MONEY SAVING BOILER CHALLENGE

FREE AND LOW-COST ENERGY-SAVING ACTIONS TO BRING DOWN BILLS, IMPROVE ENERGY SECURITY AND HELP THE PLANET

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About Cambridge Architectural Research

CAR spun out of the University of Cambridge in 1987. Our mission is to apply research and analysis to the design, construction and management of better buildings and the built environment. We are passionate about climate change, and working out how to reduce carbon emissions from buildings is one of our largest business areas. We wrote the UK Housing Energy Fact File and we developed the Cambridge Housing Model, along with other models widely used in government for decisions about saving energy at home.

We are especially keen to provide tools and information to help people make informed decisions about their own energy use and carbon emissions.

Find out more at www.carltd-energy.com and www.cambridgeenergy.org.uk

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Free and low-cost energy-saving actions can bring down bills, improve energy security and help the planet

The Energy Price Guarantee will provide many households in the UK with some much needed reassurance and relief going into winter. However, even with this additional support, the average annual energy bill will be nearly twice what it was in October 2021.[1] This could leave an estimated 6.7 million households in fuel poverty[2], and millions more worrying about paying gas and electricity bills.[3]

Helping households reduce energy use in homes is a triple win: bringing down household bills, improving energy security, and reducing carbon emissions. With the Treasury now subsidising energy bills for millions of homes, saving energy now will help reduce the bill for taxpayers in the medium term.

Many households are familiar with some energy saving advice, such as turning down the central heating, closing curtains at night, or washing their clothes at a lower temperature.[4]

However, there are other, less well-known energy efficiency measures that can generate significant savings. Several come at no extra cost and simply involve tweaking existing kit (e.g. changing settings on boilers and radiator valves). Others involve small upfront investments of between £50 and £300 each. Most are one-off actions that provide ongoing savings, rather than actions that require changes to everyday behaviours. Many come at no cost to comfort or indeed *improve* people's comfort in their homes, for example by reducing draughts. Those willing and able to accept small reductions in comfort - for example waiting slightly longer for rooms to heat up or for taps to run hot - can also achieve greater savings.

Free measures can save a typical household with a combi boiler around £210 a year when adopted together. For a typical household with a system boiler, free measures can save around £100 a year.

[1] Under the UK Government's Energy Price Guarantee, the average annual energy bill will be £2500, compared with £1277 under the Ofgem October 2021-March 2022 price cap
[2] https://www.nea.org.uk/who-we-are/about-nea/
[3]https://www.nesta.org.uk/press-release/cost-of-living-crisis-pushing-worried-parents-to-the-edge-with-2-in-3-concerned-about-paying-for-essentials/
[4] ONS, Public opinions and social trends, Great Britain: 22 June to 3 July 2022

We've carried out a new, rigorous analysis of the impact and potential uptake of twenty energy-saving measures

To better understand the impact of these measures, Nesta commissioned Cambridge Architectural Research (CAR) to model the savings that can be made through lesser known, free or low cost measures, supported by an academic literature review by the Energy House Labs Team at the University of Salford. This report is a brief summary of a detailed spreadsheet, containing the data, modelling and assumptions, which we have published alongside this summary.

Our intention is that this work will help a range of stakeholders:

- Governments, to communicate and deliver the most effective interventions to help households save energy
- Energy advisers, in prioritising tailored energy advice to households
- Media organisations, to accurately convey which energy saving actions are the most impactful.

Nesta has commissioned this work in line with our mission to accelerate the decarbonisation of household activities in the UK. Our goal is that, by 2030, the UK will have reduced household carbon emissions by 28 per cent from 2019 levels, and will be on track to reach zero by 2048.

Five free measures that are widely applicable and generate large savings

CAR's 2022 modelling found that the following five lesser-known free measures would save the most energy if adopted by all suitable households in the UK. These measures are applicable to a large proportion of the UK housing stock, and if all eligible homes adopted them, combined they could save the UK a total of £3 billion on household bills.[5]

[5] Note that the savings from energy-saving actions can't simply be added together, as some measures interact with each other. CAR have provided multiplication factors for each measure that can help estimate total indicative savings from combining measures, which have been used to calculate the 'combined savings' total of £3 billion.

Measures	Energy savings (UK total)	Energy bill savings (total UK stock, indicative)	Proportion of dwellings that could adopt the measure	Proportion bill saving/ per household	Amount bill savings/ household
	TWh/ year	*Billion £/ year*	*%*	*%*	*£/ year*
Lowering the settings on thermostatic radiator valves	13.8	1.5	*76*	*5.5*	68
Turn down the boiler flow temperature on combi boilers to 60 degrees	10.1	1	*38*	8	97
Turn down hot water temperature on combi boilers to 42 degrees	4.1	0.4	*58*	2.1	26
Reduce hot water cylinder temperature to 60 degrees	1.6	0.2	*25*	2	26
Turn off pre-heat on combi boilers	0.6	0.1	*23*	0.8	10

1. Lower the settings on thermostatic radiator valves

Thermostatic radiator valves (TRVs) are self-regulating valves fitted to radiators that control the temperature of a room by changing the flow of hot water to the radiator. Although TRVs are already fitted in the majority of UK homes, they are widely misused as on/off switches. Instead, they should be set to lower temperatures in rooms such as bedrooms and non-living areas to achieve maximum savings.

Readjusting existing TRVs outside the living room to 1.5°C cooler than before can save the UK £1.5 billion. This measure could be adopted by up to 76 per cent of UK homes, and could save individual households 5.5 per cent off their gas bill: **£68** a year off a typical gas bill.

Each TRV has a dial, usually numbered from 1 to 5 or 6. Where TRVs are currently set to 4 or above, we recommend turning the dial to the midpoint on all radiators outside the living room (e.g. to 2.5 or 3). Higher settings will heat the room to over 18°C, which uses up more energy.

2. Turn down the boiler flow temperature on combi boilers to 60°C

The majority of UK homes have combi boilers (gas boilers that provide heating and hot water on demand, and don't have a separate hot water tank). Many are currently set with a flow temperature - the temperature to which the boiler heats water that gets sent to the radiators - of between 70-80°C. Lowering the flow temperature to 60°C or less makes the boiler run more efficiently.

38 per cent of UK homes could benefit from turning down a combi boiler's flow temperature to 60°C. Adopting this measure could save the UK £1 billion per year in energy costs and save a typical household **£97** a year (or 8 per cent off their gas bill), if they are willing to accept slightly lower room temperatures.

Excluding any change to indoor temperature, efficiency savings alone would still provide savings for a typical household of **£43** a year.

Nesta have created a simple online tool to help households make this change.[6]

3. Turn down hot water temperature on combi boilers to 42°C

Combi boilers also allow users to control the temperature of hot water supplied to taps and showers. Reducing the hot water temperature reduces the amount of fuel needed to heat the water.

58 per cent of UK households could turn down their combi boiler's hot water temperature, saving the country £0.4 billion per year. Adopting the measure could save a typical household **£26**, or 2 per cent off their gas bill per year.

4. Reduce hot water cylinder temperature to 60°C

Homes that have heating systems with a separate hot water cylinder can turn down the temperature of the hot water cylinder itself so that water is not heated unnecessarily (this setting is different to flow temperature). The hot water cylinder temperature should not be reduced below 60°C, as legionella bacteria, that can cause Legionnaires' disease, can survive and grow in warm water stored below 60°C.

Up to 25 per cent of UK households could adopt this measure. Doing so could save the UK £0.2 billion a year. Those adopting this measure could cut 2 per cent of their gas use, or **£26** off a typical gas bill, each year.

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[6]https://www.nesta.org.uk/project/optimising-boilers-reduce-household-emissions/how-to-optimise-your-boiler/

5. Turn off pre-heat settings on combi boilers

Some combi boilers have a 'pre-heat' setting that enables users to get hot water straight away, rather than waiting a few seconds for the taps to 'run hot'. In order to do this, the boiler regularly fires up to heat a small amount of hot water, even when the taps are not in use.

If 23 per cent of UK households turned off their combi boiler's pre-heat setting, the UK could save £60 million per year. This measure could save households 0.8 per cent or **£10** off a typical gas bill per year.

And five further free measures that are more widely known

The findings of this study complement previous analysis by CAR in 2012 for the Department of Energy and Climate Change (now BEIS).[7] These measures tend to be more well known (for example 6 in 10 households reported lowering their thermostat in a recent ONS study[8]). Whilst the analysis was done in 2012 and some of the data used has changed since, these measures are still applicable to many households. Below are the top energy saving actions that were identified in the 2012 study:

Measures	Energy savings (UK total)	Proportion of dwellings that could adopt the measure (in 2012)	Proportion bill saving/ per household	Amount bill savings/ household
	TWh/ year	*%*	*%*	*£/ year*
Turn thermostat down by 2 degrees from 20°C to 18°C	33.3	68	26.3	£313
Turn thermostat down by 1 degree from 19°C to 18°C	16.4	68	13	£157
Delay start of heating from October to November	10.5	100	13	£69
Wear a thick jumper at home in the heating season	6	25	5.7	£157
Use radiator valves to turn off heating in unused rooms	4.2	50	4.5	£55

[7] https://www.gov.uk/government/publications/how-much-energy-could-be-saved-by-making-small-changes-to-everyday-household-behaviours

[8] https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/bulletins/publicopinionsandsocialtrendsgreatbritain/22juneto3july2022

Five lesser-known 'under £300' measures

CAR's 2022 analysis found that households that are willing and able to invest a small amount towards energy efficiency measures can save even more.

1. Install smart thermostats

Intelligent thermostats, such as Nest, can automatically adjust heating schedules and set-point temperatures according to the requirements of the occupants and weather conditions. Most systems use presence sensors and internet data to do this.

If all eligible UK households (an estimated 60 per cent of UK homes) installed a smart thermostat, it would save the UK £1 billion per year in energy costs. It would also save individual households around 5.3% off of their gas bill (**£64** a year off a typical gas bill).

2. Add window film to windows

Window film is a form of temporary secondary glazing. It has two effects: reducing draughts, and reducing conductive heat loss through the glass.

Around 87 per cent of dwellings could add window film to all windows in the property, leading to total savings of £1 billion per year in energy costs and household savings of 3.2 per cent a year (or **£43** a year off a typical gas bill). To note, it is advisable to allow some windows to open for adequate ventilation.

3. Load compensation for boilers

Similar to a smart thermostat, load compensation controls use the difference between the internal room temperature and the desired room temperature to control the boiler's output to reduce the flow temperature when less heat is needed.

Investing in load compensation controls in 60 per cent of UK households could save the UK £800 million per year in energy costs. This translates into household savings of 4.1 per cent, or **£49** off a typical yearly gas bill.

4. Weather compensation for boilers

Working in a similar way to load compensation, weather compensation estimates how much heat the boiler needs to produce based on the difference between the external and internal temperature.

Investing in weather compensation controls in 60 per cent of UK households could save the UK £500 million per year in energy costs. This translates into household savings of 2.5 per cent, or **£30** off a typical yearly gas bill.

5. DIY loft insulation

Loft insulation is one of the most impactful measures in terms of savings, although these are heavily dependent on a dwelling's current levels of loft insulation. Most homes have some loft insulation and while there are diminishing returns to adding more top-up insulation, it is still worth doing in many cases.

The highest energy UK level savings are realised when topping up existing loft insulation of 50-100m to 300 mm. This measure could apply to 17 per cent of households, and could save the UK £380 million per year in energy costs. This measure could save individual households 5.8 per cent off their gas bill (or **£81** off a typical yearly gas bill).

Five further high impact measures that cost under £300

The highest impact low-cost energy efficiency measures that CAR identified in 2012 were:

1. Replace standard shower head with a water efficient shower head and use twice every day (5.1 TWh total saving)
2. Regularly maintain heating system: use chemical inhibitor to reduce sludge and scale in the heating circuit and bleed radiators regularly (2.7 TWh total saving)
3. Insulate hot water pipework (2.1 TWh total saving)
4. Install sensors and use to turn off lights (1.6 TWh total saving)
5. Install cylinder thermostat and use to control tank temperature (0.9 TWh total saving)

What has a limited effect on saving energy

Energy saving measures with less impact

The studies by CAR in 2022 and 2012 also identified measures that have a very small effect on individual or total savings when used by themselves, saving less than 0.5% of an annual bill.

Although still worth doing, they are not the most important things that households can focus on. These include:

- Installing reflective foil behind radiators, particularly against modern cavity walls (2022 modelling)
- Use dishwasher only when full (2012 modelling)
- Install sensor in hallway and use to turn off lights (2012 modelling)

- Wash clothes at 40 degrees or less (2012 modelling)
- Cook with the microwave, not oven (2012 modelling)
- Put lids on saucepans (2012 modelling)

Measures that don't save energy: moving furniture away from radiators

CAR's 2022 study modelled the effect of moving furniture away from radiators and found that unless combined with other measures, this is more likely to raise bills than to lower them.

This is because furniture in front of radiators stops them from transferring so much heat via convection. When these obstacles are removed, the radiator heats the room more quickly. This uses more energy, rather than less.

Adopting multiple measures

Many of the measures presented already offer high savings potential. Households could save even more by combining several measures. It is worth noting that the savings from these measures cannot be simply added together to calculate total savings (as some measures interact with each other), and that they won't be applicable to every household. We created a few possible combinations of measures to illustrate how households might be able to combine different measures depending on their circumstances and shown what the combined savings to homes would be.[9]

[9] These packages have been built with the energy saving measures analysed in the 2022 Nesta study. These packages could be further enhanced using the measures covered in the 2012 DECC study, but this would first require the 2012 analysis to be updated, since savings and potential uptake are likely to have changed in the last ten years. These figures are the central estimates of savings.

"No upfront costs" package

Free actions, mainly one-off, small potential reduction in comfort from using less heat

Measures	*Combi boiler kWh savings*	*System boiler kWh savings*
Reduce flow temperature to 55°C (accepting lower room temperatures)[10]	1330	N/A
Reduce hot water cylinder temperature to 60°C	N/A	230
Close curtains at night	90	90
Turn off pre-heat facility	93	N/A
Readjusting existing TRVs outside the living room to 1.5°C cooler than before	640	640
Resulting total yearly savings per household	**£210**	**£100**
Resulting total yearly % savings per household	**17.5%**	**8%**

"Thermal comfort" package

One-off actions, some upfront investment, increased comfort overall from reducing draughts

Measures	*Combi or system boiler kWh savings*
Upgrade loft insulation from 50-100 mm to 300mm	710
Install smart thermostat	620
Add window film to all windows	380
Reduce flow temperature to 60°C (no change to room temperature)	420
Resulting total yearly savings per household	**£210**
Resulting total yearly % savings per household	**17.2%**

[10] Lower flow temperatures mean that boilers run more efficiently, and also that a lower indoor temperature is achieved, i.e. some sacrifice in comfort. Both of these aspects save energy. Some households may be willing and able to accept lower indoor temperatures, and they will achieve the larger savings from lower flow temperatures. Where households are unwilling to accept lower indoor temperatures, they will need to run heating for longer. They will still save some energy as a result of greater boiler efficiency, but the savings will be lower than for households that are willing to accept a reduction in comfort.

"High savings" package

One-off actions, some upfront investment, some potential reduction to comfort as a result of using less heat, high savings

Measures	*Combi boiler kWh savings*	*System boiler kWh savings*
Installing TRVs and adjusting them to 3°C cooler outside the living room	1270	1270
Upgrade loft insulation from 50-100 mm to 300mm	710	710
Install smart thermostat	620	620
Reduce the cylinder temperature to 60°C	N/A	230
Reduce flow temperature to 55°C (accepting lower room temperature)	1130	N/A
Resulting total yearly savings per household	**£360**	**£270**
Resulting total yearly % savings per household	**29.6%**	**22.3%**

Methodology

These estimates have been generated using the Cambridge Housing Model, a bottom-up model developed by CAR that estimates energy consumption in the 12,300 dwellings surveyed in the English Housing Survey and the CODE ("Cost Effective Domestic Electrification") model, which contains 12 archetypes of typical homes derived from English Housing Survey (EHS) data, with weights derived from the EHS. Per-dwelling energy savings are estimated using the best-available evidence from field trials and lab tests, supplemented by modelling and explicit assumptions.

A summary of the results, breakdown of the analysis, calculations for each measure, and a list of assumptions can be found in the worksheet which has been published alongside this summary.

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