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IFS Green Budget Chapter 8

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Tax policies to help achieve net zero carbon emissions

8. Tax policies to help achieve net zero carbon emissions

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Key findings

1. **Greenhouse gas emissions produced on UK soil fell 38% between 1990 and 2018 – the fastest per-capita reduction in the G7.** Over half of the reduction came from electricity getting cleaner. Emissions from international aviation more than doubled over this period.

2. **Emissions reductions will have to accelerate to reach the net zero target.** Emissions fell by an average of 1.4% of 1990 levels per year between 1990 and 2018. They will need to fall by an average of 3.1% of 2018 levels per year from 2018 to reach net zero in 2050. This will be difficult; **many low-cost opportunities to reduce emissions have already been exploited**.

3. The net zero target is based on emissions produced in the UK. **But consumption emissions are 37% higher than production emissions and have fallen by less (29%) since 1990.**

4. There are many policies that implicitly place a tax on some greenhouse gas emissions. **Overall tax rates on emissions vary wildly, including by the source of the emissions and the type of end user.** The incentives to cut emissions are therefore highly uneven. Electricity and road fuel are taxed relatively heavily per tonne of CO_2 equivalent emissions, while emissions from households' gas use and expensive personal flights are effectively subsidised relative to other forms of consumption. **This makes reducing carbon emissions more costly than it needs to be.**

[1] The authors would like to thank Przemyslaw Karpisz and Eu-Wayne Mok for excellent research assistance when writing this chapter.

5 **Renewable electricity generators receive large subsidies, paid for through substantially higher electricity prices.** The government is choosing to support specific emerging technologies, even when more cost-effective options are currently available. This approach may pay off in the long run but entails risks.

6 **The spending of the highest-income tenth of households has a carbon footprint which is, on average, more than three times as large as that of the lowest-income tenth of households.** However, the spending of poorer households is more carbon-intensive, meaning that, to the extent that policies which put a cost on emitting greenhouse gases are passed on to consumers, these costs will tend to take up a bigger share of poorer households' budgets. These policies include ones that affect the price of electricity (which has increased by over three-quarters in real terms in the past 15 years) and gas.

7 **There are clear distributional concerns with increasing the cost of emissions.** There are ways to compensate low-income households, but some households are difficult to reach: **even among low-income households, there is large variation in energy use, for example**.

8 The decision to focus energy efficiency subsidies on low-income and vulnerable households in 2013 led to a collapse in delivery of insulation projects through government schemes. **When combined with the effective subsidy for domestic gas consumption, this gives most households weak incentives to improve their energy efficiency.** Recent attempts at more general energy efficiency schemes have been short-lived and ineffective.

9 **International collaboration would help the UK reach its net zero goal.** Without it, it would be harder to apply carbon prices to international aviation. And it is difficult to see how abatement incentives can be increased for energy-intensive businesses without something – such as a carbon border tax – to tackle the risk they will relocate to countries with looser environmental policies. Seeking and facilitating international policy agreement should be a clear focus of the UK government's efforts.

8.1 Introduction

The UK has set an ambitious, legally binding target to reduce net greenhouse gas (GHG) emissions that arise from UK-based activities to zero by 2050. The 'net' in this target allows for positive emissions so long as they are offset by the removal of greenhouse gases from the atmosphere.

This chapter discusses: the progress the UK has made towards the target and the challenges ahead; the main tax and subsidy policies that have been implemented to discourage GHG emissions and encourage renewable electricity generation; the distributional concerns related to making emissions-generating activities more expensive; and the policy issues that face the Chancellor.

In Section 8.2, we show that the UK has made relatively good progress to date. UK-based GHG emissions have come down by around two-fifths since 1990 – implying a faster per-capita reduction than in any other G7 country. However, the path to net zero will require the UK to accelerate the pace of emissions reductions significantly. Moreover, most of the reduction so far has come from just three industries: energy supply, industrial processes and waste management. Home heating, land transport and agriculture have seen very small reductions to date and will pose a major challenge going forward. Aviation emissions have risen a lot since 1990, although they have stabilised in more recent years. Unlike other countries, the UK has chosen to include its share of international aviation and shipping emissions in its target, thereby making the target more comprehensive but also more ambitious.

Another challenge relates to the emissions embedded in imports. In line with international practice, these are simply ignored for the purpose of the target – i.e. the UK could reach 'net zero' but its consumption of imported goods could still be associated with a high level of emissions. This is a significant issue: emissions associated with UK consumption (including imports and excluding exports) are currently 37% higher than production-based emissions (the basis of the target).

This underlines that the challenge of climate change is a global one. The UK could reach its net zero target and that would have only a marginal effect on total global emissions – it might even increase them if UK policies lead to emissions-generating activities moving to countries with looser environmental policies. One policy solution that is currently being discussed as a way to reduce consumption-based emissions and prevent emissions from simply relocating across borders is to add a tax on imports based on their embedded GHG emissions. The European Commission has proposed a specific Carbon Border Adjustment Mechanism. This would require (or at least function more successfully with) wider international coordination. While we focus mainly on domestic policies in this chapter, the UK's role in helping to design international polices, generating new technologies, and helping encourage mitigation in other countries will be vitally important for tackling global emissions.

There is a wide range of policies – including regulations, bans, grants and planning rules – that the government uses to influence GHG emissions. We summarise in Section 8.3 the main tax and subsidy policies the government operates to try to curb GHG emissions in a number of key sectors and we show in Section 8.4 how these translate into implicit taxes on GHG emissions from various sources and a set of subsidies for renewables. Rather than adopting a uniform carbon price across sectors, successive governments have introduced a patchwork of policies that tax or discourage emissions in various ways. The overall effect is far from transparent and often inconsistent. In summary, existing policies act, in most cases, to increase the cost of generating emissions when burning fossil fuels (either directly – for example, in some manufacturing processes or as transport fuels – or in the generation of electricity) or when creating landfill (which produces methane) – but the extent of the disincentive varies enormously according to the source of the emissions. There are also large subsidies for renewable electricity generation which are directly funded through charges on electricity supply.

In the case of both the taxes and the subsidies, it may superficially look like the government is simply placing a price (through taxes and subsidies) on emissions and allowing market forces to determine the cheapest ways to cut emissions. In fact, to a very large degree, the government is effectively choosing where to incentivise the greatest reduction in emissions and which renewable technologies to support (in recent years, this has involved concentrating support on offshore wind generation). One of the major policy trends over the last decade has been a much more interventionist approach to determining the UK's energy mix. Picking winners in this way may help emerging technologies mature and become more cost effective, but carries risks.

One of the biggest concerns with designing policies to tackle climate change is, justifiably, their distributional consequences. The large increase in the price of electricity over the last 15 years partly reflects the impact of the government's climate policies. By itself, this will have been regressive – low-income households spend proportionately more on energy, although these households also receive help with their energy bills and in installing energy efficiency improvements. The recent increases in gas prices, and the hardship they may cause, starkly illustrate the importance of these issues when considering measures such as applying higher taxes to domestic gas. Setting a clear path for policy in this area, alongside temporary assistance, would give households and businesses time to adjust to permanently higher gas prices. Schemes that compensate people for permanently higher prices can be designed to protect the poorest while still incentivising emissions reductions, but some types of households will be difficult to target help towards. We discuss this in Section 8.5.

Dealing with GHG emissions is a difficult area of government policy. There is a large amount of uncertainty, including about what the most appropriate target is, how technology (such as carbon capture and storage) will develop in future, how to design policies, and what effects they will have. Various governments have made a choice about how far, and by when, to reduce UK net emissions (choices that implicitly contain judgements as to how the costs of emissions reductions should be shared across generations). Choices have also been made – at least implicitly – about how to achieve the emissions reductions to date. We cannot say exactly how the burden of policies will have been shared across different types of households, but they will, ultimately, have been borne by households. Many more choices lie ahead. We discuss some of the options faced by the Chancellor in the Conclusion (Section 8.6), where we argue that policy decisions should be taken actively, with care, and subject to scrutiny. They will shape living standards for decades to come.

8.2 Progress towards the UK's net zero target

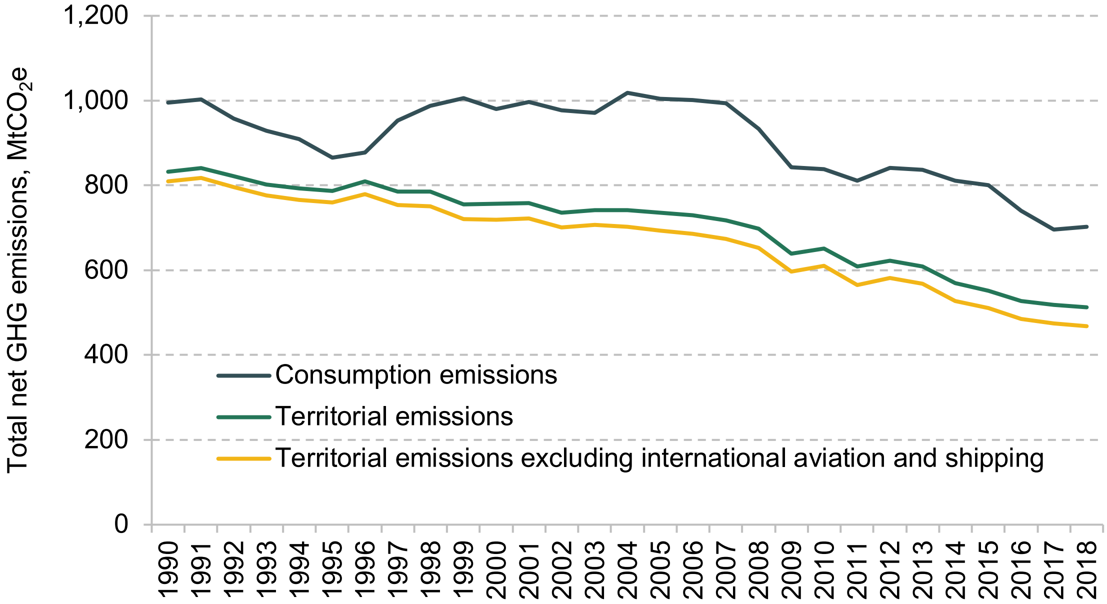
Total emissions since 1990

The UK's emissions have fallen steadily since 1990, even as its economy and population have grown. However, the extent to which they have fallen depends on exactly how GHGs are measured. Figure 8.1 shows the UK's net total GHG emissions under three definitions (in this and later figures, total emissions are measured in tonnes of *CO_2 equivalent (CO_2e)* so as to include other greenhouse gases such as methane, nitrous oxide and hydrofluorocarbons).

Since the 1992 UN Framework Convention on Climate Change, national emissions have been reported on a production (or territorial) basis – i.e. based on emissions that take place on a country's soil. This means that national emissions targets are conventionally set according to this measure. This definition includes emissions generated in producing goods and services for export to other countries and from the burning of fossil fuels that are imported, while excluding emissions embedded in imports and emissions generated when burning the fossil fuels that a country exports.[2] It also excludes emissions from international aviation and shipping. The UK's territorial emissions on this definition fell by 42% between 1990 and 2018.

[2] In principle, the UK could be viewed as responsible for both of these excluded sources of emissions. Since the UK exports roughly the same quantities of fossil fuels as it imports, the exclusion of emissions associated with exported fossil fuels is less important for the UK's current emissions, though it would affect how they changed over time. The UK became a net exporter of primary oils in 2020, for the first time since 2004, but remains (barely) a net importer of natural gas (Department for Business, Energy and Industrial Strategy, 2021a).

Figure 8.1. Annual production- and consumption-based GHG emissions in the UK, 1990–2018



Note: $MtCO_2e$ refers to megatonnes of carbon dioxide equivalent.

Source: Territorial emissions are from table 8.1 in Department for Business, Energy and Industrial Strategy (2021a), and international aviation and shipping emissions are from table 6.1 in the same source. Consumption emissions are from Department for Environment, Food and Rural Affairs (2021).

In April 2021, the UK unilaterally chose to include its share of international aviation and shipping emissions, alongside these territorial emissions, in its net zero target.[3] This addition serves to make the UK's target more ambitious than it already was, and especially so given these sectors are relatively hard to decarbonise. On this measure, which is now the most relevant for judging the UK's progress towards its 'net zero' target, emissions have fallen slightly more slowly – by 38% since 1990.

However, the UK's net zero target is still primarily based on territorial emissions and this raises a problem: stricter environmental regulation or higher environmental taxes in the UK might drive polluting activities offshore and increase the UK's imports of carbon-intensive goods. This would help the UK achieve its own targets, but without reducing global emissions, which are, of course, what ultimately determine the amount of global warming. We return to discuss the policy implications of possible 'carbon leakage' in Section 8.4.

[3] These emissions are calculated using fuel sales in the UK (Climate Change Committee, 2020a).

Figure 8.1 also shows the UK's emissions on a consumption-based measure which captures all emissions generated in the production of goods and services ultimately consumed in the UK.[4] The first thing to notice is that the UK is a net importer of carbon – the emissions related to UK consumption are greater than those from production in the UK. This is unsurprising as the UK is a net importer of goods and a net exporter of services and this is likely to continue to be the case in future. The second thing to notice is that consumption-based emissions fell by 29% over the period 1990–2018: a large fall but a significantly smaller reduction than either measure of production-based emissions. The exclusion of imported emissions in the UK's targets has therefore served to flatter the UK's progress in reducing its consumption-based carbon footprint over the last few decades. In particular, consumption-based emissions were relatively stable until the start of the recession induced by the financial crisis, even as production-based emissions fell. In 2008–09, consumption emissions began falling more rapidly – primarily due to a fall in emissions embedded in imports. They have fallen at a rate similar to production-based emissions since.

International comparisons of emissions

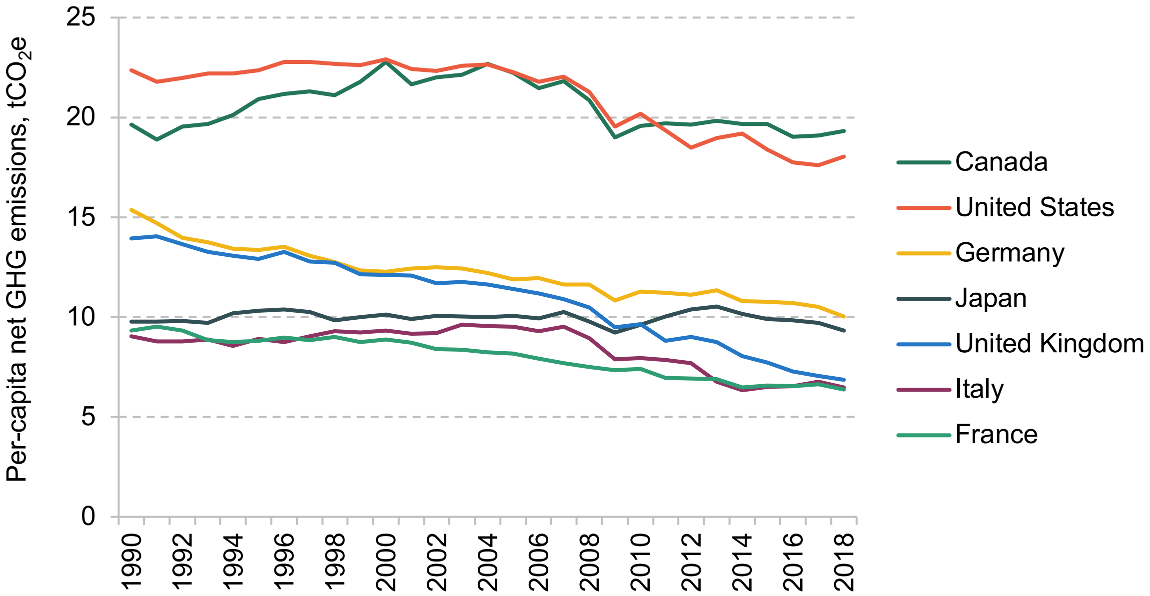
The UK's emissions reductions, at least when measured on a production basis, have been relatively rapid when compared with other rich countries. Figure 8.2 shows that per-capita emissions from UK production fell faster over the period 1990–2018 than those for any other country in the G7. Here we use an internationally comparable measure of emissions, which excludes emissions from international aviation and shipping. In 1990, the UK's per-capita emissions under this measure were in the middle of the G7: similar to Germany's, and around 50% higher than in France and Italy. By 2018, the UK had closed most of the gap with the lowest-emitting G7 countries. In that year, net GHG emissions from UK-based activities were 6.9 tonnes of CO_2 equivalent per person compared with 6.5 tonnes in Italy and 6.4 tonnes in France. This compares with per-capita emissions of 18 tonnes per person in the US and 19 tonnes per person in Canada.

Territorial emissions by source

To understand what drove the fall in the UK's emissions over this period, Figure 8.3 shows the breakdown of UK territorial emissions by source. Table 8.1 shows the percentage changes in emissions for each sector, and their contribution to the overall reduction in emissions between 1990 and 2018.

[4] A further difference between the consumption and territorial emissions measures shown in Figure 8.1 is that the consumption measure is also residency-based, and thus includes emissions associated with UK residents that take place abroad, while excluding emissions from overseas visitors in the UK. Estimates of residence-based production emissions are also published but the difference between these and territorial emissions is small (Office for National Statistics, 2019).

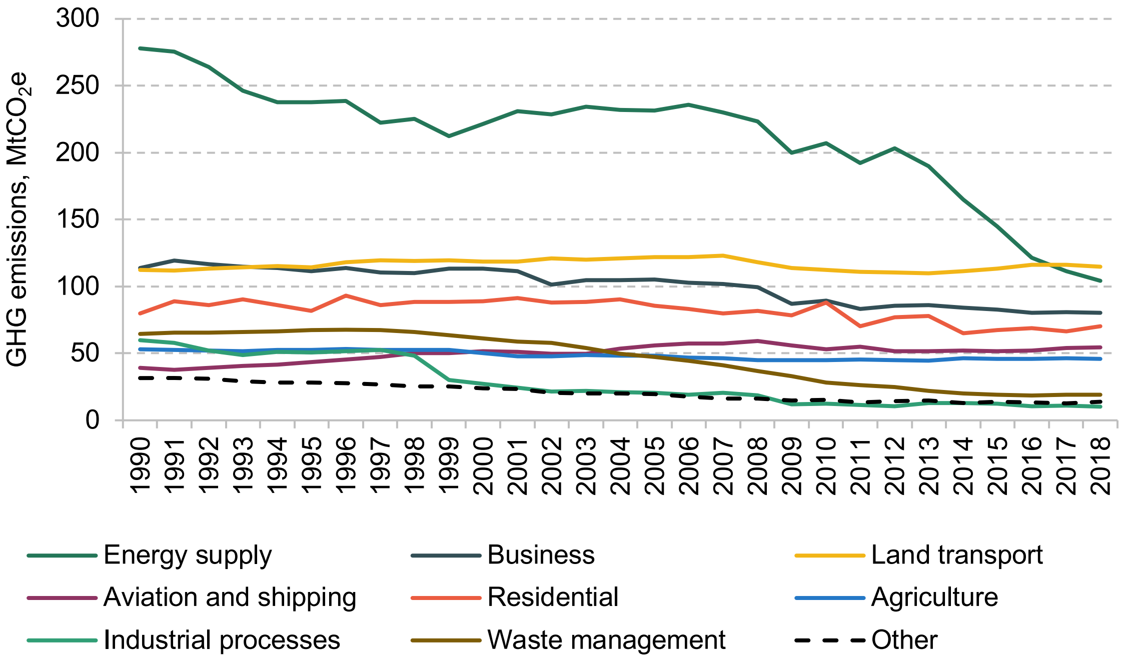
Figure 8.2. Per-capita annual territorial GHG emissions in G7 countries, 1990–2018



Note: Emissions include land use, land use change and forestry. They do not include emissions from international aviation and shipping. tCO_2e refers to tonnes of carbon dioxide equivalent.

Source: Authors' calculations using data from OECD.

Figure 8.3. Annual GHG emissions by source, 1990–2018



Note: The category 'other' includes the public sector and land use. $MtCO_2e$ refers to megatonnes of carbon dioxide equivalent.

Source: Department for Business, Energy and Industrial Strategy, 2021a.

Table 8.1. Size of changes in emissions by source

Sector	Share of emissions, 2018 (%)	% change between 1990 and 2018	Contribution to fall in total emissions (%)
Energy supply	20.3	–62.5	54.2
Industrial processes	2.0	–82.9	15.5
Waste management	3.7	–70.5	14.2
Business	15.7	–29.4	10.4
Other	2.7	–56.6	5.6
Residential	13.7	–12.4	3.1
Agriculture	8.9	–13.6	2.3
Land transport *of which:*	22.4	1.9	–0.7
passenger cars	*13.4*	*–5.2*	*1.2*
light-duty vehicles	*3.9*	*70.2*	*–2.6*
heavy goods vehicles	*3.9*	*–1.6*	*0.1*
buses	*0.6*	*–37.8*	*0.6*
rail	*0.4*	*–8.9*	*0.1*
other road	*0.2*	*20.9*	*–0.1*
Aviation and shipping *of which:*	10.6	38.3	–4.7
military	*0.3*	*–69.5*	*1.2*
domestic navigation & fishing	*1.2*	*–29.1*	*0.8*
international shipping	*1.5*	*–3.0*	*0.1*
domestic aviation	*0.4*	*20.8*	*–0.1*
international aviation	*7.1*	*136.0*	*–6.6*
Total	**-**	**–38.4**	**-**

Note: Numbers may not sum due to rounding. The category 'other' includes the public sector and land use.

Source: Department for Business, Energy and Industrial Strategy, 2021a.

Three broad trends stand out clearly. First, there were large reductions in emissions from energy supply, industrial processes and waste management – these three industries accounted for 84% of the reduction in overall UK emissions since 1990. Second, emissions from land transport have remained stable since 1990, meaning that it has become the largest single source of emissions

(22.4% in 2018). Third, emissions from aviation and shipping are unusual in that they have increased (by 38% since 1990) – although it should be noted that emissions from this source have fallen since 2008 and that 2018, the latest year in the figure, precedes the COVID-19 pandemic.

By far the most important contributor to the overall fall in emissions between 1990 and 2018 (accounting for 54% of the total reduction) was **energy supply**, whose emissions fell by 63%, with much of this decline occurring post-2010. This reflects the rapid decarbonisation of electricity generation (the total amount of electricity generated actually increased slightly over this period).[5] In the 1990s, these reductions reflected a move away from coal-fired generation, which is particularly carbon intensive, and which fell from 72% of electricity generation in 1990 to 32% in 2000 and then to 5% in 2018 (Department for Business, Energy and Industrial Strategy, 2020). Coal's share was replaced by electricity from gas-fired generation (whose share increased from below 1% in 1990 to 39% in 2000 and to 40% in 2018) and renewables (whose share increased at first slowly from below 2% in 1990 to nearly 3% in 2000 but then rapidly, to reach 33% in 2018).[6] The share from nuclear generation remained stable at around 20% over the whole period. The recent growth in renewable generation reflects strong policy incentives to switch towards low-carbon sources of electricity, as we discuss below.

Another source that saw large emissions reductions and powerful fiscal incentives to reduce emissions was **waste management**. Emissions from this source, which are mainly methane emitted from biodegradable waste sent to landfill, fell by 71% between 1990 and 2018, meaning that this sector accounted for 14% of the total drop in national emissions over this period.[7]

There was also a substantial reduction in emissions associated with **industrial processes**, which saw a decline in emissions of 83% from 1990 to 2018. Much of this reflects the reduction in emissions of nitrous oxide and fluorinated gases associated with the petrochemicals industry, due to plant closures and the installation of abatement technologies (Department of Energy and Climate Change, 2011). Indeed, the sharp 38% reduction in GHG emissions from industrial processes that occurred in 1999 is almost entirely due to the introduction of abatement technologies in just two plants (Salway et al., 1999). A disproportionate share of remaining emissions from this sector come from lime and cement production, which is particularly carbon

[5] Between 1990 and 2019, gross electricity generation increased by less than 2%. See page 27 of Department for Business, Energy and Industrial Strategy (2020).

[6] In 2019, the coal share had fallen further to 2% of electricity generated while the share of renewables further increased to 37%.

[7] In 2017, 20MtCO_2e was emitted by the waste treatment sector. 92% of those emissions came in the form of methane emitted by biodegradable waste decomposing in landfill. See page 232 of Climate Change Committee (2019a).

intensive, and which accounted for 53% of industrial emissions in 2018 (Department for Business, Energy and Industrial Strategy, 2021a).

Emissions from **agriculture** have fallen by a more modest 14% since 1990. Much of the emissions from this sector come from methane associated with livestock (mostly cattle) and nitrous oxide emissions caused by fertilisers.[8] Policy changes that had the effect of reducing these emissions include changes in EU agricultural subsidies that 'decoupled' agricultural subsidies from output and served to reduce livestock numbers, as well as regulations on the use of nitrogen-based fertiliser. Unlike other sectors, agriculture is not covered by mitigation policies such as the new UK Emissions Trading Scheme. Agricultural production also remains supported by 'direct' payments to farmers, which are based on the amount of land they maintain, and various tax advantages. Post-Brexit reforms to agricultural subsidies will see a shift away from direct payments and towards incentives for environmentally-friendly forms of land use, although the details and potential scale of the decarbonisation incentives are yet to be spelled out.

Residential emissions only fell by a relatively small amount over this period (by 12% between 1990 and 2018). These are almost exclusively due to 'residential combustion' from home heating and cooking (through burning gas in boilers and the like). This sector has seen some improvements, mostly due to improved boiler standards, but the uptake of insulation measures, including cost-efficient ones such as loft insulation, has so far fallen short of government ambitions (Climate Change Committee, 2019a, 2020b). Take-up of insulation and other energy-saving measures through government-sponsored schemes has also fallen since 2013. We discuss this further in Section 8.4.

Emissions from land transport and aviation & shipping are notable in that they saw *increases* over this period. Emissions from **land transport** increased marginally, by 1.9% since 1990, making it the largest single source of emissions in 2018. Emissions from cars, buses, heavy goods vehicles and rail declined from 1990 to 2018, but these falls were more than offset by increases in emissions from light-duty vehicles, which increased by 70% over the period. Emissions from road transport per mile driven also fell, reflecting increases in fuel efficiency.[9]

Emissions from **aviation and shipping** increased much more rapidly, by 38% since 1990. These increases were mainly driven by increases in emissions associated with international aviation, whose emissions increased by 136% between 1990 and 2018 (mostly during the 1990s when

8 In 2018, 16.5MtCO_2e of agriculture emissions were due to 'enteric fermentation' from cattle and a further 5.2MtCO_2e came from cattle waste. The equivalent figures for sheep were 4.0MtCO_2e and 0.1MtCO_2e respectively (table 1.2 in Department for Business, Energy and Industrial Strategy (2021a)).

9 Vehicle miles driven increased by 36% from 1993 to 2018 while emissions increased by only 0.30% over the same period (Department for Transport, 2021a).

emissions almost doubled).[10] Emissions from international aviation are, of course, likely to have fallen with the COVID-19 pandemic, and it is uncertain how quickly the sector will recover in the coming years.

Not all emissions from these sources need to be brought to zero to achieve the UK's net zero target. Emissions can be positive in some sectors provided they are offset by negative emissions, either through natural sequestration (such as planting more trees) or artificial carbon capture and storage (CCS) technologies. In 2018, retaining forest land, converting land to forests and grassland, and using harvested wood products led to negative emissions of 24 million tonnes of CO_2e (equivalent to 5% of total emissions, up from 3% in 1990).[11] While use of artificial CCS technology is growing, and there are demonstration projects in the UK, its use remains limited globally.[12]

Consumption emissions by use

The above statistics relate to emissions associated with production taking place in the UK. As we noted earlier, an alternative is to look at the total emissions generated when making the goods and services that the UK consumes. Most of these emissions are associated with final consumption by households (77% in 2018); the remaining emissions are due to investment demand (such as plant and machinery), non-profit organisations, changes in firm inventories and government consumption (Department for Environment, Food and Rural Affairs, 2021).

Figure 8.4 shows GHG emissions associated with different household consumption uses in the UK (e.g. the annual emissions embedded in household purchases of food and drink) in 2018 across household income deciles. It also shows the composition of consumption emissions for the average household.[13] These figures include all emissions in the supply chain of a particular product – for example, emissions associated with transporting food and drink products to supermarkets will be included in the carbon emissions associated with purchasing food and drink products.

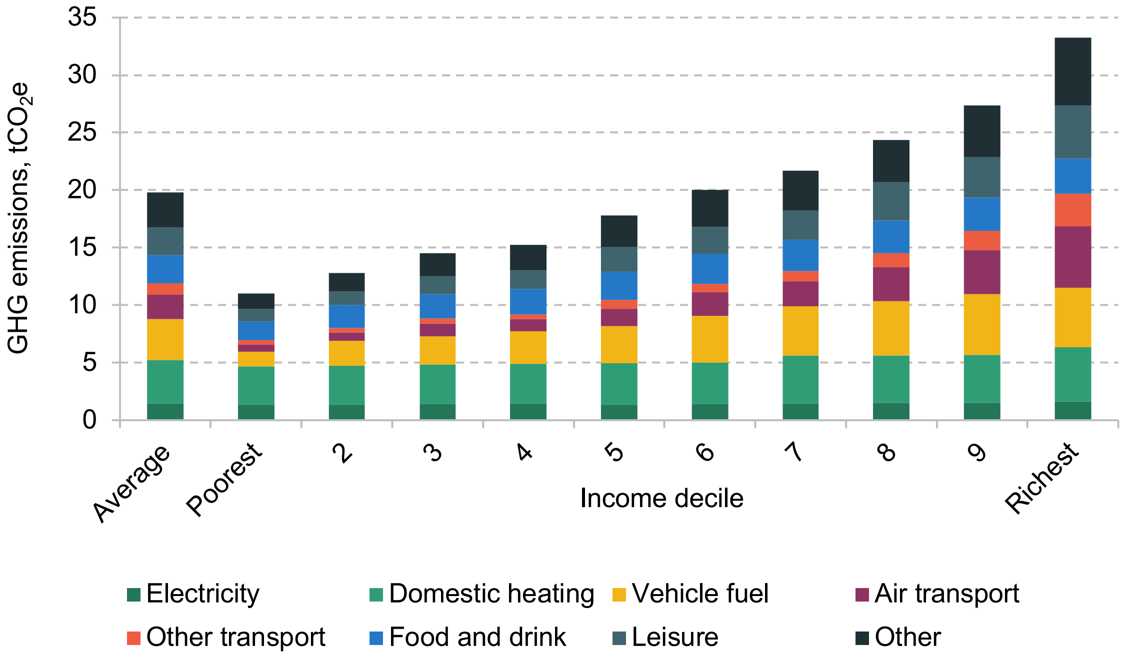
[10] See table 6.1 in Department for Business, Energy and Industrial Strategy (2021a).

[11] Table 1.2 in Department for Business, Energy and Industrial Strategy (2021a).

[12] The current estimated annual abatement capacity from large-scale CCS is around $40MtCO_2e$ globally (International Energy Agency, 2021).

[13] We assign emissions to different households according to expenditure reported using the Living Costs and Food Survey. This requires us to assign emissions to foreign and domestic package holiday spending. We use the national accounts to break out the share of spending on these holidays that goes on air, bus and rail travel under the assumption that domestic package holidays involve no flights and international package holidays involve no bus or rail transport. The remainder of spending on package holidays is assumed to go on hotel stays.

Figure 8.4. Annual GHG consumption emissions by net household income group, 2018



Note: Household incomes are equivalised using the modified OECD scale. tCO_2e refers to tonnes of carbon dioxide equivalent.

Source: Authors' calculations using the Living Costs and Food Survey 2018 and Department for Environment, Food and Rural Affairs (2021).

The average household's annual consumption-based carbon footprint was 19.8 tonnes of CO_2e in 2018, and the largest contributors to this were domestic heating and vehicle fuel (accounting for 19.2% and 17.9% of households' consumption emissions respectively). Other household goods and services accounted for 15.5% of households' average consumption-based carbon emissions, while food and drink accounted for 12.4%. Air transport accounted for 10.8% of households' average consumption-based carbon footprint.

The consumption of higher-income households generates a larger carbon footprint on average than the consumption of poorer households. Households in the richest income decile have a consumption-based carbon footprint of 33.3 tonnes on average compared with just 11.0 for households in the poorest income decile. While emissions from electricity, domestic heating, and food and drink are relatively similar across households at different points in the income distribution, richer households tend to have much higher emissions associated with vehicle fuel, air transport, leisure goods and services, and other household spending. For example, the richest households' emissions from air transport are around nine times greater than those for the poorest tenth of households.

Despite richer households' consumption having a greater carbon footprint, lower-income households are associated with 22% more CO_2e emissions per pound of spending, largely because a greater share of poorer households' spending goes on electricity, heating and food. We discuss the carbon *intensity* of different households' spending in Section 8.5.

The path to net zero

The UK will need to reduce emissions at a faster rate than it has done since 1990 to reach its net zero target. Emissions fell by an average 1.4% of 1990 levels per year between 1990 and 2018 (an annual rate of decline of 1.7%). They will need to fall by an average 3.1% of 2018 levels each year from 2018 to reach net zero in 2050.

There are good reasons to think that future reductions will not be as easy as past ones, as possibilities for low-cost emissions reductions are exhausted. Indeed, the vast majority of the carbon reductions have occurred in sectors, such as energy supply and waste management, where incentives to decarbonise are already strong and low-carbon technologies already exist. But now the total emissions from these two sectors, which together accounted for 68% of the reduction in territorial emissions since 1990, account for just 24% of remaining emissions. Future reductions in greenhouse gases to reach the net zero target will therefore predominantly need to come from other sources. Moreover, within the power sector, relatively low-cost changes, such as switching from coal-fired electricity generation to gas-fired, have already happened. Future decarbonisation within this sector, which will require further significant growth in the share of renewables and nuclear power, is likely to be more expensive. It will also have to take place in an environment where population growth and the electrification of transport and heating are pushing up overall electricity demand (Department for Business, Energy and Industrial Strategy, 2019).

8.3 Current taxes and subsidies

Economists have long argued that a key policy step in tackling climate change is to place a tax (or equivalent) on GHGs. Ideally, the tax should be proportional to the level of emissions. This would incentivise individuals and businesses to cut emissions and ensure that emissions were cut first in cases where the benefits of the emissions-creating activity or the costs of cutting emissions were lowest. Box 8.1 discusses the economics behind the idea of taxing emissions.

Box 8.1. Tackling climate change with tax

GHG emissions, and the climate change they cause, are classic examples of market failure. Individuals and businesses do not face the full costs of the emissions they create and so, left to their own devices, choose to emit more than is optimal for society as a whole.

Economists have long argued that the best way to address this problem is to put a price on emitting greenhouse gases so that individuals and firms face the full costs of their decisions. This can be done through either a carbon tax or a cap-and-trade scheme such as the UK Emissions Trading Scheme. A carbon price would provide firms and households with the right incentives to avoid carbon-intensive activities, and to invest in the development and deployment of low-carbon technologies.

To take one example, a carbon price of £50 per tonne of CO_2 emitted would give households and businesses an incentive to undertake all abatement activities that cost less than £50 per tonne of CO_2 saved. The attraction of a *uniform* carbon price across the whole economy is that it avoids a situation where one sector that faces a relatively high carbon price ends up making expensive reductions in emissions while another that could reduce emissions more easily does not do so. A uniform carbon price allows a given level of total abatement to be achieved at lowest cost to the economy as a whole. It would leave firms and households in a position to decide themselves how to reduce their emissions in the most efficient way without the government needing to work out and specify which emissions should be reduced, where and how.

Because a price on GHG emissions would change many incentives – over what to buy, how to invest and where to innovate – once it is in place, if correctly set, there would be no need to make other parts of the tax system 'green' to encourage consumers or businesses to change their behaviours further. Not every tax needs to entail green incentives for the tax system as a whole to be green: we should pick the tool most suited to the task. Attempting to use every tax to encourage emissions reductions would not only add needless complexity to the tax system but also create stronger incentives to reduce emissions in some ways than others – an unnecessarily costly way to tackle climate change.

There are some caveats to this conclusion. In particular, there may be a number of other market failures that call for other policies in addition to, or instead of, a uniform carbon price.

- Some consumers and businesses may **not respond to price signals** well because those signals are not prominent to the people making decisions, or they focus excessively on the up-front costs of large investments (such as energy efficiency improvements) rather than longer-run savings from lower running costs. Clearer information can help guide consumers to making better decisions in these cases, and where the 'right' behaviour is clear, regulations can avoid people needing to take (potentially 'wrong') decisions at all.

- **Constraints on borrowing** might prevent households and businesses from making cost-effective investments, if they cannot meet short-run costs with their own funds. Targeted subsidies or government (or government-backed) loans can be used to address these problems.

- Different groups may **not be able to coordinate** on particular outcomes. For example, a switch to electric vehicles requires simultaneous investments and innovation in charging infrastructure and battery technologies as well as in the cars themselves. This creates a chicken-and-egg problem, with different firms waiting for each other before investing themselves (Aghion et al., 2014). Moreover, each additional electric car on the road likely reduces the costs of others switching to electric cars by allowing the industries involved to achieve greater economies of scale or to 'learn by doing'. Left to their own devices, too few consumers might switch to electric cars even with a carbon price. The government can correct these sorts of problems by playing a coordinating role – which could include using targeted subsidies, direct government provision, regulations, or setting a higher carbon price in particular sectors.

- Other issues arise when there is **incomplete information**. For example, landlords or those about to sell their homes will have less incentive to invest in energy efficiency if tenants or prospective buyers cannot verify what they have done. Mandatory reporting of energy efficiency performance can help address this particular problem.

- Additional complications arise in an international environment where different countries set different (or no) carbon prices. Setting a high carbon price for tradable goods might lead to **carbon leakage**. From the perspective of a single country, this might justify setting lower prices for carbon-intensive sectors that face greater international competition or which are more likely to relocate, although this outcome would be far worse than ensuring that carbon emissions are priced appropriately on an international level. We discuss this alongside other possible responses to this problem in Section 8.4.

A further concern is that carbon pricing can have undesirable distributional consequences: for example, hitting lower-income households harder than higher-income ones and hitting disabled people more than others. These effects can be mitigated through other well-designed government policies targeted to benefit groups who would disproportionately be affected. We discuss this in Section 8.5.

Concerns about the distributional consequences of pricing carbon emissions often lead governments to subsidise low-carbon alternatives instead. In this chapter, we discuss subsidies for renewable energy and home energy efficiency (there are also others – for example, for electric cars). These subsidies provide incentives to decarbonise, and it is easy to see their appeal to governments which might otherwise have to raise taxes on vulnerable groups. However, such subsidies have a number of downsides. They cost the government money instead of raising it, and so must be funded through higher taxes elsewhere. In addition, the government must decide what to subsidise. This might mean it has to pick the future technologies most likely to succeed, with the inherent risk it will choose poorly. Since only some low-carbon activities are subsidised, it encourages a switch to subsidised activities more than reducing emissions in other (potentially easier) ways, making abatement more costly overall. Indeed, in some cases, subsidies might not lead to carbon savings at all. For example, subsidies for energy efficiency measures that save households money might lead them to use *more* heating or other carbon-intensive goods and services, or subsidies might lead some people to buy electric cars rather than cycling or using public transport, undermining some of the environmental gains.

While there are reasons to deviate from a uniform carbon price, deviating comes with its own disadvantages (not least a risk of distorted incentives, additional complexity and greater susceptibility to lobbying and special pleading). The default should be to tax carbon in a uniform way unless there are compelling reasons to do otherwise.

The UK operates a patchwork of taxes, levies and obligations that (directly or indirectly) impose costs on some GHG emissions. Here we outline those policies that impact incentives to emit in four key sectors: energy, waste management, road transport and aviation. In Section 8.4, we show how the policies combine to create a set of implicit taxes on GHG emissions and a set of subsidies for renewable electricity generators.

The list of policies and the amount of revenue they raise are presented in Table 8.2.

The closest that the UK comes to an explicit emissions tax is the **UK Emissions Trading Scheme (UK ETS)**. The UK ETS is a cap-and-trade scheme, requiring businesses to buy permits (which are limited in number) for each tonne of GHGs they emit, with permit prices determined in a market. However, the UK ETS is far from comprehensive, applying only to emissions from electricity generation and other energy-intensive industries (29% of all UK emissions).[14] And just under half of permits are allocated for free, with a more generous free allocation for businesses deemed to be at risk from overseas competition (an issue we return to in Section 8.4) and businesses in the aviation sector.[15] The scheme's antecedent is the EU ETS, which it replaced in January 2021. The UK and EU schemes are extremely similar, the primary difference being that businesses in the UK can no longer trade allocations on a Europe-wide basis. One further difference is that the UK cap on total permit issuance is set at 5% below the UK's expected notional share of the EU ETS cap each year – i.e. it is attempting to reduce emissions at a faster rate than under the EU ETS.

The UK ETS is supplemented by the narrower **Carbon Price Support (CPS)**, which imposes a further flat rate cost (currently £18 per tonne of CO_2e) on emissions, but is limited solely to electricity generators. Applying to businesses more widely is the **Climate Change Levy (CCL)**, which is charged on businesses' use of electricity, gas and coal but with some exceptions and with large discounts available for energy-intensive businesses.[16] Unlike the UK ETS and CPS,

[14] In 2019, the UK's EU ETS participants emitted just under 130 million tonnes of CO_2 equivalent, compared with total UK territorial emissions of 455MtCO_2e (Department for Business, Energy and Industrial Strategy, 2021e).

[15] UK domestic flights, flights between the UK and Gibraltar, and flights from the UK to the European Economic Area (EEA) fall within the scope of the UK ETS.

[16] Fuel and electricity used for electricity generation, passenger transport (such as trains), and metallurgical and mineralogical processes (such as steel production) are all exempt from the CCL. Energy-intensive businesses have the option to enter into voluntary climate change agreements that allow businesses to access large CCL discounts (in 2021–22, these discounts are 92% for electricity and 83% for gas and coal) in return for committing to increase energy efficiency or reduce carbon emissions.

the CCL is not explicitly linked to emissions, although efforts are currently being made to make rates better reflect the relative emissions intensity of gas and electricity.[17]

Electricity markets are also subject to three further policies which impose a tax on electricity suppliers in order to fund subsidies for low-carbon electricity generation. The most recent of these schemes is **Contracts for Difference (CFDs)**, through which the government subsidises renewable electricity generation (to different degrees over time and across different technologies) by guaranteeing renewable energy generators a set 'strike price' for the electricity they produce. CFDs are paid for through a tax on electricity suppliers based on electricity sold. CFDs were preceded by the **Renewables Obligation (RO)** – under which electricity suppliers were effectively obligated to provide a subsidy to renewable generators by purchasing government-created Renewables Obligation Certificates (ROCs) from renewable generators. The **Feed-In Tariff (FIT)** funds small-scale renewable generation with a levy on electricity suppliers. Both the RO and FIT schemes have been closed to new applicants but still operate with respect to projects that secured support prior to closure. In the case of all three schemes, the charges that fund the subsidies are untethered from emissions in the sense that all electricity (including renewable electricity) is taxed at the same rate. Taking the three schemes together, the value of the subsidies to renewable generators (and therefore the cost imposed through the taxes on electricity supply that are used to fund them) is forecast to be £11 billion in 2021–22. 26% of this relates to the CFD scheme, with the remainder accounted for by the two legacy schemes. These policies are described in greater detail in Box 8.3 in Section 8.4.

The RO, CFDs and FIT, along with the CCL, all include substantial discounts for 'energy-intensive businesses'. Broadly, these are businesses that use relatively large amounts of fossil fuels. But the exact definition varies across policies.

One additional subsidy operated by the government is the **Capacity Market**. This provides a mechanism whereby subsidies are auctioned to electricity generators who are not in receipt of CFDs or the RO (e.g. gas-fired power plants) to ensure the provision of sufficient electricity generation capacity. These subsidies are paid for via a levy on electricity suppliers known as the **Capacity Market Supplier Charge (CMSC)**.

[17] The 2021–22 CCL rates for electricity, gas and coal are 0.775p per kWh, 0.465p per kWh and 3.64p per kg respectively. In recent years, the rate of CCL on electricity has been lowered relative to gas. See HM Revenue and Customs (2020b).

Table 8.2. Emissions-related policies and associated revenues

Policy	Forecast revenue (2021–22, £bn)	Value of subsidies (2021–22, £bn)
UK Emissions Trading Scheme (UK ETS)	1.3	
Carbon Price Support (CPS)	0.5	
Climate Change Levy (CCL)	1.6	
Contracts for Difference (CFDs)	2.9	2.9
Renewables Obligation (RO)	6.5	6.5
Feed-In Tariff (FIT)	1.6	1.6
Warm Home Discount (WHD)	0.4[a]	0.4[a]
Energy Company Obligation (ECO)	0.7[a]	0.7[a]
Capacity Market Supplier Charge (CMSC)	1.1[b]	1.1[b]
5% rate of VAT on energy bills	–5.0[c]	
Fuel duties	26.4	
Renewable Transport Fuel Obligation (RTFO)	1.8[d]	1.8[d]
Air passenger duty (APD)	3.7[e]	
Landfill tax	0.7	

[a] 2019–20 figure.
[b] 2020–21 figure.
[c] Revenue figure for reduced 5% rate of VAT on domestic fuel refers to 2019–20.
[d] Figure for 2021 calendar year.
[e] 2019–20 figure. Forecasts show depressed APD revenue for later, pandemic-impacted, years.

Note: The ONS does not classify payments made by energy suppliers to renewable generators under the FIT, or costs imposed on fuel suppliers as a result of the RTFO, as tax revenue.

Source: ETS, CPS, CCL, CFDs, RO, fuel duties, APD and landfill tax from Office for Budget Responsibility (2021). Revenue figure for FIT from Office for Budget Responsibility (2019). WHD from Ofgem (2020a). ECO from Department for Business, Energy and Industrial Strategy (2018). VAT 5% rate from HM Revenue and Customs (2020a). RTFO from Department for Transport (2021b). CMSC from LCCC (2021a).

A further set of energy market policies are aimed at helping households with their energy bills. The **Warm Home Discount (WHD)** imposes an obligation on energy suppliers to provide rebates to the winter energy bills of certain low-income and vulnerable customers, while the **Energy Company Obligation (ECO)** requires energy companies to provide eligible households with energy efficiency improvements to their homes. Because these obligations are imposed on energy suppliers in proportion to their market share, both policies impact the incentives associated with electricity and gas consumption by taxing increases in energy supply. Alongside policies placing upward pressure on energy prices, there is a reduced **5% rate of VAT** on domestic energy, which acts in the opposite direction – effectively subsidising households' energy use relative to other activities.

In terms of total revenue raised, by far the largest tax discussed in this chapter is not in the energy market, but in the transport fuels sector. **Fuel duties** levied on petrol and diesel are forecast to raise £26.4 billion in 2021–22.[18] Because the tax is levied directly on each litre of fuel purchased, the amount charged is directly proportional to emissions. In addition to fuel duties, the **Renewable Transport Fuel Obligation (RTFO)** requires fuel suppliers to supply a certain percentage of their fuel in the form of renewable fuel (such as bioethanol and biodiesel, which are commonly mixed with petrol and diesel respectively) or else cover any shortfall by buying tradable permits which are issued to suppliers of renewable fuel.

Unlike fuel used by motorists, the jet fuel used by most passenger aircraft is exempt from fuel duties. Adding to this tax advantage, VAT is charged at a 0% rate on airline tickets. **Air passenger duty (APD)** is charged, per passenger, on all passenger flights setting out from the UK.[19] There are higher rates charged on long-haul flights and on business and first-class tickets, but APD is not linked to the emissions associated with a given passenger.[20] Domestic flights and outbound flights from the UK to the EEA are subject to the UK ETS.

To disincentivise emissions from waste disposal, the UK imposes a **landfill tax** on each tonne of waste disposals.[21] The main rate of landfill tax has been increased substantially since its introduction, with the largest rises occurring between 2004–05 and 2014–15 when it increased from £15 to £80 per tonne, and now stands at £96.70 per tonne.

It should be noted that the above is far from a comprehensive inventory of UK climate change policy, which includes (amongst other things) a large body of regulation and bans on some activities as well as other tax incentives.[22] In that sense, the extraordinary degree of complexity that characterises UK emissions policy is understated by the brief summary provided above. Indeed, there are a number of taxes not mentioned here that, to varying degrees, act to change the incentives of consumers or businesses to reduce emissions. Just in the area of motoring, for example, vehicle excise duty is levied annually on car ownership, and in the year a new car is

18 Unlike some other taxes discussed in this chapter, there is an argument to be made that fuel duties should be set with a view to addressing the costs imposed on society not only by motorists' GHG emissions but also by harms such as congestion and noise pollution – at least in the absence of other taxes that are better targeted at those harms. As Adam and Stroud (2019) discuss, the shift to low-emission vehicles will therefore require careful consideration of how better to gear future motoring taxes towards addressing the remaining costs.

19 Flights to the Scottish Highlands and Islands and long-haul flights from Northern Ireland incur a £0 rate of APD.

20 Long-haul flights are defined as flights to countries whose capital city is more than 2,000 miles from London. The exception is Russia, where destinations east of the Urals are considered long-haul.

21 Landfill tax was devolved to Scotland in April 2015 and to Wales in April 2018. In both cases, rates have remained aligned with those in England and Northern Ireland.

22 See Helm (2017) for a discussion of the regulatory landscape.

bought the duty is higher for higher-emission cars; the taxation of company cars also varies with the car's emissions, while London's congestion charge and Ultra Low Emission Zone discourage driving and encourage the purchase of low-emission vehicles.[23]

Many of these taxes will have an effect on reducing emissions, but they are not closely targeted at emissions: for example, vehicle excise duty discourages car ownership but does nothing to encourage car owners to drive their cars less, while the congestion charge and Ultra Low Emission Zone only discourage certain specific journeys. Our focus in this section and the next is on those taxes that are most closely linked to GHG emissions, though the division is not a neat one: air passenger duty is only loosely related to a flight's emissions, for example, while landfill tax depends on the volume of waste rather than the GHGs it emits (other than a single distinction between 'active' waste and 'inert' waste, with the latter subject to a much lower tax rate).

8.4 Implicit taxes on GHG emissions and subsidies for renewables

In this section, we set out how the policies described above, taken together, affect the overall implicit tax that is imposed on the emission of GHGs. We then discuss the subsidies for renewable electricity generators and how these vary across different technologies and we give an overview of policies aimed at improving the energy efficiency of housing.

The implicit taxes set out in this section describe the amount of tax that is paid on an extra ('marginal') tonne of CO_2 equivalent emissions. It is important to realise that this differs from the concept of an *average tax rate* and that the figures set out in this section do *not* capture the overall burden of taxes imposed on, say, electricity bills. The purpose of imposing a cost on emissions is to create an incentive for individuals and firms to shift to less emissions-intensive consumption and production – for instance, by making driving more costly, we might expect more journeys to be carried out by train. With this in mind, the implicit tax rates we describe are defined relative to goods on which the standard 20% rate of VAT is charged. In other words, if a good incurred a 0% rate of VAT, we consider it to be taxed at a negative rate (effectively a subsidy). This is intended to reflect that fact that, *relative to other goods* on which the standard rate of VAT is charged, a financial incentive has been created to consume the zero-rated good. Details of the methodology used to calculate implicit tax rates can be found in Online Appendix 8A.

[23] Adam and Stroud (2019) discuss motoring tax in detail.

While the implicit carbon taxes we show cover the main effects of the government tax and subsidy policies described in the previous section, they do not comprehensively cover how all government policies affect all possible forms of GHG emissions. We note, for example, that there are some major forms of emissions that are not taxed at all, either directly or indirectly, in the UK. These include emissions embedded in imports and emissions related to land use and agriculture. The GHG content of agricultural produce – such as the methane related to cows – is not only untaxed but in most cases zero rated for VAT (and therefore tax favoured relative to other forms of spending).

Implicit taxes on GHG emissions from gas and electricity use

Table 8.3 summarises which types of end user are impacted by the energy market policies described in Section 8.3.[24]

Table 8.3. Coverage of energy market policies across end users

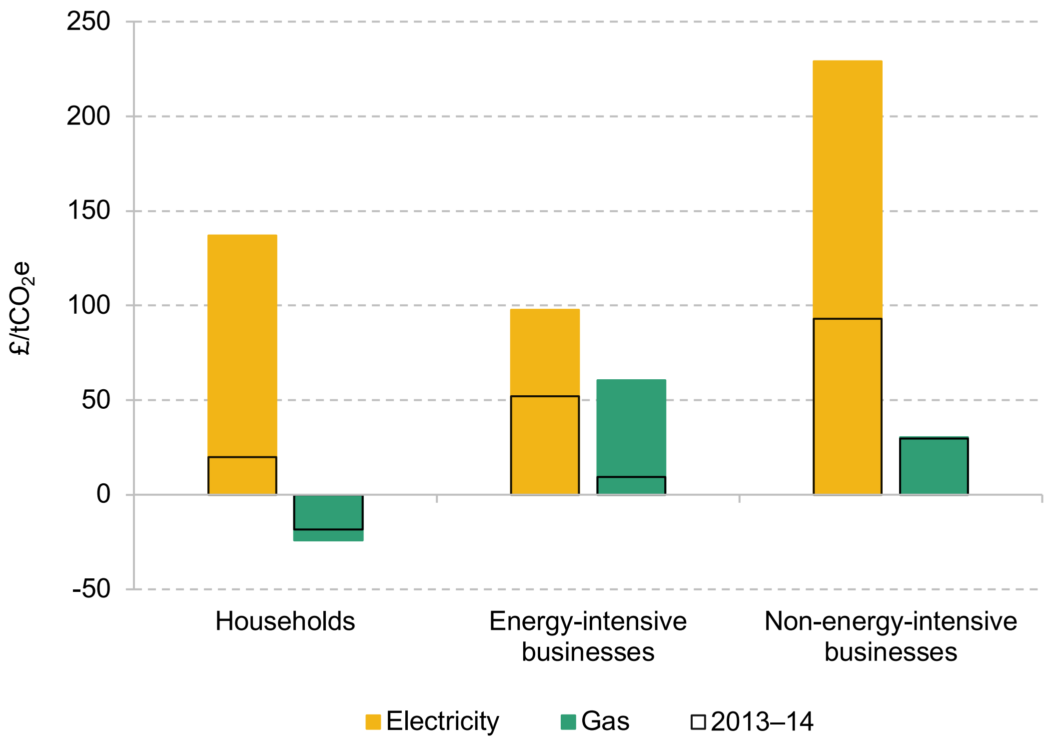
User / Energy source	ETS	CPS	CCL	CFDs	RO	FIT	WHD	ECO	VAT at 5%
Energy-intensive businesses									
Electricity	✓	✓	~	~	~	~			
Gas	✓		~						
Non-energy-intensive businesses									
Electricity	✓	✓	✓	✓	✓	✓			
Gas			✓						
Households									
Electricity	✓	✓		✓	✓	✓	✓	✓	✓
Gas							✓	✓	✓

Note: ~ indicates there is a discount. ✓ indicates where a policy effectively taxes (or subsidises, where shaded red) consumption by a particular end user (e.g. household electricity consumption is effectively taxed by the CFDs because electricity supplied to households attracts a per-MWh levy).

[24] We do not include the Capacity Market Supplier Charge which by itself raises the cost of electricity. This is because we are not able to account for the subsidy provided to generators through the Capacity Market (whose value likely differs across different modes of generation), and are therefore not able to capture the full incentive effects of this policy.

As discussed in the previous section, most of the taxes that impact incentives to engage in GHG-emitting activity are not true carbon taxes. The levy that funds CFDs, for instance, imposes a tax on the supply of all electricity, regardless of how it was generated. This fact, coupled with the patchwork nature of tax design in the sector, is what leads to different types of businesses facing incentives to abate in different ways and to different degrees, and that leads to significant variations in the incentives faced across both end users and fuel types. Figure 8.5 demonstrates some of this variation, by showing the stark differences in implicit taxes by both end user (households, energy-intensive businesses or non-energy-intensive businesses) and the form in which energy is consumed (electricity or gas). Not all emissions incentives are captured in the taxes set out in the figure. For instance, alternative, low-carbon, forms of electricity generation are also subsidised, providing further incentives to reduce emissions associated with electricity generation – a point we return to in greater detail below.

Figure 8.5. Implicit tax rates on GHG emissions in the energy market, by end user (2021–22)



Note: Figures for electricity refer to electricity generated from the burning of natural gas. Implicit taxes encompass charges made as a result of the UK ETS, CPS, the CCL, CFDs, the RO, FITs, the WHD and the ECO. Allocations of free ETS permits are ignored. An implicit tax of zero is taken to include the standard VAT rate of 20%. Additional VAT paid as a result of levies' increasing retail prices is included in the final implicit tax/subsidy figure. 'Energy-intensive businesses' excludes electricity generators. 2013–14 values expressed in 2021–22 prices.

Source: Authors' calculations. See Online Appendix 8A for details. For 2013–14 figures, see figures 6.2 and 6.3 in Advani et al. (2013).

As a point of comparison, the government publishes estimates of the carbon price that it believes would be necessary to achieve the UK's carbon reduction commitments. For the 2021 calendar year, the central estimate (around which there is much uncertainty) of this price is £245/tCO_2e.[25] This price, which is used in policy appraisal, suggests that – if accurate – all of the implicit carbon taxes we discuss are below the level that would be required to achieve net zero (although it should be remembered that these are not the only incentives to reduce carbon emissions – there are, for example, also subsidies for renewables).

We described in Box 8.1 how a uniform carbon price could help ensure that emissions reduction was carried out in the least costly way. As is clear from Figure 8.5, taxes in the energy market are far from uniform. For example, while the GHG content of household gas consumption receives an implicit subsidy of £24/tCO_2e, the emissions associated with the consumption of gas-generated electricity by non-energy-intensive businesses is implicitly taxed at a rate of £229/tCO_2e (to place these numbers in context, the annual electricity and gas consumption of the average household is associated with emissions of just over 5tCO_2e, as shown in Figure 8.4). It is almost certain that variations of this magnitude damage efficiency, leading to costly emissions abatements being prioritised over those that could be carried out more cheaply.

There are two key points to note about how implicit carbon taxes vary within the energy market:

- **GHG emissions associated with electricity use are taxed more heavily than GHG emissions from burning gas**

In general, GHG emissions associated with electricity face heavier implicit taxation than those associated with the burning of natural gas – largely as a result of the numerous levies on electricity supply used to fund renewable electricity generation. For domestic users, the implicit tax on increasing emissions through gas consumption is actually negative as a result of the preferential 5% rate of VAT charged on household energy bills. It seems likely that this has contributed to the fact (outlined in Section 8.2) that direct GHG emissions from households have reduced relatively little over the last 30 years.

This pattern of implicit taxation is at odds with the government's desire for households to move away from using gas and towards using electricity for heating (e.g. by switching away from gas boilers to electric heat pumps). A possible reason for not taxing domestic gas is that it would disproportionately hit certain households. However, there are ways to mitigate these effects with

[25] In theory, the level of a carbon tax should be set equal to the amount of social damage caused by the emission of an additional tonne of CO_2 equivalent (the theory underpinning carbon taxes is discussed in Box 8.1). In practice, calculating such a figure is extremely challenging. Department for Business, Energy and Industrial Strategy (2021c) sets out the government's method of calculating the price needed to reach the UK's net zero target and suggests that the 'true' number may lie anywhere between £122 and £367, which is a ±50% sensitivity range.

tax revenues while preserving incentives to reduce emissions – an issue we address in greater detail in Section 8.5.

The carbon content of energy consumed by households is taxed at lower rates than for most businesses (specifically those deemed not energy intensive). This results both from the fact that the CCL applies to the gas and electricity consumption of businesses (but not households) and from the fact that businesses do not receive the VAT discount on energy bills available to households.

- **Energy-intensive businesses face lower implicit carbon taxes than other businesses on electricity use (but higher implicit taxes on burning gas)**

Taxes on electricity are substantially lower for energy-intensive businesses than for their non-energy-intensive counterparts, with the gap having grown since 2013–14. This means that the businesses that use the most energy per unit of output – and therefore contribute disproportionately to the country's total emissions – face a *smaller* incentive to change their production methods. The key justification for this is that higher taxes on energy-intensive businesses could lead these industries to relocate abroad, resulting in carbon leakage. This could occur if: (i) higher energy charges would greatly increase these firms' costs and (ii) these firms operate in tradable sectors.

Carbon leakage is a valid concern. But addressing it through lower taxes has costs. A key downside is that it greatly dampens the marginal incentive to reduce GHG emissions in exactly the industries where they are highest. The UK (and EU) also tries to prevent carbon leakage by giving out free ETS permits. These free allocations are effectively cash handouts, which businesses would lose if they relocated abroad. This maintains marginal incentives to reduce emissions through improving energy efficiency or switching to cleaner energy, but means that other taxes need to be higher in order to bring in a given level of government revenue. Free allocations also dampen the incentive to abate by simply cutting output, since doing so could mean that businesses receive fewer free permits in future. Both of these approaches to reducing carbon leakage also require governments to decide which sectors are at risk of shifting abroad in response to higher energy costs. An alternative approach that is receiving policy interest at the moment is to place a tax on the embedded emissions of imports (see Box 8.2).

Energy-intensive firms also pay *higher* implicit taxes on burning an extra unit of gas. This is because these firms tend to be covered by the UK ETS while other firms are not. Of course, this might not result in greater carbon leakage if many of their permits are freely allocated, but it is a striking inconsistency. The higher implicit tax on gas gives these firms a greater incentive to cut their gas use than non-energy-intensive businesses, although again doing this by reducing their output could reduce their future entitlement to free permits.

Box 8.2. Carbon Border Adjustment Mechanism

As we have discussed, two ways to avoid carbon leakage are to allocate at-risk firms with free permits within a cap-and-trade scheme or to charge them lower tax rates on their emissions. Both would reduce firms' incentives to relocate. However, both of these approaches also undermine incentives to abate in affected sectors.

Another approach to preventing taxes in a country leading to emissions-generating activities simply moving abroad is to place a tax on imports according to their embedded and untaxed GHG emissions (or 'carbon' content). Under such a tax, there would be no tax-induced incentive for a UK producer that is selling to UK consumers to move production abroad and import into the UK, and they would not face unfair competition from a producer in a location with lower taxes on GHG emissions. There would also be no need for free permit allocations or for lower taxes on energy-intensive activities, meaning that all firms would face the right marginal price signal to cut their emissions. A border carbon tax would also give other countries an incentive to price carbon in their own tax systems.

In practice, there are a number of difficulties with operating such a tax, and a number of choices to be made. A key difficulty is that the carbon content of imports and the amount of tax already paid are not easy to measure. This is especially true for products created in more than one country and where the origin country has implicit taxes on emissions (such as the levies used to fund CFDs) rather than explicit ones (such as the ETS). Another important question is how to treat exports: in particular, whether to take one's own exports out of carbon taxation at the same time as bringing imports into tax. If exports are not given a rebate from tax, there will be an incentive for energy-intensive, exporting producers to move production to a lower-taxed country. Higher taxes could, therefore, still lead to carbon leakage. If (at least some) exports instead get a rebate for carbon taxes paid, there will be a lower incentive to cut emissions. There is also some debate about the compatibility of both taxes on imports and rebates for exports with international trade rules.

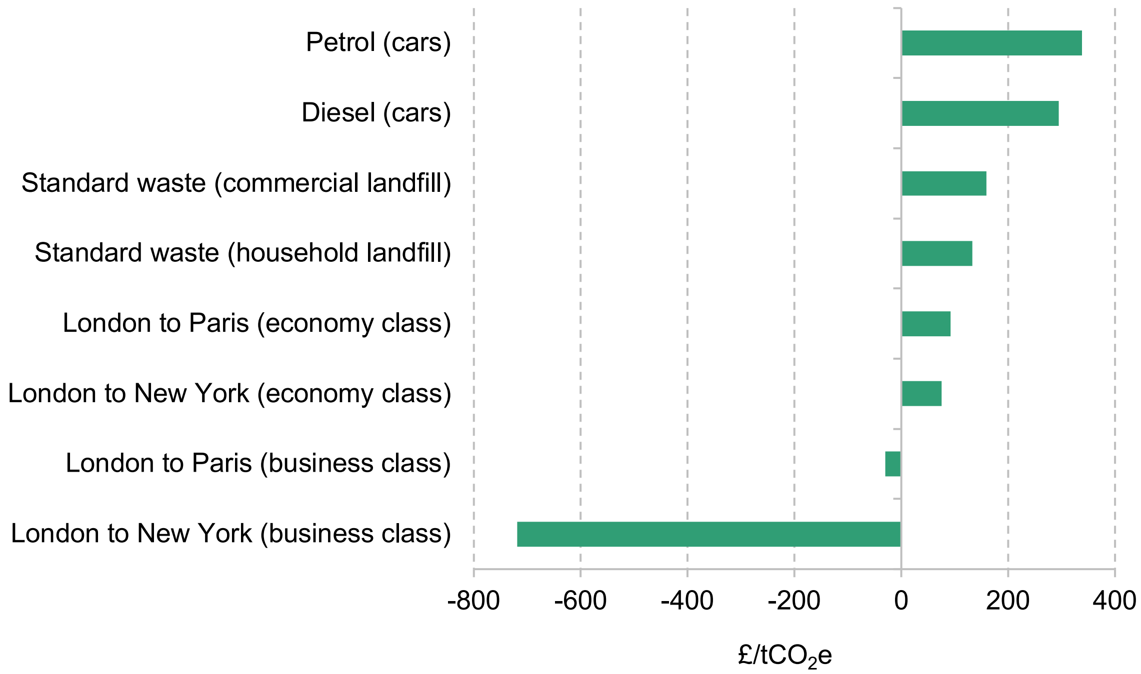
In July 2021, the European Commission published a specific proposal for a **Carbon Border Adjustment Mechanism** (CBAM) to apply to the imports (into the EU) with the highest associated emissions (European Commission, 2021a, 2021b). If adopted – which would require approval by both the European Parliament and the Council – the CBAM would, from 2023, require importers of such goods to report the direct and indirect (embedded) emissions and any carbon-related tax paid abroad for all imports. This would represent a significant increase in reporting requirements. Additional tax would only start to be due from 2026 when importers of cement, iron and steel, aluminium, fertilisers and electricity would need to buy 'CBAM certificates' to cover the carbon emissions created in the production of the imports. The price of the certificates would correspond to the price of GHG emissions under the EU's ETS. An importer would need fewer CBAM certificates to the extent that they could demonstrate that tax had already been paid in the country of origin. If the CBAM was introduced, free permits under the EU ETS would be phased out.

The UK government has also indicated that it is considering a possible tax on imported emissions (UK Parliament, 2021).

Taxes on emissions from fuel, aviation and waste

As well as taxing emissions in the energy sector, government policy creates implicit taxes on GHG emissions associated with fuel used for transport, aviation and waste management. A selection of these implicit taxes are shown in Figure 8.6.[26]

Figure 8.6. Implicit taxes on GHG emissions related to fuel, waste and aviation (2021–22)



Note: Includes charges made as a result of fuel duties, the RTFO, the landfill tax, APD and the UK ETS. An implicit tax of zero is taken to include the standard VAT rate of 20%. Additional VAT paid as a result of an increased carbon price is included in the final implicit tax/subsidy figure. Implicit taxes for aviation refer to tickets purchased by individuals, not businesses.

Source: Authors' calculations. See Online Appendix 8A for details.

In one sense, implicit taxes in these sectors are not directly comparable to those in the energy market (or, for that matter, to each other) because they are often aimed at addressing other social costs of particular activities besides carbon emissions, as we discuss. Nevertheless, it is notable that, as in the case of implicit tax rates in the energy market, the implicit tax rates levied on waste and aviation (although not on petrol and diesel) are considerably below the £245/tCO_2e that the Department for Business, Energy and Industrial Strategy estimates to be consistent with the net zero target.

[26] The figure does not produce a comprehensive list of all of the sources of emissions related to transport fuels, aviation and waste management that are taxed. There is a range of other policies, such as subsidies for fuel used by bus services and a fuel duty discount on 'red diesel' used, for example, by farmers.

In Section 8.2, we showed that **land transport** is now the UK's largest source of emissions, and that emissions from this source have been slowly increasing. Petrol and diesel used in road transport attract high taxes per unit of GHG emissions. Indeed, each kilogram of CO_2e emitted from burning these fuels is taxed at a higher rate than the emissions associated with even the most heavily taxed uses of gas and electricity. This primarily reflects the high rates of fuel duties.[27] It should be borne in mind, however, that motoring is associated not just with GHG emissions, but also with other social costs (accidents, local air pollution and most importantly congestion). While there is a strong case for other forms of taxation to address the social costs of congestion in particular – as these vary hugely by time and place – in the absence of such taxes, these other social costs may explain the high rates of duty per tonne of CO_2 equivalent (Adam and Stroud, 2019).

While taxes on petrol and diesel are relatively high, they have not, unlike implicit taxes on the GHG content of electricity, been rising over time. In fact, fuel duties have been falling in real terms for around a decade, from 71p per litre in 2010 to 58p in 2021 (2021–22 prices).

As we saw in Section 8.2, **international aviation** saw a very large increase in GHG emissions from 1990 to 2018. Under current policy, commercial passenger flights are zero rated for the purposes of VAT and incur no fuel duties on purchases of jet fuel (current international agreements largely prohibit taxes on fuel for international flights). Counterbalancing this advantageous tax treatment are charges imposed by APD and the UK ETS (which only covers emissions from outbound flights to EEA destinations). Although a higher rate of APD is payable on long-haul travel, it is far from directly proportional to the GHG emissions from different flights.

Figure 8.6 shows the net impact of these policies for both economy- and business-class tickets on two example flights – London to Paris (short haul) and London to New York (long haul). In both cases, the prices refer to purchases by an individual rather than a business, a relevant distinction because businesses are permitted to reclaim VAT paid on their costs. Emissions are taxed most heavily for short-haul, economy-class flights. As the cost and distance of flights increase, the implicit subsidy provided by VAT zero-rating quickly starts to outweigh the effects of higher rates of APD. The result is that air travel – particularly on long-haul routes and in premium classes – is heavily tax favoured relative to other emissions-generating activities. Of course, much of the additional cost of a premium-class flight may be argued to derive from on-board services (such as premium catering) as opposed to the additional emissions associated with increased space. The key point that Figure 8.6 is drawing attention to, however, is not that

[27] There are other tax incentives to purchase more fuel-efficient vehicles, most notably the higher rates of first-year vehicle excise duty for cars with higher emissions (and no charge for electric vehicles). These incentives are not included in Figure 8.6.

aviation emissions are being directly subsidised (transatlantic flights are not subject to any form of direct carbon tax), but rather that, *relative to consuming another product or service*, buying a business-class ticket to New York (and the emissions associated with such a purchase) is strongly incentivised by the tax system.

Finally, emissions associated with **landfill** are implicitly taxed through the landfill tax which, as we have noted, has increased significantly in recent years at the same time as emissions associated with landfill have fallen dramatically. This tax may also relate to other social costs, such as water pollution. As shown in Figures 8.5 and 8.6, the tax rates associated with landfill emissions are now comparable in size to those from household consumption of gas-fired electricity. Notably, however, emissions associated with landfill incineration remain relatively lightly taxed. Emissions from municipal landfill incinerators are, for example, not covered under the UK ETS.

Subsidies for renewable and low-carbon generation

The government provides substantial subsidies to low-carbon and renewable electricity generation. These take various forms. For example, nuclear generators historically received significant help with the (large) costs of decommissioning. New nuclear plants are expected to meet their own decommissioning costs, although this might simply lead to higher subsidies being paid to generators via other means.

As with the variation in taxes, the variation in subsidies means that the incentive to produce low-carbon energy varies significantly across technologies and over time.

There are three subsidy schemes that pay renewable generators per megawatt-hour (MWh) of electricity that they produce. All are paid for by either explicit or implicit taxes on electricity supply (including that produced from renewables). The schemes are summarised in Box 8.3. Only the Contracts for Difference (CFD) scheme is available to future generation capacity, but the two legacy schemes – the Renewables Obligation (RO) and the Feed-In Tariff (FIT) – account for most of the current subsidy. Of all subsidised renewable electricity generation in 2020–21, 21% received support under the CFD scheme and 71% received support under the RO.[28] Of the £11 billion of subsidies given to renewable generators in 2020–21, £2.9 billion relates to the CFD scheme and £6.5 billion (more than twice as much) to the RO. The FIT accounts for the remaining subsidies.

[28] Department for Business, Energy and Industrial Strategy (2021f), LCCC (2021b) and Ofgem (2020b). Note that these figures assume that total FIT generation in 2020–21 (for which published figures are not yet available) remains the same as in 2019–20.

Box 8.3. Subsidies for renewable electricity generation

Contracts for Difference (CFDs) is a scheme through which the government guarantees that a low-carbon electricity generator will receive a set 'strike price' for the electricity it produces. These CFDs usually have a 15-year duration (although the Hinkley Point C nuclear power plant was awarded a 35-year CFD), during which time the government pays the generator the difference between the agreed strike price and the prevailing market price for electricity.[29]

CFDs are awarded through auctions in which the government specifies which types of technology are allowed to bid and which other technologies they are competing against. In the first round of auctions (in 2015), bidders competed in two separate auctions – one for 'established technologies' (such as solar and onshore wind generation) and a second for 'less established technologies' (such as offshore wind and tidal).[30] The two subsequent auction rounds (in 2017 and 2019) were open only to less established technologies. As a result, 90% of the capacity covered by CFDs to date is made up of offshore wind and remote island generation. The government is using CFDs not simply to subsidise renewable electricity generation but to choose which types of technologies should be added to the UK energy grid.

The Renewables Obligation (RO) – the precursor to CFDs – was closed to new applicants in 2017, but continues to operate for generators who secured contracts before this date.[31] The RO operates by giving *Renewables Obligation Certificates (ROCs)* to electricity generators for each megawatt-hour of renewable electricity they produce and requiring electricity suppliers to buy ROCs for each MWh of electricity they supply to consumers (with an 85% discount for energy supplied to energy-intensive industries).[32] Renewable electricity generators receive a subsidy by selling ROCs to energy suppliers. The size of the subsidy has varied by technology type since 2009 when the government began giving more ROCs per MWh to technologies that it wished to support more generously.

Feed-In Tariffs (FITs) provide subsidies to small-scale renewable energy generation – such as through solar panels on houses – installed before April 2019. The subsidies are considerably more

29 If the market price is above the strike price, the difference is paid by the generator to the government.

30 The full list of 'established technologies' is onshore wind, solar photovoltaic (>5 megawatts), energy from waste with combined heat and power (CHP), hydro (>5MW and <50MW), and generation from landfill or sewage gas. The full list of 'less established technologies' is offshore wind, wave and tidal, advanced conversion technologies, anaerobic digestion, dedicated biomass with CHP, and geothermal. In auction round 3, remote island wind (>5MW) was added to this list.

31 Generators accredited under the RO before (on or after) 26 June 2008 will receive support until 2027 (2037).

32 A supplier with insufficient ROCs is required to make a 'buyout' payment for each uncovered MWh of electricity (the buyout price was £50.05 in 2020–21). After meeting administrative costs, the remainder of the resulting buyout fund is paid back to suppliers in proportion to the number of ROCs that each surrendered.

generous per MWh than those offered under the RO or CFD schemes.[33] The cost of subsidies is borne by all electricity suppliers (with a discount related to electricity provided to energy-intensive businesses).[34] For individuals in receipt of FITs in a non-business capacity (i.e. when generating electricity mainly for use in their own home), subsidy income is (like other home production) exempt from income tax.

The closure of the FIT scheme to new applicants from April 2019 followed significantly higher take-up than had been anticipated by the government, leading to concerns that the high per-MWh cost of the scheme was placing an increasingly onerous burden on electricity consumers (National Audit Office, 2016b). No replacement scheme was put in place following its closure, meaning that subsidies are no longer available to support new small-scale renewable generation projects in the UK.

Figure 8.7 gives a sense of the variation that we have seen in subsidies that apply per MWh to date. What matters for considering the incentive to generate an additional MWh of renewable electricity from a given plant is the difference between the subsidy received and the tax paid. The figure therefore shows the net average subsidy paid to generators using various technology types for each MWh of subsidised electricity.[35]

There are two important things to note about the pattern of subsidies. First, the figures reflect the average net subsidies that are currently being given and not necessarily the choices that the government will make in future. Much of the variation in Figure 8.7 reflects the legacy of the RO and FITs, which entailed different levels of support for different technologies from what is currently available under the CFD scheme. For example, in the most recent CFD auction round, onshore wind generators were not offered the opportunity to receive a subsidy.

Second, the extent to which the subsidies vary across technologies is a result of deliberate government choices to favour ‘emerging’ over ‘established’ technologies. Under the RO scheme, the government strongly favoured wave and tidal technologies: this is the primary factor driving the high subsidy rate shown in Figure 8.7. Offshore wind was also favoured in the two most recent rounds of CFD auctions (in which onshore wind and solar, for example, were

[33] Small scale is defined as up to 5 megawatts of capacity, or 2 kilowatts for combined heat and power (CHP) generators. FITs are available for five renewable technology types: solar, wind, CHP, hydro, and anaerobic digestion. The subsidy is received for a period of between 20 and 25 years. The average subsidy paid to solar generators subsidised under the RO and CFDs was £78/MWh in 2019–20, while the average FIT subsidy in the same year was £167/MWh (Ofgem, 2020b; LCCC, 2021b; Department for Business, Energy and Industrial Strategy, 2021f).

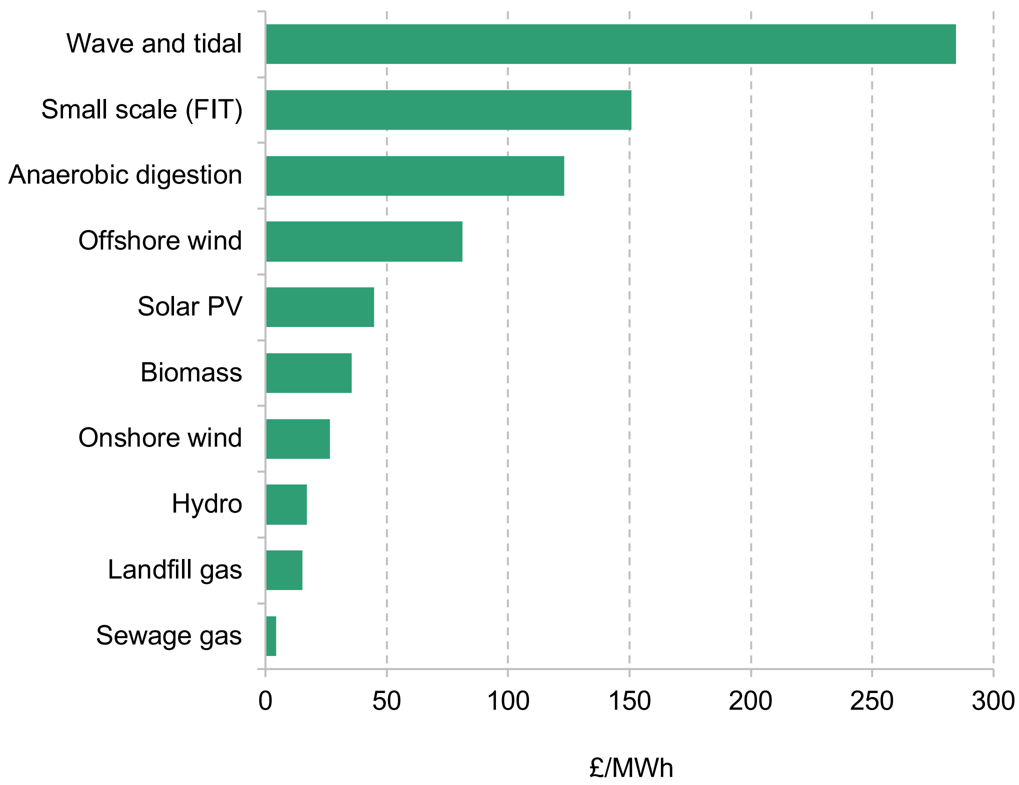
[34] FIT subsidies are initially paid by a generator’s electricity supplier but the cost is ultimately shared between all large energy suppliers (those with at least 250,000 customers) in Great Britain – the FIT is not available in Northern Ireland – in proportion to their market share through a process known as ‘levelisation’. An 85% discount is applied to electricity supplied to energy-intensive industries when calculating suppliers’ levy liability.

[35] As above, we do not include the Capacity Market Supplier Charge here.

prevented from bidding). So far, nuclear power has not been included in these schemes and so is not included in the graph – effectively, there is a net tax per MWh produced by current nuclear plants. However, the government has negotiated a bilateral CFD contract for the construction of the Hinkley Point C power plant, which is much more generous than the recent contracts awarded for other forms of electricity generation.[36]

One of the major policy trends in the past decade has been the move towards a much more interventionist approach to subsidising renewable electricity generation (the RO was uniform across technology until 2009 and CFDs were initially available to a broader range of technologies). There has also been a shift towards giving much more long-term certainty to those investing in renewables – for example, through providing guaranteed strike prices for the output of those winning CFD auctions and by setting a floor price for carbon in the electricity sector.

Figure 8.7. Net average subsidy by renewable type (2020−21)



Note: Includes all subsidies provided through CFDs, FITs and the RO. Figures are given net of implicit taxes on electricity. VAT avoided as a result of the subsidy is included in our final figures.

Source: Authors' calculations. See Online Appendix 8A for details.

36 The Hinkley Point C contract lasts for 35 years rather than the usual 15. The current value of the strike price agreed for the project (£106.12) was below the average strike price awarded in auction round 1 (£120.70), but above that for auction rounds 2 and 3 (£74.36 and £48.32 respectively). See LCCC (2021c).

These changes mean that the government, rather than purely the market, is shaping the future of the UK's energy mix. Without subsidies or with uniform subsidies (rather than the selective subsidies summarised by Figure 8.7), the grid would look very different and electricity would almost certainly be cheaper – by backing less established technologies, the government is choosing technologies that lead to more expensive electricity. The logic of this directed approach has been to foster the emergence of technologies whose costs might fall in the future as firms 'learn by doing' and the industry increases in scale. There is indeed some evidence for this in, for example, rapidly falling costs for offshore wind generation (International Energy Agency, 2019). Such an approach, however, carries risks. The main problem is that we do not know whether the government is actually picking the technologies that are best placed to allow the UK to achieve net zero at the lowest possible cost. Should small-scale generation (of the type supported by the FIT) be encouraged more than onshore wind and should either be encouraged more than nuclear? What proportion of the grid should be renewable, and what is the best mix of technologies? These are choices that the government is making under its current approach.

The government has already indicated that in the next set of CFD auctions, established technologies will be allowed to bid again and offshore wind will be given a separate auction from other 'less established technologies' (allowing the latter to win more subsidies). Whatever other choices the government makes about future subsidies, they will be extremely important. They should be taken with care and made as transparently as possible.

Subsidies for energy efficiency in homes

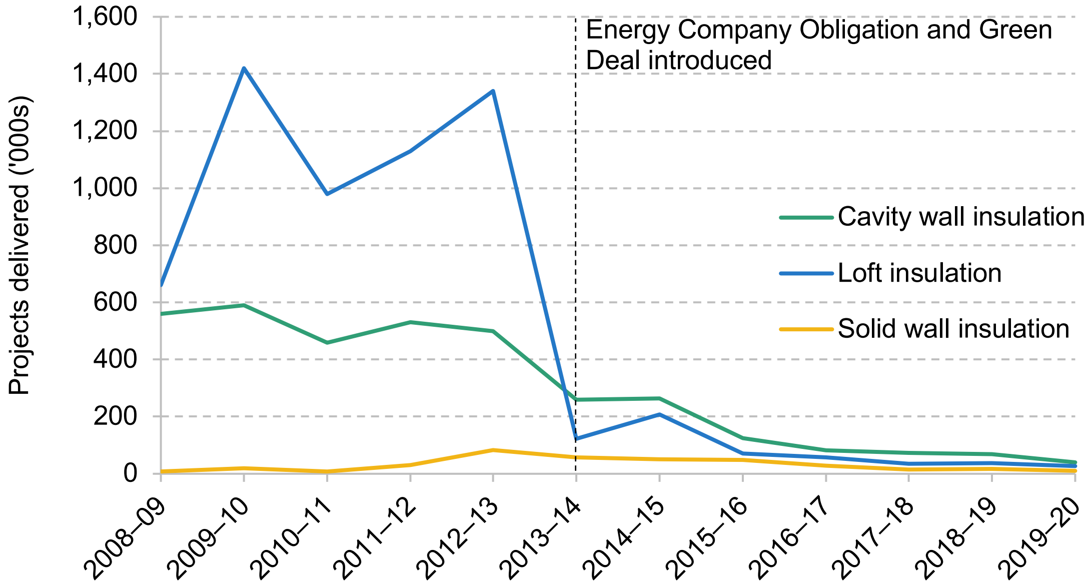
The government has for many years operated a range of schemes to encourage households to adopt energy efficiency improvements such as insulation, double glazing and replacing old boilers. Prior to 2013, the government's primary tool for achieving this was the **Carbon Emissions Reduction Target (CERT)**, which imposed an obligation on large gas and electricity suppliers to deliver specified carbon savings by retrofitting existing homes with energy efficiency improvements (primarily insulation and lighting). CERT's sister programme, the **Community Energy Savings Programme (CESP)**, meanwhile, imposed a similar obligation but focused exclusively on those living in certain low-income areas. The **Warm Front** scheme provided grants for energy efficiency measures to households at risk of fuel poverty. In 2013, the government refocused these obligations on poorer and 'hard-to-treat' households by replacing CERT, CESP and Warm Front with the new ECO. This greatly restricted the number of households that were eligible for support. From September 2018, ECO became entirely focused on low-income or otherwise vulnerable households.

Initially, households that did not receive assistance under the ECO were offered unsubsidised loans through the so-called **Green Deal**, which could be repaid through their energy bills. The idea was to facilitate cost-saving energy efficiency improvements with limited public subsidy or costs imposed on energy companies (which could be passed through to household bills).

However, the scheme's complexity and lack of financial incentives meant it suffered from low take-up, improving a mere 14,000 homes before being effectively closed in 2015 (National Audit Office, 2016a).

Figure 8.8 shows the number of insulation projects of different types that have been delivered through the schemes since 2008–09. When, in 2013, the government introduced the ECO and the Green Deal, there was a dramatic reduction in the number of home insulation projects carried out under government-sponsored schemes. This is despite the fact that many homes still lack effective insulation (Climate Change Committee, 2019b).

Figure 8.8. Insulation projects delivered through government schemes in Great Britain



Note: Includes all projects delivered through CERT, CESP, Warm Front, ECO and the Green Deal.

Source: Table 8.3 in Department for Business, Energy and Industrial Strategy (2021d) and table 4.3 in Department of Energy and Climate Change (2015).

The Green Deal closed in 2015, leaving a gap in incentives to install energy efficiency improvements for the majority of households who are not eligible for support under the ECO or other similar schemes.[37] This gap has not been filled. Combined with the relatively generous tax treatment of domestic gas we discussed above, this means that current policy gives most households little additional incentive to reduce their greenhouse gas emissions by investing in energy efficiency measures. The stop–start nature of subsidies in this area has also hindered sustained investment and training in the sector. A Green Homes Grant was introduced as a stimulus measure in October 2020, providing homes with vouchers to cover much of the cost of

[37] See Environmental Audit Committee (2021) for descriptions of other, current energy efficiency policies. Devolved administrations operate their own schemes but these also tend to focus on low-income households and areas.

energy efficiency improvements using accredited suppliers. However, this scheme ended in March 2021 with a significant underspend, as accrediting for the scheme proved costly and complex, and businesses saw little reason to scale up their operations and train new staff for such a short-lived programme (Environmental Audit Committee, 2021). While other schemes to support household energy efficiency are being introduced or scaled up, these continue to focus on hard-to-treat and low-income households.

8.5 Distributional effects of climate change policies

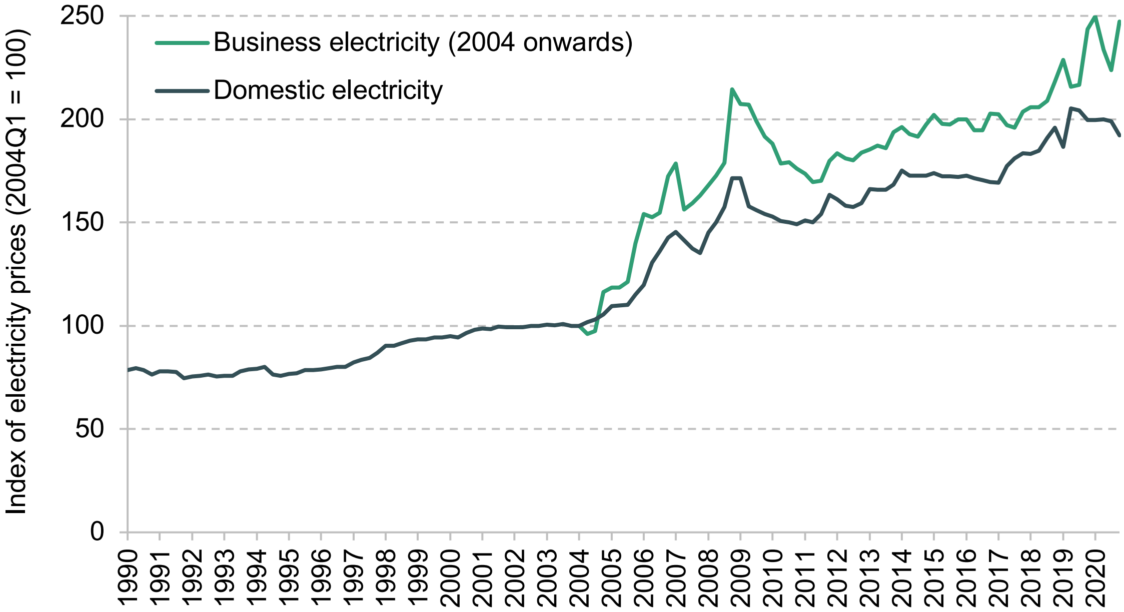
Meeting the UK's climate goals will entail significant costs for households whether as taxpayers, billpayers, shareholders, workers in carbon-emitting industries or consumers of carbon-intensive products. A key question is how these costs will be shared between different types of households.

Who has paid for policies so far?

The policies described in Section 8.3 are already pushing up the price of electricity and fuel paid by households and businesses.

Figure 8.9 shows the real price of electricity (adjusted to reflect changes relative to the Consumer Prices Index, CPI) from 1990 to 2020 for households and from 2004 to 2020 for businesses (as we do not have data for firms before this date). From 1990 to 2004, household electricity prices rose by 31% in real terms. From 2004 to 2020, electricity prices rose by 93% for households and by 133% for businesses. Much of these dramatic increases in electricity prices were undoubtedly the result of increases in levies to pay for renewable energy subsidies, obligations to source from more costly renewable sources, and taxes on carbon emissions from the energy sector. The Climate Change Committee (CCC) estimates that around two-fifths of the increase in household electricity prices between 2004 and 2016 was due to climate change policies (with most of the remainder driven by rising wholesale fuel prices) (Climate Change Committee, 2017). The importance of climate change policies in driving electricity prices is likely to have increased since these estimates were made, as the costs of government schemes have risen. It is also likely to be greater for businesses; as Section 8.4 showed, implicit carbon taxes are much higher for businesses' electricity use.

Figure 8.9. Real electricity prices for domestic use (1990–2020) and business use (including the Climate Change Levy; 2004–20)



Source: Authors' calculations using series D7BT and D7DT from Office for National Statistics (2021), and Department for Business, Energy and Industrial Strategy (2021b).

Higher domestic electricity prices will disproportionately hit low-income households, who devote a larger share of their spending to electricity (although, as we noted in Section 8.3, these households have also benefited from schemes to improve their energy efficiency, and the Warm Home Discount directly reduces their energy bills).[38] The share of households' spending going on fuel duties does not vary as clearly with income as the budget share of electricity, but is lower for the top and bottom income deciles than for those in the middle of the income distribution (Adam and Stroud, 2019). However, knowing the effects of, for example, rising domestic electricity prices on households, or the amount different households spend on fuel duties, does not tell us all we need to know to understand the full distributional impacts of charges for electricity supply and fuel taxes. The full effects of policies that address climate change – including indirect effects – are much harder to quantify and assign to different income groups. For example, the higher cost of electricity to businesses will ultimately be passed through to households by affecting the prices of goods and services they buy, as well as wages and profits – and these changes will have different impacts on different households. The same is true for other

[38] Energy *bills* fell from 2008 to 2016 even as energy prices continued to rise (Climate Change Committee, 2017). The CCC attributes this to improved energy efficiency over this period, although it is difficult to know how much of this can be attributed to government policy.

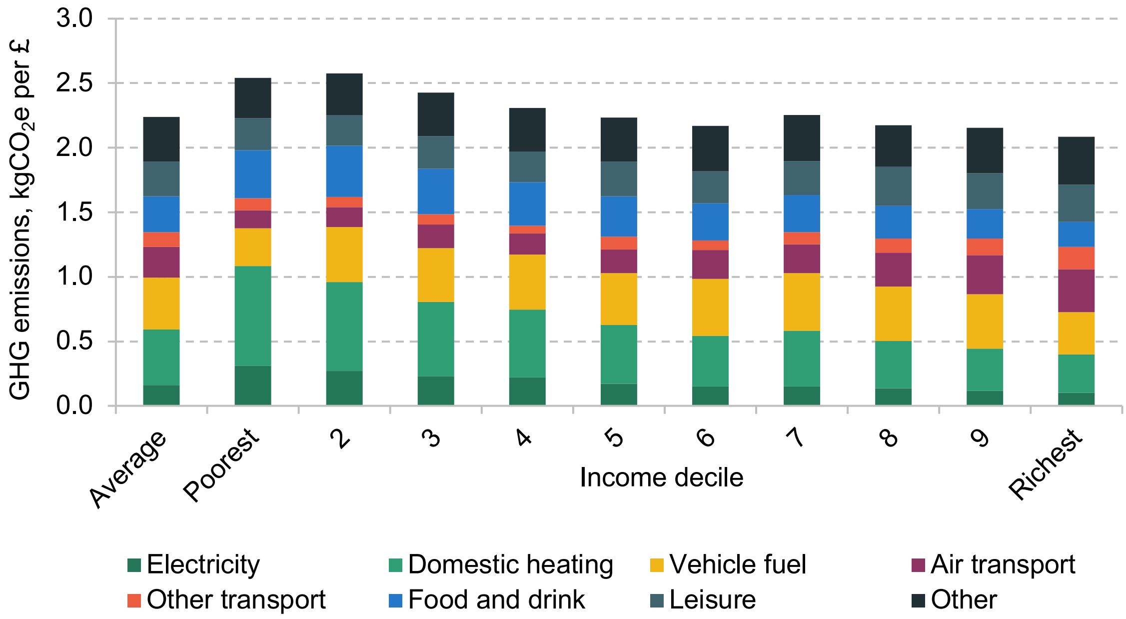
taxes or regulations that raise the cost of emissions or production, which will not only change prices and wages, but also change the types of jobs and products that are available.

Understanding the full distributional impacts of achieving the net zero target, accounting for all these different channels, is difficult. A recent review by HM Treasury highlighted risks to low-paid workers in particular occupations – such as plant and machine operatives – who are more likely to work in carbon-intensive industries (HM Treasury, 2020). However, the shift to a low-carbon economy is also likely to create new jobs in areas such as home insulation, land management and innovation. Understanding the net effects of all these changes on different households is an important outstanding question.

How might increases in the cost of emissions affect different households?

To get an idea of how increases in the cost of GHG emissions might, in general, be passed through to high- and low-income households (assuming such policies are ultimately fully passed through to consumer prices), Figure 8.10 shows GHG emissions associated with each pound of consumer spending. As with Figure 8.4, this captures all of the emissions embedded in the products consumers buy, regardless of where they occurred in the supply chain. The figure also breaks these emissions down by product group.

Figure 8.10. Average GHG emissions per pound of spending by net equivalised income decile, 2018



Note: Household incomes are equivalised using the modified OECD scale. $kgCO_2e$ refers to kilograms of carbon dioxide equivalent.

Source: Authors' calculations using the Living Costs and Food Survey 2018 and Department for Environment, Food and Rural Affairs (2021).

While we saw in Section 8.2 that richer households tend to have higher GHG emissions, Figure 8.10 shows that the GHG intensity of their spending is lower than that of poorer households. This matters because households with more GHG-intensive spending patterns will be proportionally more affected by policies that increase the cost of GHG emissions. Lower-income households are associated with more CO_2 equivalent emissions per pound of spending – 2.5 kilograms per pound in the bottom income decile compared with 2.1kg in the richest decile – largely because a greater share of poorer households' spending goes on electricity, heating and food. As Section 8.2 showed, electricity generation, home heating and agriculture continue to be amongst the largest sources of GHG emissions. Reaching net zero will require further policies in these areas, and these can be expected to hit low-income households disproportionally. These households are also likely to have greater difficulty financing the up-front costs of energy efficiency improvements or other lifestyle changes, even if these changes could save money in the long run. This would amplify the costs for this group.

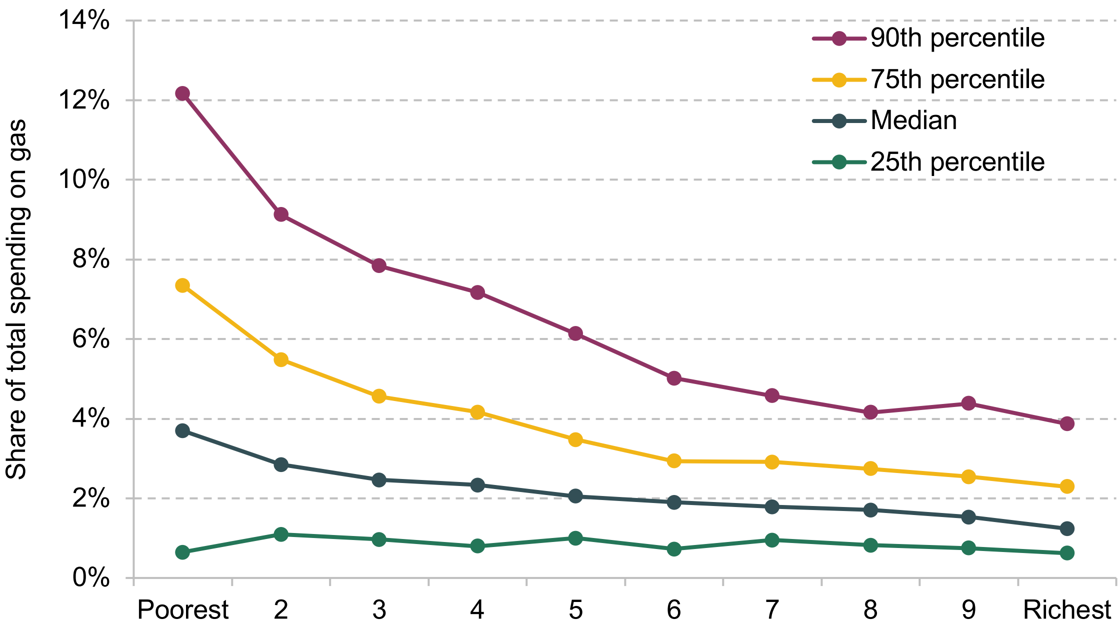
The accounting in Figure 8.10 includes emissions that took place abroad and which would not be affected by domestic UK policies that increased the cost of GHG emissions. It also tells us nothing about how the demand for different sorts of workers will be affected by the transition to net zero, and how this might affect household incomes. These factors could amplify or mitigate the implied impact of decarbonisation on different income groups. Nonetheless the figure provides grounds for concern that policies aimed at abating emissions will have a disproportionate impact on low-income households. Other differences in exposure across groups – for example, between those in different age groups, or those with and without disabilities – are also important to consider.

Possible ways to compensate those most affected by policy

What can be done about concerns that policies to achieve net zero will disproportionately affect those on low incomes for example? A standard response from economists is to note that taxes aimed at tackling climate change would also raise revenue, and that these revenues (or revenue from general taxation) could be used to compensate those groups that are most adversely affected by the costs of decarbonisation. For example, suppose the government decided to address residential emissions through increasing taxes (such as VAT) on gas used for domestic heating. The revenues from these taxes could be used to lower taxes, increase benefit rates or increase spending on public services, in a way that disproportionately benefited lower-income households while preserving their incentive to reduce gas consumption.

However, Figure 8.11 shows why such compensation needs to be designed carefully. It shows the distribution of the share of spending on domestic gas within each household income decile. It shows not only that low-income households tend to devote a greater share of spending to gas, but that there is also substantial variation in budget shares *within* income groups. Within the bottom decile, for example, household budget shares on gas vary from 1% at the 25th percentile to 4% at the median (50th percentile), 7% at the 75th percentile and 12% at the 90th percentile. The wide gap between households at the median and the 90th percentile is indicative of a small proportion of 'hard-to-help' households with particularly high gas consumption. A compensation scheme targeted only at low-income households would not necessarily reach this group, and schemes based too closely on factors related to gas consumption could lead to perverse incentives to increase energy use. Other indicators such as age, family type or disability could in principle be used alongside incomes to improve the targeting of compensation measures (which could, for example, include increases in different state benefits or pensions).[39]

Figure 8.11. Distribution of share of total spending on gas by net equivalised household income decile, 2018



Note: Household incomes are equivalised using the modified OECD scale.

Source: Authors' calculations using the Living Costs and Food Survey 2018.

Whether or not the government tackles emissions through taxes and formal compensation policies in this way, it will (at least implicitly) be making many choices about how to share the cost of emissions reductions between different groups of consumers and taxpayers.

In cases where the government subsidises low-carbon technologies or insulation or anything else aimed at tackling climate change, decisions need to be made about how these subsidies are funded. These will entail distributional consequences, as does the decision to use such subsidies rather than taxes or prices to incentivise behaviour change in the first place. Regulations also do not sidestep choices about who is ultimately paying for polices: they still impose costs on

[39] See Advani and Stoye (2017) for a discussion of different possible compensation schemes.

different households even if the way they do so is sometimes opaque (and they also do not raise revenues that can be used to compensate households afterwards).

8.6 Conclusion

The UK's net zero target is an ambitious goal. Achieving it will require substantial investments in new infrastructure and the rapid development and deployment of new technologies. The costs of this transition will be substantial; of course, if enough countries reduce greenhouse gas emissions sufficiently, there will also be large benefits. It is important that policies be carefully designed to achieve the transition at the lowest possible cost and in a manner that has acceptable distributional outcomes.

The most striking feature of the current UK policy landscape is that there are many overlapping policies, especially in the energy sector. Well-intentioned as the policies may be, their complex, piecemeal structure creates inconsistent incentives to reduce GHG emissions. Incentives to abate vary dramatically across and within sectors and across fuel types and end users, without good reason. Incentives range from positive encouragement to burn gas for home heating and to take expensive personal flights, to strong disincentives related to businesses' electricity use, and even stronger disincentives to burn petrol or diesel. Different schemes incentivise different types of abatement to differing degrees. This approach of effectively (and in some cases probably inadvertently) varying the incentives to reduce emissions compromises efficiency – emissions will not be reduced in the lowest-cost way. Ultimately the inconsistency of the taxes on GHG emissions increases the costs of the transition to net zero.

Successive governments have also subsidised renewable electricity generation and done so in ways that mean that it is Whitehall (and not the market) that is determining which technologies are developed and brought onto the UK grid. These substantial bets on the future success of particular technologies that are currently too expensive to be viable without large amounts of government support come with both upside and downside risks.

Climate change policy is a complex area, not least because domestic policy is being used in the face of an international problem and there will be hard-to-measure but important distributional consequences. But the direction of travel that is needed is clear. Although not sufficient on its own, the main aim should be a more uniform effective tax on emissions, set at a level consistent with the UK's emissions targets.

If the government were willing to be ambitious, it could look to replace a raft of existing policies with a single carbon tax, or with an emissions trading scheme that was extended to cover all emissions. There would be major benefits to having a much smaller, simpler set of policies that produced a consistent set of incentives to reduce GHG emissions. Even without going that far, the government could reform existing policies to move towards a more uniform effective tax rate on emissions. In some areas the government is moving in that direction: closing the gap between Climate Change Levy rates for gas and electricity, for example. But there is much more that could be done.

There is certainly scope to extend the ETS well beyond the 29% of emissions it currently covers, even if it never covers all emissions. The European Commission has proposed extending the EU ETS to fuel for transport and heating buildings, for example. It would also be desirable to link the UK ETS to the EU ETS to allow emissions reductions to take place where it is easiest, which was the government's (and the Climate Change Committee's) preferred option when leaving the EU but so far shows little sign of happening.[40]

The biggest challenges are the areas where emissions are not taxed, or are even subsidised – domestic use of gas, aviation, food production and imports – and land transport, which is now the largest source of emissions.

Perhaps the most important, and in some ways the most challenging, is domestic energy, and particularly domestic use of gas. The government could at least remove the effective subsidy provided by the reduced VAT rate for domestic energy – and ideally go much further, imposing a serious tax on emissions. The political obstacles to this are obvious, as the Conservative government of the 1990s discovered when it tried and failed to do it. Such a reform would in all likelihood need to be accompanied by a compensation package to address its distributional consequences and by additional measures to help households improve their energy efficiency and move away from gas boilers. The government currently provides subsidies for energy efficiency improvements that are focused on poorer households. Recent attempts to reintroduce more general incentives to apply energy efficiency measures have been short-lived and poorly implemented. Giving advance notice of tax rises would give households a chance to plan and take whatever steps they need to.

Another major inconsistency is the treatment of aviation. Taxes on aviation are low relative to its emissions, particularly for long-haul flights. There is no tax on aviation fuel, no VAT on flights, and flights outside the EEA are not included in the ETS. Air passenger duty is too low to offset this and is not well targeted at reducing emissions. Moving to a sensible system for taxing aviation would be much easier as part of an international agreement – and seeking such an agreement should be a clear focus of the UK government's efforts. Bringing aviation within the (EU and then UK) ETS was a welcome start, but there is much more to do.

[40] See Ares (2021).

Unlike aviation, land transport emissions have only risen slightly; but they are a much larger (indeed, the largest) component of the UK's GHG emissions. Road transport is one area where the UK does impose a substantial carbon tax, in the form of fuel duties (though other aspects of motoring taxation, such as the annual vehicle excise duty, are poorly designed). But we lack a serious strategy for motoring taxation. Despite apparently wanting people to move over to low-emissions cars, the government has frozen fuel duties for more than a decade (a real-terms cut of almost 20% since 2010–11) – but never as a stated long-term policy, typically announcing one more year's freeze with inflation uprating assumed to recommence thereafter. And if people do stop driving petrol and diesel cars, the government has not said whether it is content to see the current £40 billion a year of motoring tax revenues dry up and have virtually no tax at all levied on motoring despite the other harms – notably congestion – that it causes. The government should set out how it plans to tax low-emissions driving in the long term while incentivising the take-up of lower-emissions cars in the short term. In our view, the goal should be a system of road pricing that varies by time and place, perhaps with a simpler flat-rate tax per kilometre driven as a stepping-stone. The government should move towards that as quickly as possible. Switching to low-emissions cars could be encouraged via a subsidy for scrapping old cars which depends on emissions in the same way as the tax on buying new cars, and via investment in infrastructure such as charging points that makes alternatively fuelled vehicles a more attractive proposition.[41]

Agriculture is supported by subsidies and tax advantages and its emissions are not covered by decarbonisation incentives such as the ETS. Post-Brexit reforms to agricultural subsidies will give farmers greater incentives to cut output and manage their land in more environmentally-friendly ways (including by contributing to decarbonisation). However, the details of the new regime for subsidies are yet to be spelled out, and so it is unclear how far they will incentivise emissions reductions. This is also an area where the government must be careful about imported emissions: reducing UK farm output and increasing food imports would not necessarily be better for the environment. If we are thinking about the UK's contribution towards climate change more broadly than a territorial emissions target, then policy towards UK food consumption might be at least as important as policy towards UK agricultural production.

More widely, the UK could look at how it treats emissions embedded in its imports. For now, the government continues to provide preferential treatment for energy-intensive industries to reduce the risk of carbon leakage. If it continues to do so, it should review which businesses should qualify. It is hard to see why we should have different definitions of energy-intensive industries for the CCL and the levy that funds CFDs, and why the industries that receive free ETS permits should be different from both of those: it would seem more sensible to use a

[41] See Adam and Stroud (2019) for further discussion.

consistent definition across the board based on exactly where the risk of carbon leakage lies. Rather than continue to favour industries at risk of carbon leakage, the government could consider bringing in a border tax on emissions embedded in imports – like the CBAM the EU is considering – though that is not without problems of its own. This is clearly an area in which international coordination would be particularly valuable.

Whichever specific policies the government chooses, it should aim not only for greater consistency, but also for clear and credible long-term guidance. We will need policies in place for decades to come; policy stability will help businesses and households to plan and make efficient adjustments. It is important that the government conveys a clear sense of direction which in turn will help foster long-term investments and innovation.

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