

OFF GRID, OFF CARBON

Regulating the decarbonisation of heat
in homes off the gas grid

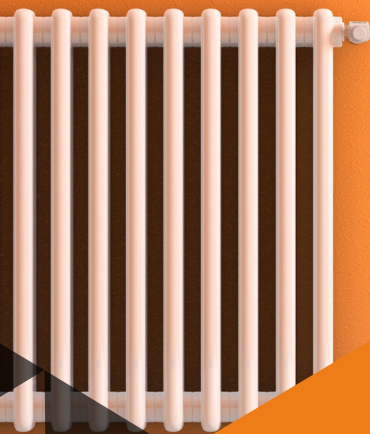


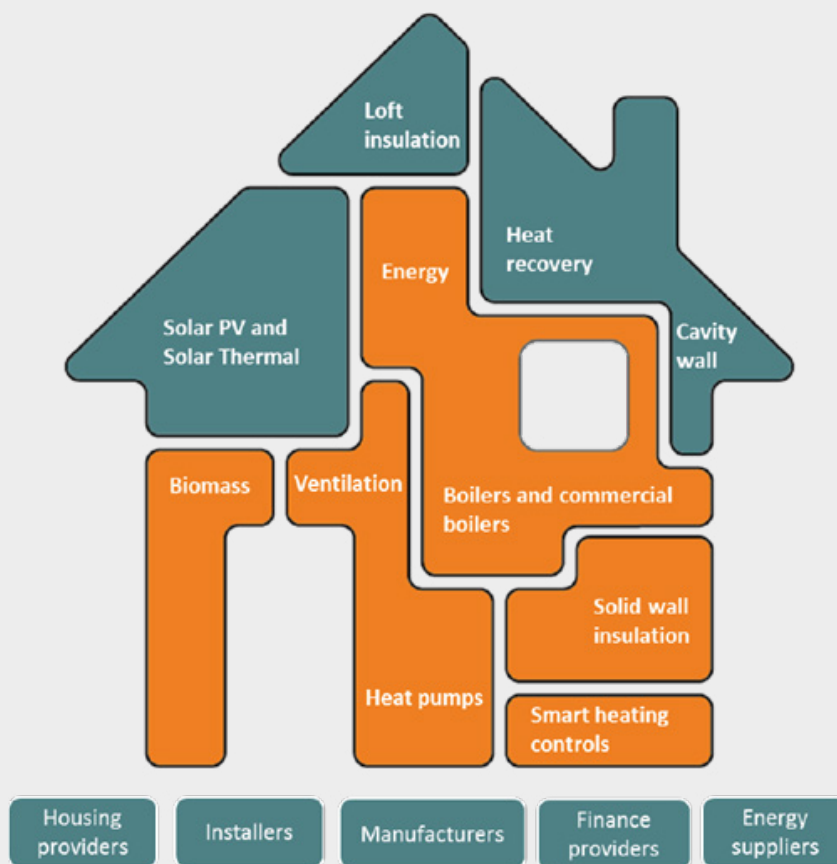
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About the Sustainable Energy Association



In a world of finite resources, the Sustainable Energy Association exists to help create living and working spaces fit for future generations. Our work seeks to align the interests of business, politicians and consumers to make this a reality.

We are industry leaders in energy in buildings. We provide objective, evidence-based policy positions which help shape how we think about, generate and use energy. We are constructive, collaborative and committed to achieving our vision, by ensuring that buildings are energy efficient, low carbon and warm.

The Sustainable Energy Association (SEA) is a member-based industry body. We draw on our wide-ranging membership from manufacturers of energy saving technologies and heating systems to housing associations with an interest in sustainable energy. SEA members manufacture, distribute, install, retail or regulate a range of technologies, they also own and manage homes and supply energy. We take an objective 'whole building, technology agnostic approach' that recognises that there is no single solution to the energy challenges faced by the UK.

Executive summary

- » In the Clean Growth Strategy, the Government committed to phasing out fossil fuel heating in properties off the gas grid by the end of the 2020s. There is a clear need for government intervention to achieve this and the Sustainable Energy Association is proposing an emissions standard for heating that takes a carbon intensity approach, setting a limit to the permitted emissions per kWh of heat provided.
- » Standards – including the mandate of condensing gas boilers and ‘Boiler Plus’ policies – have proven effective at delivering substantial emissions reductions from the residential sector. Given that existing buildings need to transition to net zero emissions in less than 30 years (equivalent to two typical boiler replacement cycles), the challenge is significant.
- » This proposal is intended to be complementary to energy efficiency improvements whilst setting the framework for heat decarbonisation in homes. Insulating homes to reduce energy demand and moving to low carbon heat sources are both necessary to decarbonise the UK’s building stock.
- » The regulation would be a function of both the carbon (CO₂) intensity of the energy vector (e.g. electricity, gas, oil etc) and the efficiency of the heating system. The value is calculated using the kgCO₂e/kWh of heat provided.
- » The regulation would apply to heating systems only at the point of replacement to encourage a shift to efficient heating technologies and lower-carbon fuels. Technologies that do not have a pathway to net-zero emissions should also be phased out.
- » This standard should be facilitated by enforcement measures detailed in the Building Regulations and accompanied by incentives for low-carbon heat to support uptake. To ensure the necessary reductions in building emissions are achieved, regulation must form part of a ‘whole house’ approach alongside associated measures to reduce energy demand and incentivise early adoption of low carbon heating.



Introduction

Heat decarbonisation is one of the toughest challenges facing the UK as we strive to meet the recently set net-zero target by 2050.¹ To date, relatively little progress has been made in this area. In recent years, for example, the rate of emissions reductions from buildings has plateaued and actually rose by 4% from 2015-2016². The Committee on Climate Change (CCC) in their recent Progress Report to Parliament identified the development of a low-carbon heat strategy as a key priority over 2019/20 to prepare for a net-zero target.³

This paper aims to contribute to the formation of such a strategy, focussing on the introduction of regulation for homes that are not connected to the gas grid. The SEA welcome the holistic view of energy efficiency and heat that will be taken in the Government's forthcoming Buildings Strategy and hope that the technology neutral approach proposed here is reflected in that document.

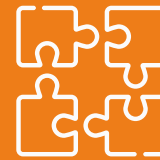
The aim of the regulation is to guarantee that heating is on the trajectory needed to reach net-zero by 2050 and to reduce carbon emissions substantially enough to avert the worst of the climate crisis. In tandem with significant demand reduction and improvements in energy efficiency, this proposed regulatory mechanism offers a means to ensure that homes off the gas grid can be decarbonised by 2050. The adoption of the 2050 net-zero target necessitates significant changes to the way that we heat our homes but large and widespread reductions in energy demand will also be crucial. The SEA advocates a 'wrap then heat' approach to delivering low-carbon homes, ensuring that energy efficiency is of a high standard before installing low-carbon heating to minimise demand, reduce waste and ensure that heating systems are sized appropriately.

Why regulate ?

Regulation forms an important part of a range of policies that need to be deployed to enable the decarbonisation of heat. Its introduction will provide certainty to the market that the transition to low-carbon heat is inevitable whilst setting out how that will be achieved will provide confidence and stability. This will deliver a strong signal to investors and manufacturers of low-carbon heating systems to scale up investment and production, incentivise installers to upskill to be able to install new methods of heating and encourage the innovation that will be necessary for current fuels to develop lower carbon alternatives.

There is a widespread consensus of the need to change, even amongst those companies currently supplying fossil fuel heating systems, who recognise their current offerings will be incompatible with averting the climate crisis and meeting net-zero by 2050. This was confirmed across the consultation period for this paper, with stakeholders across the public, private and third sectors recognising the need for intervention and emphasising the importance of decarbonising heating in homes.

There are various low-carbon alternatives being suggested as potential decarbonisation options, some that would need to be developed further to replace current heating systems, and others which are already proven and commercially available. Therefore it is important that regulation does not reduce the number of viable options, but primarily guarantees that carbon emissions are decreased sufficiently to meet climate targets. The proposed regulation provides the framework for low-carbon fuels to develop and the certainty that there is a place for them, thus enabling investment. This regulation would be aimed at an industry level but accompanied with consumer incentives.



Whilst there are low-carbon heating systems that may develop in future, there are existing solutions that offer immediate and substantial carbon savings if deployed now. In this context, regulation can work well as part of a holistic policy approach that includes financial support for the early uptake of these in replacement of fossil fuel heating systems. The cost of transitioning to a low carbon heat source is likely to be higher for early adopters due to smaller economies of scale so support will be needed to ensure that fuel poor households are not left behind.

Carbon intensity standard

The Clean Growth Strategy aims to phase out the use of fossil fuels off the gas grid in the 2020s.⁴ A carbon intensity standard would facilitate this decarbonisation in a technology agnostic manner. The proposal to set a carbon intensity standard as an interim measure to fill in policy gaps has been supported by different industry voices⁵, but we believe this is one of the first studies in the UK. As a minimum, the regulation should commit to the standard up to 2030 to provide confidence that the decarbonisation of heating in the highest emitting, off-grid areas will happen (see Figure 1). A decision needs to be taken about the future of the gas grid before 2030 and ideally in the mid-2020s as recommended by the CCC.⁶

The CCC also advise that emissions from heating in the average home fall to 1.9tCO₂ to reach the Fifth Carbon Budget.⁷ With this regulation in place, the average heating emissions from off-grid homes could only fall to the level needed to meet the Fifth Carbon Budget alongside a reduction in heat demand of around 35%.

Without a complementary improvement in energy efficiency, the standards would need to be further tightened, implying a quicker switch to low carbon heating methods. A 'whole house' approach will be fundamental to ensure the regulation achieves the overarching aim of decarbonising heat to meet net-zero in 2050.

A carbon intensity regulation would set a limit to the permitted emissions per kWh of heat provided. This takes into account both the carbon intensity of the fuel as well as the efficiency of the heating technology. The carbon intensity standard is calculated by identifying the carbon intensity of the energy vector – a value of kgCO₂e/kWh – and the efficiency of the heating system, taking into account both space and domestic hot water heating requirements¹. The emissions intensity of delivered heat is then calculated by dividing the carbon intensity of the energy vector by the efficiency. This value is then compared to the regulated standard that must be achieved at the time of replacement to ascertain whether the required standard will be met. Essentially, as long as a heating technology is efficient enough, uses a low enough carbon fuel, or a combination of both, it can continue to be installed and heating compatible with net zero will be phased in.

The CCC also advise that emissions from heating in the average home fall to 1.9tCO₂ to reach the Fifth Carbon Budget. With this regulation in place, the average heating emissions from off-grid homes could only fall to the level needed to meet the Fifth Carbon Budget alongside a reduction in heat demand of around 35%.

To refine this approach further, the Government should include a working definition for an average home’s operating efficiency that includes the heating system and the building’s fabric efficiency. This could be developed across a range of representative housing archetypes and would prevent homes using low carbon sources and efficient heating systems from scoring highly if the building is not well insulated.

The CCC’s Net-Zero Report advises that all heating system installations must be ‘low-carbon’ by 2035 such that the share of low-carbon heating in our homes rises from 4.5% today to 90% by 2050.⁸ This is a key consideration and the projected emission standard (dashed blue line) suggests a possible level to achieve heat decarbonisation across all heating systems, on and off the gas grid (see Figure 1). By 2035, heating systems being installed must either have a clear and expected route to heating without producing greenhouse gas emissions in 2050 or already be at this level. It is set at a level that allows for a steady decrease in the carbon intensity year on year, whilst still allowing time for a decision to be made, ideally in the mid 2020s⁹, about how the gas grid will be decarbonised.

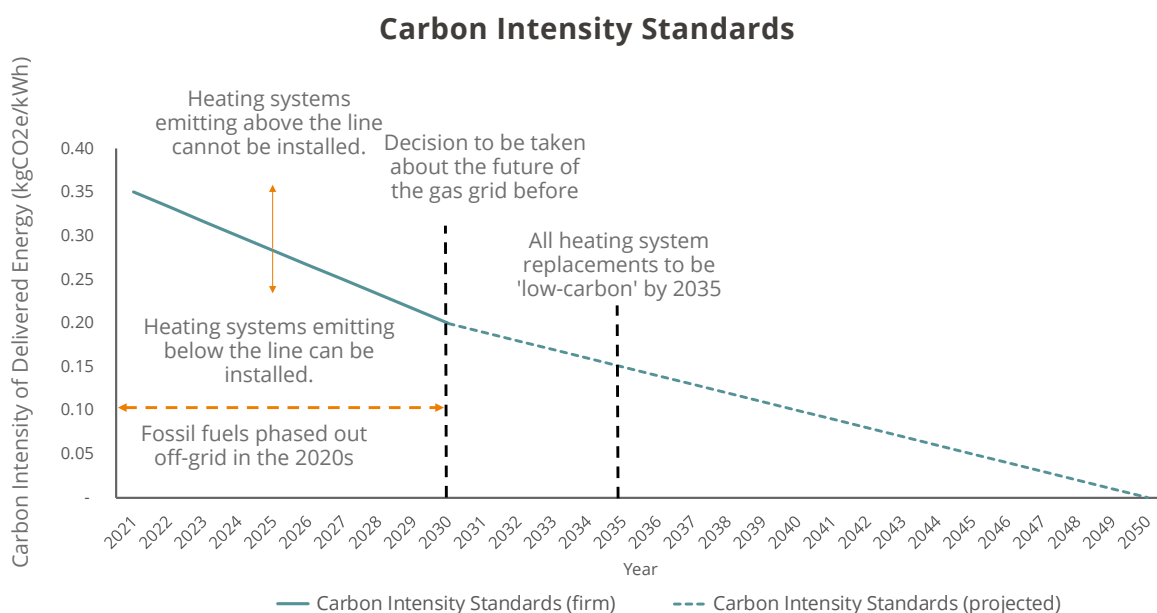


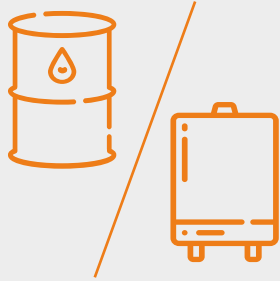


Figure 1: Proposed Carbon Intensity Standards Regulation



Table 1 - Calculating the Emissions Intensity of Delivered Heat

Model parameters	Fuel provider: Carbon Intensity of the Fuel	Heating system manufacturer: Efficiency of the Technology	Household and installer: Emissions Intensity of Delivered Heat - Can the system be installed?
<p>DESCRIPTION</p>	<p>The consumer chooses a fuel that they would use for the heating system.</p> <p>The carbon intensity of the fuel is identified – this will be a value of kgCO₂e/kWh.</p>	<p>The heating technology to use this fuel is chosen.</p> <p>The efficiency of the heating system is then considered.</p>	<p>The emissions intensity of delivered heat is then calculated by dividing the carbon intensity of the fuel by the efficiency of the heating system.</p> <p>This value is compared to the regulated standard that must be achieved at the time of replacement and if it meets this level, the system can be installed.</p>
<p>ILLUSTRATION</p>			

<p>EXAMPLE</p>	<p>Fuel oil is chosen with a carbon intensity of 0.268 kgCO₂e/kWh.</p>	<p>An oil boiler is selected with a design efficiency of 0.89 COP.</p>	<p>The carbon intensity of the delivered heat would be: $0.268 / 0.89 = 0.301$ kgCO₂e/kWh.</p> <p>In 2023, when the regulated level is at 0.317 kgCO₂e/kWh the system could be installed.</p> <p>In 2024 when the regulated level is at 0.300 kgCO₂e/kWh the system would not be permitted to be installed.</p>
<p>WHAT POLICY TOOL WOULD BE USED?</p>	<p>Fuel suppliers would need to have certification of the carbon intensities of the fuel that they provide.</p>	<p>Heating technologies would need to be tested to get an efficiency rating. E.g. ErP rating database.</p>	<p>As part of Building Regulations (Part L), the installer would have to complete this assessment. Once installed, customers would have a heating system installation code/certificate that fuel suppliers would have to use to make sure that they are supplying fuel of the awarded intensity or better.</p> <p>The codes could be stored on an open database similar to the one currently used for EPCs.</p>

Implementation of the standard

Administrative considerations

The regulation is designed to encourage uptake of low carbon heating systems over time to meet the Government's commitments. Consideration of natural boiler replacement cycles is needed to enable a smooth transition but it is also important that industry and the supply chain are given adequate notice of the regulatory trajectory to plan improvements and invest. Setting a clear date and timeline may also increase levels of public awareness amongst consumers, which has been decreasing over the last seven years¹⁰.

In order to ensure compliance, a comprehensive communication strategy must be determined and executed prior to implementation. Awareness, particularly regarding the financial incentives available, will be key to driving a widespread shift in consumer attitudes, which will in turn provide further impetus for investment into commercial R&D and installer upskilling. Within industry, there would be a particular need to ensure awareness of the standards within the installer base. The introduction of this regulation and the transition to low carbon technologies will require a level of upskilling and increased understanding of carbon intensity. Many installers are likely to need to retrain in the installation of lower carbon alternatives over the 2020s. Installers could be supported by the development of resources that allow users to ascertain the replacement fuel type based on the current heating system and vice versa.





Introduction and compliance



It is proposed that the standard would only apply on a rolling basis to heating systems at the point of replacement and as such would not be retrospectively applied to in-situ heating systems. These heating systems will be allowed to remain in homes until they need to be replaced. Publicising a clear trajectory will help households make informed decisions about their heating systems. For example, they may choose to install a system which meets future carbon intensity standards before they are required to do so to futureproof their home and minimise potential future expenditure.

The standard would mean that when the heating system comes to the end of its lifetime, the replacement system put in place must adhere to the carbon emissions intensity standard at that point in time. The replacement system could then continue to operate at the standard granted until that system comes to end of its life (see Figure 2 which provides an illustrative example of a home heated by oil requiring a replacement in 2023).

It is possible to prolong compliance with this regulation through incremental improvements to the efficiency of the heating system itself, which in some cases may support continued use of fossil fuel systems beyond 2035. Therefore, this regulation would need to be set at a sufficiently stringent level to ensure the 2050 net-zero target isn't jeopardised, otherwise the Government could introduce a firm end date for certain fuel types based on their carbon content.

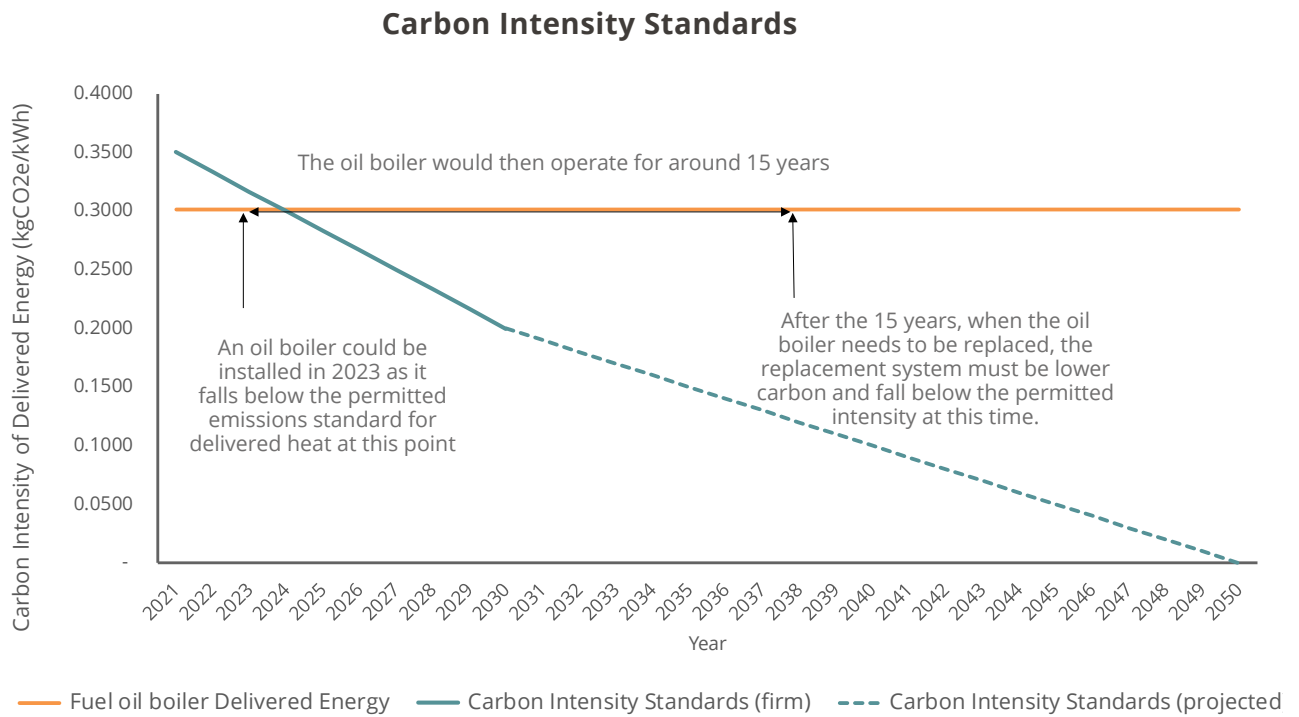


Figure 2: An example of how the regulatory standard would work



Enforcement and certification

The approach to enforcement depends on whether regulation is aimed at industry or consumers. Heating system replacements are often distress purchases and in such circumstances, homeowners tend towards continuity rather than a full consideration of low carbon options. As such, it is anticipated that enforcement of this regulation would be aimed at an industry level alongside incentivisation at the consumer level.

The Government could enforce an industry standard through the Building Regulations and incorporate guidance for installers into the Domestic Building Services Compliance Guide. As building regulations are devolved this would need to be applied separately across each national administration. However, one advantage of this approach could be in complementing the increased monitoring of in situ performance and in helping to tackle the performance gap that currently exists. In the long term, reporting on in-use performance is needed to ensure properties and heating systems perform as specified, with corresponding redress measures for consumers who are adversely affected by poor quality installations of replacement carbon heating systems.

Alternatively, the Government could mandate annual servicing for heating systems and train the installer base to undertake the calculation of carbon intensity to maintain compliance. This would require the establishment of an independent body (or use of an existing one like TrustMark) to oversee non-compliance and hold data on installations. Alternatively, the Government could work with accreditation providers to ensure that all installations are completed in a compliant manner. As biofuels can be used in existing systems, this would also require the development of fuel certification schemes to ensure that supply is standardised. A strong enforcement framework is needed to penalise non-compliant installations, and the SEA is supportive of any measures which reduce the unregistered 'black market' installations that undercut reputable installers and damage the reputation of the wider industry.

Regardless of the approach taken, regulating enforcement and ensuring traceability will be important to the success of the carbon intensity regulation. Product traceability in the built environment sector is underdeveloped when compared to other industries. The creation of Buildings Passports could include information on the heating system, fuel type, installation and replacement dates, and installer details. This could create a 'golden thread' of information transferrable between current and future owners, as recommended in the Hackitt Review and since supported by the Government in their response to the Building a Safer Future consultation¹¹. Given the 15 year average lifespan of a heating system, a Buildings Passport would be an ideal repository for compliance details, whilst also providing an evidence base to inform other policy areas.

Enabling the transition: Support mechanisms

As noted above, a clear trajectory will aid early adoption, but it is also important that support mechanisms, including financial incentives, are introduced alongside the regulation to enable this. Financial incentives could be paired with disincentives to make early adoption a 'no-brainer' for consumers. For example, the Government could consider wider changes to fuel duties to incentivise less consumption and lower emissions. VAT for domestic energy consumption is set at 5% whereas in many European countries it is set at 20%. Raising VAT would encourage a greater emphasis on demand reduction and mitigate the rebound effect amongst consumers. Any increase in revenue raised by the VAT increase could be ringfenced for energy efficiency schemes such as ECO to mitigate the impact on fuel poverty.

The Government could consider further rebalancing levies on electricity and gas to reflect the decarbonisation rate of each fuel source thus far. This would incentivise a quicker decarbonisation of the gas grid and reward consumers who use fuels with a higher percentage of biofuel or hydrogen. The Government has demonstrated its openness to this approach by freezing Climate Change Levy rates for electricity, but more significant interventions would be required to drive decarbonisation¹².

The carbon intensity regulation may encourage consumers to move to electric heating solutions because electricity now has a lower carbon emission factor than natural gas and higher primary energy than gas. However, since the cost is currently higher than natural gas, vulnerable customers who install solutions to reduce emissions in line with climate targets could be adversely impacted by higher bills.

Affordability should be accounted for in regulation and be closely aligned with the Government's revised fuel poverty strategy sustainability principle, due to be released in 2020. Recognising the Government's targets on reducing fuel poverty, the regulation could include an affordability metric that takes the approach outlined in the Future Homes Standard consultation, for a Householder Affordability Rating encompassing the notional heat demand of the building. However, it is anticipated that testing of the metric in practice would differ from the current proposal for new builds in Part L, which is tied to EPC assessments. For example, if a heating system replacement was a distress purchase i.e. the consumer had no heating, an affordability assessment could be designed to be carried out by an installer on-site.

A simpler approach to affordability would be to ensure universal access to financial support when changing fuel systems. The introduction of incentives to encourage households to lower heating demand and switch from conventional methods to available heating technologies that immediately reduce emissions will be essential to drive early adoption and mitigate the costs of enforcement. Without incentives, the regulation could increase demand for spare parts as consumers look to extend the life of their current heating system, rather than upgrade it to a compliant low-carbon alternative.

There are different approaches to incentivisation and all have their individual merits. This paper does not propose to detail a full suite of incentives or financial support mechanisms however we have set out some ideas below which could be considered:

- A subsidy scheme and/or a boiler scrappage scheme to help overcome the upfront cost barrier associated with the transition to low carbon solutions, such as the Low Carbon Heat Support Scheme. Simple financing measures like boiler scrappage schemes and upfront grants are simple to communicate and overcome cost barriers for consumers. To incentivise early uptake of these offers, the amount available to consumers could gradually be decreased as the carbon intensity regulation is tightened.
- A 'time of use' tariff scheme based on the carbon content of delivered heat, utilising smart metering to calculate half hourly incentives.
- Providing equity loans similar to the Home Energy Efficiency Scheme in Scotland. This encourages homeowners or landlords to make home energy efficiency improvements through the provision of loans that are repaid upon the sale of the property. Such a scheme would include loans for moving to low carbon heating.
- Providing saving schemes designed to support households planning for a future switch to a low carbon heating system, for example saving mechanisms like the Help to Buy and Lifetime ISAs which reward households for saving towards a specific goal.
- Reflecting the value of lower carbon heating solutions in property prices and the taxes paid by households using variable council tax and stamp duty rates.

What would this mean for current heating technologies?

The SEA is technology agnostic and understands that there is no silver bullet in the heat decarbonisation process. As such, a range of solutions will be required, and no options should be disregarded. A carbon intensity standard complements this approach since it does not pick 'winners'. Instead, it identifies and provides the opportunity for the technologies and/or fuels that simply must change in order to decarbonise our heating.

There is a need to decarbonise as soon as is practicably possible. Considering this, existing solutions offering significant carbon savings should be deployed immediately to help avoid the worst potential consequences of the climate crisis.

There is interest in the development of biofuel alternatives to traditional heating fuels, which could be utilised by heating systems that consumers are familiar with, but these are still largely in development or only hold a very small fraction of the market share.¹³ A carbon intensity standard is a means to ensure that the potential for development of bio-alternatives is encouraged whilst also allowing other readily available technologies to be deployed. The regulation will ensure that the most cost-effective, technically feasible low carbon solutions are deployed in a timely manner without limiting available options.

The following section outlines the impact the regulation would have on current heating technologies. The level of the carbon intensity standard influences phase-out rates for each fossil fuel solution and the time at which households will switch to lower carbon alternatives. The technologies are discussed in the order of phase out based on the proposed carbon intensity levels.





Coal Heating

Coal has the highest carbon intensity of all the heating fuels considered. About 170,000 homes are heated by coal. From the introduction of the regulation in 2021, newly installed coal boilers would immediately need a proportion of biocoal (see Figure 3) or would be replaced with a lower carbon alternative heating system. Industry innovations such as the Hydrothermal Carbonisation process developed by CPL Industries create the potential for increasingly higher percentages of biocoal to be produced through the utilisation of waste products.

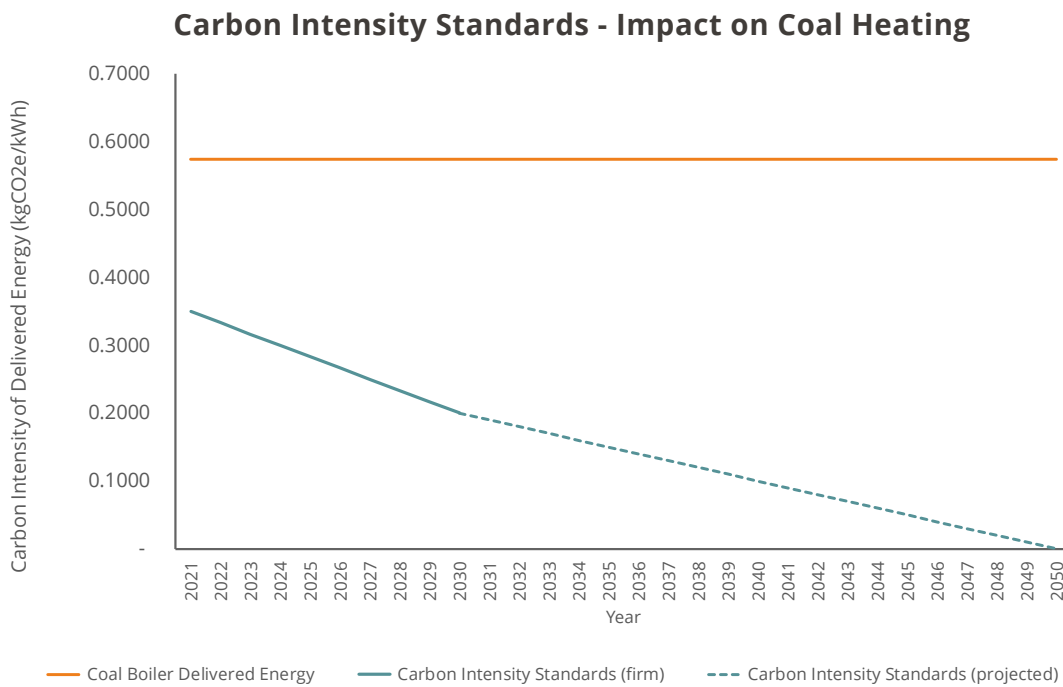


Figure 3: Coal Boilers Compared to the Carbon Intensity Standard

Due to the relatively high carbon intensity of coal, biocoal blends of up to 40% would still sit above the regulated level and so would not be allowed for replacement systems. The further blends that would be needed are shown in Table 2.

Table 2 -Biocoal Blend Proportions Needed Under the Carbon Intensity Standard

Biocoal Proportion	What year will this proportion be needed by?
20%	N/A
40%	N/A
60%	2028
80%	2037
100%	2048



Oil Boilers

Oil boilers are currently the main heating method used in off-gas grid homes with approximately 1.5m homes using oil as their primary heat source.¹⁴ Under the regulated level of the carbon intensity standard, they would be permitted to be installed with the conventional heating oil until 2024 (see Figure 4). After this point, the carbon intensity of delivered heat would need to be lowered for oil boilers to remain a viable option as we decarbonise heat.

Carbon Intensity Standards - Impact on Oil Heating

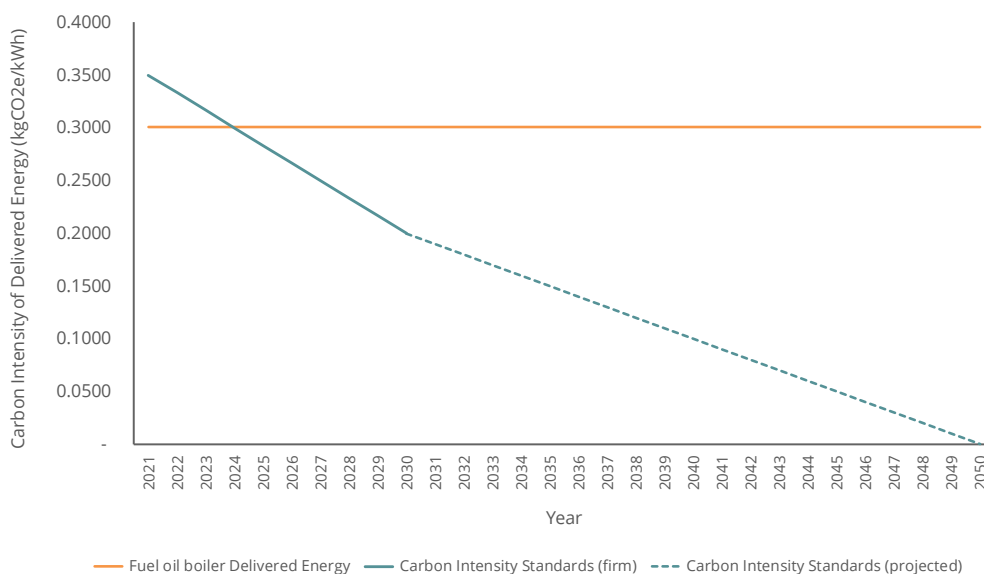


Figure 4: Oil Boilers Compared to the Carbon Intensity Standard

As a mature heating technology, the decarbonisation of oil boilers is more likely to be delivered through the development of a lower-carbon fuel rather than through improvements to boiler efficiency alone. The proportion of bio-oil (biodiesel considered in this case) would need to increase over time in the heating systems installed after 2024, the levels of which are shown below.

Table 3 - Bio-oil Blend Proportions Needed Under the Carbon Intensity Standard

Bio-oil Proportion	What year will this proportion be needed by?
20%	2028
40%	2032
60%	2038
80%	2044
100%	2050



LPG Boilers

LPG boilers are used in around 193,000 off-gas households in Great Britain, equating to around 5% of all off-gas grid homes¹⁵. Under the regulated level of the carbon intensity standard, installations would be allowed in their current form until 2028 (see Figure 5).

Carbon Intensity Standards - Impact on LPG Heating

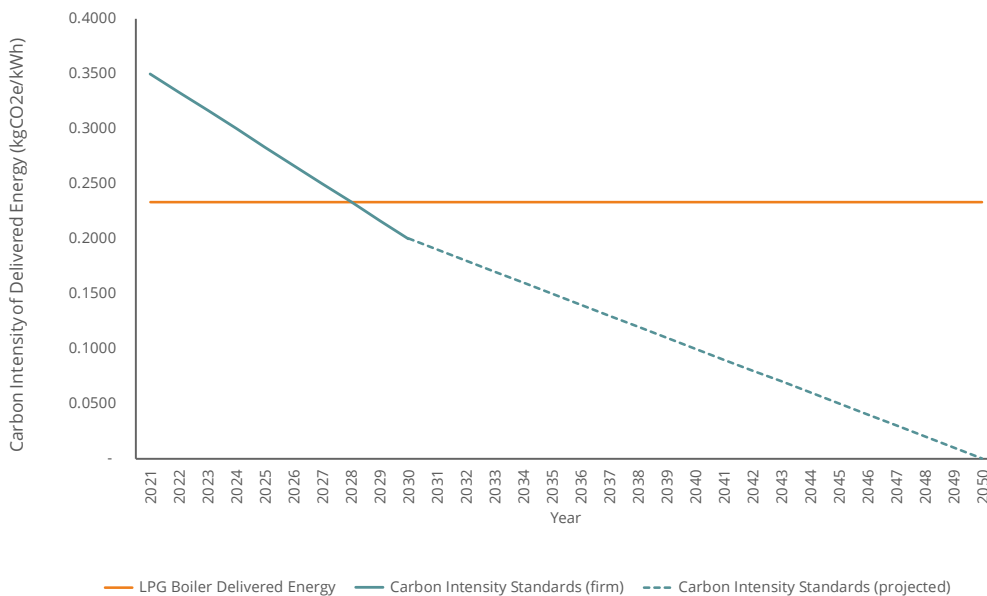


Figure 5: LPG Boilers Compared to the Carbon Intensity Standard

Again, the technology is well established and scope for potential efficiency improvements is limited, so boilers installed beyond this point will require bioLPG blends of fuel (see Table 4).

Table 4 -LPG Boilers Compared to the Carbon Intensity Standard

BioLPG Proportion	What year will this proportion be needed by?
20%	2030
40%	2033
60%	2037
80%	2040
100%	2044



Biomass Heating

Biomass is considered a low-carbon fuel so should be viewed as an important part of the decarbonisation mix. The use of biomass in heating can come through several heating technologies. This means that emissions can be further reduced through the use of more efficient methods of combustion. Despite the range in efficiencies between the technologies, biomass consistently offers carbon savings in the near term that fall well below the regulated level.

Pairing certified fuel sources with more efficient methods, such as pellet boilers, generates a level of emissions today that would be permissible up to the late 2040s based on the potential projected standards post-2030 (see Figure 6). After this point, alternative lower carbon or more efficient combustion methods may be needed but its suitability up until this date may make it an optimal solution for some off grid homes and there is the potential for supply chain decarbonisation to extend this compatibility up to 2050.

Carbon Intensity Standards - Impact on Biomass Heating

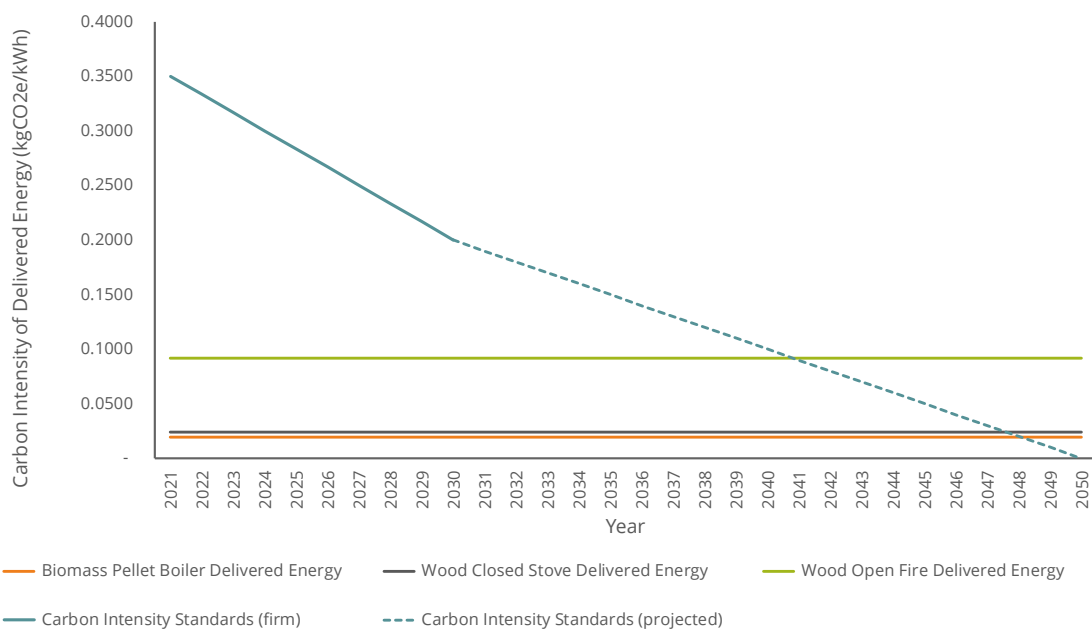


Figure 6: Biomass Heating Methods Compared to the Carbon Intensity Standard



Hybrid Heat Pumps

Hybrids work by combining the carbon saving provision from heat pumps with the use of a back-up boiler. They are normally designed with the heat pump taking the majority of the heating load and the boiler providing heat at times of very high demand or when price signals are favourable to do so. The sophistication of hybrid technologies can vary considerably, from fully integrated 'smart' communication between the two systems to two 'packaged' systems that the consumer selects when to switch on and off.

With hybrid systems installed, considerable carbon savings would be immediately achieved. Under the regulated level of emissions, they would be compliant well after 2030 (see Figure 7). It may also offer a diversified approach to the decarbonisation of heat, as advised by the CCC in their route to net-zero.¹⁶

Due to the variability in operation between hybrid systems, a generalisation has been taken for the average heat load of a heat pump in a hybrid system; the hybrid systems have been modelled with the heat pump taking an 80% share of the heating load¹⁷. This variation between systems could be accounted for when considering hybrid heat pumps under this regulation. However, hybrids should be considered as a complete system, as separating out the technologies under the regulation could overlook the overall benefits achieved. Penalising hybrids based on their current heat generator would be a backwards step as significant savings may be made through improving these systems.

Carbon Intensity Standards - Impact on Hybrid Heating

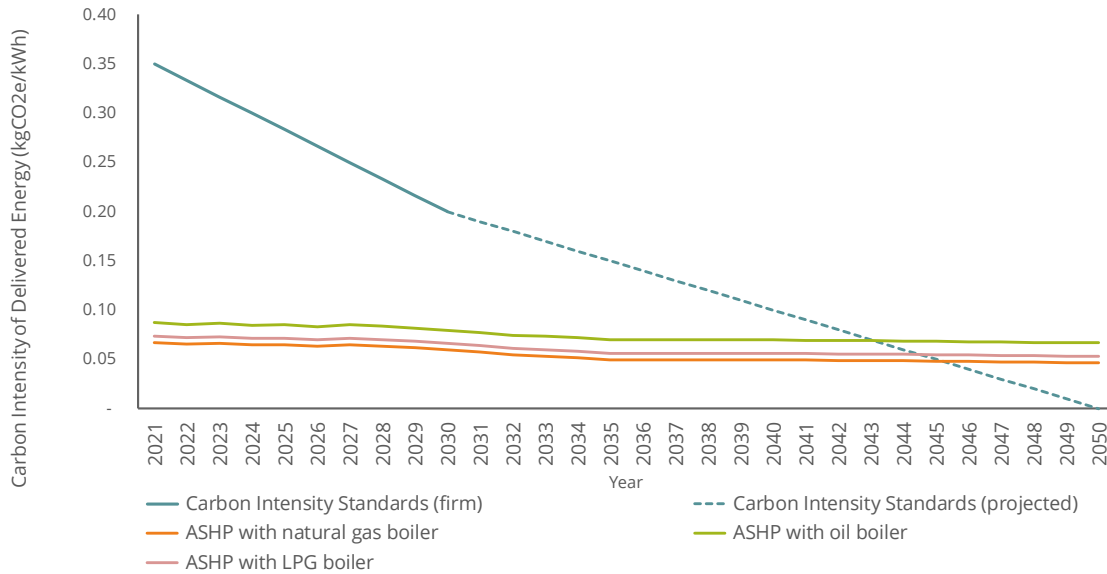


Figure 7: Hybrid Heat Pumps Compared to the Carbon Intensity Standard



Electric Heating

The increase in renewable electricity generation over the past decade has been a huge success story in the UK’s decarbonisation to date. Decarbonisation of the electricity grid looks set to continue, meaning that electricity will become an increasingly clean power supply for heating.¹⁸

Under the proposed regulation, both direct electric heating and heat pumps are on a trajectory that is predicted to be within the requirements of the carbon emissions intensity standard until close to 2050 (see Figure 8). This is based on currently electricity decarbonisation projections. If the full decarbonisation of the electricity supply is achieved, electric heating would of course be net-zero compatible in 2050.

Carbon Intensity Standards - Impact on Electric Heating

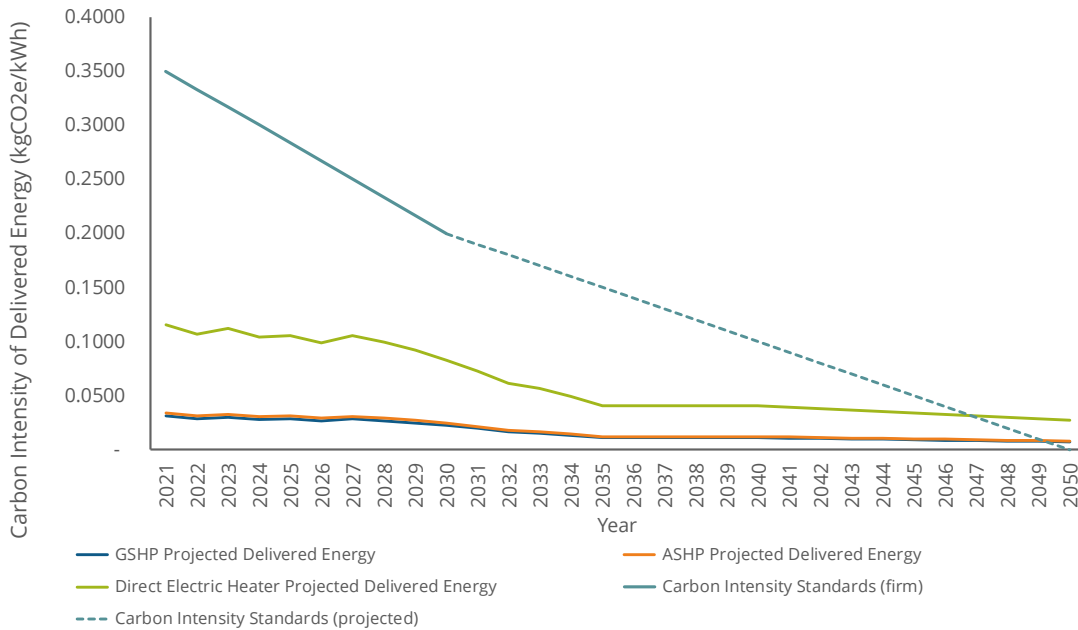


Figure 8: Electric Heating Methods Compared to the Carbon Intensity Standard



Natural Gas Boiler

Although this proposal focusses on off gas grid homes, we recognise that natural gas boilers on the gas grid currently form the vast majority of all heating systems in the country and are reliant on the fuel being delivered through the gas network. The gas supply could be decarbonised through the introduction of hydrogen or biomethane blends. Currently, these can only be blended to a certain extent due to feedstock or technical constraints. Recent trials have shown that hydrogen can be blended into the natural gas supply up to 20%¹⁹, but it is believed that the feedstocks required to supply the whole gas grid with biomethane are not realistic, limiting its potential to around 5% of UK gas consumption.²⁰

The homes currently heated using the gas grid will need to decarbonise, regardless of the approach taken, in order to meet net-zero. This means a decision about the future of the gas grid must be taken before 2030 and ideally in the mid-2020s, as advised by the CCC (see Figure 9).²¹

The roll out of hydrogen through a regionalised approach of industrial clusters is an option currently being explored for the decarbonisation of the gas grid. If such an approach is adopted, it is likely to allow some properties to continue utilising natural gas boilers for longer than others, making the universal approach offered under the carbon intensity standard more complicated to administer.

As shown in Figure 9, the 2030 carbon intensity level proposed would mean that homes on natural gas boilers would be unable to be installed as like-for-like heating systems replacements after this point if the gas grid does not decarbonise in the region. Whilst there is undoubtedly potential for the gas grid to decarbonise, this paper aims to draw on official figures as much as possible. At the time of publication, the Government has not released projections for the decarbonisation of the gas grid, so this has not been accounted for in the modelling.

Ahead of 2030, the applicability of a carbon intensity standard for the gas grid should be discussed and the use of exemptions in areas identified as suitable for hydrogen considered. To completely devolve the exemptions process to local authorities risks overly fragmenting the regulatory landscape for industry. To maintain coherence, exemptions could be granted by an independent body and only apply to larger areas such as combined authorities or industrial clusters with significant potential for hydrogen.

Whilst this approach may be considered sub-optimal for the gas grid due to the complexity of administration, the UK Government needs to set the path for decarbonisation of the gas grid within this parliamentary session. With the primary objective of the regulation discussed in this paper being homes off the gas grid, a different approach may be required for gas connected homes, but it provides a starting point for the conversation and highlights both the complexity of and the need for regulatory decisions to be taken in this area as soon as possible.

Carbon Intensity Standards

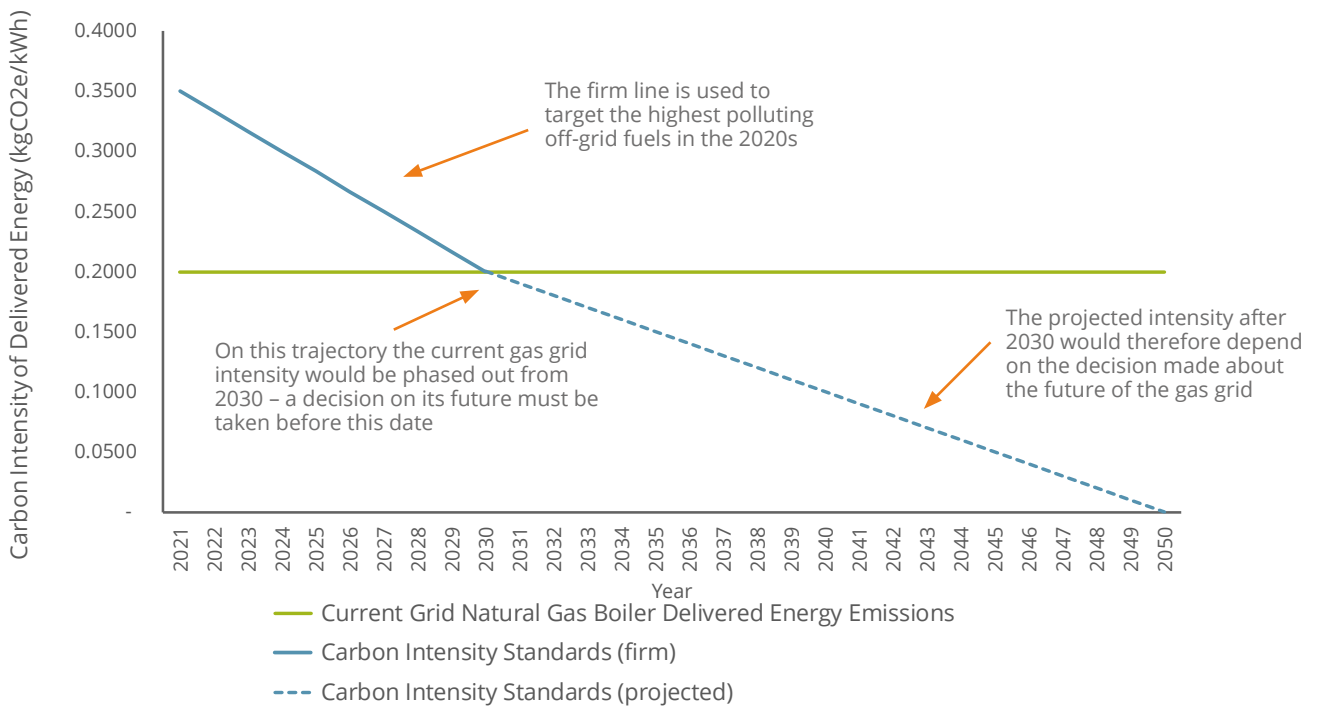


Figure 9: Future of the Gas Grid with a Carbon Intensity Standard

Next Steps: Different approaches to decarbonisation

Consultation with wider stakeholders has highlighted consensus on the urgent need for regulation to decarbonise domestic heat. The Government must set out a clear roadmap to the decarbonisation of heat in the forthcoming Buildings Strategy. Ultimately, there are different approaches the Government could take to decarbonise heat in off-grid homes. For example, they could opt to ban certain fuels or technologies if they are deemed incompatible with net zero. This may be a simple approach to communicate to the public, but risks decisively shaping the market by picking technologies and discarding some potential solutions which could lead to unintended consequences.

Alternatively, the Government could introduce an overarching carbon intensity standard that maintains customer choice and supports the reduction of carbon emissions from heating and hot water provision in homes, which currently forms 20% of the UK's total emissions²². The regulation would require close collaboration with industry and possibly the establishment of an oversight body to maintain compliance but would create the certainty that decarbonisation of heat will happen. With a clear direction established and confidence provided, industry will react and bring new products to the market that drive innovation and maintain customer choice.

The carbon intensity regulation should be implemented alongside a number of enablers that will help to improve the UK housing stock's energy efficiency and encourage uptake of low-carbon heating. The Government should consider further rebalancing of domestic energy levies to reflect the decarbonisation rates of electricity and gas and encourage consumers towards lowering their consumption. Continued support for energy efficiency improvements will also be crucial in this regard, and in mitigating the rebound effect. A long term commitment to financial support for low-carbon heating will address issues of incrementalism and lower costs for future consumers as greater economies of scale are reached. Finally, the Government should work closely with industry on the establishment of a robust enforcement framework to ensure that installers and accreditation bodies have the resources necessary to maintain compliance and reporting. As this report has focussed on individual heating systems, future collaboration will also be needed to establish how heat networks could be integrated into the regulation.

In summary, we recommend that the Government consults on the introduction of a carbon intensity regulation to support the phase out of fossil fuels in off gas grid homes. The decarbonisation of heat is a significant but manageable challenge if long term trajectories are in place and the Government pledges to work with industry on making it a reality.

Appendix: Data tables

CONVERSION FACTORS		VALUE	UNITS
DEFRA	LPG	0.2145	kgCO ₂ e/kWh
DEFRA	Natural gas (current grid)	0.1839	kgCO ₂ e/kWh
DEFRA	Natural gas (100% mineral blend)	0.1844	kgCO ₂ e/kWh
DEFRA	Fuel oil	0.2678	kgCO ₂ e/kWh
DEFRA	Coal (domestic)	0.3447	kgCO ₂ e/kWh
Assumption	Biocoal	0.0131	kgCO ₂ e/kWh
DEFRA	Biomethane	0.0038	kgCO ₂ e/kWh
DEFRA	Wood (logs, chips and pellets)	0.0156	
DEFRA	Biogas	0.0002	kgCO ₂ e/kWh
DEFRA	Electricity (current)	0.2556	kgCO ₂ e/kWh
BEIS	Electricity (projected up to 2050)		kgCO ₂ e/kWh
FRENCH GOV	BioLPG	0.0600	kgCO ₂ e/kWh
DEFRA	Biodiesel	0.0035	kgCO ₂ e/kWh
Design Efficiencies			
BEIS	ASHP	3.4000	SPF
BEIS	GSHP	3.7000	SPF
BEIS	Gas boilers	0.9200	COP
BEIS	Oil boilers	0.8900	COP
Assumption	Direct electric	1.0000	COP
DECC	Biomass Pellet Boiler	0.8000	COP
DECC	Wood Closed Stove	0.6500	COP
Assumption	Coal Boiler	0.6000	COP
DECC	Wood Open Fire	0.1700	COP
Hybrid Proportions			
WWU	Heat pump proportion	80.00%	

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