THE POWER AT OUR FINGERTIPS

A manifesto for best practice heating controls in UK homes

October 2021

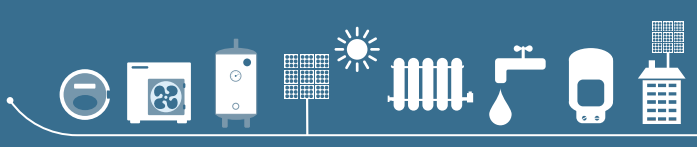
1.
Outdated technology will not deliver low carbon homes

Heating controls are one of the oldest and most familiar energy efficiency measures. Their role is to regulate the operation of a central heating boiler – which is solely responsible for 80% of the energy consumed in our homes – and reduce waste.

The first patent for a room thermostat was filed in 1883, three years before what is regarded as the birth of the modern car when German inventor Karl Benz patented his Motorwagen. Both cars and room thermostats have a far more sophisticated appearance these days but there is a big difference. If you were to look 'under the bonnet' of the room thermostat in a modern home you may well find that it communicates with and controls the boiler in an almost identical way to how it was done a century ago.

While it's inconceivable that anyone would buy a modern car powered by a 1900s engine, a lack of understanding or interest means that consumers can well make that mistake with a room thermostat. The technology for better performance is widely available but it is only in the last few years that the Building Regulations have started to include a requirement for high performance room thermostats alongside a boiler replacement. Even then, this is only as an option and not for all installations.

The path to zero carbon requires every home to adopt the best performing energy efficiency technology available. It is time for Government to take the role played by heating controls seriously and to actively drive towards the application of best practice technology in all existing homes, and as part of all heating installations.



2.
Why 'smart' room thermostats are only part of the answer

Much attention has been paid to the increasing growth of smart thermostats in recent years. These make it easier for people to adjust the time and temperature settings that they want from their heating system or will even do this automatically by sensing and learning from the occupants' lifestyle. To return to the car analogy, you can think of this as the sophisticated dashboard and infotainment options you get when you sit in the driving seat. Separate from this are the important things that happen when you put your foot on the accelerator or turn the steering wheel.

Traditionally, the heating controls in our homes would consist of a stand-alone timer and a room thermostat. These days around half of all room thermostats installed are 'programmable room thermostats', which combine both the timer and room thermostat in one package, with the additional benefit that you can set different room temperatures at different times. In most cases it is this built-in time and temperature setting control that the 'smart' aspect of a smart thermostat looks after, allowing settings to be made remotely and helping match system operation to occupancy.

The other side to a room thermostat, the engine if you like, is the way that it controls the boiler. Modern technology for room thermostats can optimise the efficiency of the boiler so that it uses significantly less energy to maintain required temperatures while also providing a more consistent temperature profile inside the house to improve comfort for the occupants. It is this technology that needs to be more widely used, including within smart thermostats.

3.
Defining best practice heating controls

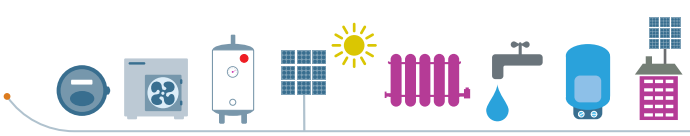
There are three specific forms of control that need to be provided for a central heating system:

1. The **room thermostat**, which provides overall control of the boiler in relation to the desired main comfort temperature in the building. These are classified as temperature controls under the Energy Labelling regulation for space and combination heaters from Class I through to Class VIII. These are explained further in Appendix A, but the key improvement is moving from a room thermostat that simply sends an on/off signal to the boiler (such as a Class I control) to a room thermostat that incorporates load compensation or weather compensation to control the boiler in relation to the amount of heat needed to maintain the setpoint.
2. The **programmer** (also known as the timeclock), which sets the overall operating times of the heating system. This function can be combined into a joint room thermostat and programmer, known as a programmable room thermostat, which can then also set operating times and setpoint temperatures. The latter settings can also be delivered by 'smart' control which provides remote access to settings, usually through a mobile phone app, and may also automatically learn from occupant behaviour.
3. **Individual room controls,** which allow different setpoint temperatures in each heated room. In a central heating system with radiators these are usually Thermostatic Radiator Valves (TRVs), which fit onto the connection between the radiator and the heating pipework. TRVs can also be 'programmable', allowing time and temperature to be set individually for each room. A system of 'connected' TRVs can allow each room to be controlled from a central interface, possibly via smart control.

For each of these forms of control we need to upgrade the current minimum standards to minimum levels that would reflect current good practice as shown below. These are based on technology that could be widely adopted across the housing stock right now, with widespread availability of the technologies and minimal compatibility issues. Setting improved minimum standards would still allow room for best practice controls to be driven or incentivised where technically and economically feasible. Smart control is recognised as an option that will provide benefits for many occupants, but it would be appropriate to maintain choice as some may prefer to use a more conventional programmable room thermostat.

Moving from current minimum standards to best practice would look like the table below:

	Current minimum standards	Good practice (new minimum standards)	Best practice
Room thermostat	Class I room thermostat	Class IV or above 7-day programmable room thermostat, with smart control as appropriate for users	Class V or above 7-day programmable room thermostat, with smart control as appropriate for users
Programmer	24-hour time control		
Individual room controls	None (manual radiator valves)	Thermostatic Radiator Valves (TRVs)	Programmable/ connected TRVs



The *current minimum* standards are those defined for replacement boilers under Part L of the Building Regulations. Since 2018, the regulations in England have required that combination boilers are installed one of four energy saving options. These options include load compensation and weather compensation but are not in themselves a requirement. It should be noted that the option for a smart thermostat does not specify that this should include load or weather compensation. In all other instances when a boiler is replaced no information is provided on the type of room thermostat or programmer, so the minimum level is often installed.

The proposed new regulations due to come into force in 2022 are expected to introduce a requirement for TRVs with replacement boilers as listed under *good practice*. The additional good practice requirement proposed here for time and temperature controls to be combined into a programmable room thermostat (smart where appropriate) of a minimum Class IV could be readily undertaken and provide a significant return on investment for consumers. These should also be mandated.

The proposed technologies under *best practice* are currently available but may currently be difficult to mandate due to compatibility restrictions or consumer preferences. These would be best covered by incentives, rather than regulation, in the short term. Incentives for both *good practice* and *best practice* should be available for all householders as an energy efficiency improvement separate from a boiler replacement.

4. The energy saving opportunity

Research shows that significant energy savings can be delivered by moving beyond the current minimum standards for heating controls.

12% savings **from best practice room thermostats**

Research carried out at the University of Salford in 2020[1] demonstrates that the amount of gas used by a boiler for heating can be reduced by 12% by replacing a standard Class I room thermostat with a Class V or VI room thermostat. They also show that this saving would be 10% with a Class IV thermostat. In both cases the savings delivered are largely independent of user interaction so would be widely achieved in practice.

19% savings **from good practice individual room controls**

Data from tests by Salford University, on behalf of BEAMA and BRE[2], showed that correctly set Thermostatic Radiator Valves in rooms other than the living room could reduce energy use by 19% by preventing unnecessary overheating in those rooms.

5% savings **from a smart programmable room thermostat**

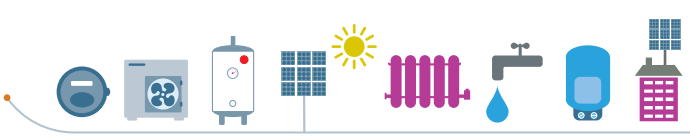
Field trials have shown 5% less gas used in homes where a room thermostat and programmer were replaced with a smart programmable room thermostat[3].

It is not as simple as adding these together but calculating the cumulative savings in a logical manner shows that the potential total saving on gas used for heating in a building with none of these measures to start with would be **over 30%**.

[1] Tests by the University of Salford 2020, on behalf of BEAMA.

[2] Savings figures from tests by Salford University, on behalf of BEAMA and BRE, at on the overheating savings from Thermostatic Radiator Valves, 2018: https://www.beama.org.uk/resourceLibrary/salford-university-tests-to-establish-the-energy-savings-from-trvs---2018-pdf.html

[3] Study by the Behavioural Insights Team on the savings from smart thermostats, 2017: https://www.bi.team/publications/evaluating-the-nest-learning-thermostat/2



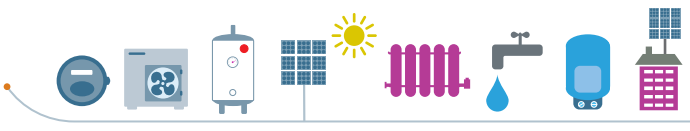
5.
This scale of savings is crucial to harness for our journey to Net Zero

The UK urgently needs to reduce carbon emissions from existing homes and over 23 million of these are heated by a gas boiler. Upgrading heating controls in these homes as laid out in this report has the potential to reduce UK CO_2 emissions by 11 million tonnes per year, while saving householders over £2 billion on their fuel bills. Even under an accelerated scenario this would have a return on investment of 5:1[4].

Future low carbon heating systems will also require enhanced controls. Improvements in heating controls carried out to on existing homes will largely be transferable to those future systems, particularly hydrogen fired boilers where control requirements should be largely identical. The process of driving towards better controlled systems operating primarily at lower temperatures will also help pave the way for installer familiarity and consumer acceptance of future heat pump system installations.

Looking at the whole of the existing housing stock there is over 320 TWh of natural gas currently used to heat homes. Upgrading heating controls as a key element of improving the heat distribution systems would reduce this by 22%.[5] Given that the transition to any form of low carbon heat, be it electrification, hydrogen or district heat networks, will require investment in infrastructure then better controlled heating has the potential to significantly reduce the cost of this investment by giving a much better picture of the amount of energy that is actually needed to comfortably heat our homes.

4 Details on calculations can be found in Appendix B.
5 BEAMA paper Thinking Outside the Boiler.



EXISTING HOMES

- Our homes would be more comfortable to live in
- Householders would save over £2 billion on their energy bills
- Measures pay back in less than 3 years
- For every £1 spent there would be £5 in savings
- Annual CO_2 emissions would be reduced by 11 million tonnes

FUTURE HOMES

- Our homes would be ready for low carbon heating
- Hydrogen boilers can be installed into systems that already optimise energy efficiency
- Lower temperature operation will build installer familiarity and consumer acceptance for future heat pump installations

RECOMMENDATIONS

Moving the UK to best practice heating controls

BEAMA believes that the following steps are necessary to deliver the full energy savings potential of best practice heating controls. These steps must be enshrined in Government's plans for heat decarbonisation and making our homes Net Zero. Simply put, we cannot afford to ignore energy savings that are possible on this scale if we are to have any chance of achieving the UK's targets for carbon reductions.

1. Fully implement and enforce the new requirement for self-regulating devices to be installed when a boiler is replaced. This new legal requirement was consulted on as part of the revised Part L of the Building Regulations for both England and Wales. In effect this would mean that TRVs, or an equivalent form of individual room temperature controls, would be installed whenever a boiler is replaced. As well as improving the heating system efficiency, this is the most practical and cost-effective time to install TRVs and not doing so is a significant missed opportunity. These requirements must form part of the final regulations.

2. Introduce by 2022 minimum standards so that all room thermostats installed are a minimum of Class IV[6]. The tests detailed in this report demonstrate clearly that Class IV, V and VI room thermostats deliver a significantly better energy performance compared to a Class I room thermostat, which is currently the predominant type installed. Current energy labelling regulations require that controls manufacturers provide information on which Class their control conforms to. The provision of this information would make compliance with these proposed minimum standards straightforward for heating installers.

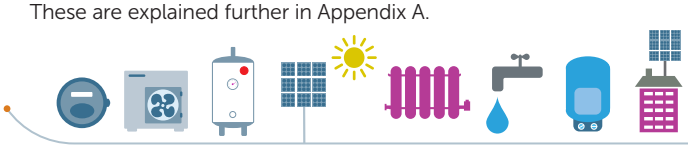
3. Implement by 2025 a strategy to transition to Directly Modulating Room Thermostats. Class V and VI should be the preferred option for heating systems and there needs to be a UK plan to widen the applicability of these controls in practice over the medium term. Industry would support this by working towards a suitable open communication protocol to facilitate the wider uptake of Directly Modulating Room Thermostats and providing improved information and training for installers.

4. Financial incentives for good practice and best practice controls should be available. Financial incentives for energy efficiency should provide a clear focus for transitioning homes to at least good practice controls. While financial incentives for energy efficiency measures, such as the recent Green Homes Grant scheme included heating controls, the specification of the measures themselves have not been clear on which heating controls measures should be adopted and can also include these as 'secondary' rather than 'primary' measures, which limits their application. Incentives should be available to encourage upgrades at any time, rather than only when work is done on the heating system, as well as to support the move to best practice controls alongside boiler replacements when there will be the facility to overcome any practical difficulties.

5. Improve Energy Performance Certificates (EPCs) to better drive the uptake of controls. To support consumer uptake there needs to be clearer messaging within EPCs on the need for better controls and a review of the cost information currently provided in these to reflect the true cost-effectiveness of modern control technology.

6. A target for all existing homes to have a minimum of good practice controls by 2030. There is a clear need for Government to recognise the significant impact that better heating controls can have; to improve the energy efficiency of existing homes, to reduce the infrastructure required to deliver low carbon heating systems, and to make future homes more comfortable and satisfactory for householders. A clear target to get all homes to at least the level defined here as 'good practice' will send the right signals to householders and installers, as well as ensuring that these technologies are sufficiently recognised in all the policy areas taking us through to a Net Zero future.

6 Classes defined under the UK Energy Labelling Regulations for space heaters and combination space heaters. These are explained further in Appendix A.



APPENDIX A

Temperature Control Classes for Room Thermostats

Eight temperature control classes are defined under the UK Energy Labelling Regulations for space heaters and combination space heaters.

Manufacturers of temperature controls are required to provide information on which temperature controls class their products belong to. When a temperature control is installed with a boiler it is a legal requirement for whoever is selling that boiler to the end customer to produce a 'package label' that combines the efficiency of the boiler with an additional improvement to efficiency dependent on the control.

The full control classes are listed opposite. The definitions are based on latest proposals as these are to provide greater clarity on current products on the market given that the original definitions are over 12 years old.

A Class I room thermostat is the current minimum standard under Part L of the Building Regulations. Class II and III are not considered to be compliant as they exclude the room sensor element, which is a UK requirement.

Under the recommended 'good practice' standard in this paper, any room thermostat from Class IV to Class VIII would be allowable.

Under the recommended 'best practice' standard in this paper, a room thermostat would need to be Class V, VI or VIII. Class VIII is a variant of Class V including more temperature sensing points and, while not specifically covered in the tests, should also be permitted for installation.

Class	
I	On/off Room Thermostat
II	Weather compensator control, modulating
III	Weather compensator control, on/off
IV	Load compensator room thermostat, on/off
V	Load compensator room thermostat, modulating
VI	Weather compensator and room sensor, modulating
VII	Weather compensator and room sensor, on/off
VIII	Multi-sensor room temperature control

APPENDIX B

Calculation of Potential UK Savings from Controls

The calculations show the potential if all room thermostats were brought up to best practice standards, assuming all are technically feasible, and TRVs were installed in all homes where these are absent or over 20 years old.

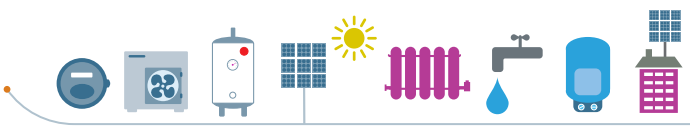
The overall percentage saving potential is calculated using a hierarchy of savings starting with (1) the addition of room temperature controls to reduce the building heat load or upgrading old devices where economically feasible, (2) upgrading the room thermostat to manage the efficiency with which the boiler meets the heat load, and (3) adding smart control to match overall operating hours of the heating systems. For each control technology the savings detailed in this paper were used, then calculated progressively in the order stated above.

The current installed base of technologies is based on industry statistics collected over the last 15 years together with data from the Energy Follow-up Survey (EFUS) to the English House Condition Survey, reported in 'How heating controls affect domestic energy demand: A Rapid Evidence Assessment', DECC (January 2014).

Installation costs were based on industry analysis. It was assumed that the upgrade of heating controls would take place over a 5-year period and that where possible the upgrade would be done as part of a boiler replacement, therefore at a lower installed cost.

Number of houses with gas condensing central heating boilers	23,393,081
Annual boiler replacement rate (existing homes)	1,400,000
Homes without TRVs	7,953,648
Homes with TRVs over 20 years old	5,380,409
Homes with less than Class V, VI or VIII room thermostat	22,223,427
Homes with a non-smart room thermostat	21,521,635
Total annual energy savings potential (GWh)	63,204
Total annual energy savings potential (Mtoe)	5.43
Total annual CO_2 reduction (MT CO_2)	11.6
Total annual reduction in gas bills (£m)	2,402
Total upgrade cost for all measures (£m)[6]	7,032
Payback time (years)	2.93
Return on investment over 15-year product lifetime	5:1

6 The upgrade cost assessed where measures could be done alongside a boiler replacement and where they would need to be carried out as a standalone measure, based on a 5-year replacement in all homes. It does not include boiler or radiator replacements that might be necessary in small numbers of older properties to facilitate upgrades of the controls.



To read more, download the BEAMA *Net Zero by Design Main report and white papers*

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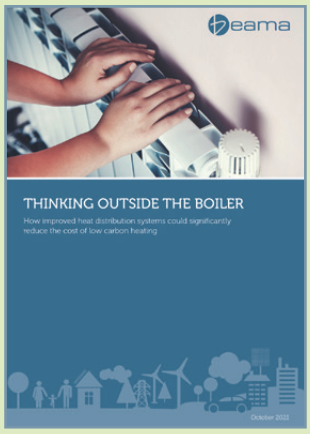

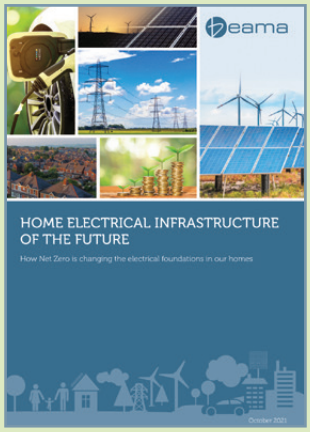

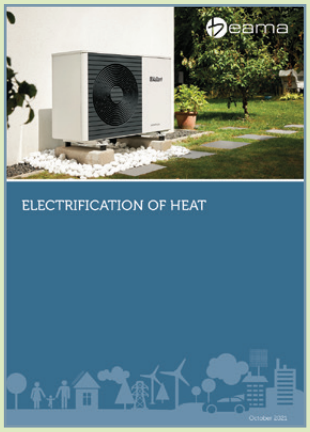

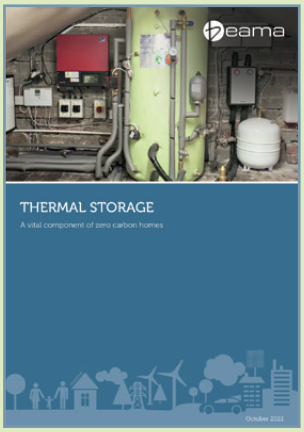

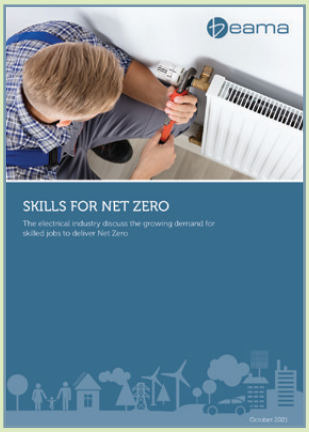

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