in the house, Jas explained that this was the most affordable way of meeting the requirement, and the advanced control would be more efficient than the existing mechanical ones.

The customer was apprehensive about using a smart control, and explained that she didn't use a smart phone either. As an alternative Jas proposed to install thermostatic radiator valves on the four suitable radiators in the house that didn't have them already. However, Jas explained that as a weather compensator also needed to be installed the total cost would be higher than the smart control. Jas showed the customer how a TRV is used and demonstrated that a smart control can be used without a smart phone. She decided that she would be more likely to use the TRVs.

Jas charged £2,550 to install a boiler, weather compensator and four TRVs.

Private Rented Sector

2.35. Alongside the added benefits to individual households and society, these technologies may also incur some additional costs at the point of boiler replacement. To minimise the impact on small businesses we could consider allowing private landlords to opt out of any policy that required their take up. This exemption could apply to any private landlord that operates as a registered business, and would be expected to save the industry £7 million each year, although at the cost of delivering less carbon savings and reduced bills savings and control for tenants.

2.36. From 1 April 2018, private domestic landlords will have a statutory duty to improve any Band F or Band G EPC rated properties they rent to a minimum rating of Band E, before issuing a tenancy to a new tenant, or renewing an existing one. This minimum standard, which will be subject to a limited number of exemptions, can be

achieved through energy efficiency improvements throughout the property[27]. A new boiler is currently one option available to landlords that can contribute to an improved EPC rating, but where there are more cost effective ways of meeting the statutory requirement we would like to ensure landlords have suitable flexibility.

2.37. However, there also remains much potential for boiler improvements in privately rented properties that already have an EPC rating of Band E or better. There are also compliance risks associated with any form of opt out provision, as the current enforcement regime is not set up to differentiate between different types of tenure. More significant legislative changes may be required to define the circumstances under which an opt out would be permitted and how the rules would be enforced.

2.38. We are aware of the pressures that also exist for the social housing sector, and we do not wish to impose additional burden on social rented properties that is not expected of the private sector. To ensure equitable standards are set for different types of rented household, it might be suitable for any opt out for the private rented sector to be reflected with a similar opt out for the social rented sector.

Consultation Questions	
5a.	Do you agree that Government should explore options to incorporate these additional technologies into minimum standards?
5b.	Should the private rented sector be permitted to opt out of more costly policy options, if undertaken?
5c.	If an opt out is offered to the private rented sector should a similar opt out be extended to the social rented sector?

Passive flue gas heat recovery (PFGHR)

2.39. Flue gas heat recovery uses of waste heat from the boiler to pre-heat household hot water. By doing so, the amount of gas used to heat water can be reduced. There are different types of product available on the market, the most affordable of which are best suited to households with a relatively high hot water demand. This

[27] Exemptions from the requirement to meet the minimum energy efficiency standard include a consent exemption, where a landlord may claim an exemption if a legally required consent (such as planning consent, for freeholder consent) cannot be obtained, and a devaluation exemption, where an exemption can be registered in situations where installation of a recommended measure may devalue the property by more than 5%.

might be the case in highly efficient properties where the energy needed for space heating is low, and so the household hot water demand is proportionately higher.[28]

2.40. Current products are designed to work only with combination boilers, which currently make up nearly two thirds of the market.[29]

Zonal control and Thermostatic Radiator Valves

2.41. Zonal control allows the heating of different parts of the home to be controlled independently. Households may achieve this in a number of ways, but the most affordable mechanism for most households will be through the use of Thermostatic Radiator Valves (TRVs). Householders can optimise how much heat they use by reducing temperature in individual rooms where they may require less heat, or turning off radiators in rooms that are used infrequently (e.g. spare bedrooms).

2.42. The benefits of TRVs depend on the extent to which households use them. If TRVs are installed but not used there will be no impact on household emissions or energy bills. Therefore, this technology is best suited to those who are minded to interact with their heating settings. These sensitivities mean there is much variation in costs and benefits from home to home.

2.43. Households that engage with their TRVs are likely to benefit far more significantly. Industry and academic research has not conclusively established the technical potential for savings from TRVs. One study found savings of around 12%[30], however our Impact Assessment indicates savings on average may be significantly lower (3%).

Time Proportional Integral controls

2.44. Conventional thermostats turn the boiler on and off at intervals to maintain the preferred temperature set by the household. TPI controls send data back to the boiler more regularly to keep its operation more steady, reducing the energy needed.

2.45. It is unclear whether TPI controls save energy in practice.[31] We welcome views on whether TPI controls are likely to deliver savings that would be achieved in practice across the housing stock. We are also interested in any further research that has been done into the installed benefits of this technology, including:

- Risk of adverse consequences such as reduced comfort levels in the home.
- Compatibility with modulating boilers.

[28] Evidence Gathering: Passive Flue Gas Heat Recovery Technologies. 2015. Prepared for DECC by Delta Energy & Environment Ltd. & Enertek International Ltd.
[29] English Housing Survey Headline Report 2014-15 Section 2: Tables, Figures and Annex Tables
[30] Beizaee et al. (2016) scoping review of heating controls
[31] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47962/1149-condensing-boilers.pdf

Automated optimisation

2.46. A growing market has emerged for 'smart' heating controls. There is no common definition for smart controls, and the term represents a broad range of products. There is potential for these to offer significant savings, as well as greater usability. Conversely, some do not appear to offer any functionality beyond the functions of a standard programmable thermostat, and research has found that some are not user-friendly for everyone.[32]

2.47. For these reasons we consider that any requirement for smart controls in the home should focus on specific functions, rather than smart controls as a broad category. Optimisation and automation are common functions that may achieve this, as set out in the Technical Annex. Many also include built in weather compensation.

2.48. In November 2016 BEIS and Ofgem published a call for evidence seeking views on questions around how our energy system could be more smart and flexible.[33]

Consultation Questions

6a.	Do installers have sufficient familiarity, training and experience to properly install each of the technologies listed above?
6b.	Can installers and consumers make confident decisions regarding which technology is an appropriate solution for a given household?
6c.	Is there evidence to suggest that any of these technologies are incompatible with each other or with any of the technologies mentioned in this consultation?
6d.	Do consumers understand how to use TRVs effectively?
6e.	Are there other technologies that should be considered on an even footing with those listed above?
6f.	Please provide any evidence in support of your answers to questions 6a-6e. In answering question 6a please consider any practical barriers affecting any of the technologies, and any steps that could be taken to address those barriers.

[32] Combe, N., Harrison, D., Craig, S., & Young, M. S. (2012) An investigation into usability and exclusivity issues of digital programmable thermostats. *Journal of Engineering Design, 23* (5) pp. 401-417

[33] https://www.gov.uk/government/consultations/call-for-evidence-a-smart-flexible-energy-system

7.	What evidence is there that TPI control can deliver energy savings in English households, and what is the range of energy savings (%) across various property types and circumstances?
8a.	Do the functionalities of automation and optimisation effectively describe the 'smart' controls that offer the greatest benefit? Should there be greater focus on remote access?
8b.	In what ways could greater uptake of these functionalities promote smart control innovation?
8c.	What evidence is there to indicate how long a smart heating control lasts?

Information and advice

2.49. Reliable and impartial advice can be key to ensure that consumers are able to consider their options, so that the right technologies are installed to meet their needs. Currently consumers can find information on their technology options and their use from a number of sources. In recent years advice has been provided to consumers through the Energy Saving Advice Service.

2.50. Research commissioned by DECC found that nearly all consumers receive advice from their installers when heating controls are installed, most commonly in the form of a manual (73%) or a practical demonstration (44%).[34] However, it has also been found that the advice given is not always consistent, and while it might help customers achieve desired comfort it often does not provide the most efficient way of doing so.[35]

2.51. The roll-out of smart meters requires energy suppliers to provide energy efficiency advice to consumers alongside smart meter installations. BEIS is currently carrying out research to develop best practice approaches, including materials providing advice about heating systems. These include accurate and practical information about what heating controls or systems may be appropriate to consumers' homes, and how to use heating controls to manage energy consumption.

2.52. Consumers may benefit from a central source of impartial advice. This might provide installers with a common language or script that would enable them to provide consistent advice that can be verified by the consumer. Such a scheme might reassure installers that they and their competitors are providing similar advice to their customers, and customers are able to verify the advice they have received which could preserve trust and benefit both the consumer and the installer.

2.53. Advice on the suitability and use of technologies such as passive flue gas heat recovery may also be appreciated by both households and installers, to assist with decision-making.

Consultation Questions

9.	Is there demand for consumer advice, and how should it be delivered? What more can the industry do to encourage consumer engagement with heating controls and their heating system?

[34] https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat
[35] Faye Wade, Michelle Shipworth & Russell Hitchings (2016): How installers select and explain domestic heating controls, Building Research & Information, DOI: 10.1080/09613218.2016.1159484

Evidence and analysis

2.54. The Impact Assessment published alongside this consultation document sets out the costs and benefits of the different options.[36] As discussed in earlier sections, the evidence we have collected and used to form these options is highly uncertain. In particular the information we have about the cost and performance of technologies and how householders might make choice decisions is sparse. This makes it difficult to present the impacts and cost effectiveness of this proposed policy with certainty. We estimate a reduction in carbon emissions in Carbon Budget 4 by 1.4 $MtCO_2e$, as well as a corresponding improvement in air quality from decreased pollution. There is much uncertainty surrounding this – our analysis is based on evidence from the Building Research Establishment.

2.55. Our analysis is underpinned by a set of assumptions about the impact of technologies, as well as future projections of fuel prices. We rely on representative, robust and verified data to ensure that costs and benefits assessments are made on the best evidence available before options are taken forward. A summary table of the assumptions and metrics used to assess the options is given below.

2.56. As set out in the Impact Assessment, there is significant variation in the Net Present Value (NPV) – a measure of cost effectiveness – depending on the policy design. Although some scenarios offer a negative NPV this value may increase with reduced costs or improved performance of components such as weather compensators. The NPVs are highly sensitive to the assumptions that underpin them so using the best available evidence is of critical importance. We have used conservative cost estimates in our analyses, taking the central cost to calculate payback periods. Many consumers are likely to choose less expensive options. In the case of weather compensators, this may halve the payback period. Similarly, for TRVs we have assumed households purchase one control for each radiator in the property, but many households already have controls on some radiators, meaning that only the remaining radiators need to be equipped, at a fraction of the cost in Table 1. Costs are also likely to come down with increased demand and competition, as happened with condensing boilers last decade.

[36] https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat

Table 1: Summary of proposal costs and benefits

System component	Total product cost[37]	Total annual bill savings	Payback period (years)	Carbon savings (CB4)
Weather compensator only	Central: £80 (£40 - £115)	£6	13	1.4 $MtCO_2e$
Options to go further				
PFGHR & Weather Compensators	£520 in year 1 £280 from year 2	Total: £24	WC: 13 PFGHR: 21 in year 1 cost, 9 from year 2	3.2 $MtCO_2e$
TRVs & Weather Compensators	Central: £430 (£270 - £660)	Total: £22	WC: 13 TRVs: 22	3.0 $MtCO_2e$
Automated optimisation & Weather Compensators	£210	Total: £22	WC: 13 AO: 8	2.9 $MtCO_2e$

2.57. The impact of some of these technologies depends upon the way they are used by the household and some technologies may be more appropriate to particular circumstances. This would make the actual impact of policy requirements hard to predict. Furthermore, it is known that installation quality significantly impacts on the capabilities of the technology being installed.

2.58. Given these uncertainties this consultation seeks to help us improve the assumptions that underpin our assessment. We are particularly eager to understand how the proposed minimum requirements might drive product innovation, potential for cost reduction and greater installer engagement, which would improve the cost effectiveness to the consumer and society.

[37] Costs provided represent the increased cost to consumers of replacing a boiler, as compared to today's average (approx. £2,500).

Consultation Questions	
10a.	Do you agree with our understanding of the costs associated with each of these technologies?
10b.	Do you agree with our understanding of the way costs may change, and the reasons why they may change?
10c.	Would consumers be willing to accept the additional upfront costs of technologies listed in Table 1, on the basis of reducing their annual energy bills and benefiting the environment?
10d.	What evidence is there on the impact of each technology on the performance of domestic heating systems? How might this change with further innovation?
10e.	Our Impact Assessment currently only considers natural gas. How might consequences be different for oil or LPG boilers?
10f.	Please provide any further information to support your answers to questions 10a-10e.

Evaluation and monitoring

2.59. If the proposed new requirements for domestic heating systems are implemented, we will evaluate the impact on consumers, the market and the environment. The principal aims of this evaluation will be to:

- understand how the regulation has affected the uptake of the technologies in scope
- understand the actual costs and practical impacts of this policy on households, installers and the supply chain.
- understand the actual benefits in terms of reductions to greenhouse gas emissions and the economic impact on consumers and the market.

2.60. We are required to undertake a post implementation review within 5 years of implementation, but we will also seek opportunities to appraise the impact of this policy earlier.

A call for evidence: further opportunities

3.1. Chapter 2 focused on opportunities that can be taken forward in the short term to reduce bills and increase comfort while reducing the amount of carbon from household heating. Our engagement with industry to date has suggested that there are additional measures and practices that could achieve further carbon savings by improving the in-situ performance of boilers. However, many of these measures may currently be costly or of limited effect in the wrong circumstances, and we do not wish to impose requirements on all households that may only be cost effective for some.

3.2. That is why in Chapter 3 we are putting out a call for evidence to help us develop additional opportunities in the short and long term. The measures and opportunities presented in this chapter may have a role to play in a future framework, either underpinned by regulation or promoted through other means, either at a local, regional or national level. We are not currently proposing to implement these measures alongside the requirements set out in Chapter 2, but we do need to consider them as part of the long term transition to meet our carbon goals.

3.3. The key measures that have been identified are:

- Hydraulic balancing
- Return water temperatures and radiator sizing
- Internal system cleanliness
- System design and components

3.4. We are seeking evidence to help us explore the potential for these measures. We wish to better understand costs and the extent of their impact at a household and national level, and any barriers to their uptake. Evidence submitted will help us to assess three key criteria:

- Deliverability and costs
- Potential carbon savings associated with measures under a wider system approach
- The role of Government in mandating, supporting and/or encouraging particular practices

3.5. We have also been alerted to a diverse range of other products and practices that may have a role to play in ensuring the efficient operation of domestic heating systems. We would like to gather more insight into innovative solutions and

opportunities that may be able to ensure households have better access to affordable and effective comfort in their homes.

Hydraulic balancing

3.6. Hydraulic balancing ensures the optimum distribution of heat throughout heating system based on the heat loss and radiator sizes in each room of the home. This reduces the risk of over or under heating rooms by ensuring each room meets the set point temperature at the same time.

3.7. At present, Building Regulations do not explicitly define hydraulic balancing or require central heating systems to be hydraulically balanced when replaced and commissioned. Statutory guidance for commissioning replacement boilers does include setting to work and making repetitive adjustments to ensure the system "uses no more fuel and power than is reasonable". However, we have received differing feedback from industry on how practitioners understand and provide hydraulic balancing for their customers.

3.8. We believe many households can benefit from properly balanced systems, but costs may be high, benefits may vary, and it is not clear whether installers are currently skilled in delivering this practice.

Call for Evidence Questions	
11a.	Do heating engineers share a common understanding of what hydraulic balancing entails, and is it undertaken regularly when a boiler is replaced or serviced?
11b.	What practical barriers might prevent a central heating system from being hydraulically balanced (e.g. system size)?
11c.	What is the average cost to a consumer when hydraulically balancing a central heating system?
11d.	What evidence is there to demonstrate the impact that hydraulic balancing can improve the performance and/or carbon intensity of domestic heating systems?

Return temperatures and radiator sizing

3.9. In order for a condensing boiler to operate in condensing mode, a return temperature of 55°C or less is required. This is not currently required under Building Regulations and associated guidance, although it is recommended. We

are aware that return temperatures are often set much higher than 55°C, and many installers feel that setting temperatures too low will result in dissatisfied customers.

3.10. Low return temperature is also an important factor affecting the efficiency of low carbon heating systems such as heat pumps, so policies that support low temperature systems is likely to facilitate the eventual transition to low carbon alternatives, by removing the barrier of needing to replace the radiator system.

3.11. Typically, radiators tend not to be sized for lower return temperatures to occur, so it is important to consider radiator sizing and system temperature hand in hand. There is no current requirement for a full heat loss calculation when a radiator is replaced or when a new central heating system is installed and commissioned. Radiator sizing is often driven by decorating requirements rather than performance.

Call for Evidence Questions	
12a.	What flow and return temperatures are typically set for a condensing boiler at the point of installation?
12b.	Can lower return temperatures be implemented in the existing housing stock without upsizing radiators on a grand scale?
12c.	Should Government consider setting a maximum return temperature in the future?
12d.	Please provide any further information to support your answers to questions 12a-12c. Please consider what barriers might prevent lower return temperatures being set in the home, or which may prevent an installer carrying out a heat loss calculation.

Cleaner systems

3.12. The build-up of debris or ‘sludge’ in the radiator is caused by corrosion of metal components inside the central heating system. This can cause systems to perform less efficiently, requiring more energy to deliver the same heat output.

3.13. Typical impacts of radiator sludge include:

- cold spots that mean that the radiators do not heat the room as required;
- blocked pipes and discoloured water;
- Internal corrosion of components such as circulation pumps.

3.14. There are various options available on the market to treat radiator sludge such as power flushing, chemical water treatment inhibitors and magnetic filtration.

3.15. Building Regulations require that chemical water treatment inhibitor be added to primary circuits to control scale and sludge on boiler installation, and thorough cleaning and flushing is a minimum requirement when replacing and commissioning a new boiler.

3.16. Similarly, limescale can reduce the performance of the heating system by blocking pipes and effectively insulating the heating system from within.

3.17. Current guidance on the regulations requires that when a boiler is replaced in harder water areas (200 parts per million), provision should be made to treat the feed water to water heaters and the hot water circuit of combination boilers to reduce lime scale.

Call for Evidence Questions

13a.	Do installers comply with requirements to treat systems for sludge and limescale when replacing a boiler?
13b.	What evidence is there to demonstrate the impact that these treatments can improve the performance and/or carbon intensity of domestic heating systems?

Targeting buildings off the gas grid

3.18. Over 1 million dwellings in Great Britain use oil as the main source of fuel to heat their homes. Together, these homes produced 7MtCO_2e in 2014[38]. An additional 250,000 homes use solid fuels.

3.19. The current policy to support these buildings decarbonise their heat supply is the Domestic Renewable Heat Incentive (RHI). Its purpose is to promote the use of renewable heat and is targeted at, but not limited to, buildings off the gas grid. Those without mains gas have the most potential to save on fuel bills and decrease carbon emissions by switching to low carbon heating technologies. Funding for the RHI has been agreed out to 2021. We want to develop the policy framework for the following period to encourage a transition away from high fossil fuel heating while moving away from subsidy and mitigating the risk of unintended effects. We

[38] DECC Updated Energy & Emissions Projections - November 2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/501263/Annex-f-final-energy-demand_160211.xls adjusted by conversion factors

would welcome views on which policy levers should be explored and how we should time the transition.

3.20. While the UK has some of the oldest building stock in Europe, many buildings have the potential to be upgraded cost-effectively with insulation or other measures to improve their thermal efficiency which will reduce their heating and cooling bills – and associated carbon emissions. We know that there may be particular challenges for some types of buildings that will remain difficult to heat cost-effectively. They will be thermally inefficient and their heating and cooling choice may be affected by other factors, such as:

- Off gas grid in a rural area, so no gas option for heating (or grid connection cost may be prohibitive) or potential for a district heating network
- Off national grid so cannot use electric heating and cooling (e.g. on an island or distance/upgrade costs are too high)
- Cost of installing energy efficiency measures necessary to make low temperature heating more viable (eg through heat pumps) is significantly more than the reduction in energy costs over the lifetime

3.21. Many such homes are currently on non-renewable solid fuel such as coal or peat, which are amongst the most potent sources of carbon emissions. It may be the case that these homes have a higher likelihood of being fuel poor and therefore may already be supported by Government activity. However, this will still leave many homes with significant costs to moving to low carbon alternatives. We are interested in views on how we support these homes to take up low carbon heating measures.

Consultation Question	
14.	What action should Government take to reduce the use of coal and oil in buildings? Over what period of time should the transition occur? Which levers should be deployed to support homes that are harder to heat?

Innovative solutions

3.22. We remain committed to meeting our carbon emissions targets. The Climate Change Act requires UK emissions to reduce by 2050 to at least 80% below 1990 levels. Success will depend on an openness in Government and in the market to new ideas: new technologies and ways of doing things that bring down costs and carbon emissions. The low carbon industry is a growing economy in which big ideas should thrive. Innovative solutions can produce new or improved technologies, novel business models can make currently expensive products pay for themselves and help consumers meet their bills. We need innovative solutions,

and in the UK we have an engaged and proactive industrial sector, and an academic community that is at the cutting edge of innovative design. We wish to hear from these and all sectors about new ways of thinking for the future.

Consultation Question	
15.	What other innovative solutions or opportunities exist that may have a tangible impact on emissions from heat in buildings, either in the next two carbon budgets or out to 2050? Please provide any supporting evidence.

Technical annex

ErP and alternative metrics

4.1. The methodology used for scoring individual products (as opposed to complete heating systems) in the Products Characteristics Database (PCDb) which supports the Standard Assessment Procedure (SAP) is also changing to allow manufacturers to use the results from a single set of laboratory tests to calculate the performance metrics for compliance with boiler performance standards in England and the Energy Related Products Directive. This means less testing is needed, minimising burden on manufacturers. However, because the PCDb has to consider seasonal performance, and hot water use, it lists the efficiency of products in a number of ways. This does mean PDCb and the ErP label may be inconsistent.

4.2. In practice this means installers should refer to a boiler's ErP label to confirm that it complies with the proposed changes to minimum standards, whereas energy assessors will still continue to use the PCDb to include product performance data in assessments for new build compliance, and when producing Energy Performance Certificates.

A minimum performance of 92% for domestic gas and oil boilers

4.3. We have been advised independently by a range of industry stakeholders that most gas boilers currently on the market perform at 92% ErP or above, and we are proposing to set this as the new minimum standard.[39] By setting a minimum efficiency of 92% ErP we expect to drive the market forward without the risk of imposing technical restraints that are too costly for manufacturers to implement without passing costs on to consumers. As such we assume no additional costs to consumers from complying with this requirement, and for this reason this part of our proposal does not appear in the Impact Assessment that has been published alongside this consultation document.

4.4. The current performance of domestic oil boilers is more diverse. We wish to gather evidence to help us determine whether there are risks associated with setting a higher minimum standard for oil boilers, and what an appropriate performance level would be.

4.5. For both gas and oil we aim to strike the right balance between an ambitious minimum performance value that encourages innovation, and a value that is too demanding and currently beyond manufacturers' capabilities. Through

[39] Between September 2015 and April 2016 manufacturers have been reassessing the performance of their products against the ErP methodology, in order to comply with international law. Representatives from leading manufacturers and trade bodies have independently indicated that existing products tend to fall within the range 91%-94%, with a significant majority performing at 92%. We are awaiting datasets to verify this.

conversations with manufacturers we believe that 92% ErP strikes this balance, but we also understand that higher standards can be reached if manufacturers are prepared to invest in further enhancements to their products and we want to encourage this investment to deliver greater benefits for consumers and the climate. We wish to gather views on the feasibility of breaking the 92% ErP threshold, and how much further innovation might take us. The proposed performance value applies to the boiler only. European labelling rules require that when a boiler is installed the consumer will receive a label that combines the boiler performance with the values ascribed to other system components such as heating controls, to give a total performance value for the system (e.g. a 92% boiler with a 3% control would be given a package label of 95%). The proposed minimum performance value of 92% ErP in England applies only to the boiler, and may not be met by augmenting a less efficient boiler with other components. These other components have a key role to play but not all of the products covered by ErP are right for English buildings.

Time and temperature control

4.6. The impact of timers and thermostats on the heat use of a building depends fundamentally on how they are used by the household. As only 36% of households claim to make a conscious effort to conserve their energy use, engagement with heating controls may remain low in the immediate future. However, it is reasonable to expect engagement to increase over time as consumers become more familiar and comfortable with the technology. Other policies will complement consumer adoption and use of heating controls: all homes (and non-domestic properties) will be offered a Smart Meter by the end 2020, letting consumers see how much energy they are using, and its cost in near real-time. The availability of feedback on energy consumption will support consumers in managing their use of energy, including through heating controls.

4.7. We are looking for views on how best to support consumers so they get the full benefit of heating controls. This includes consumer engagement with devices, but also any issues with usability. We understand that in some instances controls may be installed in inconvenient locations where they are hard to see or reach, or controls may be installed that are difficult to engage with for some users.[40] In particular we seek evidence on any risks to vulnerable consumers that would need to be addressed through industry standards or regulation.

4.8. Deployment of heating controls is already widespread, so both costs and impacts associated with this proposal are minimal. As demonstrated in Table 2, timers are already present in most English homes. Thermostats, while only present in three quarters of homes, are sold in high volumes that outstrip the number of boiler sales in any given period. This indicates that currently the majority of boiler installations are accompanied by the installation of a thermostat. Therefore the rationale for

[40] Rubens, S., Knowles, J. (2013). What people want from their heating controls: a qualitative study. A report to the Department of Energy and Climate Change. new experience. DECC, London; *and* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277552/FINALHow_heating_controls_affect_domestic_energy_demand_-_A_Rapid_Evidence_Assessment.pdf

intervention is to ensure households continue to benefit from heating controls when other upgrades are made to their heating, and to ensure all installers adopt the same interpretation of the compliance guidance. As such we assume no additional costs to consumers of complying with the proposed requirement for timers and thermostats, and for this reason this part of our proposal does not appear in the Impact Assessment.

Table 2: Proportion of households with central heating reporting primary heating controls[41]

Primary heating controls	% of English households	Number of households in thousands
Central timer	97%	19,130
Room thermostat	77%	15,065
Thermostatic Radiator Valves (TRV)	66%	13,017
'Full set of controls'[42] (TRV, central timer, and thermostat)	49%	9,620

Weather compensation

4.9. There are a variety of weather compensators available designed for use with on/off boilers or modulating boilers. Some have a temperature sensor on the outside of the building, whereas some use local weather station weather reports.

4.10. The effectiveness of weather compensation depends on a number of factors including:

- design of the compensation control,
- type of boiler with which it is installed,
- heating system capacity,
- efficiency of the building,

[41] EFUS (2011/12); n=2356 weighted and scaled to represent the English housing stock of 19.7 million households with central heating., as reported in https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277552/FINALHow_heating_controls_affect_domestic_energy_demand_-_A_Rapid_Evidence_Assessment.pdf

[42] A 'full set of controls' was calculated by combining the responses to whether households with central heating had a Thermostatic Radiator Valve, a central timer, and room thermostat as a primary heating control.

- correct setting of the weather compensation heating curves to adjust heating system flow temperatures,
- appropriate positioning of the outdoor temperature sensor, where applicable, or the accuracy of relevant weather station data,
- installation and operation of other complementary boiler and heating system controls.

4.11. From the limited sales data collected by industry it is our understanding that current deployment levels of weather compensators in England are very low. In the Impact Assessment we have set out an estimate of the savings that could be achieved, the bill and carbon savings from weather compensators are subject to uncertainty given the lack of evidence and the wide range of factors listed above.[43] However, we believe that these devices have a role to play in decarbonising and reducing consumer bills from fossil fuel boiler central heating systems, and in the longer term as a key component of certain renewable heating technologies.

4.12. They are likely to be easier to install than other potential system modifications, and the product design is adaptable so that individual products may be wireless, or may be built into the body of a boiler so that no installation is required. Weather compensators respond to the external temperature and do not require user engagement in order to deliver benefits, so are less susceptible to variations in user engagement from one house to the next. Upfront costs are lower than other options, at around £80 for an average product on today's market, and we expect this to reduce with innovation and increasing demand.

4.13. A compensation curve is the method used to vary the flow temperature of a heating system as the outdoor ambient temperature changes. As the outside temperature rises the flow temperature selected by the compensation control decreases, minimising the amount of fuel consumed to achieve the temperature desired within the home. For example, a compensation curve may set a high flow temperature of 80°C in response to periods of high winter heating demand, but adjust the flow temperature down to say 55°C in typical milder heating season conditions. This causes a condensing boiler to operate in condensing mode more frequently. Some types of weather compensator are only able to use a single compensation curve which is set by the installer during installation; other types can call upon a number of compensation curves and contain an intelligent controller which is able to automatically chose between the curves in order to further improve performance and minimise the risk of under or over heating in the home.

4.14. A mandatory requirement could involve the following for all domestic boilers installed in both new and existing heating systems (at the time of installation):

[43] Beizaee et al. (2016) scoping review of heating controls

- Weather compensation control that adjusts the flow temperature of water leaving the boiler dependent upon the prevailing outside temperature and a weather compensation curve; and,
- A suitable (set of) weather compensation curve(s) to be set by the installer to account for the thermal properties of the dwelling, to ensure the control functions as intended.
- Where the weather compensator utilises an external sensor it should be positioned appropriately and in line with manufacturers' guidelines (if applicable).

Passive flue gas heat recovery (PFGHR)

4.15. Flue gas heat recovery is the extraction of waste heat from the products of combustion (flue gases) which can then be used to pre-heat domestic hot water. By doing so, the amount of gas used to heat domestic hot water can be reduced, thereby increasing the overall efficiency of the boiler. As a 'passive' system, no additional (electrical) energy is consumed during the operation of the PFGHR device.

4.16. PFGHR products can broadly be segmented into two types (both of which would be considered compliant): those with additional thermal storage and those without. Generally, devices without thermal storage provide energy savings only when the boiler is operating in 'domestic hot water' mode. These PFGHR products are less expensive and require less space in the home, but will only produce high savings in households with a relatively high hot water demand. This might be the case in highly efficient properties where the energy needed for space heating is low, and so the household hot water demand is proportionately higher. The benefits for each household will vary depending on circumstances such as these.[44]

4.17. Current products are designed to work only with combination boilers (producing instantaneous hot water), not system boilers for which products are more expensive and complex to develop. Combination boilers currently make up nearly two thirds of the market.[45]

Zonal control and Thermostatic Radiator Valves

4.18. Zonal control is any system that allows the heating of at least two zones to be controlled independently, in terms of operation temperature, time or both. Households may achieve this in a number of ways, but the most affordable mechanism for most households will be through the use of Thermostatic Radiator Valves (TRVs). TRVs are controls fitted to radiators throughout the home (excluding the room with the main thermostat) to allow the localised control of

[44] Evidence Gathering: Passive Flue Gas Heat Recovery Technologies. 2015. Prepared for DECC by Delta Energy & Environment Ltd. & Enertek International Ltd.
[45] English Housing Survey Headline Report 2014-15 Section 2: Tables, Figures and Annex Tables

temperature in different rooms. Householders can optimise heat use by reducing temperature in individual rooms where they may require less heat, or deactivating radiators altogether in rooms that are used infrequently (e.g. spare bedrooms).

4.19. The benefits of TRVs depend on the extent to which households engage with them. If TRVs are installed but not used there will be no impact on household emissions or energy bills. Therefore, this technology is best suited to those who are minded to interact with their heating settings. More advanced products exist that allow individual room settings to be adjusted centrally, rather than visiting each radiator in turn. These sensitivities mean there is much variation in costs and benefits from home to home.

4.20. In our Impact Assessment we have estimated fuel savings of 3% on average, although there would be significant variation. Households that engage fully with their TRVs are likely to benefit far more significantly. Industry and academic research has not conclusively established the technical potential for savings from TRVs, but one study found savings of around 12%.[46]

Time Proportional Integral controls

4.21. Conventional room thermostats typically operate on a simple on/off basis around a temperature set point. TPI controls are electronic room thermostats that control both the thermostat cycle rate and the in-cycle modulation of the heater proportional to the room temperature.

4.22. Alongside improving room temperature control accuracy, manufacturers claim that TPI control should yield reduced average flow temperatures and boiler gas consumption, whilst also enabling increased boiler condensing mode operation and enhancing system efficiency. It is unclear whether TPI controls save energy in practice. In order for effective TPI control to take place the boiler must be allowed to operate for a significant amount of time at the internal temperature set point. Studies have found that this condition was not often met.[47]

Automated optimisation

4.23. Automation and optimisation are common functionalities of so-called ‘smart’ heating controls. There is no common definition for smart controls, but the term generally refers to a range of devices with advanced functionalities that use digital information and communication technology. Most use an app-based user interface so that consumers can engage with their heating from a mobile phone or tablet.

4.24. The diversity of products presents a challenge for this policy: to add value, ‘smart’ heating controls would need to offer further benefits beyond those offered by programmable thermostats. Therefore we would not consider all smart controls as being in scope, but we are also mindful to not stifle innovation by prescribing overly precise parameters.

[46] Beizaee et al. (2016) scoping review of heating controls
[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47962/1149-condensing-boilers.pdf

4.25. Automation is a functionality that turns the heating system on or off based on occupancy, depending on the location of householders relative to the property and the calculated time required for the home to achieve the desired temperature. Methods employed to detect the presence or location of householders relative to their property include occupancy-based sensors (such as CO2 sensors, Passive Infra-Red (PIR) sensors or sensor boxes) and/or smart phone geolocation or geofencing services.

4.26. Optimisation is a functionality that calculates the pre-heat time required to achieve room set point temperature and ensures the heating system is brought on at the latest time possible to achieve this. This can result in the heating switching on later during milder weather conditions when shorter pre-heat times are required, although there is also a risk of energy consumption increasing through comfort taking.

4.27. Automation and optimisation are likely to enable greater comfort efficiency in many homes. Some smart controls use proprietary learning algorithms that combine automation and optimisation with an adaptive function that monitors, learns and anticipates household needs. Many controls that offer these functions also incorporate weather compensators, giving combined fuel savings of around 6%, although it is not known which specific functions are primarily responsible for these savings.

4.28. Although app-based interfaces do not add any further performance enhancements to the system, there is evidence to suggest that users are more likely to engage with their heating if they are able to access it via a versatile and user-friendly control device. It is possible that consumers using smart controls are more likely to get the most out of their household heating, although this has not yet been verified to date.

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