# Costing the Earth

*How to decarbonise the UK without undermining competitiveness, hitting consumers or overburdening taxpayers*

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ONWARD

# About Onward

Onward is a campaigning thinktank whose mission is to renew the centre right for the next generation. We exist to make Britain fairer, more prosperous and more united, by generating a new wave of modernising ideas and a fresh kind of politics that reaches out to new groups of people.

We believe in a mainstream conservatism – one that recognises the value of markets and supports the good that government can do, is unapologetic about standing up to vested interests, and assiduous in supporting the hardworking, aspirational and those left behind. Our goal is to address the needs of the whole country: young as well as old; urban as well as rural; and for all parts of the UK – particularly places that feel neglected or ignored in Westminster. We will achieve this by developing practical policies that work. Our team has worked both at a high level in government and for successful thinktanks. We know how to produce big ideas that resonate with policymakers, the media and the public.

We will engage ordinary people across the country and work with them to make our ideas a reality.

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# Summary of the argument

We have at most three decades to deliver the wholesale decarbonisation of the UK economy. The landmark net zero target, signed into law in June, legally commits the Government to reduce net Greenhouse Gas emissions from 448.5 million tonnes carbon dioxide equivalent ($MtCO_2e$) today to zero by 2050 in order to limit the UK's contribution to global warming to 2 degrees or less. The scale and pace of change required is eye-watering.

Thankfully we do not begin from a standing start. The UK has reduced domestic emissions further and faster than any other developed economy. Total Greenhouse Gas emissions have been cut by 44%[1] even as the economy has grown. Power sector emissions have more than halved since 1990. The UK has successfully led international action on climate change for thirty years and continues to be well placed in the development of innovative clean technologies. In particular, the UK's hosting of COP26 in 2020 provides an opportunity for Britain to lead the charge and set out an ambitious policy programme for the future. But policymakers, industry and consumers have a long way to go – and voters, especially younger voters, are demanding they start acting fast.

In recent years, some have seized on environmental reform as a vehicle for radical state expansion and intervention. Political parties in the UK and US have used "Green New Deals" as cover for nationalisation, state subsidy and heavy regulation of corporate and individual behaviour. Beyond complaining about the fallacy of these ideas, the centre right has failed to put forward a positive programme of bold reforms based on market economics, fiscal prudence and concern for the bills of hardworking households and taxpayers. This is the purpose of this paper.

We deliberately base our proposals around six core principles for reform. First, use markets where possible: we will only achieve net zero by harnessing the scale and power of competitive markets. Second, use the state to foster innovation: the UK needs to catch up on R&D and focus public funding on areas where there is the greatest disruptive potential. Third, maximise synergies with other societal challenges to ensure we deliver multiple benefits at once. Fourth, ensure a fair and just transition for the poorest in society and future generations. Fifth, build efficient institutional frameworks that reduce inconsistency and build common endeavour. Sixth, set an example on the world stage to lead the world in climate action.

These principles directly counter the weaknesses of the UK regime at present and should guide any centre right approach to climate and wider environmental policy. The recommendations they guide – summarised in the following pages – are distinctive from the high taxing, heavy spending and state-centric approach of the Left. They would set the UK on a path not just to net zero but to strong clean growth, a prosperous economy, lower cost households, efficient carbon pricing and innovation. As international experience and our own history demonstrates, such a seismic shift in behaviour will only be possible with a strong economy, willing consumers and the benevolence of taxpayers.

# Recommendations

## Recommendations

| Principle of reform | Recommendations for action |
|---|---|
| **Use markets where possible**<br><br>The belief in the power of an open market economy is central to any sensible and moderate plan to deliver net zero. Carbon emissions are an externality which need to be appropriately priced to allow markets to act and investors to deploy resources in sustainable ways. | • Reintroduce the Carbon Price Floor (CPF) to create a predictable, steadily rising carbon price in the power sector.<br>• Replace the current "Contracts for Difference" (CfD) policy with a system of "Carbon Contracts" (CC).<br>• Stimulate investment in low carbon heating by rebalancing VAT – increasing rates on residential gas from 5% to 20% whilst reducing VAT on electricity to zero and removing levies from consumer bills and shifting into general taxation.<br>• Establish a carbon fuel duty escalator, rather than cutting fuel duty.<br>• Introduce Dark Green tariffs to give a guarantee of origin for unsubsidised renewables. |
| **Foster innovation**<br><br>Research and Development (R&D) will be vital to tackling the energy system challenges as we decarbonise our economy. This must be balanced between government action and market incentives in order to achieve the desired future technologies that we are likely to need. | • Sustain energy R&D investment at a level at least in line with the OECD average (as a % of GDP).<br>• Focus R&D on key energy system challenges, including solutions which could be deployed at scale in the 2030s and 2040s to help meet the 2050 target, such as CCUS and Hydrogen. |
| **Maximise synergies**<br><br>It is vital to manage tensions and maximise synergies between decarbonisation and other societal challenges. Any moderate approach will focus on the dual benefits of decreasing carbon-emissions and increasing levels of health and well-being for the public. | • Improve building efficiency by repurposing funding for Winter Fuel Payments into an Energy Efficiency Capital Grant scheme for energy inefficient households.<br>• Change mortgage affordability rules to link mortgage offers to the efficiency of a home, thereby encouraging investment in efficiency upgrades.<br>• Enhance and expand green spaces by setting a target for Local Authorities to reach 20% tree canopy cover in all urban areas.<br>• Deliver a much more stretching afforestation target of 1.4 billion trees by 2050 by redirecting agricultural subsidies towards an enhanced Woodland Carbon Guarantee scheme, and encouraging competition between traditional methods of replanting and wild seeding. |

| Principle of reform | Recommendations for action |
| --- | --- |
| **Ensure a fair transition**<br><br>The centre-right tradition of government living within its means should be maintained. This fiscal prudence will be important in order to make sure that the transition to a zero-carbon economy is one that is just and fair for present and future generations. | • Prepare for falls in tax receipts from fossil fuels by introducing, gradually, a new system of road user charging.<br>• Minimise the impact of decarbonisation on low income households through changes to the tax and benefits system.<br>• Costs will affect the UK's fiscal position and the Government must ensure that debt continues to fall as a percentage of GDP. |
| **Build efficient institutional frameworks**<br><br>Well designed and efficient institutional structures not only ensure that the government and regulators act in accordance with the net zero target, but are key to maintaining accountability across all government departments. | • Create a new Net Zero Secretariat to support the new Climate Change Cabinet Committee, mirroring the National Security apparatus.<br>• Align the fiscal framework with net zero by requiring the OBR and the Committee on Climate Change to report on emissions as part of the annual budget framework.<br>• Expand Ofgem's objectives to include net zero whilst broadening its remit to cover new technologies.<br>• Reframe the Red Tape Challenge and Regulatory Policy Committee (RPC) to consider environmental as well as business costs and benefits. |
| **Set an example on the world stage**<br><br>The UK is a world leader on everything from fintech to the creative arts, and now is also a world leader in tackling climate change given our progress to date and stretching net zero goal. Soft-power and international cooperation must be utilised to encourage a global tide change on this issue. | • End support for fossil fuel projects overseas through Overseas Development Aid and Export Finance.<br>• Maximise the impact of the 26th Global COP in 2020 conference by pushing for an agreement on border carbon adjustments and a global coal phase-out agreement. |

# Reasons to be cheerful

*The progress to date*

The climate debate has transmuted from passive concern to existential fear in a few short years. There is growing political consensus about the need to go further, faster and deeper in our search for cleaner air, clearer oceans and more sustainable ways of life. On the streets of major cities around the world, protests argue for the adoption of radical targets and revolutionary changes to how we move, what we eat, and the products and services we rely on. Policymakers know they need to act but they are struggling to catch up.

The following chapters will set out the problems the UK needs to overcome and propose a detailed plan to safeguard our future. However, in doing so we must not forget about our achievements in the recent past. The UK has already made more progress in tackling climate change than any other developed nation, both domestically and in driving international consensus, and climate change is now a salient issue for everyday people and multinational businesses. We do not start down the road to zero from a standing start – far from it. We must build on that progress, rather than trash our own reputation, if we want to reach our destination.

**Progress over the last 30 years**

- The UK has been at the forefront of international efforts to tackle climate change for forty years. The first world leader to sound the alarm about global warming was Margaret Thatcher in 1989, based on the advice of Sir Crispin Tickell, then British Permanent Representative to the United Nations. In her 1989 UN address, Mrs Thatcher warned of an "insidious danger… as menacing in its way as those more accustomed perils with which international diplomacy has concerned itself for centuries… the prospect of irretrievable damage to the atmosphere, to the oceans, to earth itself." The Intergovernmental Panel on Climate Change, established the year before, owes much to British leadership.
- This leadership has been material as well as rhetorical. Throughout the 1990s, the UK reported consistent falls in greenhouse emissions even as the US and other countries experienced double digit increases in $CO_2$ emissions. In 1997, the then Labour Government committed the UK to a unilateral target of lowering emissions by 20% by 2010 (although this was not met) and in 2007, the Gleneagles Summit led to the first lasting international agreement on climate change. During the first protocol period of 2008–2012, the UK not only met the agreed target of a 12.5% reduction in $CO_2$ on 1990 base levels, but nearly doubled it, cutting emissions by 22%.
- Since 2010, the Government has embraced further reform to deliver further improvements. Key policies include the Renewable Obligation – which was started in 2002 but has scaled up since 2010 – and Carbon Price support, which Ofgem estimate have together decreased UK emissions by 69 million tonnes a year between 2010 and 2018.[2] Contracts for Difference have helped to increase the renewable electricity supply, with the latest figures showing renewables outperforming fossil fuels for a whole quarter in 2019. In 2015 the Government announced the phaseout of coal by 2025 and has since shown global leadership on this issue through the "Powering Past Coal" Alliance.

In July, the UK became the first G20 country to legislate for net zero, pledging to deliver a balanced carbon budget by 2050, making us the first country to set a target consistent with the terms of the Paris Agreement.

**The success of policy changes since 2010**

- The vast majority of progress in decarbonisation has happened in the power sector, where total emissions have more than halved since 1990. This year – 2019 – is expected to be the first full calendar year in which zero carbon sources supplied more electricity than was supplied by fossil fuels. In June the UK achieved its longest coal-free run since records began: the UK lasted 18 days and 6 hours without coal-fired power.[3, 4] For the third quarter of 2019, renewable sources generated more power than fossil fuels for the first time.[5] Based on current policies alone, power will fall in line with the CCC's recommended carbon intensity of 50–100g/kWh by 2030.[6]

This has been achieved in three ways:

- First, the introduction of a GB-specific Carbon Price Support (CPS) in 2013 switched coal for gas, cutting coal's share of total economy-wide carbon emissions from 28% in 2012 to 5.5% in 2018,[7] as the total GB carbon price increased from below £4/tonne (prior to the introduction of the CPS) to nearly £40/tonne towards the end of 2018.[8]
- Second, energy efficiency improvements, including more efficient appliances driven by the EU-wide regulations on energy labelling and minimum standards, the phase out of incandescent light bulbs in 2009 and the EU-led improvements to lighting efficiency up until 2016,[9] has reduced demand for power. Total power consumption fell from a peak of 349TWhs in 2005 to 300TWhs in 2018.[10]
- Third, subsidies for renewable power generation increased the supply of cleaner power. The introduction of subsidies under the Renewables Obligation (RO) and Feed in Tariff (FiT) helped increase renewable sources from 4.56%[11] of the power supply Q1 2006 to 35.8% in Q1 2019[12] and from 2013 the switching of support for large-scale renewables (such as offshore wind) to "Contracts for Difference" (CfD) has significantly driven down the cost of renewable energy. The cost of offshore wind fell from £140–150/MWh for projects allocated in 2013, to £39–41/MWh for projects allocated in 2019 (all in real 2012 prices).

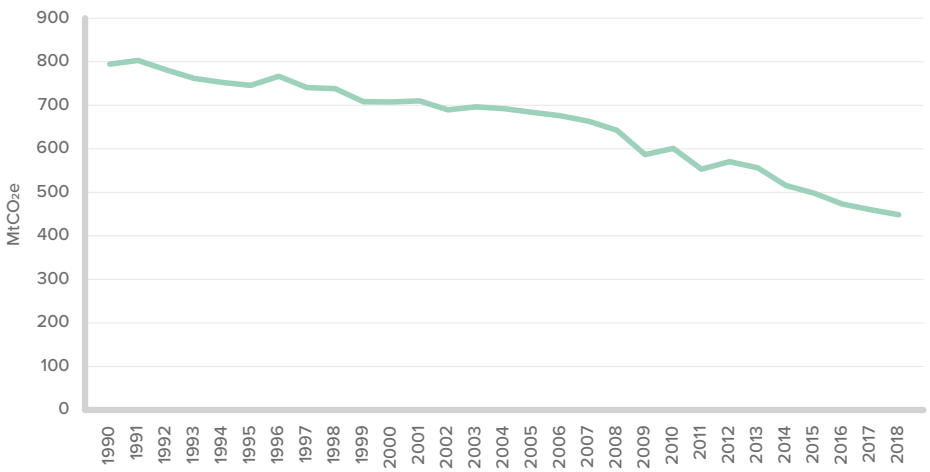
**Figure 1: Offshore wind CfD Strike Prices**


*Source: BEIS, LCCC.*

### The case for further action

The net result of this progress is that the UK has reduced economy-wide greenhouse gas emissions by 44%[13] since 1990 – faster than any other major economic power – while growing the UK economy by two thirds over the same period. But we need to go much further if we are to reduce our emissions and contribution to global warming towards zero.

**Figure 2: Total greenhouse gases in UK, 1990–2018 ($MtCO_2e$)**




*Source: DUKES.*

- There is a clear public demand for environmental action, especially among younger voters. Onward's polling has shown that 62% of 18–24 year olds and 59% of 25–34 year olds support government prioritising the environment over economic growth.[14] This pattern of public opinion is further reinforced by Ipsos Mori polling showing that 85% of people are concerned or very concerned about climate change and 78% of people predicting disaster unless we act fast, an increase of 25 points from 53% in 2013.[15, 16] BMG Research's poll showed that 60% of voters back net zero and only 8% oppose it.[17]
- Quite aside from political salience, the centre right case for environmentalism is a natural argument. In classic Burkean terms, inaction today will only require more drastic and harmful changes later and gradualism is better than revolution. For economic conservatives, there is also clearly a short window of opportunity for the UK to build competitive advantages in clean markets and technology to drive future prosperity.
- But there is a more immediate case for action: the climate debate is increasingly a proxy ideological debate. Unless those on the centre right grasp the environmental nettle, we risk ceding the environmental argument to those – such as Extinction Rebellion and numerous established political parties – whose solutions favour radical state expansion, rising tax and spend, and a regulatory stranglehold on commerce. The question policymakers need to ask is how to achieve net zero without bankrupting the country, hiking charges on consumers or undermining the UK's economic position.

We should be proud of our record on the environment and seek to build on the success of previous reforms as we develop a long-term, achievable strategy to deliver net zero and reinforce the UK's reputation on protecting the environment. This paper sets out a new plan to do just that, based on tried and tested centre right ideas around market incentives, sound money, and long-term institutions.

# The challenge

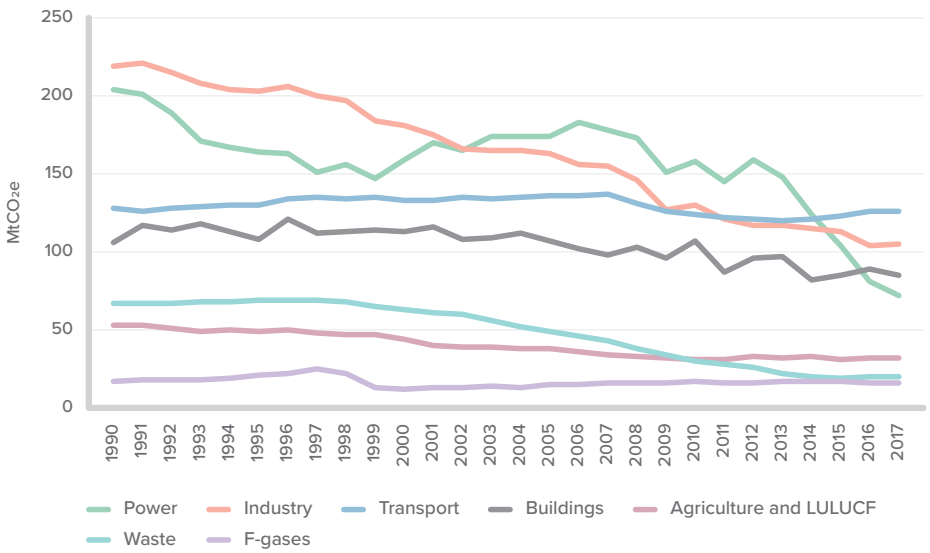
*The problems with the UK's approach to decarbonisation*

This chapter explores the core problems to be overcome in delivering net zero by the middle of this century, which includes both entrenched issues particular to the UK energy market, issues all countries are grappling with, and future technological and cultural barriers to be overcome.

## Despite success in power, progress to decarbonise heat and transport remains slow

- While the UK has successfully reduced fossil-fuel dependency in power, this is not true of two of the other biggest contributors to emissions: heat and transport. In both, poor incentivisation, policy uncertainty and a lack of institutional frameworks have held back progress. Emissions from buildings have fallen by only 20% since 1990.[18] Emissions from transport have actually increased since 2013, as fuel economy improvements have been more than offset by an increase in vehicle-miles (particularly for light goods vehicles as we receive more home deliveries).

**Figure 3: Emissions by industry ($MtCO_2e$)**



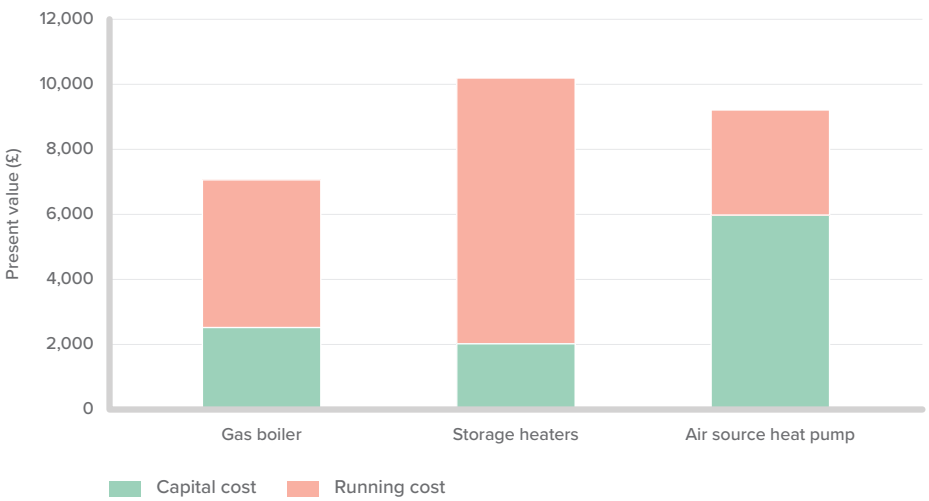

*Source: BEIS (2018) 2017 UK Greenhouse Gas Emissions, Provisional Figures; BEIS (2018) 2016 UK Greenhouse Gas Emissions, Final Figures; CCC calculations.*

- Heating buildings comprises 19%[19] of the UK's carbon emissions, of which more than three quarters – 77%[20] – is from domestic homes. Many are old, drafty, and suffer from poor insulation, illustrated by the fact that just 13.5 million properties have cavity wall insulation, out of a total of 28.1 million properties (69% of properties with a cavity wall).[21] The UK's poor housing stock presents a considerable cost for consumers: high energy costs mean

there are 2.53 million[22] households are in fuel poverty, unable to pay their bills without being pushed into poverty. The social cost of this inefficiency is vast, with over 50,100 winter deaths in 2017–18,[23] and cold homes causing roughly a fifth of those.[24] Putting the vast social costs aside, the estimated financial cost of poor housing to the NHS is £2.5 billion per annum.[25] There is substantial evidence showing the damaging effects of having inefficient homes both economically and at a human level.

- Most heating in the home is delivered by gas. 86%[26] of homes have gas central heating, contributing to 13% of total UK greenhouse gas emissions.[27] Whilst lower carbon alternatives are available, such as electric storage heaters or high efficiency electric heat pumps, consumers are unlikely to shift towards these alternatives due to the incentive structures at play. Specifically, the low unit cost of gas relative to electricity, and low upfront cost of installing a gas boiler, means that gas is the most economic choice for most consumers.
- Figure 4 below compares the lifetime cost of a number of heating options – gas boiler, electric storage heater, and electric air source heat pump – showing both the upfront capital cost, and the lifetime running cost (discounted present value over 20 years). As shown, the capital cost of an electric heat pump is significantly higher than a gas boiler. The high unit cost of electricity relative to gas means that the running cost saving of a heat pump is insufficient to outweigh the higher capital cost. Overall this means that there is insufficient financial incentive for households to switch to alternatives such as a heat pump – despite the lower carbon emissions. To date the Government has tried to overcome this through the provision of subsidy payments for heat pumps under the Renewable Heat Incentive – although even with these in place the uptake of heat pumps has been low.

**Figure 4: Comparison of cost of heating options and present value of 20-year cost**




*Source: BEIS, Ofgem, Energy Savings Trust, Policy Exchange.*

- There are a number of reasons why the unit costs of electricity and gas are so different. Part of the reason that electricity is expensive is that retail prices include a number of levies to fund investments in renewable power generation. These levies amount to just over 20% of the average household electricity bill.[28] Another reason is that electricity generation is subject to carbon taxes, in the form of the Carbon Price Support and EU Emissions Trading System (EU ETS) mentioned in the next chapter, which are passed through in the wholesale price of power. By contrast, the price of residential gas is not subject to bill levies or carbon taxes.
- The folly of previous initiatives demonstrates the unintended consequences of even the best-intentioned government action to change consumer behaviour. The Green Deal Home Improvement Fund (GDHIF), launched under the Green Deal in 2013, attempted to incentivise households to upgrade the efficiency of their homes. However loans under the schemes included higher interest rates than high street loans, meaning only 35,347 individual households had a measure installed before the scheme was abandoned in 2015. In total, just 15 in every 10,000 households in England and Wales took advantage of the GDHIF.[29]
- The decarbonisation of transport would require a similar cultural revolution. Transport is now the largest contributor of any sector to the UK's carbon emissions, totalling 27.6% or 126 metric tonnes of 456 metric tonnes each year.[30] The UK currently has the fifth highest proportion of passenger car usage in the whole of Europe, and limited public transport, cycling and walking infrastructure makes the UK relatively car-dependent among international comparators.
- The balance of government economic spending has reinforced reliance on passenger cars. Between 2011 and 2017 there was a £358 million, or 11%, decrease in rail spending.[31] The electrification of the railways, despite suffering steep peaks and troughs in funding over many years, stood at 36%[32] of the total railway route in 2017 – by comparison only 6%[33] of passenger cars use alternative fuel. A similar trend has been seen in the investment in cycling and walking infrastructure, which is set to fall 48% by 2020–2021 from 2016–2017 levels.[34] For the year 2017–2018, cycling and walking infrastructure was just 1.6%[35] of total Department for Transport departmental spending.

## The incentives regime for carbon is patchy, complex and highly susceptible to abrupt policy changes

- The number of policies and interventions applied to the UK energy market is so great that the abbreviated list in the Cost of Energy Review ran to three pages. It excluded regulatory rules, codes, licences, and other interventions administered and enforced by at least 19 departments, regulators and non-departmental bodies with responsibility for different aspects of the UK energy and environment framework. As Dieter Helm, the review author, remarked, the number of interventions in the energy sector is "so great that few if any could even list them all".[36] In energy as in tax and markets, complexity is the enemy of efficiency.

- Complexity is compounded by continued chopping and changing in Whitehall. The energy market has been subject to an extraordinary number of interventions in recent years, several of which dragged over many years only to be abruptly halted at the last minute. While it is normal for Whitehall to change its position based on changing political weather or new evidence of value for money or impact, much of these changes have defied conventional analysis. As the Cost of Energy Review makes clear: "it is not possible to make a cost-effectiveness assessment of almost any of the specific policies, despite numerous claims in particular cases. Each partial silo analysis typically leaves out the impacts on all the rest of the energy sector, and indeed other parts of the economy too."[37]

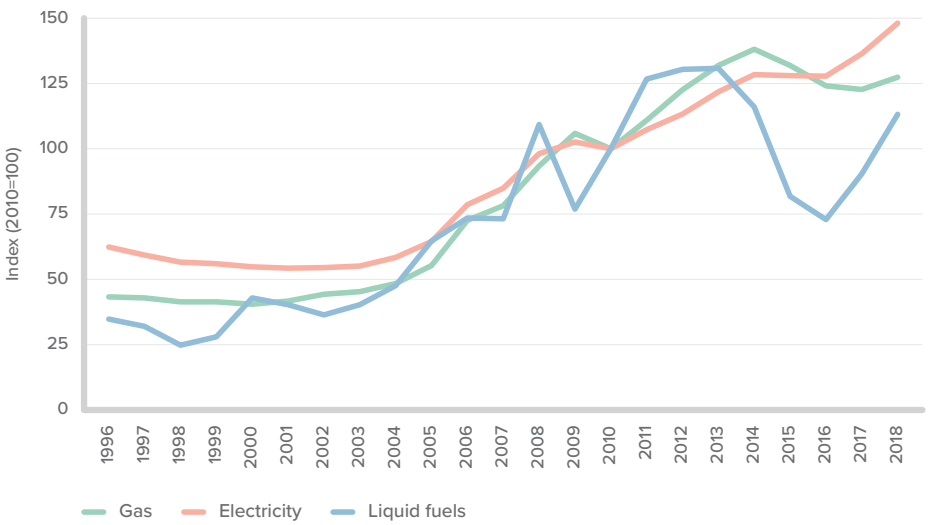
### Table 1: Ineffective incentive regime

| Year | Measure | Notes |
|---|---|---|
| 2000 | Fuel Price Escalator | The measure, first brought in in 1993 under John Major's Government, had steadily risen to be 6% above inflation by 1999. In 2000 the New Labour government abandoned the steadily rising fuel prices and instead maintained it at the rate of inflation. While this was said to be because of rising oil prices, it hindered market incentivisation to find low-carbon alternatives.<br>That Government oversaw an increase in car use as a result: between 1997 and 2007 there was a 12% increase in road traffic (vehicle miles).[38] |
| 2001 | Vehicle Excise Duty (Diesel) | The Labour Government's decision to cut VED on diesel cars on the basis they had lower $CO_2$ emissions proved to have perverse effects when they were then found to produce four times more nitrogen dioxide ($NO_2$) as well 22 times more particulate matter than petrol equivalents.<br>Consumers now face a considerable VED rise on diesel cars, leading to a 34%[39] decline in diesel registrations between 2016 and 2018. Increased awareness about the environmental harm of diesel was also a factor in this. |
| 2013 | Carbon Price Floor | Brought in in April 2013 to support the EU Emissions Trading System (EUETS), it was originally due rise incrementally to £30 (per $tCO_2e$) by 2020. However, the price trajectory was abandoned and capped to £18.08 (per $tCO_2e$) until 2021. |
| 2015 | Carbon Capture (Usage) and Storage | The planned £1 billion investment was scrapped in 2015 six months before the funding was due to be awarded. Technology deemed by the CCC as "essential" in any net zero future.[40] |
| 2015 | Onshore Wind | Onshore wind has seen conflicting messages due to political uncertainties for many years. The Renewables Obligation scheme for new onshore wind was abruptly removed in 2015 and the Government has prevented onshore wind projects from competing in the Contracts for Difference (CfD), despite their low cost. |
| 2015 | Small Modular Reactors (SMRs) | £250m was announced for nuclear R&D in the spending review and autumn statement 2015. Of this, George Osborne – the then Chancellor of the Exchequer – announced that a part of the funding would be for a competition to "identify the best value Small Modular Reactor design for the UK".[41]<br>Phase One of the competition for SMRs (2015–2017) was ineffective and the Government failed to award funding to participants. This indecision over SMR investment has stifled private sector investment in the UK nuclear energy sector. |

## Policy changes have hit consumer bills, undermining living standards for the poorest

- Energy bills made up 4% of average household income in 2016. While this is falling from a peak of 5.1% in 2013, it remains high by recent historical standards and higher than any year between 1997 and 2008.[42] Energy costs disproportionately hit those on lower incomes: the lowest 10% of households spend an average of 8.4% of their income on energy bills, compared to 2.6% of those in the top 10% of incomes.[43]
- Policy changes and consumer levies have meant that energy prices for consumers have risen in spite of wholesale energy costs, especially from renewables, falling in recent years. In the case of electricity, the upward pressure on prices has been due to the increase in consumer levies on bills to pay for policies such as the Renewables Obligation and Contracts for Difference. The sum total of these costs already amounts to £10.1 billion in 2019/20, and will further rise to £11.9 billion in 2023/24.[44]
- The reason for this increase is because older projects that won CfDs a few years ago when prices were higher are now being commissioned. We would expect the spending levels to level off in the mid-2020s, even if we continued holding CfD auctions given the current costs of technology.

**Figure 5: Fuel price index numbers (retail prices)**




*Source: BEIS.*[45]

- This understandably feeds through into popular concern: 28% of the public are worried (very or fairly worried) about paying for energy bills in March 2019.[46] The level of worry over energy bills has remained relatively stable in recent years after falling from a peak of 59% in March 2013, as a result of peaking energy prices for consumers as seen in Figure 5.[47]

## Decarbonisation has clashed with competing government priorities

- Spending battles between the Treasury and rival departments are by no means unique to the decarbonisation debate but the impact on the economy and wider government targets has made these battles more frequent and increasingly bitter, and climate action has often lost out to other priorities.
- For example, the Zero Carbon Homes policy was introduced in 2006 with an aim for all new homes from 2016 to be zero carbon. It was scrapped in 2015 due to the perceived regulatory burden it placed on the construction sector, despite saving new homes occupants an estimated £200 per year on their energy bills and considerably reducing new build emissions.[48]
- The recently approved Private Rented Sector Minimum Energy Efficiency Standards (MEES) regulations, which require landlords to upgrade the energy efficiency of their Band F and G properties to Band E by 2020, with a cap of £3,500 expenditure by the landlord, were substantially watered down in the policy development process. The Government's fixation with the one-in-two-out rule on regulation was a factor in this, as well as the narrow remit of the Regulatory Policy Committee.
- Individual policies may or may not have merited government support. But the pattern of environmental objectives being subjugated below other departmental priorities means the UK has been trying to reduce emissions with one arm behind its back.

## International ambition and action on decarbonisation is insufficient

- Action by the UK alone, however, will be inadequate. The UK contributes less than 2%[49] of global greenhouse gas emissions, compared to 15% from the US and 28% from China.[50] There is little point cutting emissions in isolation: we can only safeguard our own future and that of future generations if we act in concert with other countries.
- This is particularly important given trends in global emissions. China, for instance, has overseen a 321%[51] increase in carbon emissions since 1990 levels, now making it – by some distance – the largest emitter in the world. India has seen a 261% increase in emissions since 1990.[52] Meanwhile, the UK has decreased Greenhouse Gas emissions by over 44% since 1990.[53]
- It is also worth noting that after accounting for "imported" emissions – the overseas emissions created by products and services for UK consumers and businesses, and their import to the UK – the UK has a less impressive record than first appears. Without accounting for imported emissions UK carbon emissions peaked in 1972, but if imported emissions are factored in then the peak happened 35 years later, in 2007.[54] This means that the UK's "carbon footprint" (measured by consumption emissions) was no lower in 2015 than it was in 1990 although our footprint has continued to fall in recent years.

# Solutions

*Why we need a principled centre right approach to decarbonisation*

The objective of most environmental activism has been to put net zero on the national and international agenda and – in this – climate movements have been extraordinarily successful. But the most prominent activists have deliberately stayed clear of solutions and stayed silent on how to deliver the wholesale decarbonisation of developed economies, let alone developing nations where limited access to energy is also a considerable barrier to social and economic development.

Many of the most eye-catching policy answers have so far come from the Left, and have tended to find their answer in the form of the State. The Green New Deal, popularised in the US by Alexandria Ocasio-Cortez and Bernie Sanders, represents an extraordinary expansion of state intervention into green technology, jobs and industry, at a staggering $10 trillion cost to US taxpayers.[55] The recent proposals put forward by those on the Left in the UK to deliver net zero by 2030 similarly see an explosion of taxpayer liability as the engine of accelerated environmental progress, with little regard for the costs involved or current technological capability. We explore these proposals and their costs in greater detail in the coming pages.

The purpose of this chapter is to set out a principled approach to net zero, rooted in a centre right belief in markets, innovation and fiscal prudence. It is guided by six core principles for a fair and sustainable net zero:

1. **Use markets where possible.** The belief in the power of an open market economy is central to any sensible and moderate plan to deliver net zero. Carbon emissions are an externality which need to be appropriately priced to allow markets to act and invest in sustainable ways.
2. **Fostering innovation.** Research and Development (R&D) will be vital to tackling the energy system challenges as we decarbonise our economy. This must be a balance between government action and market economics in order to achieve the desired future technologies that we are likely to need.
3. **Maximising synergies.** It is vital to manage tensions and maximise synergies between decarbonisation and other societal challenges. Any moderate centre-right approach will focus on the dual benefits of decreasing carbon-emissions and increasing levels of health and well-being for the public.
4. **Ensuring a fair transition.** The long centre-right tradition of government living within its means should be maintained. This fiscal prudence will be important in order to make sure that the transition to a zero-carbon economy is one that is just and fair for present and future generations.
5. **Efficient institutional frameworks.** Well designed and efficient institutional structures not only ensure that the government and regulators act in accordance with the net zero target, but are key to maintaining accountability across all government departments.
6. **Setting an example on the world stage.** The UK is a world leader on everything from fin-tech to the creative arts, and now it is also a world leader in tackling climate change given our progress to date and our stretching net zero goal. Soft-power and international cooperation must be utilised to encourage a global tide change on this issue.

## Use markets where possible

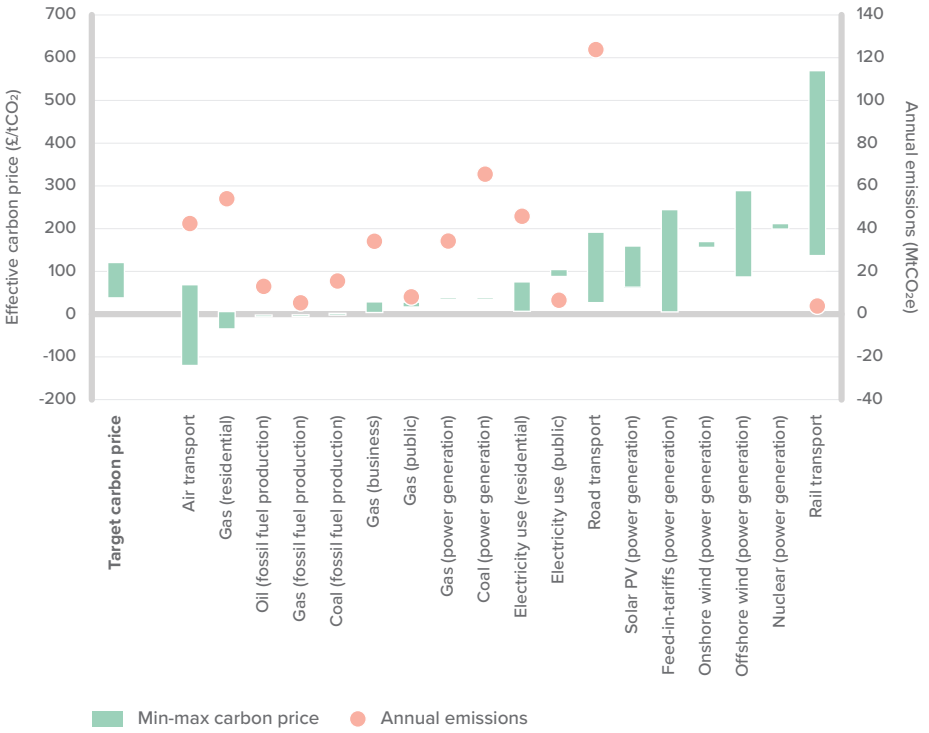
The only way we will ever achieve net zero is by using the power of markets to discover new technologies, fund the industrial transformation and scale the innovation needed to offset and replace existing carbon-emitting activity. However at present inconsistent and inefficient carbon pricing, through multiple tariffs and trading mechanisms, prevents effective internalisation of carbon costs and leads to perverse investment and consumption incentives.

Carbon pricing is a means of control that must be utilised as it can promote cost-effective reduction in emissions, deliver efficient innovation incentives, avoid the risks of picking technology winners, and improve the Government's fiscal condition. As we leave the EU, we will also likely exit the EU Emissions Trading System (EU ETS), creating scope for the UK to rethink its approach towards carbon pricing and introduce a system which helps to deliver net zero without simply avoiding offshoring emissions. It should also be noted that carbon pricing alone will not be sufficient to get to net zero. As this paper shows, carbon taxes and price signals frequently get changed by politicians and so they are not bankable by investors. Legally-binding, long-term contracts – like CfDs – are needed to give investors the confidence to invest.

As Figure 6 shows, there is a substantial disparity between effective carbon prices. For example, residential gas use, which equates to 10–11%[56] of total emissions, has a negative effective carbon price since its use is supported by a 5% VAT rate which is below the prevailing rate for other goods and services. At the other extreme, rail transport is subject to an effective carbon subsidy of up to £568/t$CO_2$.[57] The huge disparity in carbon pricing – visualised in Figure 6 below – creates perverse incentives and inefficiencies, in that we may be pursuing expensive decarbonisation options in some sectors (with high carbon taxes or subsidies), before completing much cheaper decarbonisation options in others (which face low carbon taxes or subsidies).[58] Campaigns such as ZeroC have also called for a General Carbon Tax to combat this issue, which – like the recommendations in this paper – would in effect create a uniform carbon price in order to spur innovation.[59]

Whilst the idea of a general carbon tax is conceptually appealling, it is likely to prove difficult to implement in practice within a single scheme. Therefore this paper would propose a general principle of harmonising effective carbon prices across sectors over time – even if they remain as separate instruments. Carbon prices should converge on a level consistent with meeting the net zero goal – for example to £60–140/tonne by 2030 and £125–300/tonne by 2050.[60] Below we set out some recommendations on steps towards this end goal.

**Figure 6: Effective Carbon Prices by industry**




*Source: Energy Systems Catapult.*

**Recommendation 1**

Reintroduce the Carbon Price Floor (CPF) with a predictable, steadily rising carbon price in the power sector.

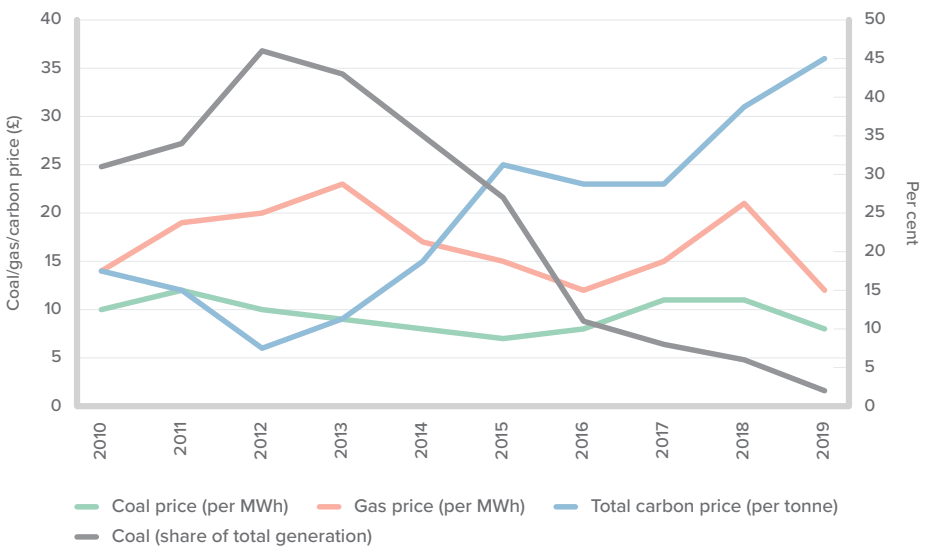
In the power sector, carbon pricing is delivered through the combination of the EU ETS, and a GB-specific Carbon Price Support tax. The EU ETS creates a European wide cap on emissions from large point sources of emissions such as thermal power stations and certain industrial sites. Permits to pollute are then created up to this emissions budget, which are allocated or auctioned to companies. These companies are then able to trade permits (EUAs) between each other, introducing a market for emissions that should ensure that the carbon savings benefit from market competition and are as cheap as possible.

What should work efficiently in theory has not worked in practice. A combination of factors, including the European recession in 2008, energy efficiency improvements, and the rapid expansion of renewables, mean that demand for permits from thermal power stations (i.e. coal and gas) has been lower than expected. This led to a period

of very low EUA prices from 2009 until 2017. In 2011, the UK Government responded by introducing a GB-specific scheme in order to supplement the EU ETS price. This required GB power generators to pay a minimum carbon price, which is referred to as the Carbon Price Floor (CPF). The CPF was originally brought in on 1st April 2013 at a rate of £16 (per $tCO_2e$) and was set to increase to £30 by 2020. The effectiveness of this policy can be seen by the significant falls in coal electricity generation output. Coal generation fell from 46% of total generation in 2012, prior to the introduction of the Carbon Price Support, to just 2% in 2019. This fall in coal generation can be attributed initially to the significant rise in UK carbon price as a result of the introduction of the Carbon Price Support in 2013, exacerbated by a rising coal price from 2015 onwards, and a sharp decline in gas prices in 2019.

Yet in 2014 the Government failed to increase the CPF to £30 by 2020 and it has been capped at £18/tonne ever since. This policy inconsistency – a recurring theme of this paper – has undermined confidence from industry that the Government will follow through on its proposals. It has also disincentivised less carbon-intensive sources of power. Reinstating a steadily rising carbon price floor would mobilise market forces to seek out low-carbon alternatives, steadily drive out fossil fuels while providing certainty to business.

**Figure 7: Commodity prices vs percentage coal generation**




*Source: BEIS, ICE, HMT, Business Insider.*

**Recommendation 2**

Adopt "Carbon Contracts" (CC) as a replacement of the current "Contracts for Difference" policy (CfD).

Whilst a reintroduced Carbon Price Floor would signal an intent to drive decarbonisation through carbon pricing, it may no longer be sufficient on its own. Ministers' failure to consistently apply a rising Carbon Price Floor from 2014 directly undermined the primary market driver of behavioural change – certainty of rising prices – and gives investors and businesses false confidence that government may change its mind again. It is no longer certain.

To date, this problem has been overcome by Government providing subsidies to low carbon technologies, and "de-risking" investments by providing revenue certainty. The current "Contract for Difference" scheme for large scale renewables and nuclear offers high levels of revenue certainty for investors by guaranteeing a fixed price for low carbon generation. This has been highly effective in stimulating investment in low carbon generation, in particular offshore wind (with 19.5GW of offshore wind contracts secured to date). But it has also meant government absorbing significant levels of market price risk, and passing this through to consumers as levies on consumer electricity bills. The total magnitude of these levies has already reached £10 billion per year, equivalent to an average of £370 a year if it was split between every household in the UK. It should be noted that not all of this cost is borne by households, some falls on businesses. Given the pressure this places on disposable income, the Government has rightly signalled that it sees the CfD as transitional, and would like to see renewables delivered through subsidy-free market-based approaches in future.

One way to square this circle would be to replace the Contracts for Difference model with a "Carbon Contracts" model, accessible for all new low carbon generators. The mechanism takes carbon price risk away from generators and investors, but otherwise leaves them fully exposed to market prices and associated risks – which are better borne by the private sector than by Government or consumers.

A Carbon Contract would be similar to the CfD in that it would provide a private law contract between a generator and the Government (via the existing Low Carbon Contracts Company) for new low carbon generation. The contract would provide a guarantee over future carbon prices by compensating generators if the actual future carbon price is below a pre agreed level – for example if Government were to abandon the Carbon Price Floor again in the future.

Contracts would be allocated through a competitive tender akin to CfD model – whereby generators would bid the carbon price they require over the project lifetime in order to proceed with their project (known as a "Carbon Strike Price"). The auction mechanism would have a Carbon Price Cap – set at the social cost of carbon – ensuring that all investments at Carbon Strike Prices below this level have a positive societal value. The tender would auction a fixed amount of TWhs

per annum – in line with what is required by carbon budgets and the pathway to net zero in 2050. This model could be applied to all forms of low carbon generation, including renewables, nuclear and CCS.

**How would payments work under the "Carbon Contract" model?**

Payments would be made on the following basis:

Payment in year t = (Carbon Strike Price – Actual Carbon Price) * (System Carbon Intensity – Project Carbon Intensity) * Total generation (in MWhs)

This structure means that if future carbon prices are high then the generator could receive little or nothing through this contract, but will secure revenues through the wholesale market due to impact of high carbon prices on wholesale power prices. If future carbon prices are low then the generator would receive lower revenues through the wholesale market, but receive a top up through the "Carbon Contract". The System Carbon Intensity could either be the carbon intensity at the time of bidding (simpler to implement) or calculated on a dynamic basis each year over the lifetime of the contract (more complex to predict *ex ante* for investors). The Carbon Strike Price would be indexed with inflation.

The Carbon Contract would be for a given number of TWhs of generation over the project lifetime. One advantage of this model would be that it no longer incentivises generators to keep generating when the power price is well below zero – unlike the current CfD structure.

In theory it could also be extended to other parts of the energy system such as heat – for example a project to inject biomethane into the gas grid, where the System Carbon Intensity would be that of grid gas rather than grid electricity. The advantage of this is that it would allow low carbon projects across a range of sectors to complete on a fair and open basis – ensuring that the lowest cost decarbonisation measures are pursued first.

The CC policy could be rolled out alongside an "Equivalent Firm Power" capacity auction to ensure security of supply, as suggested in the Cost of Energy Review. Projects would be able to bid for both a capacity contract, reflecting their contribution to security of supply, and a Carbon Contract, reflecting their provision of low carbon generation.

Overall, this policy would give low carbon generators a high level of surety over the future direction of carbon prices. Once in place it would also discourage the Government from reneging on its Carbon Price Floor commitment. The payments under a CC model should no longer be seen as a "subsidy" – they are simply an expression of the gap between the prevailing carbon price set by Government, and the carbon price needed to drive to net zero.

**Recommendation 3**

To rebalance carbon prices in the heat sector, the Government should change VAT rates for gas and electricity.

Delivering net zero by 2050 will require the decarbonisation of 866,000[61] homes every year between now and then. This is a forty-three-fold increase on the current rate of heat decarbonisation of 20,000 homes per year.[62] The costs of this are estimated to be £19,300 per home by 2030: to fully insulate a home and fit a low carbon heating appliance.[63] Beyond the pure cost, this is also likely to result in significant disruption to homes. Switching to low carbon sources of heating often causes disruption throughout the homes as even the radiators need to be changed to other ways of distributing the heat such as underfloor heating. Externally insulating a property can significantly change the way it looks.

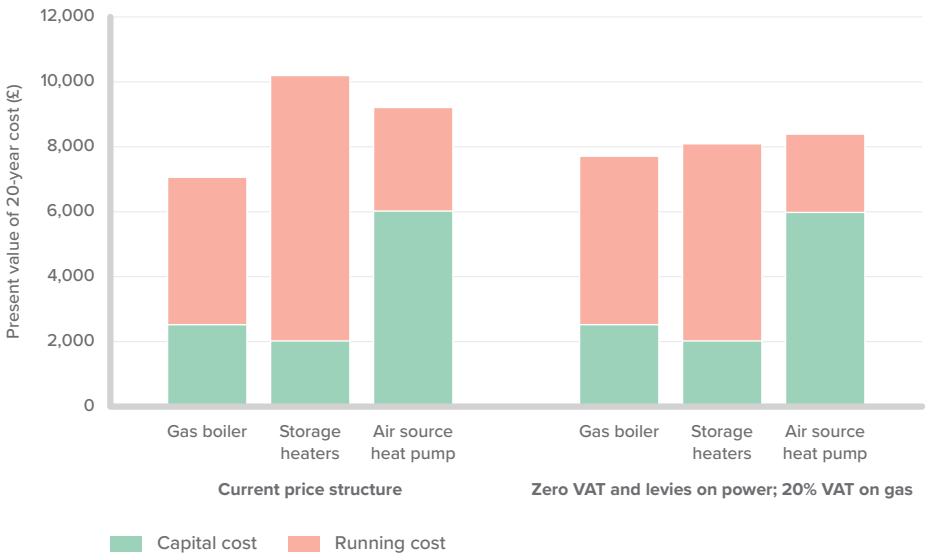
As discussed in Chapter 1, the Government has tried to use subsidies to encourage domestic heat decarbonisation but efforts have not proved sufficient. Takeup of subsidised heat pumps under the Renewable Heat Incentive was extremely low despite generous support, whilst take up of energy efficiency loans under the Green Deal proved not to be a compelling proposition for consumers. As we uncovered in Chapter One, the relative cost of electric heating – electric storage heaters and electric air source heat pump – is significantly higher than that of a gas boiler. This means that the running cost saving of a heat pump is insufficient to outweigh the higher capital cost. Overall this means that at present there is insufficient financial incentive for households to switch to alternatives such as a heat pump – despite the lower carbon emissions.

The Government needs to use other market-based levers to alter these incentives and encourage households to adopt lower carbon forms of heating. VAT should be one of them. In the EU, each country has a standard rate of VAT which applies to most supplies which cannot be less than 15%. Reduced rates – of which countries can have a maximum of two – may be applied to a limited variety of sales and normally cannot be less than 5%. The UK government has chosen to opt for a reduced rate of 5% for electricity and gas in an attempt to keep bills low but once the UK has left the European Union, these rules will no longer apply and the UK will be free to choose VAT levels, including whether they want 0% VAT for some goods and services, in this case: electricity.

The Government should move VAT rates for Electricity from 5% to 0% whilst increasing the VAT rate on gas to the standard rate of 20%. In order to mitigate the impact of this on consumer energy bills, this could be offset by taking environmental bill levies off electricity bills and moving these into general taxation. This would reduce retail electricity prices by a total of 26%. Overall this would significantly reduce the disparity in the effective carbon prices on gas and electricity, harnessing market forces to deliver low carbon heating alternatives.

These changes would be sufficient to bring the "all in" cost of installing and running a heat pump in line with that of a gas boiler, as shown in Figure 8 below, and as the deployment of heat pumps scales up, the capital cost of these units could start to fall further. Importantly, this change will enable the maximum shift in energy use behaviour with the smallest amount of consumer pain – since the changes in the treatment of VAT and levies would broadly speaking balance out for the majority of households who are "dual fuel" (i.e. electricity plus gas users).

**Figure 8: Comparison of cost of heating options by present value of 20-year cost with VAT change**




*Source: BEIS, Ofgem, Energy Savings Trust, Policy Exchange.*

**Recommendation 4**

Establish carbon fuel duty escalator, rather than cutting fuel duty.

There are obvious political advantages to cutting fuel duty. Since 2011, fuel duty has been frozen, meaning that the price of fuel at the pump has been cut by 13% in real terms. In a time of public sector cuts and a struggling economy, this freeze was understandable. However, the freeze oversaw a 4% growth in road traffic in the UK, producing an estimated extra 4.5 million tonnes of $CO_2$.[64] This enormous environmental cost is added to by a £7 billion loss to the Treasury in tax receipts.[65] Any further cuts would be both financially damaging as well as strategically ill-judged if the Government are serious about their net-zero emissions target.

If fuel duty is seen as purely a carbon tax, then it equates to a very high carbon price of £190/t$CO_2$. However, in reality it is a tax on a wide range of negative externalities including carbon emissions, pollution and congestion. Looking at the duty through this lens, the effective carbon price falls to £29/t$CO_2$, which is actually below the target range for carbon prices. Therefore, any reduction of fuel duty would be underpricing the externality even further. So, not only would a cut to fuel duty be financially and environmentally damaging in the short term, but it would also act to further imbalance carbon prices, hindering the vital technological innovation that uniform carbon prices could bring.

When considering fuel duty, the Government should also re-evaluate the treatment on red diesel, which has a significantly lower tax rate. The original rationale for red diesel subsidies, was that it was used in agriculture and farmers should be given a lower rate of tax than ordinary consumers as they do not use roads to the same extent as private motorists. However, red diesel now accounts for over 15%[66] of all diesel despite agriculture only accounting for 1%[67] of diesel use. This is a clear sign that drivers are using the subsidy to take advantage of considerably lower tax (11.14 pence per litre) than that of regular diesel (57.95 pence per litre). Red diesel is also sometimes used in heating in off grid homes, so clamping down on this would help to decarbonise heating too.

One option would be to break out the carbon tax component of fuel duty, and apply a new form of fuel duty escalator to the fuel carbon duty that rises consistently over time. The escalator could start at current level of £30/t (once other externalities are taken into account) and rise to £70/tonne by 2030, in line with the Carbon Price Floor. This would give motorists certainty and ameliorate any sharp price rises at the pump, while increasing the incentive to switch to more sustainable fuel sources over time.

**Recommendation 5**

Encourage patient capital, especially from UK pension funds, to invest in low-carbon assets and innovation.

There is a strong case for encouraging greater investment of patient capital into the low carbon economy to deliver a high rate of environmental return for the country and a high rate of economic return on capital deployed. This could deliver considerable savings to the economy: the OECD has shown that at a global level a 17% increase in the type of investment needed to deliver low-carbon energy systems between now and 2050 would yield an estimated cumulative US $112 trillion in fuel savings.[68]

Pension funds are looking for long-dated assets with inflation protection, a steady yield and which have a low correction to the rest of their portfolio. Assets under pension funds management in the UK total around 105% of GDP at £2.25 trillion.[69] Yet the UK Sustainable Finance and Investment Association found this year that 47% of fund managers have no corporate commitment to achieving the Paris Agreement targets.[70] There is clearly much greater scope for pension savings to be deployed towards low carbon schemes.

The Government has already made a good start in encouraging managers to consider green investment strategies. The Green Finance Strategy compels schemes to clearly and openly explain how they take climate change into account when they invest their assets.[71] The Pensions Regulator has set up a working group to produce guidance for pension schemes about carrying out and reporting a climate risk assessment, with a view to this being put on a sustainable footing. The Pensions Minister, Guy Opperman, has also made clear the short-sightedness of fossil fuel investments at a time when governments around the world are intent on long-term decarbonisation.

Ministers should go further by doing more to use public resources to leverage much greater private investment. This might take the form of the Government actively seeking to create a more effective investment market for low carbon schemes through the development of the green bond market. The UK is unusual among developed countries in not issuing a sovereign green bond and sterling-denominated bond issuance is a fraction of what it is in other countries: in the first six months of 2019, €65 billion worth of green bonds were sold compared with £2 billion in the UK.[72]

**Recommendation 6**

Create a certification scheme for "Green" power tariffs to enable the delivery of new unsubsidised renewables and establish "Dark Green" tariffs for suppliers that create new renewable capacity.

"Green" power tariffs are already provided by many of the major energy providers in the UK. Some end consumers, such as businesses and households, are interested in purchasing green power and are willing to pay a premium for it.

40 suppliers currently offer a green tariff, and there at least 100 green tariffs on the market overall.[73] However, these vary significantly in how they are structured, with some suppliers contracting directly with new renewables to source the green power – meaning they enable additional green power capacity to be built – and others buying Renewable Energy Guarantees of Origin (REGO) certificates to claim they are supporting green power, despite the fact that this does not bring new renewables capacity on to the system. It is therefore difficult for customers to see which green tariffs are truly "green" and which ones are made up of REGOs, which have no impact on the actual amount of green power capacity on the grid.

Firstly, a certification scheme should be established to regulate green tariffs and provide clarity for consumers. This could be done through a traffic-light system which distinguishes between "Dark Green" tariffs, which enable new unsubsidised renewables to be built, and "Light Green" tariffs which purchase power from existing subsidised renewables assets. This could either be formally regulated by Ofgem or administered via a voluntary scheme through an industry body such as Energy UK, Renewable UK or the Renewable Energy Association.

Secondly, a new green certificate scheme should be created for unsubsidised renewables. All new unsubsidised renewables assets would receive green certificates for each unit of low carbon energy that they generate. These would be tradeable with the suppliers offering "Dark Green" tariffs, and sit alongside the existing REGOs system.

This system would create a market-based mechanism to accelerate the deployment of renewables, without relying on Government subsidies. Consumers who want to actively enable the decarbonisation of the power system can pay a premium to do so through a Dark Green tariff, while other consumers are not obligated to pay a premium.

There is already evidence that some consumers are willing to pay this green premium. Some consumers already have a supply deal which fits the definition of the Dark Green tariff above. Through schemes such as RE100, many large corporates have set targets to procure 100% green power, and in many cases have said that they want to demonstrate "additionality" by supporting new renewables rather than simply buying existing renewables – but the market does not provide an easy solution to fulfill their needs.

## Fostering innovation to tackle future issues and address system challenges

The alignment of incentives and removal of inconsistency in subsidies will improve the functioning of energy markets and encourage decarbonisation. However the pressing deadline of 2050 means that accelerated innovation in complex areas such as heating, transport, power and industry is needed. Alongside the improvement of market incentives to maintain competition, the most important tool at the Government's disposal is Research and Development (R&D) funding.

**Recommendation 7**

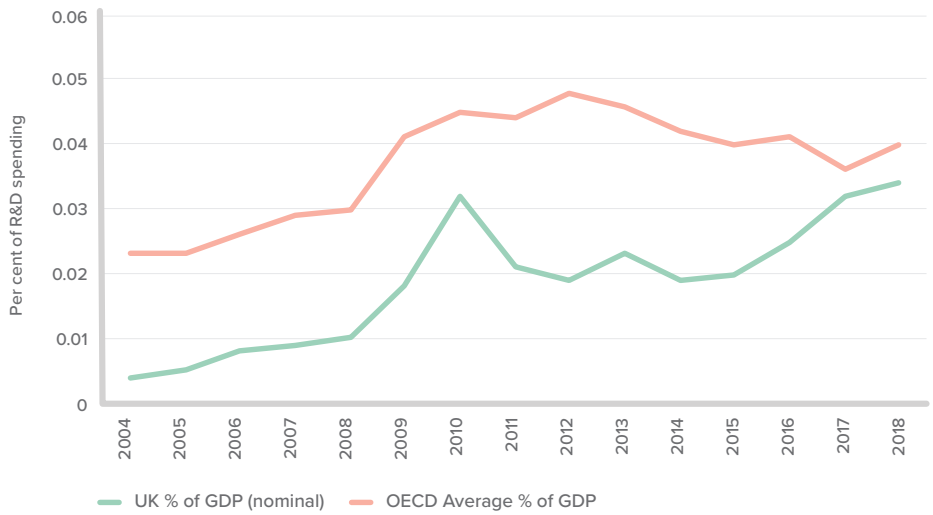
The UK should sustain energy R&D investment at a level at least in line with the OECD average (as a % of GDP).

Overall levels of R&D funding in the UK are currently 30% lower (as a proportion of GDP) than the OECD average. This funding gap has only increased in recent years, as Figure 9 shows. This indicates a lower level of not only investment in but technological innovation from technologies in the UK relative to our immediate competitors and equivalents. Onward has previously made the general case for higher R&D spending, but there is a clear economic case for investing specifically in early stage activity to support industries that are needed to power the future economy.

**Figure 9: Overall R&D spending as a percentage of GDP, UK vs OECD average %**


*Source: ONS.*

**Figure 10: Percentage of Research and Development spending on energy technologies: UK vs OECD average (% of GDP)**




*Source: IEA, Onward Calculations.*

The UK's record on funding energy R&D in particular is not much better. Between 2010 and 2016 the UK spent on average 0.024% of GDP on energy research, compared to an average of 0.044% across all OECD countries. The UK ranks 15th out of OECD countries by this metric[74] – an embarrassment for the fifth largest economy in the world.[75] Figure 10 shows both the disparity between average OECD R&D funding for energy and that of the UK over the last ten years. The UK has increased energy R&D spending since 2016, as part of the UK's Industrial Strategy, and has come a long way towards what is needed. However, it will be important to ensure that this level of investment is sustained, and not subject to cuts as seen between 2010–2015. This extra R&D funding would help to foster the vital innovation that we need in order to achieve net zero carbon emissions by 2050.

**Recommendation 8**

Energy R&D should be focused on addressing key system challenges, focusing on large-scale solutions which could be deployed in the 2030s and 2040s such as CCUS and Hydrogen.

The challenge of net zero will affect all parts of the energy system – including power, heat, transportation, and industry – but it is already possible to identify specific energy system challenges where current technologies are unlikely to be sufficient or cost-effective, and new breakthroughs will be needed to avoid the costs of decarbonisation spiralling.

While it is not the job of this report, or government for that matter, to pick the precise solutions to these problems, there is a role for industrial strategy in directing research efforts towards the range of technologies where we know there is a specific challenge and the greatest promise of it being addressed. Table 2 below sets out some of the key system challenges of the future, such as the need for gas in industry, the management of intermittency, the decarbonisation of heat and large transport vehicles and the range of possible solutions that government might seek to foster.

## Table 2: System challenges and possible solutions: a plan for directed R&D

| System challenges | Possible solutions |
|---|---|
| **Power: challenge of operating a high renewables system**<br><br>A net zero power system is likely to incorporate a large amount of renewables. The key challenge with integrating renewables is the variability of output from sources such as wind and solar. This gives rise to a number of system challenges concerning capacity adequacy (i.e. what will provide power when wind/solar do not), and system operability (what forms of flexibility are required to balance out renewables to meet demand). These system challenges are currently satisfied by thermal generation such as gas, but this cannot carry on unabated in a net zero power system. Current forms of storage such as lithium-ion batteries only provide short duration storage of power. | **Hydrogen**<br><br>Hydrogen has the potential to provide both short and long-duration storage to balance out supply and demand. The stored hydrogen could be used in power or other parts of the energy system such as heating or transport.<br><br>**Carbon Capture and Storage**<br><br>Gas generation can continue in a net carbon system provided the emissions are captured and stored. Gas CCS plants could provide baseload power or flexible power to complement renewables. CCS technology exists but is yet to be deployed on a commercial scale in GB. Opportunities arise for applying CCS across power and industry – although again this is far from commercialised. |
| **Heating: challenge of meeting peak demand in winter**<br><br>As we have already discussed in depth in Chapter Two of this paper, decarbonising heating – particularly in our homes – is an enormous challenge. Currently 86% of our homes are fuelled by natural gas, which causes 13% of our total carbon emissions.<br><br>This challenge is made even more difficult by the fact that heat demand is concentrated in winter, particularly on colder days – meaning that vast amounts of energy need to be delivered in a short space of time.<br><br>The gas system satisfies this need, but cannot continue unabated in a net zero system. | While Biomethane can be a useful substitute for natural gas on a minor level in the short term, Hydrogen is the only gas-based alternative that has long-term potential. Another alternative to natural gas is the use of electric heating, which 9% of UK households already use (although the economics of this are challenging as described above).[76]<br><br>**Hydrogen**<br><br>The introduction of Hydrogen into the heat network could be done by blending Hydrogen with natural gas and other renewable gases or alternatively re-designing and re-engineering the gas network to carry 100% hydrogen. Hydrogen conversion is at feasibility stage, and the next step required is to undertake large scale trials of the technology.<br><br>**Electricity**<br><br>Electric heating could be a solution to decarbonise heating. However, the power system challenges of this – in particular how to deliver sufficient volumes of power during peak demand periods – are enormous. Further research is needed into how to improve the efficiency of electric heat pumps and how to manage system challenges. |

| System challenges | Possible solutions |
|---|---|
| **Transport: Heavy Goods Vehicles (HGVs) and aeroplanes must be decarbonised**<br><br>Limited progress has been made to date in decarbonising transport, as discussed in Chapter 2. For small transport vehicles such as cars and vans, electric solutions have already been developed and are at the stage of mass roll out. The real challenge of the transport sector is how this can be achieved in aviation and with HGVs.<br><br>In the UK, aviation accounts for roughly 7% of our carbon emissions.[77] HGVs are currently estimated to account for around 17% of UK emissions from road transport and around 21% of road transport NOx emissions, while making up just 5% of vehicle miles.[78]<br><br>As the CCC says, aviation will have the largest residual emissions in 2050 of any sector, based on current technologies. Net zero will be much easier and cheaper if we can reduce emissions from aviation and it will potentially be a huge economic prize if we are to crack the solution first. | **Electricity**<br><br>Batteries could potentially be applied in Heavy Goods vehicles. Tesla has already announced the development of the "Semi" electric truck which it says could compete with conventional internal combustion engine technologies. However there are a limited number of companies active in this space.[79]<br><br>There is also the potential for electrification of aviation – with some technologies companies and operators already identifying the potential for use of hybrid planes for short haul passenger flights by the 2030s.<br><br>In both cases, further R&D is likely to be required to fully realise these opportunities.<br><br>**Hydrogen**<br><br>Hydrogen fuel-cells could be well suited to provide the necessary power and range that is required in HGVs and buses. Hydrogen buses are already available but far from commonplace. Further research is required in terms of low carbon hydrogen production and vehicle technology. |
| **Industry: the challenge of providing high temperature heat for industrial processes**<br><br>Beyond the challenges identified above in decarbonising domestic heating, the industrial sector has some more significant challenges concerning how to provide heat for high temperature processes such as metals – in particular aluminium smelters and steel mills – rubber and plastic processing. These processes are currently reliant on natural gas or coke as a fuel source. | **Carbon Capture (Usage) and Storage (CCUS)**<br><br>CCUS is a technology that can capture up to 90% of the $CO_2$ emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere. It is one of the few technologies that has the potential to be "carbon negative" – in that it not only minimises carbon emissions but actually takes carbon out of the atmosphere if biomass is the fuel source (on a full lifecycle basis).<br><br>It is hard to envisage a zero-carbon future without a fully fledged CCS programme, so it must be prioritised in any re-allocation of R&D funding.<br><br>While the Government's stated ambition of "having the option to deploy CCUS at scale… during the 2030s" is positive, there should be a hard target of 2030 for the roll out of CCUS, with trials taking place over the next decade.[80] |

While picking technology winners of the future is not the focus of this report, it is clear that CCUS and Hydrogen continually arise as possible solutions to overcome the identified system challenges. That said, Government-funded energy R&D should also be open to alternative solutions to these identified problems.

As a further caveat, R&D spending should only focus on solutions that are workable in the next three decades, and redirect investment from longer-term technologies – such as Nuclear Fusion[81] – towards these shorter-term solutions. This will quicken the pace of innovation in these vital technologies and increase the possibility of the 2050 target being achieved.

## Maximising synergies of decarbonisation and other agendas

The decarbonisation of the UK economy is undeniably a momentous task, but with it will come great benefits to people's health and well-being. There are a number of areas where this can be foreseen, such as the health benefits of reducing air pollution and from healthier lifestyles due to more active travel and more green space in cities. It is vital that these co-benefits of decarbonisation are maximised in the Government's plan and the way that considers the costs and benefits of intervention.

In this section we will explore two areas of Government policy which cut across deacrbonisation and health and well-being, namely: improving building efficiency and investing in green spaces.

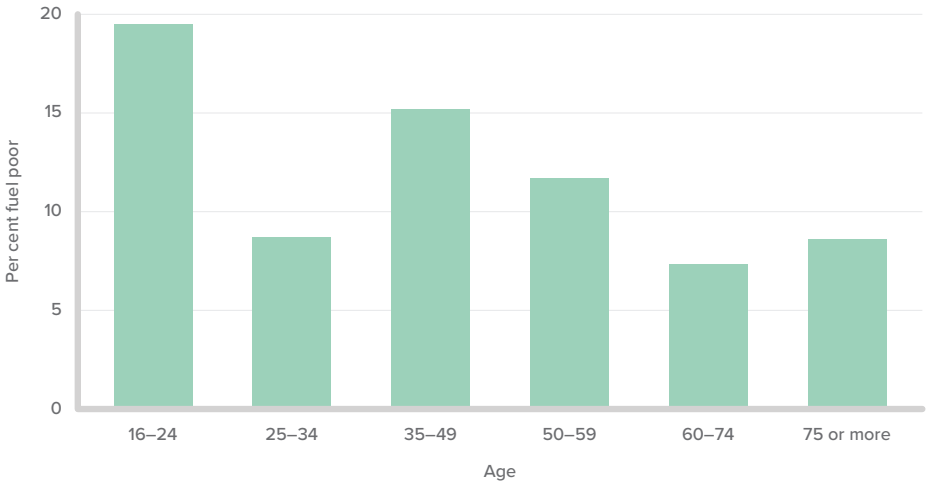
**Recommendation 9**

Winter Fuel Payments (WFP) should be converted into Energy Efficiency Capital Grants for households in fuel poverty.

Winter Fuel Payment is a state benefit for individuals aged over 65, giving recipients an annual payment of between £100 and £300 (the average is £172) to help them pay heating bills. It is intended to cover the additional costs of heating over the winter months for the elderly, but in practice the money can be spent on anything the recipient chooses.

As a policy, it is incredibly poorly targeted. 90% of the recipients are not in fuel poverty and the policy does not distinguish between older people who are in fuel poverty and those who are relatively wealthy. This means that a large proportion of the £2 billion annual cost is spent on households for whom energy costs are financially manageable while 2.5 million households exist in fuel poverty nationwide. While fuel poor households are eligible for Warm Homes Discounts on their energy bills, and receive support for under the Energy Companies Obligation, the imbalance is increasingly difficult to justify, especially as falling pensioner poverty means that, of all age groups, those over the age of 60 are the least fuel poor of any age group.

**Figure 11: Fuel poverty by age of oldest person in household, 2017**




*Source: Fuel Poverty Data 2019.*

The distributional problem compounds a decarbonisation issue: Winter Fuel Payments are likely to *increase* carbon emissions as the benefit encourages higher use of energy, rather than measures to reduce usage and cut consumer bills.

Reform of Winter Fuel Payment is understandably fraught with political controversy. Since the policy's introduction in 1997, governments have been loath to change the system for fear of a backlash among older voters despite the material changes in pensioners' average finances in the intervening period. It is paramount that any reform is sensible, explained properly and does not inadvertently penalise those who need help with their heating in winter.

We propose that the revenue allocation for Winter Fuel Payment should be repurposed as Energy Efficiency Grants to support measures such as loft and cavity wall insulation for fuel poor households. This would require the Department for Work and Pensions and Treasury agreeing to re-allocate this spending as capital funding, which could be overseen and managed by local authorities in a decentralised manner. The net cost – £2 billion per annum – would be the same, and the return on investment would be considerably higher, generating economic activity and long-term savings for households.

If the current £2 billion WFP budget was split between the UK's 4.6 million households with energy efficiency ratings E to G, the Government could offer £436 a year, or an upfront ten-year grant of £4,360 for energy efficiency measures.[82] That would be sufficient for significant energy improvements, moving millions of low EPC rated homes to higher levels of efficiency. To give an idea of the savings this might generate: the average savings on a consumer energy bill generated by moving from Bands E or F to Bands C and D would be in the region of £353 per annum, delivering total annual savings to fuel poor bill payers in the region of £1.6 billion[83] a year, while reducing emissions by an average 1374 $kgCO_2$ per home or 6.3 $MtCO_2$ (million tonnes of $CO_2$ equivalent) overall.[84]

**Recommendation 10**

The Government should review mortgage affordability rules to encourage green mortgages.[85]

There are currently minimal incentives for homebuyers to seek out energy efficient homes. Although the savings in the long-term are clear, there is not enough emphasis in the market to reward energy efficiency at the point of sale. There is limited evidence that home-buyers are willing to pay a premium for more efficient homes, making it less attractive for individuals to make the investment to upgrade their home.

Current mortgage affordability rules do little to help. Historically, mortgage lenders would calculate borrowing capacity by "income multiples". After the financial crash in 2008, the Financial Service Authority (FSA) undertook a Mortgage Market Review to assess mortgage lending practices. Lenders now must make a detailed assessment of income, expenditure, utility bills and other items when calculating the borrowing capacity of a potential buyer. This is positive but fails to specify how energy assessments in mortgage should take place.

Research by UK Green Building Council has shown that these assessments typically do not take into account the energy costs or energy efficiency of the property being purchased, even though such information is readily available at the point of sale through the Energy Performance Certificate. On the one hand, this fails to accurately reflect energy expenditure and efficiency, increasing the risk of defaults and discouraging energy efficiency. On the other, it creates a barrier for prospective buyers of efficient homes, where they may have been able to borrow more once lower energy costs are taken into account.

The Wales Low/Zero Carbon Hub analysis suggests that owners of more efficient properties have energy bills £1,000 lower per annum than owners of less efficient properties. This difference in income should therefore allow the buyer of the more efficient home to borrow an extra £15,600, assuming a typical repayment mortgage with a 5% repayment rate (at the lower mortgage rates seen today of less than 2%, the additional borrowing possible would be much higher still). Despite this huge potential for consumer gain, it still fails to be picked up in the mortgage affordability assessment. As research by both the UK Green Building Council and Policy Exchange illustrates, if mortgage lenders were to include other variables in their assessment such as: EPC rating, dwelling type, size and age, this would significantly improve the accuracy of mortgage affordability calculations.

The Government could usefully work with lenders to improve mortgage affordability calculations, initially on a voluntary basis and enforced through the Mortgage Market Review (MMR) legislation thereafter. MMR rules currently allow "known positive changes" to be included in any assessment for mortgage affordability, however the legislation should be extended and firmed up in order to ensure that these energy efficiency checks are included.

With simple changes to mortgage rules, these changes would have an immediate impact on the 1.5 million households taking out a new mortgage every year and harness the £300 billion or so of private sector mortgage investments to encourage efficiency improvements.[86] They would shift focus of purchasers and lenders alike towards energy efficiency and the running costs of a property. In turn, this would allow purchasers to borrow more if they are purchasing an energy efficient home or if they plan to invest in upgrading the efficiency of a home. This change will then inevitably be reflected in house prices and mean the housing market rewards fuel efficient homes.

**Recommendation 11**

Invest in green spaces to achieve minimum canopy cover target of 20% in urban areas.

Alongside the clear health and happiness benefits of green, open spaces to local communities, tree-planting also remains among the most cost-effective strategies for reducing the UK's carbon emissions.[87] This section proposes for the Government to commit to a 20% canopy cover target by 2035 in all urban areas in the UK.[88]

Many local authorities have failed to protect their urban forests and green spaces. This has most acutely been seen recently in Sheffield. The city has experienced protests, uproar and outrage at their tree-felling programme over the last decade. The "Streets Ahead" project is a 25-year Private Finance Initiative (PFI) to carry out essential restoration works on roads, pavements and bridges. It is this PFI project which has been the cause of the disastrous felling programme in Sheffield. In a 2007 consultancy report, they found that 1,000 street trees were dead or dying and required removing.[89] However, consecutive councils have approved the removal of 5,000 trees by 2017 as a part of this PFI contract. Figures released in 2018 suggest that upwards of 18,000 trees will be lost throughout the 25-year project, from a total of 35,000 street-trees.[90] The root of the problem here is that the scope of the PFI contract is for tree maintenance, and as such the contractors have found it easier and cheaper to remove trees rather than maintain them. Both the council and contractors have overlooked or ignored the positive externalities from maintaining trees and green spaces.

Tree canopy cover is "the layer of leaves, branches, and tree stems that cover the ground when viewed from above".[91] London has one of the lowest and fastest falling tree populations of any major global city. In fact London doesn't even make the top 15 global cities for canopy cover when using MIT's Green View Index: just 12.7% of London is classed as being under canopy cover. The table below shows the poor rating of London in an international context:

**Table 3: Canopy cover by international comparison**

| | Canopy Cover according to the Green View Index (GVI)[92] |
|---|---|
| Tampa | 36.1 |
| Singapore | 29.3 |
| Oslo | 28.8 |
| Sydney | 25.9 |
| Vancouver | 25.9 |
| Montreal | 25.5 |
| Frankfurt | 21.5 |
| Amsterdam | 20.6 |
| Miami | 19.4 |
| Boston | 18.2 |
| Tel Aviv | 17.5 |
| Turin | 16.2 |
| Los Angeles | 15.2 |
| NYC | 13.5 |
| Cape Town | 13.4 |
| **London** | **12.7** |
| Paris | 8.8 |

On a more local scale, canopy cover in the UK is extremely variable depending on which city or town you live in, with richer areas having a disproportionately higher percentage. In the whole of England, measured from 283 towns and cities, canopy cover is on average just 16%. Within this, there is a huge variability between settlements. In Fleetwood, there is just 3% of canopy cover, in contrast to 45% in Farnham.[93] Not only does this data from the Urban Forestry and Woodland Advisory Committee Network (UFWACN) show the poor levels of green space in UK cities, but the data also highlights disproportionately high canopy cover in wealthy areas in the South East and South West, compared to extremely poor canopy cover in de-industrialised towns in the north. A focus on tree cover in these poorer, less green areas will not only assist in benefiting these towns and therefore the health and well-being of their residents, but it will also assist in reducing pollution and carbon emissions.

As the UFWACN set out, the Government could set a uniform target for tree cover in the UK of a minimum of 20% set for an urban local area, to be delivered and reported on by the local authority. This level of canopy cover would improve urban

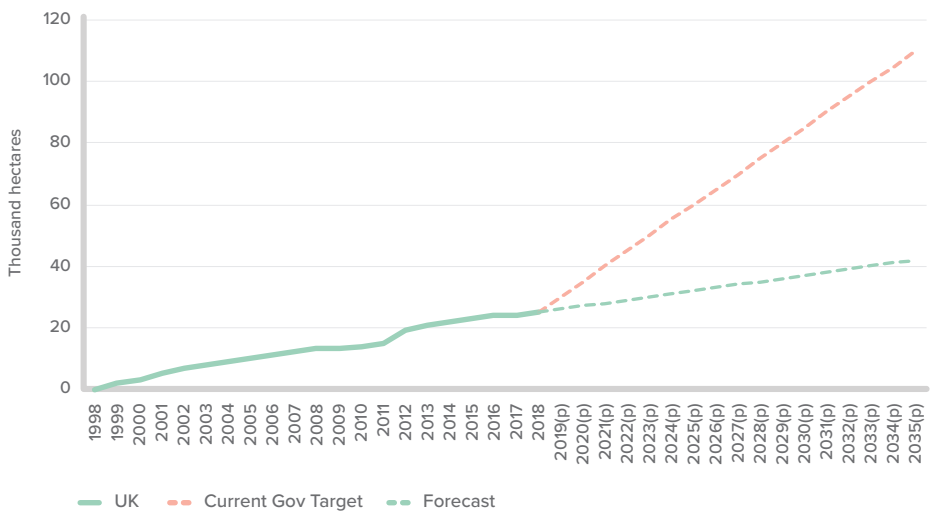
areas, boosting the mental and physical health of their inhabitants, and reducing carbon emissions. If the UK Government is to fully maximise the synergies of a zero-carbon future, reforestation of urban areas must be prioritised.

**Recommendation 12**

Plant 900,000 hectares of forest by 2050 – equivalent to planting 1.4 billion trees – through low cost, high impact methods.

Only 1,420 hectares (3,507 acres) of trees were planted in England in the year to March 2019. This is considerably lower than the Government's target of 5,000 hectares and well below average rates of reforestation in other developed nations.[94] Even against the Government's current target, the UK is currently set to miss its targets by a considerable margin.

**Figure 12: Woodland planting in the UK (1998–2035)**




*Source: Forestry Commission, Natural Resources Wales, Forest Service, National Forest Inventory.*

Yet the Government's own targets are low by international standards. In the quarter of a century between 1990 and 2016, the UK increased its forest area by just over 380,000 hectares, equivalent to 2% of total land mass, despite having less than a third as much forest proportionally than other EU countries. Over the same period, France increased its forest coverage by 18%, or 2.6 million hectares, to cover nearly a third of its total land area.

**Table 4: Afforestation comparison**

| Country name | Population density (people per $km_2$ of land area) 2018 | Forest as share of land area, 1990 | Forest as share of land area, 2016 | Increase (hectares) | Total increase as share of land mass | 25 year rate of growth |
|---|---|---|---|---|---|---|
| United Kingdom | 275 | 11% | 13% | 383,000 | 2 | 13.8% |
| Switzerland | 216 | 35% | 38% | 106,800 | 3 | 9.3% |
| France | 122 | 26% | 31% | 2,666,000 | 5 | 18.5% |
| Ireland | 70 | 7% | 11% | 294,700 | 4 | 63.4% |
| European Union | 121 | 35% | 38% | 13,526,330 | 3 | 9.1% |

This slow rate of tree planting is a huge missed opportunity to realise cost-effective carbon sequestration, as well as the wider environmental benefits associated with tree-planting. The Committee on Climate Change estimates that the cost of carbon sequestration through tree planting is £12/tonne $CO_2$ – which is significantly below the cost of carbon reduction in other sectors. This does not include non-carbon benefits that trees can deliver such as flood alleviation, air and water quality improvements.

The Government has recognised the low rate of tree-planting and has recently scaled up efforts to meet its current targets. It recently announced the Woodland Carbon Guarantee scheme – a £50m programme to encourage reforestation by farmers and landowners – as well as a commitment to planting 30 million trees per year in the period to 2025. The scheme allows participants to sell Woodland Carbon Units to the Government over a 35-year period at a guaranteed price set by a competitive auction – and therefore provides long-term revenue certainty. It is estimated that it will deliver 10 million trees (or 6,250 hectares).[95]

However, even this policy will not deliver a rate of tree planting sufficient to make a meaningful contribution to climate change mitigation in the coming decades. On this basis we propose a number of policy changes which could accelerate and scale up afforestation activities.

Firstly, agricultural policies could be changed following Brexit to support activities such as tree-planting, as part of a wholesale shift in agricultural policy towards supporting public goods and natural capital enhancement.

As context, the EU Common Agricultural Policy, currently provides £3 billion of subsidies a year to farmers and landowners in the UK. In the early days of the CAP, these subsidies were tied to production of agricultural goods – and in cases this resulted in excess production and the metaphorical “butter mountains” and “wine lakes”. From an environmental perspective this process was hugely damaging, since it paid insufficient attention to environmental externalities in the way the funding was allocated. It led to the intensification of farming, with increased use of chemicals (which can run off into water courses), the removal of trees and hedgerows (with negative outcomes for biodiversity) and degradation of soil condition (which is bad for carbon sequestration). Reforms in the 1990s and 2000s started to decouple the link to production, and instead tie single farm payments to the ownership of

productive agricultural land; whilst additional CAP pillars were created to support environmental stewardship and rural development. Whilst these reforms mitigated some of the perverse incentives, they arguably have not gone far enough. From a GHG perspective, it is notable that the agricultural sector still contributes nearly 50MT$CO_2$e per annum (9% of total UK GHG emissions) a significant proportion of which is in the form of methane.[96] The linking of Single Farm Payments to agricultural activity, as opposed to woodland creation, still acts as a significant disincentive for farmers to turn their land over to woodland.[97] The CAP remains relatively inequitable, since the largest landowners receive the most money and the capital value of their land holdings remains highly inflated relative to their economic output.

Following Brexit, the UK has an opportunity to fundamentally redesign agricultural and rural funding such that it avoids unintended negative externalities, and instead supports the enhancement of the natural environment by linking payments to the provision of public goods. This could be about carbon sequestration through tree planting or improvements to soil condition, or supporting measures to enhance natural capital and thereby prevent flooding or improve water quality. Such a scheme could be defined to support particular *input* activities that are required, such as tree planting; or in terms of the natural capital *outcomes* that are desired, such as carbon sequestration or water quality improvement. Both options can enable a competitive auction where farmers and other landowners can bid on a transparent and equal basis.

In the first instance, a simple way to scale up the Government's ambition for tree-planting and carbon sequestration would be to reallocate a portion of CAP funding into an expanded Woodland Carbon Guarantee scheme. Meeting the Government's tree planting target in the period to 2030 would require funding to be increased from £50m to around £300m (over the lifetime of the scheme, which extends to the 2050s – or around £10m per annum). However, we believe that as a cost effective form of carbon sequestration, the Government should go much further. Increasing funding further to £65m per annum would allow the Government to increase its tree planting target further to a total of 30,000 hectares of new woodland per year – in line with recommendations in the Committee on Climate Change's Net Zero report. This would deliver 0.9 million hectares of new woodland by 2050 – equivalent to 1.4 billion trees and 16 Mt$CO_2$e of carbon sequestered by 2050.

The Woodland Carbon Guarantee programme could be taken a step further to encourage innovation in methods of delivery. Farmers and landowners could be able to bid in these auctions for a range of different mechanisms to deliver afforestation and carbon sequestration projects. Some may opt for traditional tree-planting with plastic-coated nursery whips, but others would be open to more ecologically-friendly alternatives such as wild-seeding and rewilding (see box below). Voluntary and community groups could also bid in prospective projects – and may be able to deliver at low cost with wider benefits in terms of civil involvement in decarbonisation. The efficacy of all options would be subject to scrutiny, since under the Woodland Carbon Guaranteed programme, all successful bidders must have their woodland projects validated and verified every 5–10 years to confirm the level of carbon sequestration.

### Wild seeding

The core focus of reforestation in the UK has previously been on plastic-cased nursery whips, which are not only unnaturally formed but also cost £1.60 per tree.[98] While there will be cases where the approach of wild-seeding and rewilding is not possible, assisted natural regeneration, in which naturally-appearing seedlings are "liberated" by keeping competitors at bay in their immediate vicinity, could be a more cost effective and rapid approach than plastic cased nursery whips.

There may also be corollary benefits: evidence shows that moderated rewilding efforts increase tourism revenue, as seen by the £5 million a year tourism spending in the Isle of Mull, which government research puts down to wildlife tourism resultant from rewilding.[99]

Such a system of Carbon Units, with the correct funding, could potentially be extended to include an array of other natural capital enhancements such as improving water quality. It could also be extended so that other parties can purchase natural capital outcomes – such as large corporates purchasing tree planting as a carbon offset, or water companies paying farmers to reduce chemical usage or runoff into water courses to improve water quality. Rather than building something from scratch, a system of this kind could be built on existing natural capital or carbon offset markets such as Veridium Labs or Nori (although Govt would need to ensure that schemes are meeting strict environmental and additionality criteria).

Learning from Ethiopia and domestic initiatives like the Woodland Trust, the Government should also consider voluntary approaches to this issue. This could be in the form of community and school-led programs, harnessing the support for environmentalism among younger generations. An equivalent the the Ethiopian initiative would be for DEFRA to work with schools, local authorities and charities to provide all 4.7 million primary school children in English schools with seedlings for planting every year, as part of a nationwide tree-planting initiative in local gardens, parks and planters. A program of this kind would not only be relatively low-cost, thanks to the voluntary workforce, but it would also serve to increase awareness and civic action for decarbonisation.

## Ensure a fair transition and address the fiscal challenges of decarbonisation

The transition to a decarbonised economy requires considerable change, evolution and regeneration. There will inevitably be labour market and fiscal changes as fossil fuel industries decline and new technologies and industries grow. The way in which we consume, move and live will need to adapt to new societal norms. Some of the policies suggested and needed will have distributional effects, and there is a risk that if not designed correctly they will be regressive – either by exacerbating

issues of fuel poverty or shifting demand without considering how to help transition current supply. The "Gilets Jaunes" protests in France, originally over fuel price hikes, are a reminder that environmental debates are double sided. It is essential that:

- Decarbonisation is pursued in a way that minimises overall cost and maximises benefits – this can be done through carbon pricing to let the market decide the most economically attractive options;
- Policymakers manage the distributional effects and avoid wherever possible regressive policy outcomes;
- Support is provided for workers in fossil fuel-dependent industries, be it in re-skilling or transitioning to new jobs; and
- HM Treasury is cognisant of the fiscal implications of decarbonisation, in particular the additional costs to bear and investment needed, and reduced revenue from tax receipts, that will be passed onto current and future generations of taxpayers.

**Recommendation 13**

Prepare for falls in tax receipts by introducing, gradually, a new system of road user charging.

The most significant example of falling tax receipts is fuel duty, which are at risk of decline as we decarbonise the transport sector. In 2019–2020, fuel duty is projected to collect £28.4 billion in receipts and Vehicle Excise Duty is projected to collect £6.5 billion.[100] The current OBR Fiscal Sustainability report 2014 suggests fuel duty receipts could reach upwards of £40 billion by 2030.[101] However this fails to properly account for the likely fall in tax receipts which will take place as road transport is decarbonised. Policy Exchange analysis suggests this if the UK hits its fifth carbon budget targets then tax receipts will be £23 billion lower per year than the OBR is currently projecting.[102] Notably, this analysis was based on hitting the fifth carbon budget, which is on course towards an 80% reduction by 2050: an even steeper decline in revenues is likely if we are to set on a path towards net zero by 2050.

HM Treasury has already changed VED and Company Car Tax rates to reflect the trend towards lower $CO_2$ vehicles. But if anything, the reduction in Company Car Tax rates for zero and low emission vehicles from April 2020 will accelerate the decline in tax receipts. Looking further into the future, the government should consider moving from the current system of taxing fossil fuels and carbon emissions to a system of road user charging. This could be in the form of toll charges, charges per mile or an expansion of congestion charge zones in urban areas, phased in over time to gradually deliver tax receipts without undermining the incentives for switching to low emission transport.

Another option is to introduce a small per-mile charge on driverless vehicles, using the hyper-accurate GPS monitoring on which they rely to measure mileage accurately. If the Treasury did this before the widespread adoption of driverless cars, this would encounter considerably less political opposition which has historically blocked other forms of road user charging.

**Recommendation 14**

Minimise impact of decarbonisation on low income households.

The richest 10% of households consume an average of 12.7 tonnes of oil equivalent compared to 3.3 tonnes consumed by the poorest 10%.[103] However, the decarbonisation of the economy will almost certainly add disproportionate cost to the poorest decile of households because fuel costs are more than three times as high (10% of income) for the poorest tenth of households as they are for the richest tenth (3%).[104] This is not inevitable and policymakers should strive to mitigate it.

**Make decarbonisation policies progressive**

There are a number of examples where decarbonisation policies have hit the poorest households hardest or disproportionately benefited the wealthiest households. For example, the Feed in Tariffs for solar ended up being regressive as they were largely taken up by middle and higher income households and pensioners with available capital to invest in solar panels. In the first three years of the scheme, the poorer half of British households received between £14.2 and £26.6 million less per year than their wealthier counterparts.[105] The long-term effect of this was that richer households received a healthy return on their investment of 10–15% per annum, depending on when they installed the panels, whilst poorer households disproportionately picked up the costs through their electricity bills.

A similar effect is likely to be seen if the widely coveted policy of interest free loans of up to £33,000 for purchasing electric vehicles is implemented. It would in any event cost government an estimated £1,263 per loan in interest subsidy costs assuming they meet their 2030 target.[106] The beneficiaries of such a policy are overwhelmingly likely to be well-off households who can afford the high cost of electric vehicles and are keen to benefit from interest free loans. This will also add considerable deadweight costs due to people using the scheme for purchases they would otherwise have made anyway.

**Ensure progressive outcomes through the tax and benefit system**

In the event that policy provisions do not go far enough in protecting low-income households from regressive costs, compensation could be provided through general tax and benefits changes. Onward has previously made the case for numerous reforms to help those in lower income households, and for the low paid to be first in the queue for tax cuts. Given the enormous costs involved in decarbonising the economy, this is particularly important. The transition to a low cost energy future should not depend on adding a huge tax burden onto low paid households.

**Recommendation 15**

Ensure that the costs of transition are proportionate and that low paid taxpayers are not overburdened by higher taxes or higher levels of government debt.

The table below shows a breakdown of costs associated with reaching net zero. These are derived from the Climate Change Committee estimate that reaching net zero by 2050 will cost between 1–2% of GDP – or around £35 billion per year. If summed over the period to 2050 this implies a total cost in the order of £1.05 trillion. Using this headline benchmark, we condense the costs into shorter timeframes of getting to net zero by 2025 or 2030, which some people argue is a necessary and deliverable timescale for decarbonisation.

These costs are necessarily reductive. However, they are likely to be an under-estimate as they exclude the frictional costs of accelerating decarbonisation activity, for example through the need to train personnel, deploy capital resources over a shorter timescale, or accelerate the deployment of technologies before they have reached maturity. A shorter time scale also reduces the savings that may accrue from innovation or the consistent diffusion of new technology, and inevitably increases the risks of costly disruption or wrong turns. Beyond cost considerations, in some sectors it is simply unfeasible to get to net zero as early as 2025 or 2030, as we explore further below, since the required technology will not be ready to deploy in this timescale.

It should also be noted that the CCC's costing of 1–2% of GDP combines up front capital expenditure with changes in operating costs to 2050. In many cases low/zero carbon technologies have higher capital costs than fossil fuel technologies, but then lower running costs over their lifetime. It should be recognised that there is an up front capital investment requirement which could be many times higher than the aggregate £1 trillion figure mentioned above. Reaching net zero in 2025 or 2030 would involve accelerating this capital investment over a much shorter period, which could present a significant challenge in respect of the capacity of public and private sector players to invest such a significant sum in a condensed period.

**Table 5: Annual costings of net zero by 2019 figures**

| | 2025 | 2030 | 2050 |
|---|---|---|---|
| Annual Cost (by 2018 levels of GDP, rounded to nearest £5bn) | £200 billion (£7,336/household) | £100 billion (£3,668/household) | £35 billion (£1,223/household) |
| % of GDP | 9% | 4.5% | 1.5% |

Taking a more bottom up approach, we now look at three specific challenges we will have to overcome to reach net zero: heat in domestic homes; electrification of road transport; and the electrification of short-haul aviation.[107] In each case we provide

headline figures for the costs associated with getting to net zero emissions in this sector alone, and what this implies as an annual cost if the costs are spread to 2025, 2030 or 2050. As Table 6 below indicates, this approach reveals how costs could conceivably grow to well above £200 billion by 2025 given the costs of transition in specific sectors. In Annex 1 there is a detailed table explanation and methodology which provides context to these figures. The household cost is indicative – and would be expected to accumulate through either higher bills, replacement costs or through taxation.

**Table 6: Annual costings of net zero broken down into specific areas**

| | Challenge | Total CAPEX | Cost per annum | | |
|---|---|---|---|---|---|
| | | | 2025 | 2030 | 2050 |
| Heat in domestic buildings | Replace gas boilers with low carbon alternatives such as electric heat pumps | £180 billion | £38 billion<br>£1,478/ household | £19 billion<br>£739/ household | £6 billion<br>£246/ household |
| | Improvement of Energy Efficiency Standards to Minimum EPC rating of D | £270 billion | £57 billion<br>£2,180/ household | £28 billion<br>£1,090/ household | £9 billion<br>£363/ household |
| Electrify the UK car fleet | Replace all petrol and diesel cars with electric alternatives | £1.11 trillion | £223 billion<br>£8,573/ household | £111 billion<br>£4,286/ household | £37 billion<br>£1,429/ household |
| Electrification of UK short haul airplanes | Replace all of these planes with new electric alternatives | In the region of £100 billion (but hard to estimate since technology not yet commercially available) | £15 billion<br>£592/ household | £8 billion<br>£296/ household | £3 billion<br>£99/ household |

Beyond pure cost considerations, in practical terms, reaching net zero by 2025 or 2030 is also likely to run against some significant capacity issues – in some sectors we do not have the supply chain or workforce in place to deliver everything which is required to get to net zero in such a short space of time. In other cases, the technology envisaged to decarbonise activities will simply not be ready for mass deployment until the 2030s or 2040s.

For example:

- In order to install the amount of heat-pumps required, an extra 270,000 plumbers would be needed in the workforce, nearly tripling current levels. They would also need to be retrained on how to install electric heat pumps as opposed to gas boilers;

- Levels of energy efficiency improvements would need to rise from 166,000 homes per year to 5.2 million per year;
- Battery electric vehicle sales would need to rise from 25,000 in the year to date to over 6 million per year – this is more than the entire global sales of plug in EVs, which currently stands at just over 2 million per annum.
- Electric air travel remains in an embryonic stage, with commercial scale electric short haul planes unlikely to be available until around 2030, and mass roll-out not expected until the 2040s, meaning an earlier target would mean an end to air travel (low carbon options for long-haul air travel will take even longer to be realised given the physical challenges involved).

Overall, a 2025 target means consumers would have to upend the way they stay warm, travel and spend their hard-earned money, most likely hitting the poorest hardest.

## Efficient institutional frameworks

The Climate Change Act 2008 set out a long-term institutional framework for climate action that has been replicated by many countries around the world. It set a framework of five-year carbon budgets to link long-term goals to short term policy delivery and established the Climate Change Committee as an independent advisory body.[108]

However, the wider institutional framework is convoluted and overlapping. The UK has at least five government departments, four regulators, several non-departmental public bodies, and a raft of independent committees and companies with the power to issue or oversee climate action.[109] As the CCC highlighted in their 2019 report, the crossovers of climate change policy are numerous, for instance: MHCLG, DHSC, HMT and BEIS must cooperate on the decarbonisation of heat; DfT, BEIS, HMT must cooperate on the decarbonisation of transport.[110]

Much of this activity takes place away from the centre of government, at arms length from ministers and Parliament, which serves to limit coordination, undermine accountability and create complexity for industry and consumers. We need a stronger framework for cross-departmental action if we are to transform the industrial foundations of our economy to zero-carbon by 2050.

The new Government has rightly recognised this. In October, the Government established a new Cabinet Committee on Climate Change, chaired by the Prime Minister, and a new regulator, the Office for Environmental Protection, which, although not included in the Bill, the Government have made it clear that this body will hold Government to account for its emissions and air quality targets, including the 2050 net zero commitment itself. However there is a need to go further. We propose four institutional reforms to better align incentives and improve delivery across a complex landscape:

**Recommendation 16**

The Government should establish a new civil service unit, the Net Zero Secretariat (NZS), to service the Cabinet Committee on Climate Change.

This would operate in the same way as the National Security Secretariat, which has provided advice and intelligence to the National Security Council (NSC) since its establishment in 2010. This model has proved effective in coordinating the cross-government response to complex terrorist and security threats across multiple actors and – while the threats are different – the magnitude of net zero warrants a similar command structure. Like the NSS, the NZS should be situated in the Cabinet Office and report into a Prime Minister-chaired committee.

The benefits of such an approach would be considerable. It would enable the centre of government to have a unified view on decarbonisation trajectory under current and proposed policies. It would also encourage departments to come forward with new policies and plans to tackle residual emissions, with a strong enforcement mechanism if they were reluctant. Finally, it would maximise synergies and resolve tensions between policies across departments.

**Recommendation 17**

HM Treasury should align fiscal budgets with the net zero target by asking the Office for Budget Responsibility and Climate Change Committee to jointly report on environmental progress alongside the annual Fiscal Sustainability Report.

This would ensure that both the trade offs and synergies between economic growth and environmental action – such as the abandonment of zero-carbon house building and CCS or the reduction of fuel duty – are transparently understood and debated simultaneously in the round, rather than as separate issues. This could in time be extended to include all forms for Natural Capital, building on the work the ONS and DEFRA began in 2011 to incorporate Natural Capital into the UK Environmental Accounts by 2020.[111]

**Recommendation 18**

BEIS should broaden the scope and revise the objectives of Ofgem to include the delivery of net zero by 2050.

The current principal objective of the energy markets regulator, Ofgem, is first and foremost to protect the interests of customers. It does this through promoting value for money, security of supply and sustainability, and ensuring the effective

functioning of markets and competition. While it should remain a consumer regulator, the sustainability objective of Ofgem should be widened to specifically refer to the achievement of net zero.

This would remove perverse incentives where Ofgem activity can inadvertently frustrate progress towards net zero. For example, the price control framework for electricity and gas network, RIIO-2, guidelines discouraging investment which may facilitate decarbonisation, including saying that it would be "premature for GDNs (gas distribution network operators) to begin making material investments in anticipation of a particular scenario" (i.e. the decarbonisation of heat). If network companies leave it until the end of the next price control period (2028) to make such investments, lead in times may preclude meaningful change ahead of 2050, or mean that changes have to happen over a condensed period of time, raising costs.

Ofgem's statutory objectives should be revised to make a specific link to the achievement of the interim targets set by the Climate Change Act. It is not the job of Ofgem to ensure the delivery of these targets (that role falls to BEIS and other departments) but Ofgem should act in a way which facilitates meeting these targets at the lowest cost to consumers.

Ofgem's remit should also be extended to take responsibility for additional parts of the energy system such as heat networks, electric vehicle (EV) charging and hydrogen markets/networks, alongside its existing responsibility for gas and electricity markets. While the Government has already announced plans to regulate EVs and heat networks, there has been some delay in this being fully implemented. We urge the Government to include these activities within Ofgem's remit as soon as possible to ensure they receive sufficient regulatory attention as these important low carbon options are rolled out.

**Recommendation 19**

The Government should reform the Red-Tape-Challenge to include decarbonisation in its assessment of new regulatory interventions.

The Red Tape Challenge was introduced to reduce the regulatory burden on small businesses by creating a gateway for new regulations. The current "one-in-two-out" rule means that for every piece of regulation which adds cost to business, government and regulators must remove regulations with a cost saving of twice as much as the increase. The danger of this approach is that it focuses purely on the cost to business without considering broader environmental or social costs and benefits. On this basis it could be in direct conflict with the achievement of the net zero target – since any policy which achieves decarbonisation through additional costs to business, however small, is likely to be resisted.

A good example is the recently approved Private Rented Sector Minimum Energy Efficiency Standards (MEES) regulations that require landlords to upgrade the energy efficiency of their Band F and G properties to Band E by 2020, with a cap

of £3,500[112] expenditure by the landlord. While the regulations were eventually passed, the final product was substantially watered down due to the narrow-focus of the RPC, which limited the reach of the regulation.

Including decarbonisation in the RPC methodology would ensure that the one-in-two-out rule, does not lead to short-term regulatory efficiency at the expense of the achievement of carbon targets. Despite this change, the RPC should seek to ensure that regulations which are introduced for the purpose of achieving decarbonisation, do so at the least cost to businesses. A reasonable test of the threshold for what is deemed cost effective decarbonisation would be to compare the cost per tonne of carbon saved to the "shadow price of carbon" used by the HM Treasury in Green Book economic appraisals and cost-benefit analyses.

## Setting an example on the world stage

The UK is a world leader on decarbonisation and should seek to remain so. However, such a pursuit is in vain if it is not backed up by international partners: the UK contributes less than 2%[113] of global greenhouse gas emissions, compared to 15% from the US and 28% from China.[114] There is a desperate need – for both achieving the desired goal and not leaving the UK unfairly disadvantaged economically – to ensure that other countries follow suit.

**Recommendation 20**

End support for fossil fuel projects overseas through Overseas Development Aid and Export Finance.

The UK currently offers three types of energy support to countries overseas: Official Development Assistance (ODA), other official flows (OOF) which are controlled by The Foreign Office, and then UK export credit guarantees (UKEF) which are controlled by the Department for International Trade. Between 2010 and 2017, the UK spent £7.8 billion to support energy provisions in developing countries, comprising both Official Development Assistance (ODA) support and non-ODA (including UKEF).

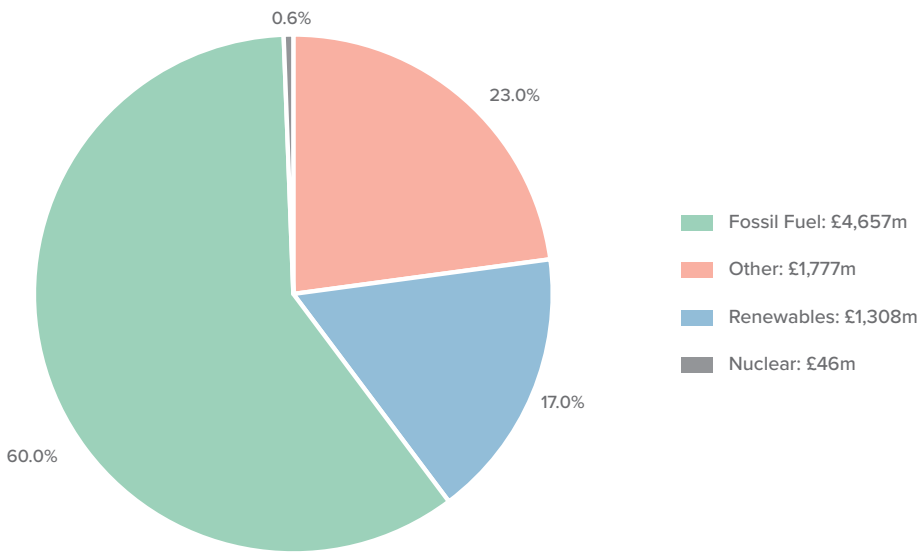
At least 60% of this spending was on fossil energy, as shown in Figure 12. When ODA support is considered alone, the figures improve, but are still counterproductive to the UK and global community's climate goals. 34% are attributed to renewable energy but 22% – nearly a quarter – is still spent on fossil fuels. Moreover, 42% is spent on "Other" which account for sector wide initiatives and projects that involved a mix of renewables and fossil fuels, or where the energy source could not be identified.

Between 2013 and 2018, 96% – £2.529 billion – of UKEF's energy budget was spent on fossil fuel projects, making up 21% of UKEF's whole budget.[115] This is, as the Environmental Audit Committee described, "unacceptable". Through the lens

of net zero it is not just unacceptable but it is counter-productive because any gains we are making at decarbonising at home are being cancelled out by the high-carbon investments overseas.

While we are aware that the Government have recently rejected a similar recommendation from the Environmental Audit Committee, in order to reinforce the UK's role as a world leader in this space and encourage other countries to fall in line, investment in fossil fuel projects overseas by agencies like UKEF must come to an end. This is essential to ensure that the UK delivers a reduction not only in its domestic carbon emissions, but also the UK's overall carbon footprint (including the "embodied emissions" in the goods we import). As shown in Chapter 2, the UK's carbon footprint is falling much more slowly than our domestic carbon production.

**Figure 13: UK support for energy in developing countries 2010–2017**[116]




*Source: Dr Sarah Wykes' analysis from OECD, UKEF and CDC.*

**Recommendation 21**

Maximise the impact of the 26th Global COP in 2020 conference by pushing for an agreement on border carbon adjustments and a global coal phase-out commitment.

Levels of climate ambition differ across countries, meaning that carbon leakage – when carbon emitting corporations go abroad in order to emit more freely – damages the capabilities of countries to aggressively tackle their carbon emissions while simultaneously protecting their competitiveness internationally. Border Carbon

Adjustments (BCA) can assist in creating an internationally uniform carbon price which can level the playing field in competitive markets, prevent carbon leakage and incentivise emitters to strengthen their climate efforts.

As of late, there have been signals from Emmanuel Macron in France and other EU leaders such as Ursula von der Leyen the new EU Commission president, that they would be in favour of using BCAs to create a uniform carbon price on an international level. In a post-Brexit Britain, the Government should work closely with the EU on this. It should become a cornerstone of future policy that is worked into all future UK trade deals. The political economy of such a policy is such that once some countries implement BCAs, others are likely to start to follow suit.[117] Ironically, a BCA policy is one of few decarbonisation policies which would appeal to a Republican US Government, given the ongoing trade wars taking place with China.

On a wider level, the ongoing political atmosphere is changing rapidly on this debate and market-led ideas to counter the anti-capitalism of Extinction Rebellion are in short supply. This internationally uniform carbon price, potentially achieved by the implementation of BCAs, could provide an alternative.

The COP26 summit next year will fall in the midst of huge political pressure and it provides an opportunity for the Government to use this position as host to their advantage and propose BCAs to – for the want of a better phrase – "level up" international carbon prices. We suggest that they should follow the specifications of the High-Level Commission on Carbon Prices and propose an international carbon price of at least US$40–80/$tCO_2e$ by 2020, and US$50–100/$tCO_2e$ by 2030.[118] Building on this, the UK should also use their advantageous position as a part of the Powering Past Coal Alliance to push for a global commitment to the phase out of coal. As we have already outlined in this paper, the UK has decreased it's share of emissions from coal from 28% in 2012 to 5.5% in 2018. The UK is coal-phase out success story and COP26 provides an opportune moment to encourage coal-phase out across the world through a global commitment.

# Conclusion

The climate issue must not be hijacked by anti-capitalists on the left who wish to use the debate as a vehicle for socialist transformation. We must forge a centre-right path towards net-zero emissions that is radical, pro-market, innovation-centred and most importantly does not hit the poorest in society.

This paper has set out six pillars of centre-right thinking: using markets where possible; fostering innovation; maximising synergies; ensuring a fair transition; building efficient institutional frameworks; and setting an example on the world stage. In doing this, we have presented a sensible, pragmatic and fiscally responsible vision for reaching net zero emissions by 2050. In turn, we aim to ignite an era of radical policy development that will hopefully wrestle back ownership of this issue from the left.

# Annex

## Table 7: Specific annual costings of net zero by 2019 figures

| | Importance | Challenge | Capacity | Methodology<br>Cost per household/year<br>Overall annual cost | 2025 | | 2030 | | 2050 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cost per household/ year | Overall annual cost | Cost per household/ year | Overall annual cost | | |
| **Heat in domestic buildings** | 86% of households use gas heating. Net zero means replacing heating systems in 26 million buildings by 2050 – the equivalent of ten times the homes in Milton Keynes every year. | Replace gas boilers with low carbon alternatives (without hydrogen rollout). | The UK currently installs an average 5,000 boilers per day. This means, at current capacity, it is possible to install a maximum of 1.6m new systems in one year. Installing 26 million new heat systems in five or even ten years would be extremely challenging. In order to achieve a 2025 target, an extra 268,409 plumbers would be needed in the workforce (from 145,000 today to 413,409 in 2025). This would triple the current workforce. In order to achieve 2030 target, an extra 61,704 plumbers would be needed in the workforce (from 145,000 to 206,705 up from 145,000), or a 43% increase. These increased labour costs are not factored in to our financial calculations. | The mean cost of replacing a whole heating system for a small semi detached home is £8,426. This is costed for heat pumps because hydrogen and other alternatives will not come online in the short to medium term. The calculated figures are the upfront capital cost needed for the 22.8 million homes that have the capability. | £1,478 | £38.4 billion | £739 | £19.2 billion | £246 | £6.4 billion |

## Table 7 continued: Specific annual costings of net zero by 2019 figures

| | Importance | Challenge | Capacity | Methodology<br>Cost per household/year<br>Overall annual cost | 2025 | | 2030 | | 2050 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cost per household/ year | Overall annual cost | Cost per household/ year | Overall annual cost | | |
| | | Improvement of Energy Efficiency Standards to Minimum EPC rating of D. | The UK currently carries out energy efficiency improvements at a rate of 166,000 per year (year ending September 2019). In order to carry out these improvements by 2025 for 26 million homes, this would need to increase to 5.2 million a year, or to 2.6 million a year for a 2030 target. | The mean price per sq ft of property of internal wall is £5,633. The equivalent price for loft insulation (joists) is £453 and £4,813 for double glazing. At an average cost of £10,899 per household, the overall cost is £283 billion for the 26 million strong UK housing stock. | £2,180 | £56.7 billion | £1,090 | £28.4 billion | £363 | £9.5 billion |
| **Electrify the UK car fleet** | There are currently only 178,000 plug-in electric cars in the UK. Net-zero emissions will require the 31.8 million cars on British roads to become electric. | Replace all petrol and diesel cars with electric alternatives. | There have been severe supply shortages over the last year, with reports of long waiting times of several months from placing an order to receiving an EV. Battery Electric Vehicle sales are only 25,000 in the year to date. In order to achieve net zero by 2025 we would need to ramp this up to over 6 million per year. This is nearly three times the entire global sales of plug-in EVs, which currently stands at £2.1 million per annum. | The whole fleet of 31.8 million cars would need to be replaced by electric alternatives if we are to achieve net-zero in the short to medium term. Using the best selling electric car in the UK – the Nissan Leaf – as an example, the total cost comes to £1.1 trillion. The figures presented are this cost split across the different timeframes for decarbonisation. | £8,573 | £222.9 billion | £4,286 | £111.5 billion | £1,429 | £37.1 billion |

## Table 7 continued: Specific annual costings of net zero by 2019 figures

| | Importance | Challenge | Capacity | Methodology<br>Cost per household/year<br>Overall annual cost | 2025 | | 2030 | | 2050 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cost per household/ year | Overall annual cost | Cost per household/ year | Overall annual cost | | |
| **Electrification of UK short haul airplanes** | There are 1,000 British-owned short haul aircrafts from RyanAir, FlyBe, British Airways and EasyJet. | Replace all of these planes with new electric alternatives. | There is not currently the supply chain capacity or capability to deliver all electric planes by 2030. There will soon be commercially viable small planes for 10 or so passengers, but industry is a long way from having larger planes for a mass consumer segment.At best, these will start to become available from the late 2020s (and even then presumably in small numbers with mass rollout in the 2040s). | The mean cost of a short-haul Airbus airplane is £77million. There are currently 1,000 UK-owned short-haul airplanes in the UK. The lack of data and capacity for electrification means that the best estimation for overall cost is putting them at the same cost as the current fleet. In reality the running costs of electric aircraft would likely be lower and the capital costs would likely be higher than current levels. | £592 | £15.4 billion | £296 | £7.7 billion | £99 | £2.6 billion |

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