Title: Domestic Heating Replacement Regulations	Impact Assessment (IA)
IA No: BEIS028(C)-16-HB	**Date:** 31st October 2016
Lead department or agency: Department of Business, Energy and Industrial Strategy	**Stage:** Consultation
	Source of intervention: Domestic
	Type of measure: Secondary legislation
	Contacts for enquiries:

Summary: Intervention and Options

RPC: GREEN

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB in 2014 prices)	**In scope of One-In, Three-Out?**	**Measure qualifies as**
-£104m	- £217m	£10.5m	Yes	IN

What is the problem under consideration? Why is government intervention necessary?

The market failures and barriers within the new and replacement boiler market mean that the deployment of technologies which could deliver potentially cost effective energy savings is low. The existing regulatory structure in the market delivers significant carbon abatement, but could deliver further savings, including for energy bills, with additional government intervention.

New technology installed at the point of boiler replacement presents an opportunity to deliver bill and carbon l savings, at low cost to consumers and in a way which minimises hassle and maximises the quality of installation.

What are the policy objectives and the intended effects?

The policy objectives are to deliver additional energy and carbon savings from the domestic heating sector in England by lowering overall gas demand from domestic properties, thereby reducing fuel bills for these properties and contributing towards meeting the UK's legally binding carbon budgets. It aims to do this by increasing the deployment of systems which increase the efficiency of domestic heating systems, through controls and measures to make gas boilers use gas more efficiently.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Several broad policy options have been considered. One option is to develop the quality and standards of heating system installation and maintenance. At this stage it has only been possible to assess this option qualitatively and is the reason a call for evidence sits alongside this consultation. The four options assessed quantitatively in this IA relate to extending the existing regulatory requirements for gas boiler replacements from April 2017. These are:

i. Mandate the installation of weather compensators at the point of boiler replacement for all new gas boilers.

ii. As option i but <u>also</u> mandate the installation of additional measures from a list designed to reduce energy consumption. This is a more stretching option for which we need further evidence.

Additionally, each of these options has variants with different requirements for the Private Rented Sector in order to minimise the impact on business given this market area is one which is currently subject to regulation. The options considered in this IA have attempted to build on this. There is one lead option which our costs and benefits in these summary pages relate to.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 2020

Does implementation go beyond minimum EU requirements?			**N/A**		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro:** Yes	**< 20:** Yes	**Small:** Yes	**Medium:** Yes	**Large:** Yes
What is the CO2 equivalent change in greenhouse gas emissions? (Million tonnes CO2 equivalent)			**Traded:** 0	**Non-traded:** -1.4 in CB4	

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister: Neville-Rolfe Date: 7/11/16

Summary: Analysis & Evidence — Lead Policy Option 1a

Description: When replacing a gas boiler in England, householders must also install a weather compensator to improve the whole system performance and reduce the carbon emissions associated with heating.

FULL ECONOMIC ASSESSMENT

Price Base Year 2015	PV Base Year 2017	Time Period Years 30	Net Benefit (Present Value (PV)) (£m)		
			Low: Optional	High: Optional	Best Estimate: -£104m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low				N/A
High				N/A
Best Estimate				£1,144m

Description and scale of key monetised costs by 'main affected groups'

The costs considered in this policy are the additional capital costs of installation of measures such as higher efficiency boilers, heating controls and other measures, by all householders in England including the Private Rented Sector. This is the total cost excluding VAT and therefore may include a small element of profit for manufacturers and installers of boilers and weather compensators, slightly over-estimating resource costs.

Given the significant uncertainty around costs and performance for these measures we conduct a threshold analysis of the key assumptions which shows that costs required for a zero NPV are in the range used in the modelling.

Other key non-monetised costs by 'main affected groups'

This Impact Assessment does not attempt to monetise the hassle costs which might be associated with some of the measures considered. In addition this assessment does not assume any cost reductions for weather compensators; we will use the consultation to collect evidence on this. We have performed sensitivity & threshold analysis on this, detailed in Section B.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low				N/A
High				N/A
Best Estimate				£1,040m

Description and scale of key monetised benefits by 'main affected groups'

The monetised benefits are the energy savings as a result of the policy, the air quality impacts and the carbon emissions reduction. There is significant uncertainty about these benefits which is explored in more detail in Section B of this Impact Assessment.

Given the significant uncertainty around costs and performance for these measures we conduct a threshold analysis of the key assumptions which shows that performance required for zero NPV is within the range used in the modelling.

Other key non-monetised benefits by 'main affected groups'

Non-monetised benefits include the benefits of allowing people to better control their heating and achieve a level of comfort they desire. In addition this policy could have health impacts through householders being able to heat their homes more effectively.

Key assumptions/sensitivities/risks — **Discount rate (%)** 3.5

The key assumptions for this analysis are the cost and performance of the measures considered. This is highly uncertain and discussed at length in the Impact Assessment. For example there is little in-situ evidence as to how weather compensators might perform, or how householders' behaviour might change.

This Impact Assessment looks to communicate these uncertainties through sensitivity and threshold analysis. We will use the consultation period to improve our evidence base.

BUSINESS ASSESSMENT (Option 1a)

Direct impact on business (Equivalent Annual) £m:			In scope of OI3O?	Measure qualifies as
Costs: £10.5m	Benefits: £0m	Net: £10.5m	Yes	IN

Summary: Analysis & Evidence — Stretch Policy Option 2b

Description: When replacing a gas boiler in England, householders must also install a weather compensator and another energy savings technology from a list of available measures to improve the whole system performance and reduce the carbon emissions associated with their heating. The PRS sector does not have to install the additional technology. We would use consultation feedback to further our evidence on these technologies.

FULL ECONOMIC ASSESSMENT

Price Base Year 2015	PV Base Year 2017	Time Period Years 30	Net Benefit (Present Value (PV)) (£m)		
			Low: -£166m	**High: £559m**	**Best Estimate: £172m**

COSTS (£m)	**Total Transition** (Constant Price) Years		**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low (High upfront cost)				£2,085m
High (Low upfront cost)				£1,360m
Best Estimate				**£1,747m**

Description and scale of key monetised costs by 'main affected groups'

The costs considered in this policy are the additional capital costs of installation of measures such as higher efficiency boilers, heating controls and other measures. As an illustration these costs presented here relate to weather compensators and learning thermostats. This is the total cost excluding VAT and therefore may include a small element of profit for manufacturers and installers, slightly over-estimating resource costs.
Given the significant uncertainty around costs and performance for these measures we conduct a range of sensitivity and threshold analysis from pg 33 of this IA. For this summary we vary upfront costs of the weather compensator only.

Other key non-monetised costs by 'main affected groups'

This impact assessment does not attempt to monetise the hassle costs which might be associated with some of the measures considered nor does it assume any cost reductions for the technologies. We will use the consultation to collect evidence on these assumptions. For the purposes of this consultation stage IA we have performed sensitivity & threshold analysis on these assumptions, detailed in Section B.

BENEFITS (£m)	**Total Transition** (Constant Price) Years		**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low				£1,919m
High				£1,919m
Best Estimate				**£1,919m**

Description and scale of key monetised benefits by 'main affected groups'

The monetised benefits are the energy savings as a result of the policy, the air quality impacts and the carbon emission reductions. As an illustration these benefits presented here relate to weather compensators and learning thermostats. There is significant uncertainty about these benefits which is explored in more detail in Section B of this Impact Assessment.
Given the significant uncertainty around costs and performance for these measures we conduct a range of sensitivity and threshold analysis from pg 33 of this IA. For this summary we vary upfront costs of the weather compensator only and benefits remain unchanged.

Other key non-monetised benefits by 'main affected groups'

Non-monetised benefits include allowing people to better control their heating and achieve a level of comfort they desire. In addition this policy could have positive health impacts through householders being able to heat their homes more effectively.

Key assumptions/sensitivities/risks — **Discount rate (%)** 3.5

The key assumptions for this analysis are the cost and performance of the measures considered. These are highly uncertain and discussed at length. For example there is little in-situ evidence as to how weather compensators might perform, or how householders' behaviour might change. This IA looks to communicate these ranges through sensitivity and threshold analysis. During the consultation period we will look to gather evidence that supports alternative assumptions to those included in this IA.

There are multiple ways of meeting the requirements of this regulation. For the central assessment we assume households use the option with the lowest upfront costs; however they could choose to use other technologies. The social costs and benefits are detailed in Section B.

BUSINESS ASSESSMENT (Option 2b)

Direct impact on business (Equivalent Annual) £m:			**In scope of OI3O?**	**Measure qualifies as**
Costs: £10.5m	**Benefits: £0m**	**Net: £10.5m**	Yes	IN

Contents

Section A

Problem under consideration

1. The Climate Change Act 2008 established a target for the UK to reduce its emissions by at least 80% from 1990 levels by 2050. In order to successfully deliver this, significant carbon reduction is required, particularly from the domestic heat sector which accounts for around 45% of UK energy demand and 19% of final UK greenhouse gas emissions.

2. Most long-term modelling suggests this sector needs to reach near zero emissions by 2050 if we are to deliver our commitment to an 80% emissions reduction. In the shorter term there is an on-going role for gas fired central heating systems in the home, which make up over 85%[1] of domestic heating systems in England, into at least the 2030s.

3. With around 1.2 million gas and 50,000 oil boilers[2] replaced each year in England[3] a sizable opportunity exists to reduce emissions from this sector in a way which is more cost effective than many other types of action and more affordable than longer term efforts to displace fossil fuels. Minimum standards already apply when consumers choose to install new or replacement boilers, which we would seek to update to reflect the advances that have been made in recent years and are achievable in the future.

4. The following market and behavioural barriers have been identified that prevent the uptake of more efficient boiler systems:

    a. **Carbon externality:** householders do not value the carbon savings associated with more efficient heating systems in their decision making and so there is no commercial motivation for manufacturers to increase the performance of their products. This stifles innovation, and allows less efficient products to remain firmly in the market.

    b. **Bounded Rationality:** consumers are unaware or unengaged with the performance enhancing potential of heating controls and other system components. Householders prioritise comfort in the home; however they often lack the information and tools to enable them to control their heat supply in a way that delivers comfort levels in the most efficient way[4].

       For example, in many homes it is necessary to heat the entire property to a high temperature in order to achieve desired comfort in one specific room. This means many households have potential to reduce the fuel needed to satisfy their heat demand, leading to emissions reductions and bill savings without affecting their comfort. Most consumers hardly consider cost when using heat at home – heat consumption is generally a by-product of daily life, rather than a conscious choice. While bills are important for heating choices they are not the only consideration, and issues like hassle and personal priorities also significantly affect engagement with heating.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/345142/uk_housing_fact_file_2013_tables.xlsx
[2] Based on Heating and Hot Water industry Council boiler sales figures scaled to England
[3] A commonly quoted figure is of 1.5-1.6m gas boiler sales, this includes sales in Scotland, Wales and Northern Ireland
[4] http://www.eti.co.uk/future-heating-systems-should-improve-experiences-be-simpler-to-install-and-provide-consumers-with-enhanced-control-if-the-challenge-of-decarbonising-domestic-heat-is-to-be-met-eti-report/

This is illustrated by consumers not picking additions to their current boiler system which might prove cost effective. This is explored in more detail in this impact assessment.

c. **Valuing bill savings:** while consumers achieve bill savings or comfort increases with many of the innovations detailed in this impact assessment, typically they do not value these future bill savings highly. While not a market failure in of itself, this is an important barrier which prevents consumer action, even if the identified market failures have been addressed.

5. These barriers mean that without Government intervention the domestic heating market will not deliver the additional carbon and energy saving abatement required to make a contribution to the Government's legally binding carbon budgets.

6. This Initial Stage Impact Assessment (and consultation) considers ways to build on the existing regulatory framework for heating to further address some of these issues and optimise the performance of domestic central heating systems.

Background on heating systems, standards and controls

7. This section lays out some of the significant elements and key facts of the heating market in England, focusing on how people currently make choices and the key characteristics of the market. It is intended to give context to the discussion of options and impacts.

How people make heating choices

8. There are three significant elements of the domestic heat market that are driven by consumer choice:

    a. Selecting a heat system; the technologies that combine to generate heat and distribute it throughout the property

    b. **Heat demand;** the profile and total consumption of the household's heat energy usage, for heating the living environment and providing hot water as needed.

    c. **Selecting an energy provider:** this is who supplies a householder with the gas and oil for their system.

9. A recent ETI survey found that around a third of people (36%) claimed to try to conserve how much energy they used, for instance by turning thermostats down, turning heating off when they went out and down in rarely used rooms. Another third put more emphasis on ensuring their heat demands were met (9%), or meeting the needs of others in the property (18%), for instance by preheating empty homes or rooms to avoid waiting for them to warm up when needed. The final third (37%) were relatively disengaged with the issue.[5]

10. The decision to install a new boiler is typically driven by a number of factors, but predominately because households thought that their system was either broken down (30%) or near the end of its life (31%).[6]

Boiler Market

11. The UK has one of the largest and most valuable gas boiler markets in the world. 23m[7] domestic properties in the UK use a gas-fired wet central heating system as their primary heating provision and 1.1m households use oil boilers.

12. Minimum standards for boiler installations are set under Building Regulations. Building Regulations are a devolved matter, although a single market operates across the UK. The proposed interventions impact on England only. England makes up the vast majority of the gas boiler market.

Current Boiler Performance

13. The SEDBUK[8] 2005[9] minimum technical boiler installation standards drove the deployment of highly efficient condensing boilers, which now make up the majority of the installed stock. In 2009 the minimum performance standards were updated to 88%, reflecting a new

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[5] Energy Technologies Institute (ETI) Heat Consumer Insights (2015)
[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191541/More_efficient_heating_report_2204.pdf
[7] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/345142/uk_housing_fact_file_2013_tables.xlsx
[8] Seasonal Efficiency of Domestic Boilers in the UK
[9] Came into force in 2006

methodology to assess boiler efficiency[10]. Where this current standard cannot be met a less efficient boiler can be installed provided this is compensated for in other ways. The minimum requirements for oil boilers have been set at a similar level.

14. The market has continued to trend towards more efficient products with most new boilers achieving a SEDBUK 2005 rating of between 90-91%. Many boilers (30%) are achieving a higher SEDBUK 2005 efficiency greater than 91%[11]. However there is still a gap between design performance, which is achieved in laboratory testing, and the in-situ performance, achieved in usage in the home, identified by the EST field trail for gas boilers.

Heating Control market

15. Heating controls are system components that allow a consumer to have greater control when their heating is in operation, for what duration and to a set temperature of the consumer's choice. Basic controls include standard timers and thermostats, while more advanced controls incorporate various forms of use optimisation to improve comfort and/or efficiency. Some controls also differentiate between separate 'zones' so that individual rooms can be provided with a different heating pattern and/or temperature. A second category of controls allow a heating system to operate more efficiently by optimising the operation of the boiler in response to conditions in the environment. The controls can be used with gas boilers as well as low carbon heating technologies such as heat pumps.

16. Table A1 below gives a description of the types of heating control identified in the policy options presented, and Annex 3 provides a more detailed summary. The market is evolving rapidly, so reflects the current functions of controls on the market presently. The more stretching policy proposals have been designed to encourage new innovative products that can combine requirements in single, lower cost products, or exceed the minimum requirements. Many modern 'smart' thermostats already achieve this by combining programmable thermostats, weather compensation, automation and optimisation features. Many also include additional innovative capabilities that exceed requirements, such as learning algorithms or synchronicity with household appliances. The consultation will test the impact and appetite of these policy proposals on further innovation.

Table A1 Heating Controls (Typology)

Control	Description
Central timer	Allows a specific heating pattern to be set on a daily and/or weekly basis.
Room thermostat	Allows householders to set a desired temperature in one room.
Programmable thermostat	Combines the functionalities of both central timers and room thermostats.
Thermostatic Radiator Valves (TRV)	TRVs fitted to radiators throughout the building allow the localised control of temperature in different rooms.
Weather compensation	Adjusts the output of the boiler dependent on the prevailing temperature outside the building. Can be separate to or integral to the boiler.
Time Proportional Integral (TPI)	An electronic room thermostat that controls the output of the heater in order to more accurately maintain the desired temperature.
Automation and	Automation is the function of turning off the heating system when it detects that the building is unoccupied. This is often combined with optimisation which calculates

[10] Came into force in 2010
[11] Based on Heating and Hot Water Industry Council figures

optimisation	the time taken to achieve a desired temperature.

17. Typically consumers will have one or more of the three most common types of heating control: timers, thermostats and thermostatic radiator valves (TRVs), although many homes are still without any independent controls at all. Table A2 below shows their prevalence in the English housing stock in 2011[12].

Table A2 Heating Controls prevalence (English Housing Survey Analysis)

Primary heating controls	Percentages (weighted)	Number of households in thousands (weighted)
Central timer[13]	97%	19,130
Room thermostat	77%	15,065
Thermostatic Radiator Valves (TRV)	66%	13,017
'Full set of controls'[14] (TRV, a central timer, and room thermostat)	49%	9,620

18. The table shows that an overwhelming majority of households have central timers (97%). Two in three (66%) have at least one TRV and just under half of households (49%) have all three (timers, thermostats and thermostatic radiator valves).

19. Based on figures cited in the 2008 TACMA[15] survey, the 2010 Heating and Hot Water Taskforce report suggests that heating controls are most likely to be replaced at the same time as boilers and that consumers tend to install new heating controls when replacing existing boilers, often as a consequence of breakdown or failure[16]. Boilers currently on the market tend to include timers as standard (either as a separate product or integral to the boiler), which explains the extent of their deployment in contrast to other types of heating control.

20. Our evidence base for more advanced heating controls is less developed. It is an emerging market with many new products being advertised and installed over the last few years. This makes it difficult to understand the prevalence and impact of these controls, but the limited evidence we have suggests some of them can deliver higher savings in energy than more traditional controls.

21. It is also important to realise the controls market is one which is rapidly developing with new products and ways of controlling energy use coming onto the market. There is some evidence that householders see these new controls as a fundamentally different proposition to the existing market for controls, with them being marketed more as a lifestyle addition.

22. Low and zero carbon heating technologies that are expected to play an increasing role in the future are more sensitive to the way they are used, with poorly controlled systems

[12] Proportion of households with central heating reporting primary heating controls. Source: EFUS (2011/12); n=2356 weighted and scaled to represent the English housing stock of 19.7 million households with central heating.
[13] *Appendix C – EFUS analyses technical appendix - footnote 3* contains information on the differences in the percentages reporting a central timer.
[14] A 'full set of controls' was calculated by combining the responses to whether households with central heating had a Thermostatic Radiator value, a central timer, and room thermostat as a primary heating control.
[15] The Association of Controls Manufacturers
[16] Energy Efficiency Partnership for Homes (2010). Heating and Hot Water Taskforce - Heating and hot water pathways to 2020: Full report and evidence base.

significantly underperforming. As such, effective control of heating systems is even more imperative for these technologies as poorly controlled systems can result in underperformance both thermally and in efficiency. Driving the uptake of advanced controls now to ensure a period of user engagement will mitigate the potential for under performance, before mass deployment of low/zero carbon systems.

Overview of policies active in this area

23. There are a significant number of policies which act in the heating market which these policy proposals have the potential to interact with. The below list summarises these policies and provides a brief description of how they function:

    a. **Building Regulations 2010** and subsequent amendments (2013) provide the requirement for domestic heating systems to be energy efficient and have effective controls. Specifically, approved Document 'L1B: Conservation of fuel and power in existing dwellings' describes how to meet this requirement through the Domestic Building Services Compliance Guide, which specifies:

        i. The SEDBUK 2009 efficiency for gas boiler replacements should not be less than 88% in most cases (90% in SEDBUK 2005).

        ii. System control should be wired so that if there is no demand for space heating or hot water, the boiler and pump are switched off.

        iii. And where entire heating *systems* are newly installed in existing dwellings (as opposed to replacing the boiler only), each space heating circuit should be provided with an independent time control, and either:

            1. a room thermostat or programmable room thermostat located in a reference room served by the heating circuit, together with individual radiator controls such as thermostatic radiator valves (TRVs) on all radiators outside the reference rooms, or

            2. individual networked radiator controls in each room on the circuit.

    b. **Energy Company Obligation / Affordable Warmth** provides an obligation on energy companies to meet carbon emission reduction and fuel poverty reduction targets. Some of these targets can be met through installing new boilers in fuel poor homes.

    c. **Smart Meters** every household will be provided with a smart meter giving real time information of their gas and electricity use. This is likely to increase householders' engagement with installed heating controls.

    d. **Energy Related Products Directive (EU)** requires the performance boilers, controls and other system components to be labelled using a standard process and metric. Performance must be calculated using a standardised methodology for each identified technology.

Policy Objective

24. The overall objectives of this policy intervention are to **lower fuel bills for consumers** through reduced gas consumption and **reduce carbon emissions from heat in domestic buildings**, contributing towards legally binding carbon budgets. The aim is to do this without necessarily triggering high-cost technology changes for consumers.

25. This is most achievable through higher standards expectations for the prevailing heating technologies currently in use across England: gas and oil-fired central heating systems. Standards may be set that drive enhancements to boilers or additional system components that reduce demand on the boiler for the same amount of useful heat (such as by minimising the amount of time the boiler operates or works more efficiently when it is in operation).

26. Minimum boiler product standards set in 2005 drove the rapid replacement of less efficient boilers with comparatively high performing condensing boilers. After the first year demand drove down the cost of installing condensing boilers to be level with conventional products, and they are now less expensive than the less efficient alternatives which have become a niche market. Approximately 53% of homes in England have a condensing boiler of some type[17]. Alongside minimum requirements, supplementary information is provided in guidance documentation to encourage best practice that is thought to further enhance performance. However, engagement with the heating industry suggests compliance with non-compulsory practices is uncommon.

27. This indicates that significant penetration of new standards in this industry can only be expected if underpinned by regulation. Historically progress in this market has been driven by legislative change, without which uptake is expected to be minimal as trades people seek ways to offer more competitive quotes than their competitors.

28. There are several additional potential benefits that may be achieved depending on policy design:

    a. **Drives fuel bill savings** for consumers through reduced fuel consumption.

    b. **Better consumer engagement with domestic heating**. The policy proposals cause householders to make decisions about their heating system which will increase awareness and understanding of their heat use and energy saving potential.

    c. **Gas and oil boilers are familiar** and trusted by the majority of householders, and do not require fundamental changes to behaviour.

    d. **Consumers are given greater control** over their heat supply, increasing comfort as well as engagement – many households are unable to heat specific rooms to the desired temperature without compromise, e.g. by heating the rest of the property including rooms that are not in use, or making reference rooms hotter than necessary in order to achieve the desired temperature elsewhere. More control also contributes to the longer term objective of encouraging greater consumer engagement with decisions about their heating and the most efficient use.

[17] https://www.gov.uk/government/statistics/english-housing-survey-2014-to-2015-headline-report

e. **Heating measure costs reduction** through increased manufacture production, economies of scale, innovation and competition benefitting the consumer.

Description of options considered

29. The preferred option is to require further action by householders who are replacing or installing a new gas boiler, to improve both the efficiency of the system and its use. Oil boilers are not considered here, though are still in scope. This is because we require further evidence that we will request at the consultation stage.

30. This initial Impact Assessment considers minimum standards underpinned by Building Regulations options which have the following scope:

    a. **Sector:** Domestic households

    b. **Geographical region:** England

    c. **Population:** All households replacing a boiler including privately rented accommodation

    d. **Boiler type:** Gas (mains and LPG)

    e. **Minimum standards introduction date:** April 2017

31. The requirements only apply in England due to the devolved powers in effect outside this population.

32. For the purpose of this Impact Assessment, the Private Rented Sector (PRS) refers to domestic properties which are privately rented where the landlord is a registered business.

33. The proposed policy is designed to help to address the carbon externality and the informational and bounded rationality barriers to the deployment of more efficient heating systems and control systems.

Option 0: Do nothing

34. This option assesses the situation in the absence of further intervention in the heating market and is the baseline which the options below are compared to. In this option the barriers identified above will remain and householders will continue their existing behaviour, preventing the incremental improvement in heating system efficiency and use, which will lead to no further carbon or energy bill savings from this sector.

35. Further details of this counterfactual and the assumptions behind it can be found in Section B.

Rationale for Options considered

36. The rationale for this policy is that further reductions in carbon and energy emissions from additional heating measures (to the boiler) will not occur at pace without intervention. Action here is required to address the carbon budgets targets that the UK is legally obliged to meet as well as improving the scope for innovation in addressing carbon externalities, which consumers do not value and presents as a key market failure.

37. The bounded rationality market failure means that non-regulatory options such as information provision are unlikely to have a significant impact on the deployment of upgraded heating systems. Therefore without regulation, consumers may not be able to control their heat supply in a way that delivers comfort levels in the most efficient way.

38. Other options such as training and installation standards are currently being developed through a call for evidence which will be published alongside this consultation.

39. The previous standards introduced in 2005/2009 demonstrate that regulatory standards are effective in achieving carbon abatement and driving down the cost of more efficient technologies, and therefore we feel that a similar approach can build on this success. It is critical to note that there are diminishing returns in the domestic gas boiler sector and much of the carbon cost effective potential was captured by earlier reforms, these reforms are much more limited in scope and potential.

40. The impact of Building Regulations on carbon emissions reduction in the domestic sector can be seen in the Energy and Emissions Projections (EEP 2015). This drove significant carbon abatement. While much of the abatement potential has been tapped through these measures, they illustrate the effectiveness of regulation in achieving abatement in this area while also improving outcomes for householders.

Structure of new regulatory requirement

41. The consultation sets out a number of options for the regulatory requirement, with varying levels of ambition and costs to business.

42. In all options we will additionally update the minimum boiler efficiency standard to align with the Energy Related Products calculation methodology used by British manufacturers since April 2016. We will also extend the requirement for timers and thermostats to apply to all boiler replacements rather than only new systems, thereby removing the current scope for interpretation in the requirement. This will bring the requirement in line with today's common practice, ensuring that the worse performing gas boilers are removed from the market. We are taking a conservative approach so for the purpose of this Impact Assessment no costs or benefits are associated with this update. Benefits are derived from the further changes summarised in the table below:

Table A3 Options Considered

	Additional action required by the householder	Does this affect the Private Rented Sector (PRS)?
Option 1a: Weather Compensators	Installation of a weather compensator.	Yes
Option 1b: Weather Compensators	As Option 1a	No
Option 2a: Weather Compensators plus additional component (stretch option)	Installation of a weather compensator Installation of an additional component from a list which includes[18]: a. Passive Flue Gas Heat Recovery (FGHR) b. zonal control c. TPI control d. Automated optimisation	Yes
Option 2b: Weather Compensators plus additional component (stretch option)	As option 2a	PRS sector are not required to install an additional component

43. Householders can choose how to comply with the additional requirement in Options 2a (incl. PRS) and 2b (excl. PRS for additional components), meaning more flexibility for householders to choose whichever option works best for their personal circumstances and preferences.

44. The detail as to how these requirements would be implemented can be found in the accompanying consultation. We consider these as our more stretching policy options.

45. The structure of the proposed standards recognises that weather compensators can achieve bill savings and carbon abatement under the right conditions. The impact of measures listed in Option 2a vary significantly in impact from property to property depending on technical and behavioural variables in the household. Impact will be maximised where technologies are chosen with deference for particular circumstances, such as TRVs in households where occupants are most engaged with their heat use. TRVs

[18] More detailed on these technologies and their cost and performance can be found in Annex 3.

would have less impact for consumers who are disengaged with their heating. The consultation will explore ways of encouraging consumers and installers to select the most appropriate technology for each household, should evidence be forthcoming that favours these more stretching options.

Rationale for Private Rented Sector Exemption

46. Options 1b and 2b include a partial opt out for the Private Rented Sector (PRS), to reduce the regulatory burden on businesses. Allowing this sector to opt out of requirements makes proposals more affordable, with a corresponding decrease in carbon savings and energy bill savings for tenants.

47. We are consulting on this option because we want to understand what the impact could be on this sector.

Non Regulatory Option: Action of system design and quality

48. Field trials conducted by the Energy Savings Trust found the average in-situ performance of a condensing boiler to be 84.5%, significantly below the manufacturers' laboratory testing.[19] In-situ performance is the efficiency achieved when a boiler is installed and operating in the home environment. It differs from the design performance which is achieved under set laboratory or "ideal" conditions and is advertised on boiler labels and packaging.

49. In-situ performance is affected primarily because the whole system is not balanced properly when installed, but also by uneven heating throughout the property, debris within the system that can affect the flow and transmission of heat throughout the system, and the temperature of the system which is often too high to permit the boiler to condense.

50. We are minded to explore a range of measures that may improve the in-situ performance and help close the gap between performance under test conditions and performance in real circumstances. These measures include a range of technological solutions and practices that might be undertaken by registered competent installers, including:

    a. Hydraulic balancing to ensure radiators heat up at a similar rate, and reduce the risk of under- and over-heating;

    b. Reducing system return temperature to a maximum of 55 degrees Celsius to ensure the boiler operates in condensing mode;

    c. Correctly sizing radiators to match the thermal demand of the property;

    d. Magnetic filtration to extract debris from within the system;

    e. Use of chemical enhancement to remove or prevent build-up of debris, improve the fluidity of the system for better heat exchange, or treat limescale in hard water areas that may inhibit the efficiency of the heat exchanger.

51. Some of these measures may be deliverable through the regulatory framework, while others might be better implemented in the longer term through broader enabling activities that

[19] EST Field Trial: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/180950/In-situ_monitoring_of_condensing_boilers_final_report.pdf

target installation practices. Deliverability depends in part on the willingness and skillset of heating engineers, as well as possible changes to the enforcement framework.

52. As part of this consultation we are issuing a Call for Evidence to build on our understanding of these and other measures that might improve the performance of domestic heating systems, with a view to assessing these options subsequently.

Section B

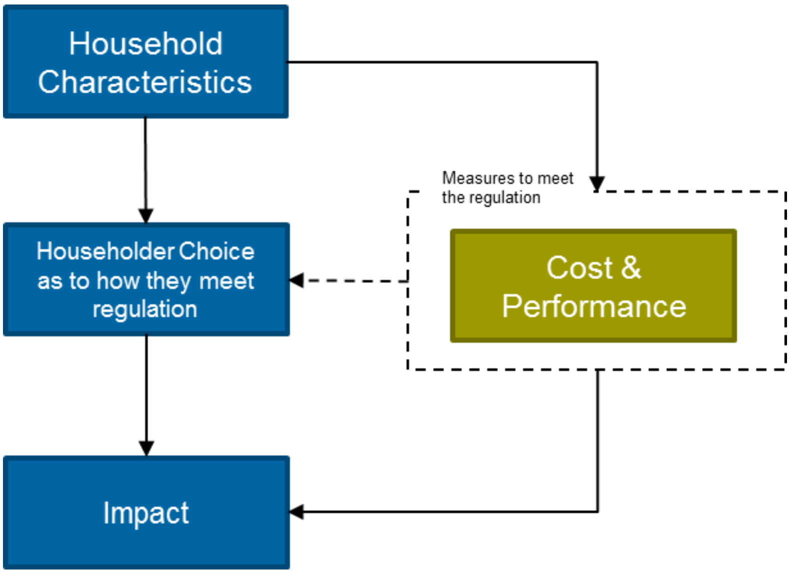
Evidence and Uncertainty

53. The evidence collected to support this initial IA has been acquired from a wide range of sources spanning industry, academic papers, field trials and consumer surveys.

54. The sources have been considered alongside one another to construct our assumptions (detailed in annex 3). There is however significant uncertainty around many of the assumptions which lie behind this assessment. The consultation and research undertaken in parallel will be used to help clarify the evidence base and get further expert view on the best evidence to use.

55. The below diagram illustrates the main categories of evidence we have considered and the relative strength and sources of evidence in each area.

Diagram B1: Simplified structure of evidence



56. The three main categories of evidence we consider:

   a. **Household Characteristics:** The technical characteristics of the building and behavioural characteristics of the household have a significant influence on the impact of the proposed requirements. This is because these dictate the choices a household might make in complying with the regulations and the cost and performance of measures which they mandate.

   Generally we have good evidence from the English Housing Survey on the technical characteristics of households, but poorer information of the behavioural characteristics which dictates choice and decision making.

b. **Cost and Performance of measures:** the new requirements will mandate the installation of two types of measures:

   i. Technical measures which do not require consumer interaction to deliver carbon reductions;

   ii. Devices which allow householders to control their heat usage.

   Through technical studies we have some evidence for the costs and performance of the technical measures; however the benefits of many of these measures depends on building form and fabric, heating and hot water use patterns and the quality of installation and we have limited understanding of the impact of these factors at a societal level. Some heating controls are dependent on consumers interacting with them, which have significant degrees of uncertainty.[20]

c. Choice: these minimum standards allow consumers to make a choice as to what technologies are installed under Options 2a (incl. PRS) and 2b (excl. PRS for additional components). At this time we have no evidence as to how householders might choose, although in the consultation we will explore ways of encouraging consumers and installers to select the most appropriate technology for each household should we consider taking up these more stretching policy options.

57. The approach we take in this Impact Assessment to deal with these uncertainties is twofold:

   a. **Threshold & what if Analysis:** We assess the costs and benefits of this regulatory change in several ways, one of which is to look at what the energy use reduction from controls might have to be in order to achieve a payback in five and ten years or achieve a positive Net Present Value.

   This approach will assist with good policy design over the consultation period and after, as it allows policy makers to assess what further work they might wish to do to mitigate some of the risks associated with this policy. For example review points or whether additional information provision might be necessary.

   b. **Ranges:** The current evidence base for the impact of many of these measures is very disparate, giving us wide ranges of possibility. This is due to the extensive list of technical and behavioural variables that affect the impact of each technology.

Plan for improving the evidence base

58. The consultation aims to resolve some significant uncertainties. The consultation will help clarify the installed costs and impacts of many of the relevant technologies, particularly those listed in Options 2a (incl. PRS) and 2b (excl. PRS for additional components). We anticipate respondents to the consultation may share some of their own evidence and analysis.

59. We particularly anticipate consultation responses on the scope and costs for technical measures discussed in this impact assessment. We will rely on these to make a more informed decision with respect to the stretching policy options and it will also be key to our understanding of costs to business.

[20] Through consultation we will explore ways of increasing awareness of heating controls and their proper use.

60. While the evidence base for some of the impact analysis may improve over the consultation period, there are significant uncertainties which will remain. This is particularly true for enabling measures which rely on consumer interaction and those where the installed performance is dependent on multiple influencing variables.

61. We will need to keep the impact of the requirement under review and consider what further action (for example information) may be desirable to maximise the impact of these measures.

62. Annex 3 sets out the evidence base as we understand it and we welcome further evidence to help us develop our costs and performance assessments as well as appetite for the more stretching policy options.

Analytical Approach

Scope of modelling

63. The aim of the modelling is to assess the impact of these proposals on consumers, the Private Rented Sector (PRS) and society through financial impacts and carbon abatement. In the face of uncertainty of the underlying assumptions it also seeks to consider what performance would be required for consumer cost-effectiveness.

64. The requirement only applies to England due to the devolved powers in effect outside this population.

65. At this stage analysis covers natural gas wet heating systems only; however the consultation seeks to keep oil in scope and asks for further evidence about what action might be appropriate in the oil sector. The vast majority of consumers affected are on-grid natural gas customers, and we therefore only consider this market in this Impact Assessment. The oil boiler replacement sector represents approximately 50 to 60 thousand replacements per year, compared to 1.2m in the gas boiler sector in England.

Modelling approach

66. The impacts have been appraised according to Green Book[21] and supplementary guidance[22] principles and are presented in discounted real 2015 prices, against a counterfactual of no change to minimum requirements. In addition this Impact Assessment considers detailed threshold, what if and sensitivity analysis because of the inherent uncertainties in the impacts of these measures.

67. The modelling process looks at the household level effect of measures installed, for example the impact of installing weather compensation on the costs and performance associated with household heating. This is then aggregated to a societal level.

68. At this stage and given the evidence base we have available on the impact of measures and how variation in household characteristics affected the offer to consumers, we use an average household for most technologies, and vary the hot water demand for FGHR given the significant interdependency for this technology.

69. This approach also allows a segmentation of the costs and benefits by householder choice; this is particularly useful when considering the relative uncertainties around the impacts of different options for meeting the regulatory requirements.

70. This simple approach is proportionate for this stage of policy development. We will seek to add complexity to this approach by the final stage Impact Assessment as the options under consideration are filtered down and the evidence base for some of the technologies becomes clearer.

71. Installations of the heating controls are active for 15 years from the policy start year of 2017. This covers one replacement cycle of the English household stock. Given the lifetime of these controls is approximately 15 years from installation date, the benefits are continued to be collected for a further period of 15 years. Therefore the cost benefit analysis is conducted over a 30 year period.

[21] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf
[22] https://www.gov.uk/government/publications/2010-to-2015-government-policy-energy-and-climate-change-evidence-and-analysis/2010-to-2015-government-policy-energy-and-climate-change-evidence-and-analysis#appendix-2-policy-appraisal

72. It is assumed that there are sufficient means to deliver this policy in terms of technical ability of boilers, ability of manufacturers to produce the required boiler demand, skills basis for installers to install the boilers and other components such as heating controls.

73. The evidence base for zonal controls is strongest for thermostatic radiators valves (TRVs), therefore in this analysis we will assume that households can meet the regulatory requirements for zonal controls through using TRVs in the stretch options.

74. The evidence base for automated optimisation is limited and the definition is wide, though BEIS has some evidence on learning thermostats from market intelligence sources. In the stretch options, we therefore assume that households can meet the regulatory requirements for automated optimisation through the use of learning thermostats.

75. The impacts of Time Proportional Integral (TPI) are particularly uncertain with the independent evidence we have available based on in-situ measurements demonstrating no statistically significant impact on energy demand. However, manufacturers and engineers claim that TPI control can yield reduced average flow temperatures and boiler gas consumption, whilst also enabling increased boiler condensing mode operation and enhancing system efficiency. While it is an eligible measure it is unclear whether TPI controls save energy in practice, and we do not consider it as an option in the cost benefit analysis because of this. The consultation attempts to get further information on this measure and whether there are benefits we are not fully considering from this technology.

Technology characteristics

76. This section provides a summary of the range of cost and impact of the performance of the measures which could be used by householders to meet the requirements of this regulation. Further details can be found at Annex 3.

Table B1 Measure Impact and Cost Range Summary

	Impact	*Cost*
Weather Compensators	0% - 2.2% Reduction in heat demand Central: 1.1% reduction	£40-£115 Central: £80
TRVs	0% - 6% reduction in heat demand Central: 3% reduction	Variable depending on household size, £280 - £420 Central: £350
FGHR	Dependent on hot water demand	£460 in year 1, reducing to £200 with mass production in year 2
Learning Thermostats	4% reduction in heat demand, including 1.1% impact of weather compensators	£210, including integrated weather compensator

77. The lower bound for many of these measures is zero impact. This can occur if these measures were systematically installed and set up poorly, or in some cases if householders do not use them effectively. In an extreme scenario, some of these measures might increase householder energy demand. For example if weather compensators are set up so

that the heating period in a house is increased then energy consumption could increase accordingly.

78. In low impact cases the carbon emission abatement delivered by these measures would be zero. It is possible that some of these measures would still deliver some benefits to householders, by increasing the level of comfort a householder experiences, or providing health benefits, however these are not the primary objectives of this policy intervention.

79. We will use the consultation to help to understand how we can mitigate the low impact risk through good policy design.

Measure overlap

80. It is typical for automated optimisation such as learning thermostats to have weather compensators built into them. As such the costs and benefits associated with learning thermostats used in this analysis are marginal costs (i.e. a learning thermostat could cost approximately £210 and a weather compensator on its own £80. The marginal cost of the learning thermostat is therefore £130).

Counterfactual

82. With no further action in the minimum standards for the domestic heating market we would expect the following:

   a. **Number of installations:** The number of boiler replacements is influenced by a number of factors, such as economic conditions, technical condition of the boiler stock etc. We would anticipate that the number of gas boiler replacements would continue following existing market trends.

      We anticipate that there will be approximately 1.2m boiler replacements per year in both the counterfactual and policy scenarios

   b. **Boiler choice:** households would continue to install boilers with an average design efficiency of 90.5% (the current market average), which is above the mandated minimum of 90%. Based on SEDBUK 2005.

      We do not anticipate changes in the installed boiler efficiency in the absence of further requirements underpinned by regulation, as there is no commercial motivation for manufacturers to develop boilers beyond current levels. Competition in the boiler market is not thought to be largely affected by the performance of products.

      We anticipate that householders will continue their existing behaviour and install boilers with a design performance of 90.5% (in-situ performance of 84.5%).

   c. **Heating control choice:** at the point of boiler replacement we would anticipate the continued installation of timers and thermostats in all households and Thermostatic Radiator Values at similar levels to that suggested by the English Housing Survey and industry sales data.

      Our evidence suggests that 66% of households already have at least one TRV. However we have little evidence on what the installation rate of TRVs is as a proportion of the total boilers installed. As this number is uncertain, we will assume that TRVs are installed alongside 50%[23] of new and replacement boiler installations in the central scenario.

      While more sophisticated heating controls are moving into the market, we do not anticipate that they will reach a mass market at boiler replacement stage at this point. Consumer panel findings in Annex 2[24] show that over half of consumers are not currently willing to pay an additional cost for a learning thermostat (a type of more sophisticated heating controls) and few would pay more than £150. This shows that consumers are not aware of the benefits that these controls can provide. These controls therefore are not widely taken up. In addition, the findings show that consumers would not be willing to pay for additional advisory services[25].

[23] The evidence base for the number of new TRVs installed is uncertain. It is mainly based on the stock of TRVs currently in English homes and not the flow of TRVs installed currently. The English Housing Survey identifies that 66% of homes have TRVs. Our qualitative assessment is that the likely installation rate in existing buildings is lower because of requirements for TRVs for new builds etc which skew the stock average.

[24] Chart in section 1.6 Willingness to pay for learning thermostats

[25] Chart in section 3.2 Willingness to pay for additional boiler services

In the medium to long term an increased uptake of so-called ‘smart’ controls is possible given the extensive marketing that has been invested by leading manufacturers[26], though at this point we have little evidence in this area. ‘Smart’ controls are very diverse in their functionality, and while we would welcome increased deployment of some varieties which would benefit the intention of this policy, we might expect the market for less beneficial varieties to grow at the same rate. This is as all varieties would benefit from the marketing approach currently taken by manufacturers.

We would welcome future projections from consultation respondents on how the future market for controls may evolve, so we can update our counterfactual at final Impact Assessment stage.

83. There are other policies operating in the home heating market which may influence some of these assumptions. These are summarised on page 10.

[26] Such as Nest and Hive systems

Key Costs and Benefits

Summary of costs and benefits

84. This section summarises the key additional costs and benefits of the regulatory options considered and where they are expected to accrue.

85. The costs and benefits categories will be the same for the different options, however the level of costs and benefits associated with each option will vary significantly.

Table B2 Costs and benefits

Affected Group		Costs	Benefits
Society as a whole		Additional upfront capital costs	Net Energy savings Carbon Savings Air Quality
Owner Occupiers		Additional upfront capital costs Other costs	Net Bill savings
Private Rented Sector	Landlords	Additional upfront capital costs Compliance costs	Non monetised benefits from tenants
	Tenants	Passed on costs from landlords	Net Bill savings
Supply Chain	Manufacturers	Costs of producing products	Increased sales
	Installers	Costs of retraining	

Costs

86. The key costs identified in table B2 are examined in detail below:

    a. **Additional upfront Costs –** these costs are defined as the total additional upfront costs of the purchase and installation of measures to comply with the regulation (excluding VAT), compared to the current regulatory requirements.

       These vary significantly from measure to measure and are detailed in Annex 3.

    b. **Other costs –** some of the measures under consideration may have associated costs, for example, depending on the specification of the opt-outs, the installation of boilers with a FGHR system may require additional space compared to current gas boilers. At this stage we do not quantify this for lack of evidence for both products available and the cost of this additional space.

    c. **Compliance Costs –** all householders and landlords will face a compliance cost for any regulatory burden. The regulatory set-up proposed builds on the current regulatory requirements, so should not impose any additional burden. This therefore is not monetised in this assessment. We will consider feedback from the consultation if stakeholders feel that these costs are significant.

    d. **Passed on costs from landlords –** we might expect that additional costs faced by landlords will be passed on to tenants. This is a transfer and an indirect benefit to business.

e. **Costs of producing or re-testing products –** if new products were needed to meet the minimum standard then we could expect there to be additional costs to manufacturers.

Benefits

87. The key benefits identified in table B2 are examined in detail below:

a. **Net energy savings** Installation of the measures set out in this IA reduces the resources needed to meet demand. This has been monetised in accordance with Green Book supplementary guidance on 'valuing energy use and GHG emissions'. Energy savings mean fewer resources are required to meet energy service demand, which is a benefit to society. This is valued using the long-run variable cost of energy supply.

b. **Air quality improvements and carbon savings.** Improvements in energy efficiency reduce the amount of energy that needs to be used. This reduction improves air quality and reduces carbon emissions. The benefits have been calculated in accordance with Green Book supplementary guidance.

c. **Net Bill savings –** the reduction in energy use for the same level of comfort will result in lower energy bills for householders. This is not included in the societal analysis, however is a key element of the policy as it illustrates the benefit householders accrue for the investment.

   This is distinct from energy savings as the bill savings experienced by consumers include elements of profit etc. which is a transfer rather than benefit to society.

d. This analysis will look at two key metrics to simply address this: firstly the first year bill savings, and secondly a simple payback on upfront costs analysis.

Impact Appraisal – Societal Cost Benefit Analysis

88. The minimum standards proposed in this consultation will promote the installation of better performing boilers and heating controls. However as noted in the Evidence section of this IA there is significant uncertainty surrounding the impact of these measures on actual energy demand and so the benefits outlined in this Impact Assessment.

89. The analysis conducted therefore looks at three types of analysis:

    a. Central assessment for appraisal purposes

    b. Threshold analysis for particular technologies

    c. Sensitivity analysis.

Central Assessment for appraisal purposes

90. The impacts of this change are best considered in two parts:

    a. Impact of mandatory elements: this is the impact of measures which are compulsory for all households (e.g. weather compensation)

    b. Impact of measures where a householder has choice of how to comply (stretch option)

91. This approach allows the identification of the policy costs and benefits which are most certain (mandatory elements, with a greater evidence base) and those which are less certain, (element involving consumer choice both in how they meet the regulatory requirements, and then how they use the systems).

92. In Options 2a (incl. PRS) and 2b (excl. PRS for additional components), householders have a choice of how to comply with the regulatory requirement. This means they can choose the best option for their own personal circumstances.

93. At this point we do not know how householders will choose to comply. For appraisal purposes we therefore illustrate the “solution space” or the extreme position of all householders making the same choice. For example all householders choosing to install TRVs, or all households choosing learning thermostats.

94. For the appraisal sheets at the front of this Impact Assessment and Table B3 we assume that householders choose the lowest upfront cost option: Learning Thermostats.

95. The red shaded cells in Table B3 show a cost to society; the green cells show a benefit. Where consumers have a choice of additional heating measure, the cells are shaded grey.

96. Our lead option of Option 1a (incl. PRS) has been indicated in the table.

Table B3 Cost Benefit analysis (2017 to 2047, Discounted at Government rate £2015m)[27]

		Additional Upfront Costs	Monetised Energy Savings	Air Quality Savings	Monetised Carbon savings	Net Present Value (NPV)
Option 1: Weather Compensators only						
Option 1a: including PRS (Lead Option)		-£1,144	£592	£11	£437	**- £104**
Option 1b: PRS exemption		-£927	£479	£9	£354	**-£84**
Option 2 (stretch option): Weather Compensators and additional measures[28]						
Option 2a: including PRS	**Weather Compensators**	-£1,144	£592	£11	£437	**-£104**
	FGHR	*-£1,269*	*£721*	*£14*	*£533*	***-£1***
	Learning Thermostats	*-£744*	*£617*	*£12*	*£456*	***+£341***
	TRVs	*-£2,003*	*£639*	*£12*	*£472*	***-£880***
	Total Range *(Weather Compensators and measure)*	-£1,888 to -£3,147	£1,209 to £1,313	£23 to £25	£894 to £970	**-£984 (TRVs) to +£237m (Learning Thermostat)**
Option 2b: PRS exemption for additional measures only	**Weather Compensators**	-£1,144	£592	£11	£437	**- £104**
	FGHR	-£1,028	£584	£11	£432	**-£1**
	Learning Thermostats	-£603	£500	£9	£370	**+£276**
	TRVs	-£1,622	£517	£10	£382	**-£713**
	Range *(Weather Compensators and measure)*	-£1,747 to -£2,767	£1092 to £1,176	£20 to £22	£807 to £869	**-£817 (TRVs) to +£172 (Learning Thermostat)**

97. The table illustrates that there is significant variation in the NPV of the policy depending on the policy option chosen. As highlighted in the earlier evidence section, there is considerable uncertainty around the impact particularly of the various heating controls and their attributed costs. Therefore this assessment should be considered with the sensitivity and threshold analysis presented in this Impact Assessment. We are looking to add greater certainty to these estimates through consultation responses and evidence provided.

98. The results show that weather compensators alone do not make for cost effective policy options as demonstrated by the negative NPV values of -£104m for Option 1a and -£84m for Option 1b. This is due to the high upfront costs that consumers face, which outweigh the benefits of monetised energy savings, air quality and monetised carbon which rely on high energy demand reduction. The exclusion of PRS landlords in Option 1b does produce a less negative NPV however due to the reduced number of households in scope.

99. When considering the stretch options, 2a (incl. PRS) and 2b (excl. PRS for additional components), the additional heating measures have different net values. Whilst learning thermostats alone are cost effective (+£341m for Option 2a and +£276m for Option 2b),

[27] As outlined in the Green Book, societal costs and benefits are discounted at a rate of 3.5%: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

[28] Householders have a choice about how to comply with the regulation. This analysis looks at the costs and benefits if all households made the same choice. Some householders will find it much more cost effective to use TRVs for example than learning thermostats, depending on their behaviour and house type.

TRVs are not (-£880m for Option 2a and -£713 Option 2b). FGHR systems by themselves are only just cost ineffective (-£1m for both Options 2a and 2b).

100. Therefore, when layered onto the negative NPV for weather compensators, there is a range of NPV outcomes, most of which produce a negative NPV. The exceptions are where households install weather compensators and opt for the least cost additional heating control of a learning thermostat. This produces a positive NPV of +£237m in Option 2a and +£172m in Option 2b. In these cases the benefits of the learning thermostat offset its own costs and also that of the weather compensator.

101. Energy bill savings (+£617m in Option 2a and +£500m in Option 2b) make up a large proportion of the benefit and can be appreciated directly by the consumer. Monetised carbon savings (+£456m in Option 2a and +£370m in Option 2b) also provides a large valuation in benefit.

102. Another drawback is that through discounting there is a greater weighting of upfront costs borne only in the first half of the modelling period (15 years). This has a significant effect on the NPV as the costs offset the benefits which are spread over the full period covered by the modelling (30 years). Benefits accrued in the second half of the modelling period are valued less as the discounting factor increases.

103. The figures presented in Table B3 are sensitive to our cost assumptions which have a considerable degree of uncertainty. This is in relation to the unit cost of the heating controls and the degree and rate of price reduction over time.

104. For all heating controls other than FGHR, price remains static over the modelling period. However, in reality we might expect these to reduce as a result of higher demands for the products from the policy and from innovation in the boiler manufacturing sector, for example installing weather compensation directly within the boiler unit. We are seeking further evidence on this matter through consultation.

105. Cost reduction profiles will certainly have a positive effect on the NPV. In some cases, this may be enough to change the sign of the NPV (from negative to positive) and also the order of attractiveness of the options when compared.

106. NPV valuation may also be altered as a result of changes to performance of the heating controls, where carbon savings are monetized, and gas and carbon prices. The impacts of these are considered in the sensitivity analysis.

107. In addition to the societal costs and benefits, it is important to consider two other metrics which play a key role in the determination of the policy, the achievable carbon savings and the proposition to the consumer. These are summarised below.

B4 Carbon savings in CB4 of the policy (MtCO_2e)

	Carbon Savings in CB4			Carbon Savings in CB5
	Weather Compensators	Other Measures	Total	Total
Option 1: Weather Compensators				
Option 1a (incl. PRS)	1.4	-	**1.4**	**2.2**
Option 1b (excl. PRS)	1.2	-	**1.2**	**1.8**
Option 2 (stretch option): Weather Compensators and additional measures				
Option 2a (incl. PRS)	1.4	1.5 – 1.7	**2.9 – 3.1**	**4.5 – 5.2**
Option 2b (excl. PRS for additional components)	1.4	1.2 – 1.4	**2.6-2.8**	**4 – 4.2**

108. All savings from this policy would be in the non-traded sector as all domestic gas use is counted in this sector.

109. The ranges in Option 2a (incl. PRS) and 2b (excl. PRS for additional components) relate to carbon savings from the different component measures under central assumptions of performance. Carbon savings are greater when the policy design includes an additional heating component i.e. in Options 2a and 2b. The cheapest option, learning thermostats, gives the lowest carbon savings; the most expensive option, FGHR, gives the highest carbon saving.

110. In the case of the learning thermostat, the carbon savings rely on consumer interaction to achieve the desired performance. Where measures have a behavioural element, we are less certain, meaning savings could be much lower or indeed, much higher. The level of sophistication of the weather compensator may also make a difference to the savings. If manufacturers were to build in weather compensators, reducing installation issues, the carbon savings potential could rise.

111. FGHR on the other hand is a boiler component and does not need consumers to engage for carbon savings to be achieved. However, if installed in a household with low hot water heating demand, the carbon savings would be low. We would expect the installer to aid the household in selecting the most appropriate option for them though we have little evidence on household water demand.

112. For Option 2a (incl. PRS), relative to Options 1a (incl. PRS) and 1b (incl. PRS), the carbon savings double in CB4 even with the lowest performing additional measure (learning thermostats) and installation in fewer households than weather compensators (our assumption for this element of the policy). This reflects the combination of price, measure performance and number of households in scope to benefit from the policy options.

113. Carbon savings are also higher when PRS landlords are included in the policy design given the greater number of households in scope making the energy demand reduction changes.

114. The benefits over both CB4 and CB5 contribute to the intended rationale of this proposed regulation through carbon abatement. Savings in CB5 period (2028 – 2032) are much higher than CB4 as the number of installations of the measures continues in this period. This means benefits accumulate not only from installations in the CB4 period but also from those in CB5.

115. The savings quoted here are highly dependent on the performance of the measures and are highly uncertain due to aspects including lack of evidence available, differing behaviour by and circumstances for households. We therefore seek to consider performance in the sensitivity and threshold analyses. To test our assumptions we will also make a call for evidence with respect to these technologies.

Offer to the consumer

116. We consider the consumer offer in a deliberately simple way, this is based on three key metrics: firstly the average cost of compliance, then the average energy bill savings

achievable in the first year of operation and finally, the implied payback period. This, taken together, gives an impression of how the offer to consumers would change.

117. BEIS realises that the offer to consumers will vary significantly depending on the household type and heating behaviour. For example a FGHR system will provide significant benefits to those who use a lot of hot water[29], or TRVs may provide particular benefit to those who are engaged with their heating systems.

Table B5 Offer to the consumer

		Offer to the consumer		
		Additional Upfront Costs[30] (£ 2015)	Bill savings in 2017 (£ 2015)	Payback period (years)
Option 1: Weather Compensators				
Option 1a (incl. PRS) and 1b (excl. PRS)		£80	£6	13
Option 2: Weather Compensators and additional measures				
Option 2a (incl. PRS) and 2b (excl. PRS for additional components)	**Weather Compensators**	£80	£6	13
	FGHR	Year 1: £460 Year 2 onward: £200	£18	At year 1 cost: 21 (Unlikely to payback initially) At year 2 cost: 9
	Learning Thermostats	£130	£16	8
	TRVs	£350	£16	22 (Unlikely to payback)
	Range *(Weather Compensators and measure)*	£210 (Learning Thermostats) - £540 (TRVs)	£22 (Learning Thermostats, TRVs) - £24 (FGHR)	13 (Learning Thermostats) – 22 (TRVs)

118. The results show that while most of the ways of complying with these requirements have low upfront costs (under £500) they also offer small bill savings. The small savings are directly related to the performance of the measures.

119. The implication of this is that payback periods are mostly long (over 10 years) and sometimes longer than the performance lifetime of the measure itself (approximately 15 years). Though there is likely to be significant variation around this broad average.

120. The high payback period is inferred from our current evidence base which suggests that householders installing controls is not enough to achieve significant bill savings. They have to choose to use them. Choosing to use them can be incentivised by policy design and/or installer action. The threshold analysis section of this impacts section details the change in behaviour which would be required in order to achieve a shorter payback period or a net zero NPV.

121. We conducted some consumer research to understand consumer reactions to these types of measures and what they might be willing to pay. More information about the consumer survey results can be found in Annex 2.

[29] Such as properties with high occupancy which might demand more water for washing than a comparable property with fewer occupants. Or a highly efficient property with a relatively low space heating demand, where the ratio of hot water to space heating is higher than average.
[30] These costs exclude VAT

Threshold Analysis

122. Given the uncertainties in the evidence base, we have conducted a threshold analysis to illustrate "what you have to believe" to generate various payback periods and cost to society from the energy savings products under consideration in this Impact Assessment.

123. This analysis is most appropriate to consider for control systems such as TRVs or weather compensation, where there is significant uncertainty about the costs and impact and both of these variables can be affected by policy design, for example experience for installing these systems may increase installation or set-up quality which could result in small but significant changes to upfront costs and performance.

124. The two tables below consider the performance and cost changes required to achieve a certain simple payback period and a zero NPV, considering the requirements at both the consumer and societal level.

Table B6 Threshold analysis - Performance

Technology	Assumptions used in modelling		Performance required to achieve:		
	Measure performance	Measure cost	A payback within 5 years	A payback within 10 years	A zero NPV
Weather compensation	1.1% (0% - 2.2%)	£80	3.5%	1.8%	1.2%
TRVs	3% (0 – 6%)	£350	15.5%	7.7%	5.4%
Learning Thermostats	2.9% (no range)	£130	5.8%	2.9%	2.0%
FGHR	3.1% (weighted average) (2.0 – 4.9%)	£460	20.3%	10.2%	3.1% (weighted average)

Table B7 Threshold analysis - Costs

Technology	Assumptions used in modelling		Retail cost required to achieve:		
	Measure cost	Measure performance	A payback within 5 years	A payback within 10 years	A zero NPV
Weather compensation	£80 (£40 – £115)	1.1%	£25	£50	£72
TRVs	£350 (£280 - £420)	3%	£68	£136	£196
Learning Thermostats	£130 (£120 - £140)	2.9%	£66	£131	£190
FGHR	£460 (no range) £200 in year 2	3.1% (weighted average)	£70	£140	£460 £200 in year 2

<u>Weather compensators</u>

125. Small changes to the cost and/or performance of weather compensators have a large impact on the payback and NPV of this policy, as they are relatively low cost, small impact, but high volume products under this policy.

126. If weather compensators cause a 1.2% change in heat demand instead of 1.1% (0% to 2.2% range), the policy proposed would have a zero NPV. There are significant

uncertainties for the performance of weather compensators (detailed in Annex 3). Higher impacts are possible in cases where installers are engaged with the customer, providing advice on how to use these systems effectively and set them up correctly. While this is not our central assessment given lack of evidence, it is plausible that mass deployment may increase set-up quality in this area, leading to increased performance and a positive impact on the NPV.

127. The upfront costs of weather compensators will depend on the extent to which they are integrated into boilers and controls and how sophisticated the weather compensating systems are. The central £80 upfront cost assessment assumes system integration does not happen and is based on a mid-range product. A cost of £72 (for a zero NPV) or even lower is plausibly achieved through products being integrated into the boiler, or simply installers choosing the cheapest product on the market (the lower bound estimate of £40 is based on a basic weather compensator product available on the market currently).

TRVs

128. The achievable savings from TRVs depends on how consumers use and interact with them and this will vary significantly from house to house. Average savings of the level required to achieve rapid paybacks (illustrated in Table B6) are unlikely, however guidance on how best to use TRVs may result in them being installed into households where the impact can be greater. For example if householders have un-occupied rooms which are currently being heated such as a spare bedroom.

129. The installation of TRVs in households where they could have greatest impact could mean that the average impact is greater than the central estimate we use in this analysis.

130. With TRVs being already prevalent within households, the retail price of each valve may not decrease over time. The time taken to install the TRVs, which is also included in this cost, may not decrease either as it is assumed that most installers are skilled in this, however by installing them at the same time as replacing a boiler means that some of the fixed costs of call out will be already being paid. This is unlikely to reduce the costs by £150 (to achieve a zero NPV), but could reduce costs somewhat.

Learning Thermostats

131. Learning thermostats and automated optimisation is a technology area which is developing quickly, with new products being introduced with new ways to help people control their energy use. Under our current central assumptions they offer a marginal payback in about 10 years, further developments in this rapidly changing sector and the application of smart functions offers the opportunity to increase the impact on household heat demand and possibly to reduce costs through mass deployment. This is a particularly uncertain area.

FGHR

Given FGHR is only just cost ineffective at societal level (-£1m NPV), when rounded and averaged (over different household water demands), the performance required for a zero NPV is the same as the modelled performance (3.1%).

Sensitivity Analysis

132. There is a significant degree of uncertainty in many of the assumptions used in this appraisal. This section therefore looks to illustrate the sensitivity of the key assumptions on carbon savings and NPV to changes to some of the more sensitive assumptions.

133. The following sensitivities have been conducted on Option 2b (excl. PRS for additional components) for illustrative purposes, with consumers installing weather compensators and choosing learning thermostats to meet the user selected option. Learning thermostats have been chosen as they are the cheapest cost to compliance in this more stretching policy proposal. These are standalone sensitivities where variations are made from the central assessment.

a. **S1: Changing weather compensator impacts –** The analysis presented in this Impact Assessment assumes a 50% in-use factor in order to represent the gap between modelled performance and actual performance. In reality this gap may be substantially less or substantially greater. We therefore test the results assuming a 0% and 100% in-use factors for high and low scenarios respectively.

b. **S2: Costs of a weather compensator –** If weather compensators were deployed in a mass market situation, boiler manufacturers may choose to incorporate this into boiler design, therefore reducing costs significantly. In order to test this we look at a sensitivity to assess the cost and performance if costs faced are at the low end of the range. This low end is the cheapest product on the market from our cost review. We also test the high end of the cost range for comparison.

c. **S3: Carbon valuation –** the value of carbon is highly uncertain, we therefore conduct two sensitivities for high and low carbon prices to illustrate how this influences the NPV.

d. **S4: Energy prices –** energy prices (both faced by the consumer and the Long Run Variable Cost of Energy used for assessing the NPV of the policy) are highly variable. We therefore conduct a sensitivity on this variable. We assume that energy prices do not affect the demand, or how households may choose to meet this requirement and test with projected low and high gas prices.

Table B8 sensitivity analysis compared to Option 2b (excl. PRS for additional components) – Weather Compensator and Learning Thermostat for owner occupiers

	Carbon Savings in CB4 ($MtCO_2e$)	**Net Present Value (£2015m discounted to 2017)**
Option 2b: Central Assessment (Weather compensator for all households and Learning Thermostat for owner occupiers and social landlords)	**2.6**	**£172 (Costs: £1,747) (Benefits: £1,919)**
S1: Weather compensator impacts	1.7 – 3.6	-£521 to £873
S2: Weather compensator costs (Used for low/high on summary page)	2.6	High cost: -£166 *(Costs: £2,085)* *(Benefits: £1,919)*
		Low cost: £559 *(Costs: £1,360)* *(Benefits: £1,919)*
S3: Carbon Valuation	2.6	-£231 to £576
S4: Energy Prices	2.6	-£197 to £632

134. The table shows that there is large variation in carbon abatement potential and NPV when we vary our input assumptions. As expected, carbon savings are impacted by

changes in the performance of the measures, NPV by prices (gas and measures) and carbon valuation by the measure cost only.

135. Changing the performance of the weather compensator (S1) has a significant effect on cost effectiveness and carbon saved.

Conclusions

136. The results of the societal impact appraisal section show that each of the proposed regulation options has its own strengths and weaknesses when considering NPV, carbon and bill saving and cost to the consumer/business. It discusses the highly uncertain evidence base and how small and plausible changes in key assumptions have a significant impact on the metrics such as NPV. Additional evidence provided through the consultation will help resolve some of these uncertainties and could provide more evidence for the costs associated with these technologies.

137. Summarising the results from this section in Table B9 however, we consider Option 1a as the lead option given technical, delivery and cost constraints.

Table B9 Summary of Societal Impact Appraisal

	NPV	CB4 Carbon Saving	Additional Upfront Cost
Option 1a: Weather Compensators (Lead Option)	-£104m	1.4 $MtCO_2e$	All: £80
Option 1b: Weather Compensators (PRS exemption)	-£84m	1.2 $MtCO_2e$	Owner Occupiers and Social Landlords: £80 PRS Sector: £0
Option 2a: Weather Compensators and Learning Thermostats	+£237m	2.9 $MtCO_2e$	All: £210
Option 2b: Weather Compensators and Learning Thermostats (PRS exemption for additional measure)	+£172m	2.6 $MtCO_2e$	Owner Occupiers and Social Landlords: £210 PRS Sector: £80

138. The primary objective of the policy is to reduce carbon emissions from domestic heating, whilst not imposing a significant cost to consumers and businesses. Balancing these objectives and constraints, we feel that Option 1a best meets this.

139. Exempting the Private Rented Sector in Option 1b delivers less carbon savings and does not deliver the potential benefits to private tenants.

140. Option 2b illustrates a more ambitious option asking consumers to do more to achieve significantly greater carbon savings whilst exempting the Private Rented Sector from the additional component. This reduces the costs to small businesses, compared to Option 2a (which includes PRS) while still achieving carbon and energy savings. It is important to note that unlike owner occupiers, private landlords do not receive the benefits of reduced system running costs.

141. Both options (2a and 2b) do present higher cost burdens to consumers compared to Options 1a and 1b. We may revisit these options subject to evidence received in consultation.

Impact Appraisal – Costs to Business

142. This section of the IA considers the direct costs and benefits to businesses to assess the net regulatory impact for one in, three out purposes. Direct costs or benefits are defined in Better Regulation Executive guidance as costs or benefits that can be identified as resulting directly from the implementation or removal/simplification of a regulation[31]

143. For this analysis we have assumed that all private landlords are businesses. Social landlords are not considered to be businesses.

Direct Costs and Benefits

144. There are two types of businesses directly affected by this regulatory change:

a. **Installers:** Individual and organisations who install boilers and heating controls in households.

b. **Private Sector Landlords:** The proposed requirements affect all domestic properties in England. While the majority are owner occupiers, a significant proportion (approximately 20%) are owned by private landlords. Often in the first instance the costs of compliance will be borne by them, not their tenants.

Installers

145. Our assessment is that installers will face little to no additional costs to comply with the new technical standards. They may benefit from additional trade.

146. There are established channels through which installers keep up-to-date with developments in the domestic heat industry, enabling them to familiarise themselves with new requirements without incurring additional costs.

147. Installers keep up to date with developments in the market through an existing network of media and professional connections. They operate within a community of practice in which information sharing is understood as an element of professional participation. It is crucial for both the engineer, and the community, that they are seen as experts by customers. In practice this means installers become aware of changes to industry or regulatory standards through:

- **Gas Safe magazine** – in order to operate as a gas engineer, it is a legal requirement to be registered with Gas Safe and have the qualifications and training necessary for that. Their monthly publication details changes in the regulations and guidance surrounding the installation of central heating systems.
- **Trade press** – in addition to Gas Safe, other organisations provide advice and information to installers about developments within the sector.
- **Manufacturers** – as installers are the main source of advice for end consumers, manufacturers maintain on-going engagement with them and provide training to ensure installers are familiar with their products.

[31] Definitions of direct costs and benefits can be found within the Better Regulation Framework Manual, along with the methodology used to calculate the annualised equivalent net cost to business https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211981/bis-13-1038-better-regulation-framework-manual-guidance-for-officials.pdf

- **Large installer companies** – companies such as British Gas monitor the regulatory and commercial landscape affecting the industry.

- **Builders merchants** – builders merchants provide a hub for daily interaction between installers, manufacturers and other tradespeople who all have a stake in ensuring the credibility of the profession.

148. These channels facilitated the dissemination of new regulations when they were set in 2005. BEIS has been working closely with organisations that are central to these existing, on-going practices, to ensure information is freely available. Where installers are not engaged with their wider industry they are likely to learn of changes through word of mouth, or as a final backstop through Building Control, the compliance and enforcement regime.

149. By convention implementation of new requirements is followed by a coming into force period of 3-6 months to allow the industry time to become aware of the changes.

150. These regular channels of updating knowledge for installers mean that it is our assessment that there will be no additional costs of learning about new standards on top of what they do currently to keep up to date with developments in the market. We will use the consultation to test whether the installer base shares the assessment.

151. Indirectly, if manufacturers choose to comply by developing new boilers then they may face design and testing costs.

<u>Private Landlords</u>

152. In many cases private landlords will face the upfront costs of compliance with the proposed requirements (increased costs of heating controls). They will not receive the benefits of reduced energy bills, which will instead be accrued by tenants. In some cases the upfront costs will be borne by tenants, depending on the conditions of their tenancy. For this Impact Assessment it is assumed that costs are met by landlords in 100% of privately rented properties.

153. Table B10 shows the range in EANCB for Options 1a, 2a and 2b which have implications on landlords in respect to EANCB. Option 1b has no impact on landlords as they are excluded entirely from the proposed requirements. Option 2b shows the option with the least cost combination (i.e. with a learning thermostat).

Table B10 EANCB for Private Sector Landlords

	Option 1a and option 2b	Option 1b	Option 2a
Landlords affected per year	0.2m weather compensators	0	0.2m weather compensators, 0.1m additional measures
Cost of compliance (2015 prices)	£80 (£40-£115)	n/a	£210 (£160 - £255)
EANCB (2014 prices)	**£10.5m**	**£0m**	**£17.4m**

154. The cost of compliance ranges provided show the extent to which costs may differ from our central assessment which is used to calculate the EANCB. Were costs to deviate toward the low or high end of the range, our EANCB could change for better (lower cost) or worse (higher). We might expect that with greater demand of the measures that costs would fall over time. The uncertainty is by how much and how quickly this may occur.

155. The vast majority of benefits from this policy are accrued to society through monetised carbon savings, paid for by higher upfront costs to landlords and owner occupiers.

156. The cost to business is one of the key factors considered in determining the leading options for this consultation. While Option 1b has zero cost to business because of the private landlord exemption, it also has lower carbon savings and does not offer the same bill saving opportunities to tenants as owner occupiers.

Small and Micro Business Assessment

157. This section considers the specific impacts on small and micro businesses, in addition to the general impacts on business.

Installers

158. The boiler installation sector is dominated by small businesses; there are over 70,000 registered GasSafe businesses, comprising 125,000 registered GasSafe installers[32].

159. Based on the technologies which might be chosen by householders to comply with these minimum standards we do not anticipate significant extra training for installers to be able to supply this demand. All technologies in scope are reasonably mature so most are well known to many installers. Some are more niche technologies for which there may currently be fewer trained installers, but for the same reason demand is not expected to exceed the capacity to supply. Some installers may choose to undertake training if they are not currently familiar with any of the relevant technologies, however this would be an indirect commercial decision to expand the purview of their business.

160. These minimum standards create an opportunity for small and micro businesses to sell additional products at the point of boiler replacement.

Private Rented Sector

161. As set out in the policy description section, the lead policy option will have impacts on the Private Rented Sector and therefore impact landlords. Based on The Private Rented Sector Landlords' Survey 2010, 78% of landlords own 1 property.

Table B11 Properties Owned by domestic Landlords[33]

Number of Properties	Percentage of Landlords
1	78%
2-4	17%
5-9	3%
10-24	1%
25+	1%

Mitigating the Impact on Small and Micro Businesses

162. Our assessment is that the installer segment will not face a significant cost of compliance, however we do anticipate costs of compliance for Private Rented Sector

[32] http://www.gassaferegister.co.uk/about/stakeholder_hub/key_stats_and_prosecutions.aspx
[33] DCLG Private Rented Sector Landlords' Survey 2010

Landlords under policy Options 1a, 2a and 2b. In addition the Private Rented Sector already has some regulations on F and G rated properties, designed to improve the energy efficiency of these properties.

163. We therefore propose to allow the Private Rented Sector to opt out of the requirement described in Option 1b and face a reduced requirement in Option 2b. This is designed to limit the additional costs these small and micro businesses might face.

Conclusion of Impact Analysis

164. The Impact Analysis described shows that Option 1a, which features weather compensation, presents the most favourable benefits to society in terms of energy bill and carbon savings, without high costs to consumers. Option 1a achieves average annual bill savings of £6 for all households and saves 1.4 $MtCO_2e$ of carbon in CB4 at an additional cost of £80; the lowest of all options. Although there is a cost to PRS landlords, this allows carbon abatement to be achieved and bill savings for tenants in the rental sector.

165. The results are highly sensitive to a number of factors such as cost and performance of systems and assumptions such as fuel prices and carbon valuations. For example, varying the cost of a weather compensator in Option 2b, could vary the central NPV of +£172m to between -£166m (high cost scenario) and £559m (low cost scenario).

166. The threshold analysis demonstrates that plausible changes in the costs and performance of some of the technologies can lead to a positive NPV and/or substantially different costs to consumers and businesses. For example, if weather compensators were integrated into the boiler or installers chose the cheapest product on the market, the lower end of the cost range (£40) could be achieved compared to our central cost assessment (£80). We lack evidence in areas such as potential for cost reduction, so have taken a conservative route to determining assumptions for this IA.

167. The consultation will help us understand the evidence for these sensitive cost and performance assumptions. Views will help particularly to understand how cost and performance might change if these regulations were brought in due to factors like product innovation, potential for cost reduction and greater installer engagement.

168. Our analysis of the costs to landlords shows that most of the options impose additional costs to business. The lead Option 1a (incl. PRS) has an EANCB of £10.5m. While greater carbon savings are available in Option 2a (incl. PRS), cost to business is higher given the marginal additional carbon savings achieved. Option 2b (excl. PRS for additional components) has the same cost to business as Option 1a however requires a higher upfront cost from other consumers.

169. The primary objectives of the policy are to reduce carbon emissions from domestic heating and increase energy bill savings, whilst not imposing a significant cost to consumers and businesses. Balancing these objectives and constraints, with the best evidence we have to hand, we feel that Option 1a best meets this:

Option 1a: Weather compensation for all households

170. While Option 1a has an associated negative NPV of -£104m and there are significant uncertainties in the evidence base, it is the option which has the lowest upfront cost for consumers (£80) compared to the other option considered with additional measures. As shown in the threshold analysis, with small improvements to cost and performance of the technology, to £72 or 1.1% heat demand reduction, this option would be considered a zero NPV option.

171. Although not selected as a lead option at this point, we leave open consideration of Option 2b (excl. PRS for additional components), as it has a positive NPV when combined with learning thermostats. This will be subject to the evidence we receive at consultation.

Annex 1: Other Wider Impacts

172. This section considers the wider impacts that this policy might have. It covers the standard test, but also considers the qualitative impacts on other major policies in the area of home heating system replacement.

Equality Impact

173. This section of the Impact Assessment provides an overview of the impact of the proposed requirements against the protected characteristics for example age or gender.

174. The requirements apply to all those replacing a gas boiler (the majority of the population of England). We therefore have no reason to anticipate a disproportionate impact on protected groups.

175. The proposals will promote the use and installation of controls and more sophisticated control systems. It is therefore important that everyone regardless of age or disability is able to appropriately access and use controls which are on the market. We will use the consultation to explore further these issues.

Fuel poverty

176. We anticipate that this policy will have a small impact on fuel poverty in England. Approximately 10% of households on the gas grid in England are classed as fuel poor, compared to 14% off the gas grid.

177. The proposed minimum standards could help reduce bills for households who install a new gas boiler. However, as this proposed policy affects households at the point of replacement, the action of installing a new boiler will likely reduce the chance of that house being in fuel poverty. This means that this measure will likely have a small impact on fuel poverty.

ECO interaction

178. BEIS will be bringing forward proposals for the structure and design of ECO shortly. We will examine the potential for interaction at that point.

Human Rights

179. Proposals for the private rented sector engage Article 1 of Protocol 1 to the European Convention on Human Rights, as they will affect landlords "property rights by controlling the use of rented property".

Wider Environmental Issues

180. This Impact Assessment covers potential carbon emissions and air quality impacts savings. Any other environmental impacts are considered out of scope.

Justice System

181. Enforcement of these standards will be conducted through the present building regulations framework. This will be examined in more detail in the final Impact Assessment and policy design.

Annex 2: Consumer Panel Findings

Introduction

Background to BEIS Consumer Panel

182. The BEIS Consumer Panel was commissioned to provide policy teams with flexible, rapid and cost effective access to a cross-section of households for the delivery of small-scale consumer insight projects. This generates early learning and insight to inform policy development and communication design.

183. The panel is managed by research agency TNS-BMRB and includes a database of over 25,000 people willing to take part in consumer insight. Panel members were recruited via a profiling survey covering background information on a range of variables including; demographics, characteristics of their property, and their attitudes, knowledge and behaviour in relation to key BEIS policy areas. The panel has not been recruited via random probability sampling, although quotas are applied to survey samples that use panels to ensure they are broadly representative of the wider population on a wide range of characteristics.

Aims and methods of Consumer Panel Survey on domestic heating systems

184. To inform development of boiler policy options, BEIS (then DECC) commissioned TNS-BMRB to carry out a 10 minute online survey of 1,000 panellists. The aims of the project are to:

   a. Test acceptability and response of the public to different policy options. Including insight into how much consumers may be willing to pay for a more efficient boiler.

   b. Fill knowledge gaps in consumer attitudes and behaviours around the various in-scope technologies. For example, what types of heating control functions will enable different types of households to better manage their heating?

   c. Identify how best to design the requirement so that it meets the right balance of ambition and acceptability for those who will be most directly affected.

185. A sub-sample of consumer panellists was drawn to exclude those living outside England and without boilers, who were sent an invitation to complete this online survey. Quotas were set on sex, age and social grade and surveys were completed until the target of 1000 interviews was reached. Screening questions included checks on household heating system; with those without gas, oil or LPG central heating screened out. At the analysis stage, data has been weighted to reflect the adult population of England by sex, age, tenure and region.

186. **Note that consumer panel statistics presented here on the prevalence of heating controls are not necessarily nationally representative and should be not be used in place of other sources of national statistics such as the English Housing Survey.**

187. This Annex presents headline findings from each main section of the survey, including;

   a. Heating controls and their perceived usefulness.

   b. Experience of boiler replacement

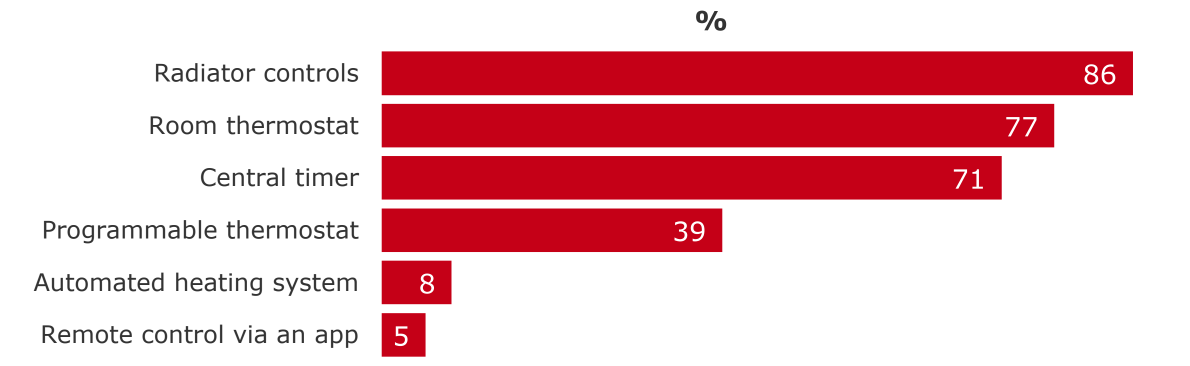
   c. Preferences on other services and willingness to pay.

1. Heating controls and their perceived usefulness

1.1. Prevalence of heating controls

More than 7 in 10 respondents had radiator controls, room thermostats and central timers; other controls less common.

Q. *Do you have [type of heating control] in your home*?

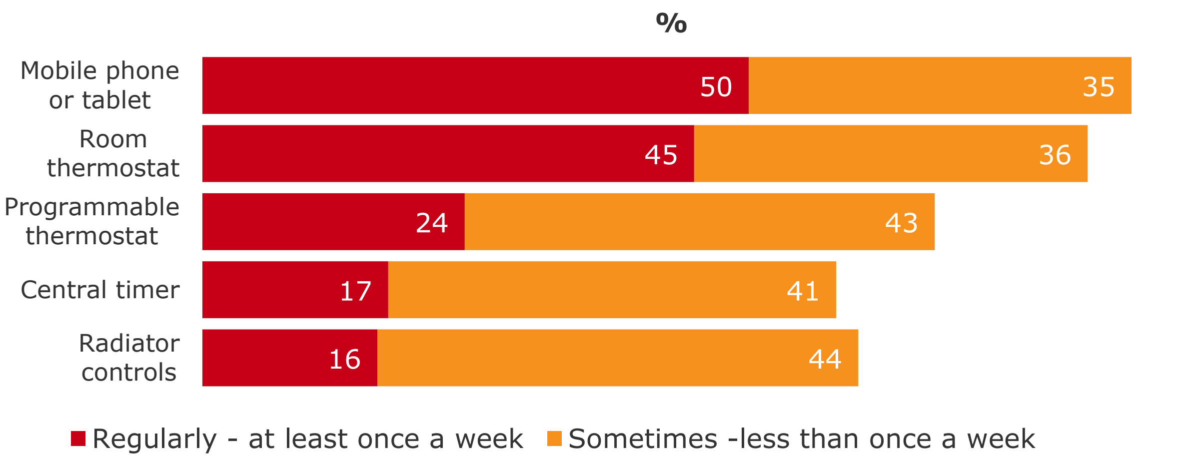


Base: All adults: 1,000

1.3 How often control functions are used

Settings on mobile phone apps (among those who have them) and room thermostats more likely to be regularly changed compared with other types of control functions.

Q. *Generally speaking, how often do you change the settings on/use [type of heating control]?*

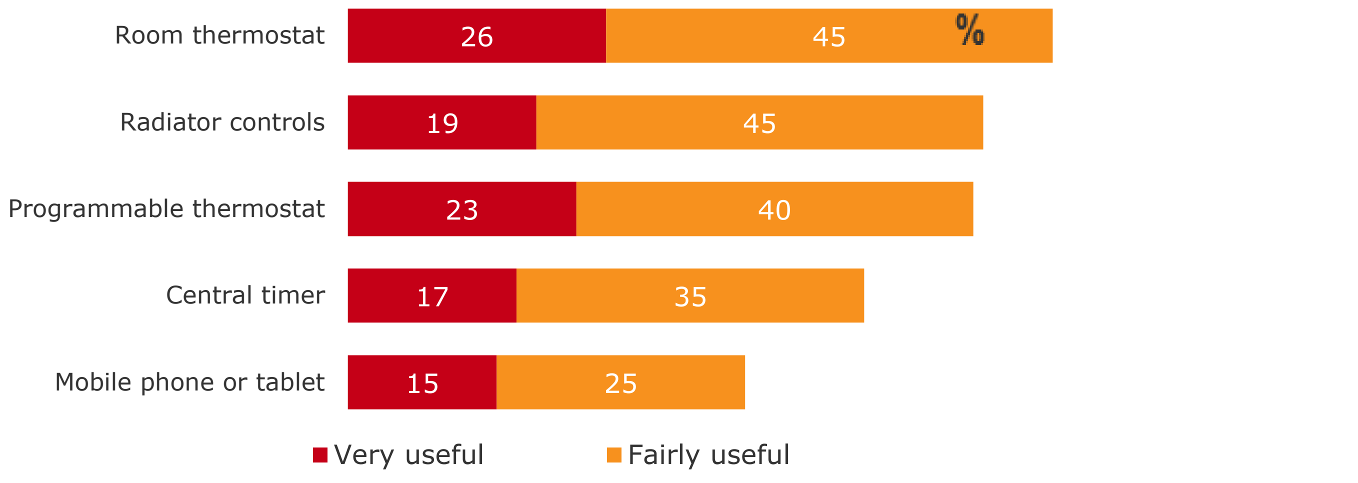


Base: All who have the heating control – QB2: 768, QB5: 724, QB8: 387, QB11: 867, QB14: 51

1.4 <u>Perceived usefulness of different heating controls</u>

Room thermostats, radiator controls and programmable thermostats generally perceived to be the most useful heating controls.

Q. How useful would you find it to have [type of heating control]?

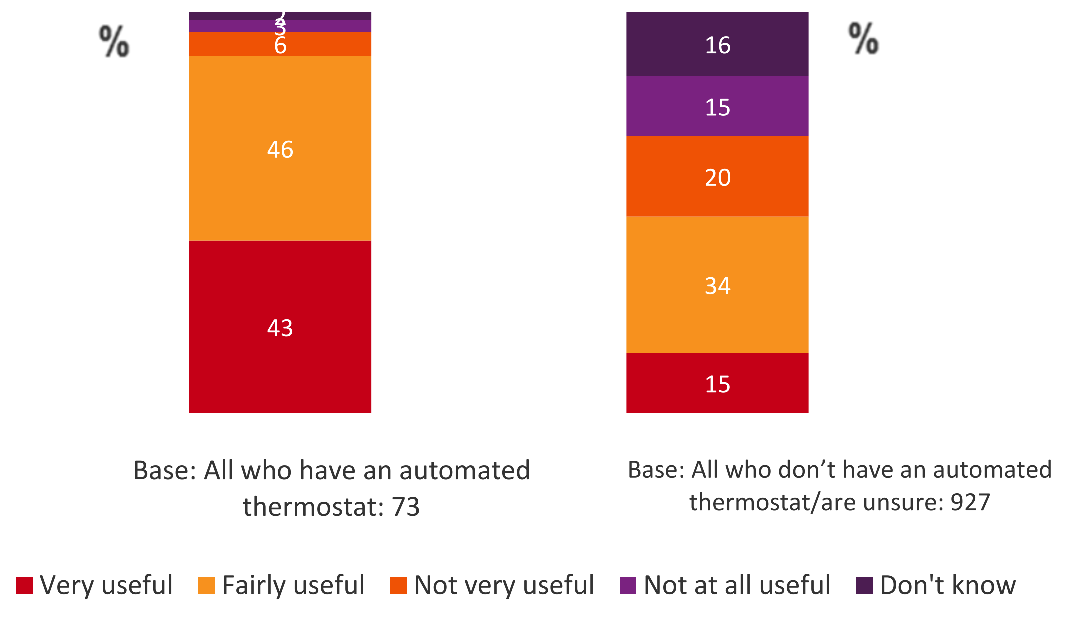


Base: All who don't have the heating control – QB3: 232, QB6: 276, QB9: 613, QB12: 133, QB15: 949

1.5 <u>Perceived usefulness of learning thermostats</u>

Nine in ten of those with learning thermostats consider them to be useful. Perception is less positive among those without them.

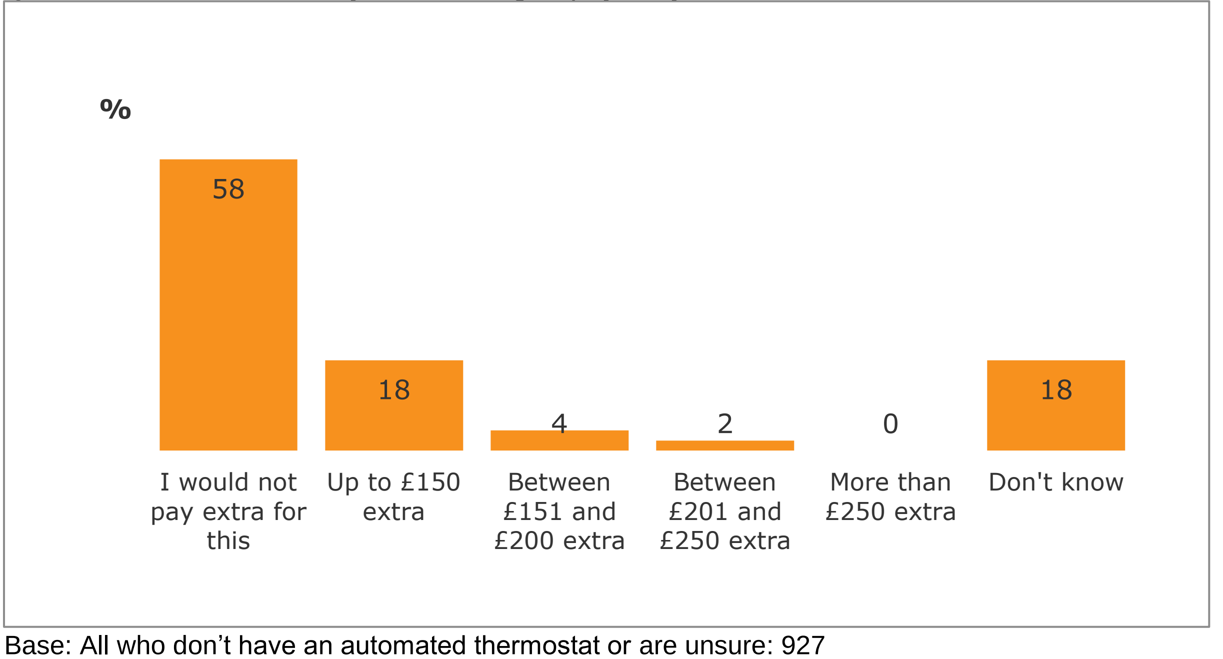
Q. How useful do you/would you find it to have an automated thermostat to control the heating in your home?



1.6 Willingness to pay for learning thermostats

Whilst the majority of people who had learning thermostats considered them to be useful, among people who did not own one, few said they would be willing to pay more than £150 for one

Q. How much extra would you be willing to pay for your next boiler to include an automated thermostat?



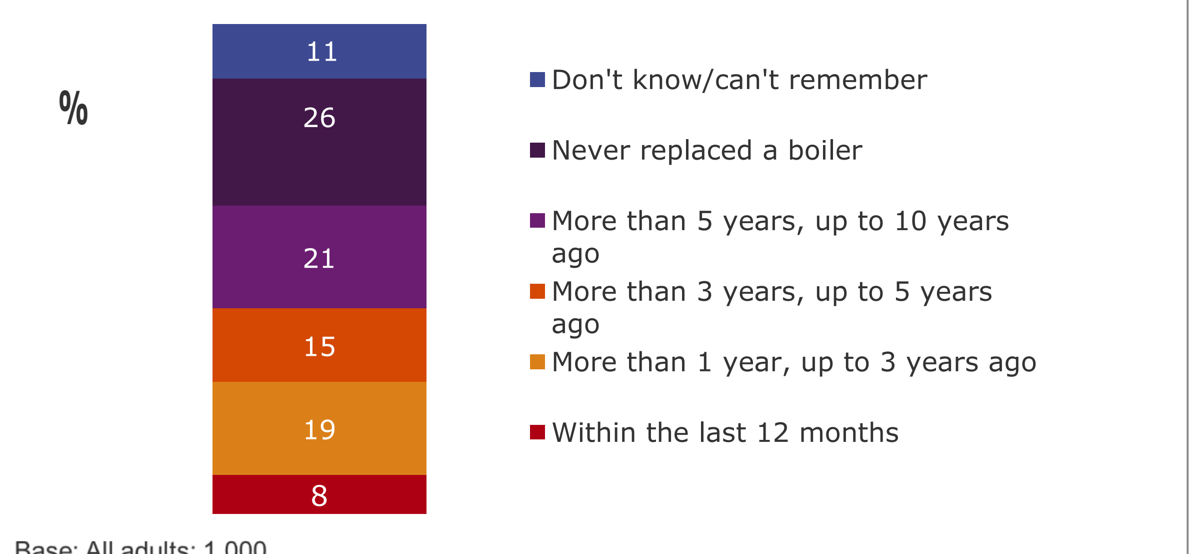
Base: All who don't have an automated thermostat or are unsure: 927

2. Experience of Boiler Replacement

2.1 When last boiler was replaced

A quarter of panellists have never replaced their boiler. 1 in 10 had replaced their boiler in the last 12 months.

Q. *When did you last replace your boiler, either in your current home or where you lived previously?*

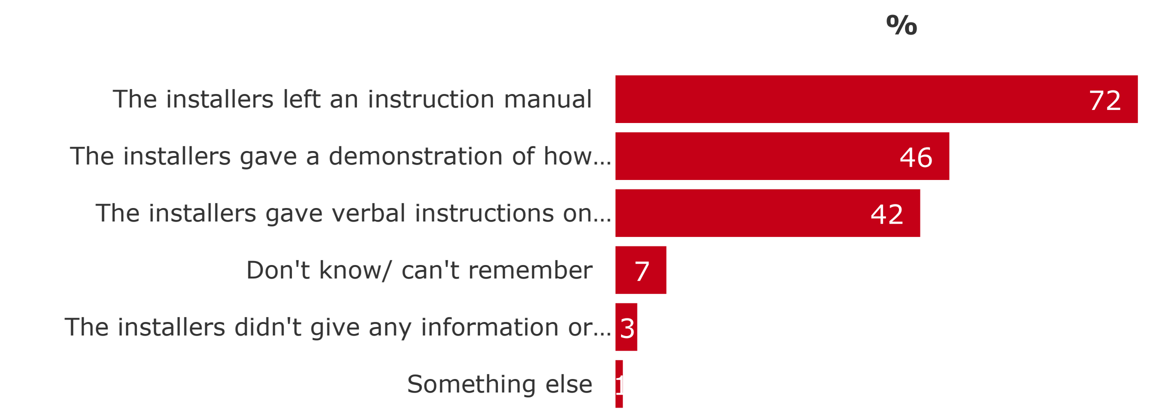


Base: All adults: 1,000

2.2 Guidance received from installers

Nine in ten received some form of information or guidance about heating controls from the installer when replacing their boiler. Half received a demonstration on changing controls.

Q.When your boiler was installed, what information or guidance, if any, did you receive from the installer about how to use the heating controls?

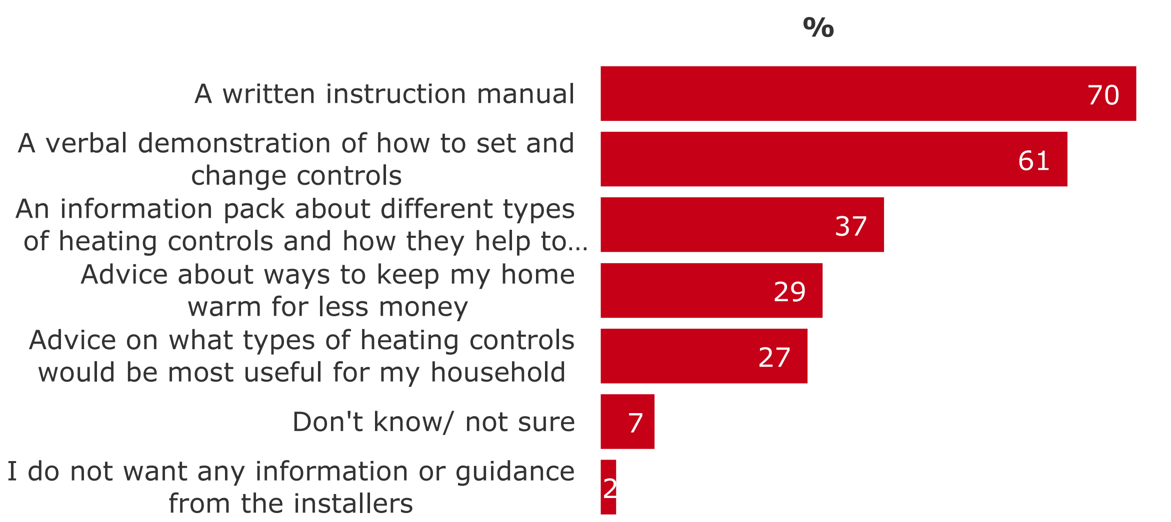


Base: All who replaced their boiler within last 10 years: 641

2.3 Preferences on guidance to be received at next boiler installation

Consumers most likely to want an instruction manual and verbal demonstration when next replacing a boiler.

Q.Which, if any, of the following types of information or guidance would you like to be given by the installer?



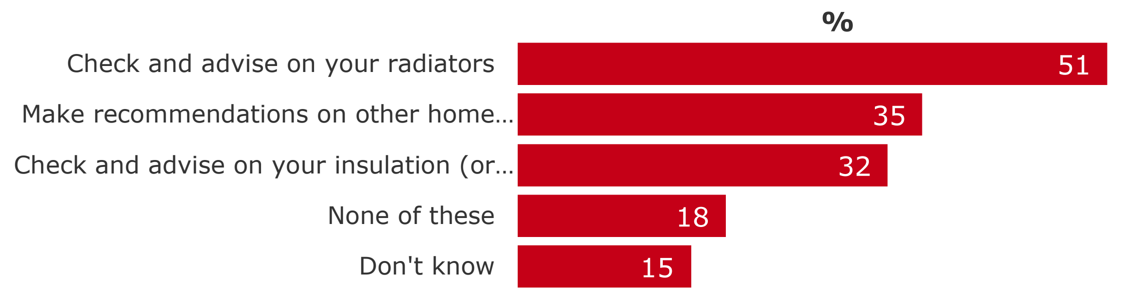
Base: All who replaced their boiler within last 10 years: 641

3. Other Services and Willingness to Pay

3.1.Preferences for other energy efficiency advice from boiler installers

Half of consumers said they would like boiler installers to check and advise on their radiators.

Q. Boiler installers can check parts of your heating system and make recommendations that might reduce your bills. If you were to replace your boiler, which of the following would you also like the boiler installer to do?



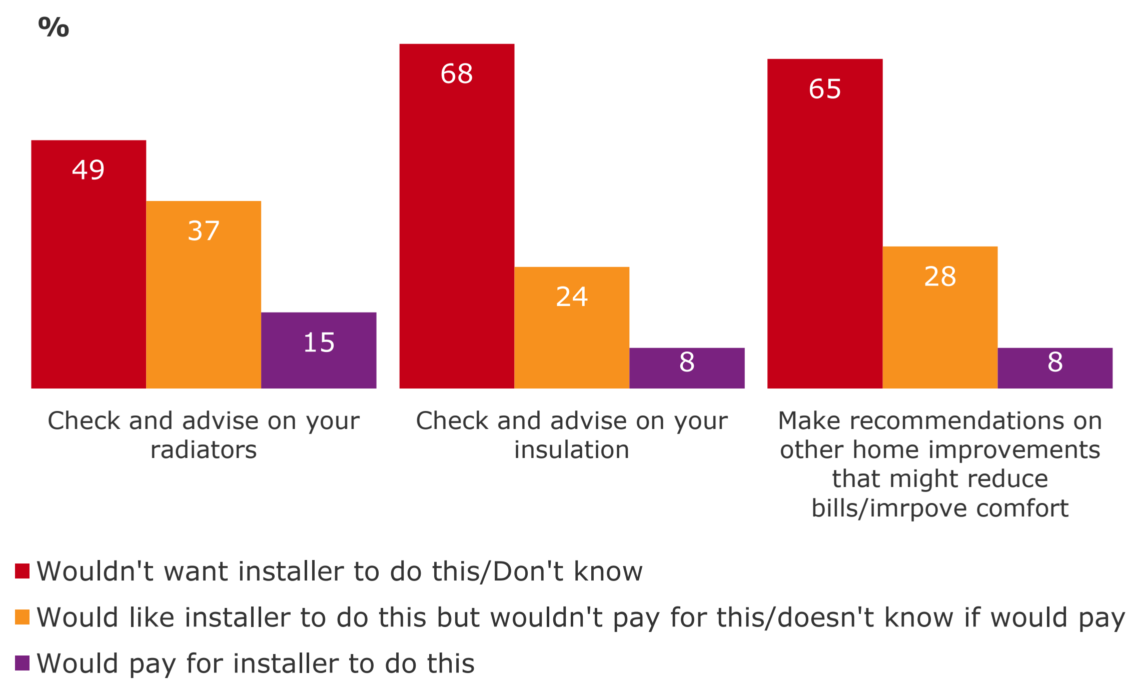
Base: All adults: 1,000

3.2 Willingness to pay for additional boiler services

Although many people would like boiler installers to provide additional advisory services most claimed they would not be willing to pay extra for these services.

Q1 If you were to replace your boiler, which of the following would you also like the boiler installer to do?
Q2: If the installer charged you an extra hour's work to complete these checks (up to £80), which of the following would you be willing to pay the installer to do?

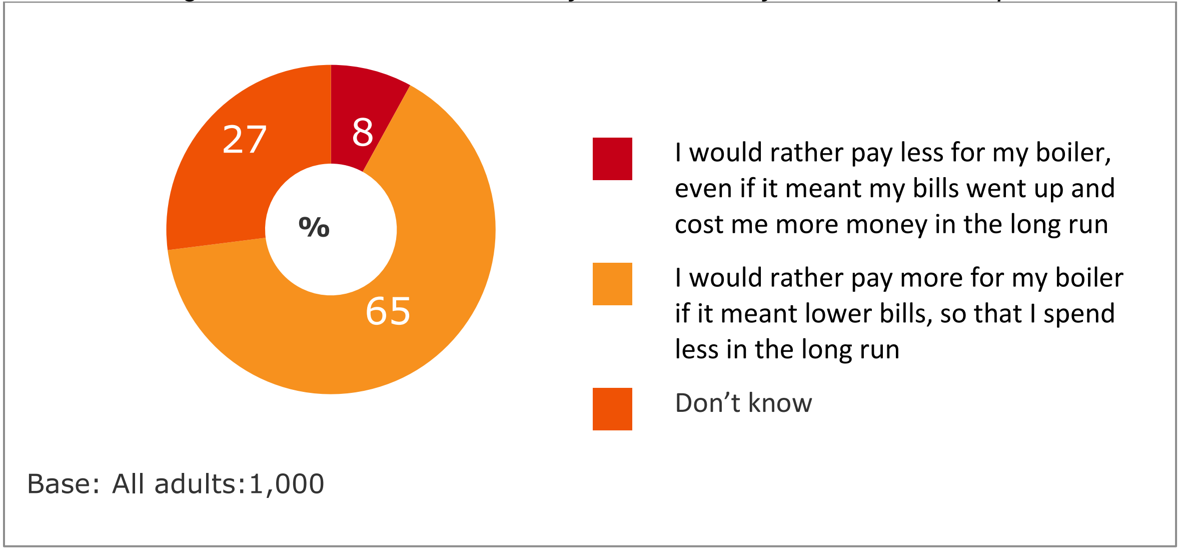
Base: All adults: 1,000



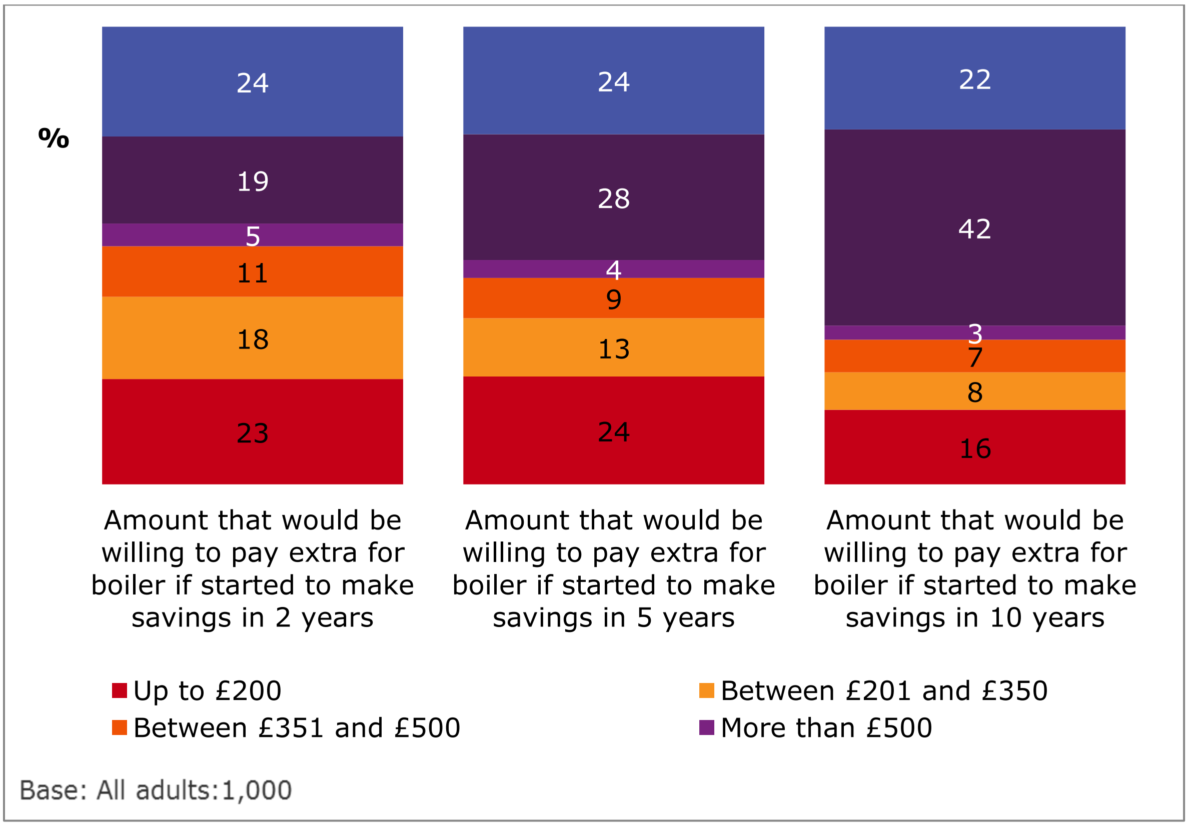
3.3. Willingness to pay higher upfront costs for boiler if there are long-term savings

Two thirds of consumers would rather pay more for their boiler at installation if it meant spending less on energy bills in the long run.

Q *The average cost of a domestic boiler replacement is around £2,500. Taking that into account, which of the following statements is closer to how you feel about your next boiler replacement?*



3.4. How much extra are consumers are willing to pay if savings are made within 2 years, 5 years or 10 years?



Annex 3: In scope technologies

188. This annex summarises the measures that might be used to comply with the proposed minimum standards, a description of what they do and sets out the evidence base for the costs and performance of these measures.

a. Domestic boilers
b. Central timers
c. Room thermostats
d. Weather compensation
e. Zonal control (where TRVs are the most affordable option)
f. Automated optimisation
g. Passive Flue Gas Heat Recovery (FGHR),
h. Time Proportional Integral (TPI) control

189. We welcome stakeholder's views on the evidence used and particularly if there is further evidence we should consider when finalising policy design.

Heating Control:	Boilers

General description

Boilers consume fuel to release heat energy. In a standard wet central heating system this heat energy is distributed throughout the property by means of water that is heated and circulated in a closed loop. In England the majority are condensing boilers, which recover some of the waste heat exiting the system to maximise efficiency. Some less efficient, non-condensing boilers are still available for exceptional circumstances where condensing boilers are not practical.

Increasingly householders are selecting combination (‘combi’) boilers which can provide space heating and hot water on demand. Alternatively, many households use non-combi ‘system’ boilers, which have a cylinder for storing hot water.

Boiler design efficiency is the rate at which the boiler converts input gas into output heat. This can be measured in a number of different ways:

- Design performance: This is the efficiency of a system reached under test conditions to a set methodology (Either SEDBUK 2005 or SAP 2009/2012).
- In-situ performance: This is taken from the EST field trial

The current regulations say that new gas boilers must reach an efficiency of 88% under the SAP2009/2012 methodology or 90% under the SEDBUK 2005 method.

The sales data we have available reports the SEDBUK 2005 efficiency of newly installed boilers, this demonstrates that average current efficiency is ~90.5%. The top of the range systems have an efficiency of ~91.4%. In BEIS’s judgement this is broadly the maximum efficiency which could be achieved with the current level technology.

Costs (£ exc VAT)	Costs vary by installation capacity. Generally we anticipate that around a third of the cost to the consumer of a new boiler is the boiler itself (£800 out of £2,500).

Efficiency Levels	SEDBUK 2005	SEDBUK 2009 / PCDB
Building regulation minimum Performance	90%	88%
Typical Design Efficiency on the market	90.5%	
Maximum Design Efficiency on the market	91.4%	
Assumed difference between design efficiency and in-situ Efficiency	5.5 pp – difference between minimum standard and EST field trial average efficiency	3.5 pp – difference between minimum standard and EST field trial average efficiency

Heating Control:	Central Timers					
General description A central timer enables control of the heating system by allowing the user to choose one or more heating "on" periods, usually in a daily or weekly cycle.						
Evidence available	Evidence is based on the EFUS (2011/12) which states that 97% of households have central timers. Other evidence suggests that new boilers being sold on the market already have a central timer installed on the unit as standard. Shipworth et al[34] and Kelly et al[35] have respectively investigated the impact of timer controls from a heating duration and internal temperature perspective.					
Costs (£ exc VAT)	Low	0	Medium	0	High	0
Source of cost data	As boilers being sold on the market already have a central timer installed on the unit as standard, we assume the cost is absorbed in the boiler unit price.					
Quality of cost data	This assumption has been affirmed by industry.					
Heat Demand reduction	Low	0%	Medium	0%	High	0%
Source of demand reduction	Evidence based on field temperature measurements, central heating settings reported by participants, along with building, technical and behavioural data.					
Quality of demand reduction	Demand reduction can be influenced by how occupants use and interact with timers. For example, some occupants may set their timers early in the winter heating season and extend heating "on" cycles during colder winter periods. Occupant interaction with timer to adjust heating duration in response to changes in external temperature later in the heating season will influence timer heat demand reduction potential.					

[34] https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/11586/7/Shipworth%20et%20al%202010%20CH%20thermostat%20settings%20and%20timing%20-%20building%20demographics%20-%20Accepted%20Manuscript.pdf

[35] http://discovery.ucl.ac.uk/1362438/1/1362438_Kelly%20et%20al%202012%20A%20panel%20model%20for%20predicting%20the%20diversity%20of%20internal%20temperatures%20from%20English%20dwellings%20-%20Tyndall.pdf

<table>
<tr><th>Heating Control:</th><th colspan="6">Room Thermostats</th></tr>
<tr><td colspan="7">General description

Room thermostats are a common form of heating system control usually located in open hallways within domestic buildings where living rooms and bedrooms operate as a single zone. It allows a single target room set point temperature to be set by the user. This set point temperature can be manually adjusted to change desired room temperatures.

A temperature sensor within the thermostat measures room air temperature and feeds a signal back to switch on and off the space heating as necessary.</td></tr>
<tr><td>Evidence available</td><td colspan="6">Evidence is based on the EFUS (2011/12) which states that 77% of households have room thermostats.
Kelly et al has investigated the impact of room thermostats on mean internal room temperature.</td></tr>
<tr><td>Costs (£ exc VAT)</td><td>Low</td><td>0</td><td>Medium</td><td>0</td><td>High</td><td>0</td></tr>
<tr><td>Source of cost data</td><td colspan="6">Although room thermostats have a retail price, it is assumed that all consumers installing new boiler units purchase room thermostats. Therefore there is no additional cost to the consumer.</td></tr>
<tr><td>Quality of cost data</td><td colspan="6">-</td></tr>
<tr><td>Heat Demand reduction</td><td>Low</td><td>0%</td><td>Medium</td><td>0%</td><td>High</td><td>0%</td></tr>
<tr><td>Source of demand reduction</td><td colspan="6">The evidence reported that the mere presence of a thermostat had the effect of reducing average internal temperature by ~0.24°C.</td></tr>
<tr><td>Quality of demand reduction</td><td colspan="6">The reported demand reduction contrasts with Shipworth et al. who used the same dataset over a different time period and found no statistically significant difference in temperatures between households with and without thermostats.
Shipworth et al. analysed maximum daily internal temperatures averaged over time while Kelly et al. employed arithmetic mean daily temperatures. The latter concluded that their methodology yielded an improved means of reporting household heating profiles and a more accurate picture of the effects of thermostats on internal temperatures.</td></tr>
</table>

<table>
<tr><th>Heating Control:</th><th colspan="6">Weather Compensation</th></tr>
<tr><td colspan="7">General description

Measures the temperature outside the building and adjusts the flow water temperature of the heating system accordingly.

Boilers are designed to provide sufficient output under cold weather design conditions. A weather compensator can reduce the heat output of the boiler to correspond to different external temperatures so that less fuel is consumed to achieve the desired thermal comfort.

There are a variety of weather compensators available, some of which have a temperature sensor on the outside of the building, and some of which use local weather station weather reports.

The effectiveness of weather compensation depends on the thermal efficiency of the building, alongside the correct setting of weather compensation heating curves to adjust heating system flow temperatures and the appropriate positioning of the outdoor temperature sensor, where applicable.</td></tr>
<tr><td>Evidence available</td><td colspan="6">Evidence is based on emerging data developed as part of general updates to the Standard Assessment Procedure. This has been developed by the Building Research Establishment and peer reviewed.</td></tr>
<tr><td>Costs (£ exc VAT)</td><td>Low</td><td>40</td><td>Medium</td><td>80</td><td>High</td><td>115</td></tr>
<tr><td>Source of cost data</td><td colspan="6">BEIS review of products on the market, with the assumption that labour costs are integrated into the general boiler installation. The weather compensator is therefore an internet enabled device</td></tr>
<tr><td>Quality of cost data</td><td colspan="6">There is significant variety in the costs by different product types, with higher end products bringing extra functionality and integrating extra features. These extra features may offer additional potential for demand control and reduction.</td></tr>
<tr><td>Heat Demand reduction</td><td>Low</td><td>0%</td><td>Medium</td><td>1.1%</td><td>High</td><td>2.2%</td></tr>
<tr><td>Source of demand reduction</td><td colspan="6">Impact dependent upon being commissioned correctly, the heating system design and operation.

High: From BRE research. Assume presence of a room temperature sensor to monitor internal temperature and adjust weather compensation curve to improve room comfort.

Central (for appraisal purposes): Mid-point

Low: Certain heating systems & properties may have limited scope for reduced flow temps - therefore no impact assumed as bottom of range</td></tr>
<tr><td>Quality of demand reduction</td><td colspan="6">The key uncertainty for weather compensation is how the installer has set the compensation curve and the return temperatures of current systems. These are unknown at this time.</td></tr>
</table>

Heating Control:	**Zonal Controls**					
General description – A system that allows the heating of at least two zones to be controlled independently, in terms of temperature, operation time or both. For the purposes of this Impact Assessment we assume zonal controls are Thermostatic Radiator Valve systems (TRVs), as the most affordable way of meeting this requirement. More expensive options may work differently and offer greater benefits, but are unlikely to be taken up extensively due to capital costs. TRVs are controls fitted to radiators throughout the building (excluding the room with the main thermostat) to allow the localised control of 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).deactivating radiators altogether in rooms that are used infrequently (e.g. spare bedrooms).						
Evidence available	No field trial evidence available, however some modelled evidence is available. For example Marshall et al[36]					
	Supply and fit new thermostatic radiator valves (TRVs) in a small two-bed terraced house with eight radiators. (includes 4-6h labour)		Supply and fit new thermostatic radiator valves (TRVs) in a medium three-bed semi-detached house with 10 radiators. (includes 5-8h labour)		Supply and fit new thermostatic radiator valves in a large four-bed detached house with 14 radiators. (includes 6-10h labour)	
Costs (£ exc VAT)	230 – 290 - 345		280 – 350 - 420		365 – 440 - 545	
Source of cost data	Source is a Which? Survey[37] of how much consumers might expect to pay					
Quality of cost data	The costs of TRVs depends on the number of radiators in a household.					
Heat Demand reduction	Low	0%	Medium	3%	High	6%
Source of demand reduction	The demand reduction estimates above are based on Marshall et al 2016. These results produced a modelled saving of 6%, however there is evidence that a significant in-use factor should be applied to this as consumers might not engage with the controls. Kelly et al suggest an impact of approximately 1.5-2%.					
Quality of demand reduction	There is significant variation in the achievable savings which will ultimately depend on consumer engagement with these systems. While we take an average impact we appreciate there will be smaller and greater savings depending on this engagement.					

[36] Combining energy efficiency measure approaches and occupancy patterns in building modelling in the UK residential context Marshall et al 2016
[37] http://local.which.co.uk/advice/cost-price-information-boiler-repair-central-heating

Heating Control:	Automated Optimisation					
General description Smart thermostat: A device, or feature within a device, combining (but not limited to) room thermostat, central timer, weather compensation and one/or more of the following control functionalities: automation or optimisation. Automation 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 building to achieve the desired temperature. Methods employed to detect presence or relative location of householders to their property include occupancy sensors and/or smart phone geolocation services. Optimisation calculates the pre-heat time required to achieve room set point temperature and ensures the heating system is brought on at the latest time to achieve this This can result in the heating switching on later during milder weather conditions when shorter pre-heat times are required. Learning algorithms use sensors (e.g. occupancy sensors) and other sources of data (e.g. smart phone geolocation capabilities) to automatically control the heating system. This can be achieved through adaptive occupancy learning (learning consumers' occupancy patterns), automation or optimisation.						
Evidence available	Manufacture commissioned field trial to evaluate the impact of their smart heating control device.					
Costs (£ exc VAT)	Low	250	Medium	260	High	270
Source of cost data	Online research of distributors. To note, all systems have weather compensator included, hence lower costs used for the purposes of analysis.					
Quality of cost data	Although the cost range is small, only a small sample of measures have been sampled.					
Demand reduction	Low	0%	Medium	4%	High	N/A
Source of demand reduction	Manufacturer commissioned field trial to evaluate the impact of their smart heating control device on energy consumption. Field trial undertaken by an independent evaluator, working closely with BEIS experts to ensure methods and quality assurance. Trial undertaken on more than 2,000 customers each with and without a smart heating control to compare impacts.					
Quality of demand reduction	The findings, which are commercially sensitive, provide the basis for the 4% impact set out in Table B1. Field trial findings do not detail what proportion of savings can be attributed to each element of control functionality e.g. automation, optimisation, weather compensation. Weather compensation assumed to account for 1.1% of reported savings, with remainder then resulting from automation, learning algorithms and optimisation functionalities.					

<table>
<tr><th>Boiler Improvement:</th><th colspan="6">Passive Flue Gas Heat Recovery (PFGHR)</th></tr>
<tr><td colspan="7">General description
Passive Flue Gas Heat Recovery (PFGHR) is the extraction of waste heat from the products of combustion (flue gases) which can then be used for the purpose of pre-heating 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. It should be noted that the term ‘passive’ implies that no additional (electrical) energy is consumed during the operation of the PFGHR device.

PFGHR products can broadly be segmented into two types: those with additional thermal storage and those without. PFGHR devices without thermal storage only provide energy savings when the boiler is operating in ‘domestic hot water’ mode. Those with thermal storage (typically a 5 to 10 litre store) provide additional energy savings when the boiler is operating in ‘space heating’ mode, as well as when operating in ‘domestic hot water’ mode.

Current products are designed to work only with combination boilers (producing instantaneous hot water), not system boilers (products for these boilers would be much more expensive and complex to develop).

For the purposes of this assessment we assume that all FGHR systems installed come with some integrated storage. There are systems without integrated storage, which face significantly lower costs, but also have a significantly lower impact.</td></tr>
<tr><td>Evidence available</td><td colspan="6">BEIS PFGHR evidence gathering report</td></tr>
<tr><td>Marginal Costs (£ exc VAT)
(PFGHR with storage)</td><td>Low</td><td>-</td><td>Medium</td><td>£458, reducing to £200 in Year 2</td><td>High</td><td>£458, no reduction in costs</td></tr>
<tr><td>Source of cost data</td><td colspan="6">Interviews with PFGHR suppliers and manufacturers to inform DECC’s PFGHR evidence gathering report.</td></tr>
<tr><td>Quality of cost data</td><td colspan="6">The cost data for any PFGHR device is a function of the underlying manufacturing cost; transportation and assembly of parts; costs associated with retail, distribution and installation; and profit (and contingency) margins at every point. A licence fee may also be payable if the appliance was not designed by the manufacturer/retailer.</td></tr>
<tr><td>Efficiency Improvement (Low hot water demand)</td><td>Low</td><td>2.02%</td><td>Medium</td><td>2.72%</td><td>High</td><td>3.37%</td></tr>
<tr><td>Efficiency Improvement (Average hot water demand)</td><td>Low</td><td>2.20%</td><td>Medium</td><td>2.93%</td><td>High</td><td>3.66%</td></tr>
<tr><td>Efficiency Improvement (High hot water demand)</td><td>Medium</td><td>2.94%</td><td>Medium</td><td>3.95%</td><td>High</td><td>4.91%</td></tr>
<tr><td>Source of demand reduction</td><td colspan="6">EST[38] domestic hot water consumption monitoring report, EFUS[39] energy consumption data and BEIS PFGHR evidence gathering report modelling using accepted assumptions on heating cycles (during seasons when space heating is required) and domestic hot water usage patterns (also referred to as ‘tapping cycles’).</td></tr>
<tr><td>Quality of demand reduction</td><td colspan="6">Actual savings may vary from one property to the next, and will be dependent on: the volume of thermal storage, total domestic hot water demand, the heating season (i.e. how often the boiler operates in space heating mode), and the extent to which DHW demand overlaps with periods of space heating.</td></tr>
</table>

[38] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48188/3147-measure-domestic-hot-water-consump.pdf
[39] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/274771/3_Metered_fuel_consumption.pdf

<table>
<tr><th>Heating Control:</th><th colspan="6">Time-Proportional Integral (TPI)</th></tr>
<tr><td colspan="7">General description

Conventional room thermostats typically operate on a simple on/off basis around a temperature set point. TPI controls are electronic room thermostats that enable time to also be taken into consideration when meeting room temperature set point by calculating how long a boiler is required to fire across a defined set of hourly operating cycles to reach the desired room temperature.

As TPI devices calculate the amount of heating required based on the difference between target room set point temperature and the measured room temperature, overshoot of set point temperature should be eliminated or significantly reduced.

Alongside improving room temperature control accuracy, TPI control is expected to yield reduced flow temperatures and boiler gas consumption, whilst also potentially enabling increased boiler condensing mode operation and enhancing system efficiency.</td></tr>
<tr><td>Evidence available</td><td colspan="6">EST In-situ monitoring of efficiencies of condensing boilers[40] – TPI control project extension</td></tr>
<tr><td>Costs (£ exc VAT)</td><td>Low</td><td>Not considered</td><td>Medium</td><td>Not considered</td><td>High</td><td>Not considered</td></tr>
<tr><td>Quality of cost data</td><td colspan="6">Not considered</td></tr>
<tr><td>Demand reduction</td><td>Low</td><td>-</td><td>Medium</td><td>0.0%</td><td></td><td>-</td></tr>
<tr><td>Source of demand reduction</td><td colspan="6">EST trialling of TPI controls in 47 trial households that previously participated in the same organisation’s condensing boiler field trial. Laboratory trials had previously identified an improvement in energy efficiency from the operation of TPI controls and the trial was conducted to assess whether similar energy efficiency savings were achievable in situ.</td></tr>
<tr><td>Quality of demand reduction</td><td colspan="6">Trial households generally did not reach internal temperature set points and boilers were frequently not operating for a significant period of time at temperature set points, both of these conditions must be achieved to enable effective TPI control. There are two fundamental prerequisites for observing the characteristics of effective TPI control.

Flagged potential for conflict between the logic of the TPI controller and the in-built logic of a modulating boiler and subsequent impact on the effectiveness of both the TPI control unit and the in-built modulating controller of the boiler require further consideration.

Evidence does not assess TPI controls with eco-functions that may reduce energy consumption by reducing comfort and how occupants may adjust temperature set points in response to narrower temperature dead bands.</td></tr>
</table>

[40] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47962/1149-condensing-boilers.pdf