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Emissions and our tax forecasts

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Abstract

Several of the UK's tax bases are directly linked to activities that generate greenhouse gas emissions, with others indirectly linked. So as emissions fall as the UK transitions to net zero, receipts generated from these emissions-linked taxes will be affected. In this working paper, we conduct an initial, high-level analysis to explore the proportion of emissions that are directly or indirectly linked to tax bases, the value of the associated receipts, and the risks they face from decarbonisation. We find that three-quarters of the UK's territorial emissions are directly or indirectly linked to tax bases, with around 60 per cent directly linked. The associated tax revenues were worth over £50 billion in 2022-23. The transition to net zero will therefore have direct implications for the outlook for tax revenues. The findings of this paper underscore the value for the OBR of being able to draw upon detailed and high-quality medium-term forecasts for emissions, and of understanding of how these develop as the UK decarbonises. Prospects for decarbonisation will become an increasingly important input for the OBR in delivering against our core remit of forecasting the public finances.

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1 Introduction

1.1 In 2019, the Government legislated its target to get to net zero emissions by 2050. It has since set out a Net Zero Strategy and a wide range of sector-specific strategies to underpin the decarbonisation of activity across the economy. These contain an array of targets including an ambition to fully decarbonise the power system by 2035;[1] the phasing out of new petrol and diesel car sales by 2030;[2] and the 'Future Homes Standard', which, by 2025, will require new-build homes to produce at least 75 per cent lower emissions than those allowed by current standards.[3]

1.2 In our 2021 *Fiscal risks report* (*FRR*), we presented several potential scenarios for the fiscal implications of getting to net zero by 2050. But the transition to net zero is affecting many tax bases now – most noticeably, the rise of electric vehicles has started to have a material impact on our forecast for fuel duty revenues. So in this working paper, we map the UK's greenhouse gas emissions onto our tax forecasts to show how the activities that currently generate those emissions are taxed, how the revenues from those taxes feature in our forecasts, and what the transition to net zero might imply for the future sustainability of different tax bases.

1.3 This is a relatively simple initial analysis of the extent to which emissions are taxed in different ways and the extent to which our tax forecasts might be influenced by reductions in emissions during the transition to net zero. We will continue to refine our methodologies in the future as necessary and as new data becomes available.

1.4 The paper is structured as follows:

- In Section 2, we describe **the UK's greenhouse gas emissions**, including the different ways that they are measured and the sectors and activities that generate emissions.
- In Section 3, we take each sector and show **how emissions-generating activities are taxed** and how that maps onto individual elements of our tax forecasts.
- In Section 4, we conclude by summarising **the degree to which emissions and tax revenues overlap** and how the transition to net zero might influence our forecasts and the risks around them.

[1] In October 2021, in the lead-up to hosting the COP26 Climate Summit, the Government announced a "*landmark commitment to decarbonise the UK's electricity system by 2035*". Following the Russian invasion of Ukraine, in Department for Energy Security and Net Zero, *Powering Up Britain*, March 2023, this was qualified such that this commitment has become "*an ambition to fully decarbonise the power system by 2035, subject to security of supply*".
[2] Department for Transport, *Transitioning to zero emission cars and vans: 2035 delivery plan*, July 2021.
[3] Department for Business, Energy and Industrial Strategy, *Heat and Building Strategy*, October 2021.

2 The UK's greenhouse gas emissions

2.1 The greenhouse gas (GHG) emissions that countries are required to monitor and report on are anthropogenic sources of emissions (those produced by human activity, which have risen sharply since the industrial revolution), net of removals via GHG sinks (such as oceans and forests).[1] Emissions are usually reported in terms of carbon dioxide equivalents (CO_2e).[2] Within the UK, the Department for Energy Security and Net Zero (DESNZ) is responsible for monitoring, reporting on, and projecting the UK's emissions. It does this on a 'territorial' basis, meaning those emissions produced and released within a country. For example, it includes the emissions produced by a car while being driven in the UK, but it does not include the emissions released in the production of that car if it was manufactured elsewhere. On an accounting basis, UK territorial emissions do not currently include international aviation and shipping (although they will from 2033 onwards).

2.2 In 2019, the Government committed to reducing UK emissions to 'net zero' by 2050 – that is, gross GHG emissions will not exceed gross removals. On this path to net zero, the Government has made an international commitment to a 'nationally determined contribution' as well as setting domestic 'carbon budgets' – total UK territorial emissions allowed in successive five-year windows. The latest carbon budget advice from the Climate Change Committee (CCC), the UK's official body that advises the Government on what budgets it should set, is the sixth (CB6) and covers the period 2033 to 2037. CB6 was signed into law in June 2021 and states that maximum average UK GHG emissions should be at least 78 per cent below 1990 levels. DESNZ is responsible for setting out the UK's strategy to meet it, including setting a path for the emissions reductions required by different sectors. The CCC's advice includes several potential pathways for sectoral reductions.

2.3 There are different ways of classifying emissions into high-level sectors. A key distinction relates to whether emissions are allocated according to their 'source' – where energy supply (which includes electricity generation, refineries, and fuel extraction and manufacture) is included as a standalone sector – or their 'end-use' – meaning emissions originating from energy supply are reallocated to the sectors using that energy and in that sense ultimately responsible for the emissions generated in producing that energy. Intuitively, considering emissions according to their end-use appears attractive: it relates most closely to where the emissions-producing consumption occurs, which in turn relates to virtually all the activities that are taxed in the economy to some extent. But the relevant income and consumption taxes are not sensitive to emissions, i.e. the consumption will still take place if and when the

[1] Emissions removed by engineered greenhouse gas removal technologies are also netted off. Emissions from biomass burning at Drax are netted off from the energy sector, as they are already accounted for in the land use sector.
[2] While CO_2 is the greatest source of anthropogenic emissions, other gases, such as methane and hydrofluorocarbons, are also potent sources of GHGs. The concentrations of these other GHGs are converted into the equivalent level of CO_2 needed to produce the same warming effect to get total GHG emissions, which allows comparison of emissions across countries that have different emissions profiles.

energy supply on which it relies shifts to lower- or non-emitting sources. By contrast, several taxes on emitting energy and fuel supply *are* sensitive to the emissions produced.

2.4 For this reason, in the remainder of this paper we focus on the relationship between emissions broken down by source activity, and receipts from various taxes levied on those activities. In particular, we look at how emissions reductions have influenced receipts to date, or can be expected to do so in the future. As such we make use of the sector definitions set by the United Nations' Intergovernmental Panel on Climate Change (IPCC) and the corresponding UK statistics published by the Office for National Statistics. This approach allocates emissions according to their source in the latest release. In previous releases, emissions were also reallocated into 'end-use' categories, with the latter being similar to the approach used by the CCC in its carbon budget advice.[3]

2.5 Chart 2.1 sets out total territorial emissions for the UK by sector for 1990 and 2019 (the latest year of outturn not significantly affected by the pandemic and associated lockdowns), based on both the 'source' and 'end-use' sectoral categorisations.[4] It shows:

- **1990 by source**: the largest source of emissions by some margin in 1990 was the energy supply sector, which accounted for 35 per cent of total emissions, followed by business and industry (21 per cent), and surface transport (14 per cent). Buildings (primarily gas heating) were the fourth-largest sectoral source (12 per cent), followed by waste (9 per cent) and agriculture (7 per cent).

- **2019 by source**: by 2019, emissions from the energy supply sector had fallen by 66 per cent (now comprising 21 per cent of total emissions, the second-largest source) due to the phasing out of coal-fired power stations, and more recently the increase in the share of renewables in power generation, alongside continued de-industrialisation reducing demand for energy supply in the industry sector. The largest source of emissions in 2019 was surface transport, whose levels were unchanged from 1990, now making up 25 per cent of the total. Business and industry remained the third-largest source in 2019, although the sector's emissions had halved in absolute terms thanks in part to de-industrialisation, while emissions from buildings had reduced by 24 per cent. The biggest reduction in percentage terms was in the waste sector, where emissions fell by 71 per cent relative to their 1990 level.

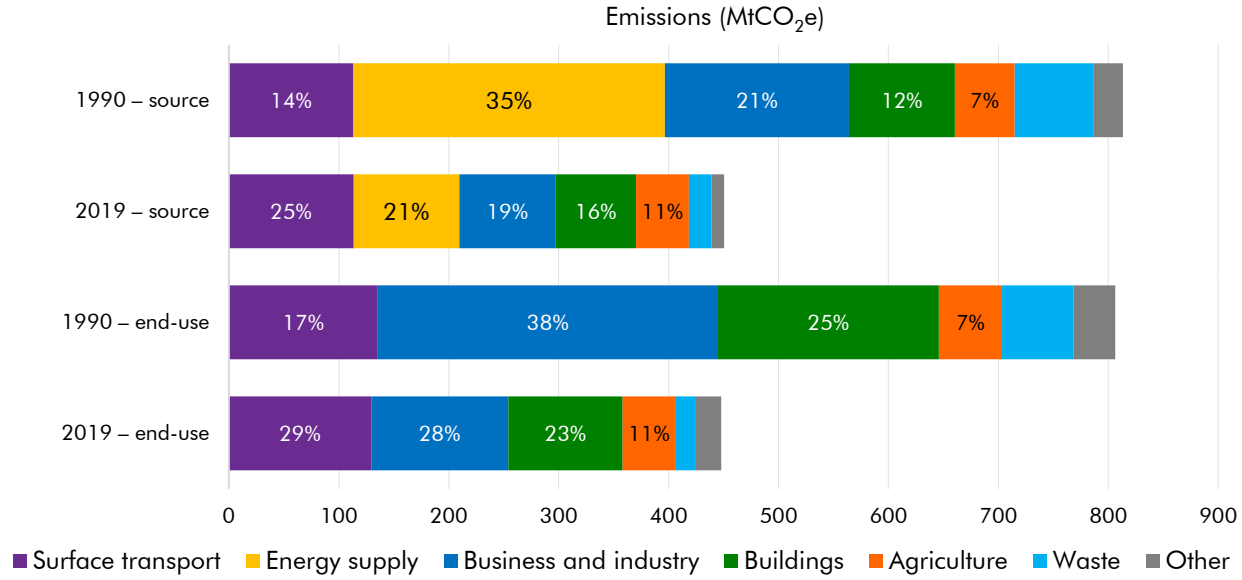
[3] The CCC's sectoral pathways formed the basis of our first estimate of the potential fiscal costs of the transition to net zero in our 2021 *FRR*. There is a high degree of overlap between the sectors used in the CCC's pathways and those in the IPCC classification, but they do not align fully. For example, many of the sub-categories of 'business' as per the IPCC classification would fall within the CCC's 'manufacturing and construction' sector.

[4] We use the 31 March 2022 update of ONS territorial emissions data release for end-use data (which includes outturn up to 2020), as this was the most recent release to include an end-use breakdown. Data on emissions by source are from the latest ONS territorial emissions release (February 2023, which includes outturn up to 2021), which contains minor revisions to the back series compared to the 2022 release. We present 2019 data as the latest pre-pandemic outturn, with lockdowns having a marked impact on the more recent UK emissions profile.

- **1990 by end-use**: reallocating to end-use mainly shifts emissions from energy supply to the business and industry and buildings sectors due to their use of electricity. These sectors were the largest and second-largest sources in 1990 on an end-use basis, at 38 per cent and 25 per cent of total emissions, respectively. Other sectors made up a similar absolute level and share of emissions as on a source basis.

- **2019 by end-use**: as was the case on a source basis, in 2019 the largest share of emissions came from surface transport, at 29 per cent of the total. Alongside de-industrialisation, the reduced emissions-intensity of energy supply since 1990 led to significant reductions in end-use emissions from business and industry (a 60 per cent reduction) and buildings (a 48 per cent reduction) – larger percentage reductions than on a source basis thanks to these sectors' use of greatly decarbonised electricity.

Chart 2.1: UK territorial emissions by sector



Note: 'other' includes the 'shipping', 'aviation' and 'land use, land use change and forestry' sectors, and for end-use only, 'exports'.
Source: ONS, OBR

3 How emissions-generating activities are taxed

Defining emissions-related taxes

3.1 In our 2021 *FRR*, we considered the fiscal risks involved in the transition to net zero by drawing on Bank of England macroeconomic scenarios, to which we added our own estimates of the potential direct fiscal costs of investment in decarbonisation and the loss of emissions-sensitive tax bases. Here we focus on the last of these: the taxes that are more directly linked to activities that emit greenhouse gases, where tax revenues (in the real world and in our forecast models) are also more directly linked to emissions.

3.2 The two clearest examples are the emissions taxed under **the UK Emissions Trading Scheme**, where the tax base is literally tonnes of emissions; and **fuel duty**, where the duty rate is set in pence per litre of fuel consumed, and therefore, in effect, pence per gram of CO_2 emitted (since there is little variation in the volume of emissions per litre of fuel burnt).

3.3 The other taxes covered in this paper are:

- **other taxes on road transport** (vehicle excise duty (VED) and VAT on fuel used in passenger cars);
- the **climate change levy** applied to energy used by business and industry (and the associated carbon price support rate);
- **reduced-rate VAT** and the **green gas levy** paid on domestic heating;
- **landfill taxes** levied on waste sent to landfill; and
- **air passenger duty** levied on domestic air transport (but excluding international flights since these are not included in the territorial emissions statistics).

3.4 In each case, we discuss the proportion of emissions that is taxed, the strength of the relationship between emissions and tax receipts via the tax base, and how this has changed over the recent past and is expected to change over our latest medium-term forecasts.

3.5 One category of taxes that may appear absent from the list above is **revenues from the North Sea**. These comprise 'ring fence' corporation tax, the supplementary charge, and the temporary energy profits levy, which together mean that the headline tax rate on the ring-

fence profits of oil and gas companies stands at 75 per cent.[1] North Sea oil and gas production are the ultimate source of some of the UK's emissions from the energy supply and surface transport sectors (to the extent that domestic production supplies their gas and oil inputs). But gas and oil markets are global (or at least regional in the case of gas), so taxes on profits from the North Sea are more sensitive to changes in economic inactivity or consumption patterns associated with decarbonisation at the global level than they are to the UK's transition to net zero. Indeed, most domestically produced oil (around four-fifths) and some domestically produced gas (around one-fifth) is exported.

3.6 As we have shown in previous long-term projections, North Sea revenues are expected to decline in the long run as oil and gas reserves are depleted – rather than as a result of global demand falling away due to decarbonisation.[2] Furthermore, over shorter horizons the tax base (profits) has tended to be more sensitive to changes in global commodity prices than to production volumes.[3] And our latest forecasts assume that medium-term North Sea gas production will decline by 10 per cent a year as existing gas fields go offline, implying that absent a significant number of new licenses, domestic production will remain lower than domestic gas requirements under net-zero-consistent gas-usage pathways.

3.7 Other seemingly relevant taxes not covered in the discussion below include the **electricity generator levy** (a temporary 45 per cent tax on windfall revenues from electricity production from renewable, nuclear, biomass and energy from waste sources in place from January 2023 to the end of March 2028) and various **environmental levies on energy bills**. The former is a tax on *low carbon* (largely renewable) energy producers so is not associated with emitting energy supply, while the latter comprises subsidies for renewables production that are funded by levies on consumers' energy bills.[4] As a result, on the basis of existing policy neither varies with territorial GHG emissions, although any changes to the structure of these taxes as the UK transitions to net zero could affect emissions, particularly in terms of the relative tax treatment of emitting and non-emitting energy sources.

3.8 Finally, it should be noted that the link between emissions (by source sector) and taxes set out below is made more complex by some taxes touching multiple sectors, or being levied on a consumption rather than a production basis. For example, while fuel duty is mainly associated with emissions from the surface transport sector, it also relates to some emissions from shipping, some types of aviation, agriculture (on a discounted basis via 'red diesel'), industrial equipment that uses diesel (and petrol), and elements of energy supply. And while the reduced-rate VAT applied to spending on *gas* used in residential buildings relates to emissions from the buildings sector, reduced-rate VAT is also applied to residential

[1] 'Ring fence' corporation tax, whose current rate is 30 per cent, is calculated in the same way as onshore corporation tax, but with the addition of a 'ring fence' and the availability of permanent 100 per cent first-year allowances for virtually all capital expenditure. The supplementary charge is an additional charge on oil and gas companies' ring-fence profits, and currently stands at 10 per cent. The energy profits levy is a temporary additional 35 per cent tax on ring-fence profits (but with allowances for investment in decarbonisation), in place from end-May 2022 until the end of March 2028.
[2] See the long-run projections for North Sea revenues in our July 2015 *Fiscal sustainability report*.
[3] For example, the 69 per cent fall in oil and gas production between 2000-01 and 2014-15 corresponded with a 75 per cent fall in real (GDP-deflated) tax receipts from profits on production, despite the real oil price rising by 157 per cent. However, year-to-year variation in receipts is more strongly associated with changes in prices than volumes produced. See Box 4.3 of our March 2023 *Economic and fiscal outlook* and paragraph 3.48 and Chart 3.7 of our March 2022 *Economic and fiscal outlook*.
[4] The ONS treats several of these schemes as both spending and taxes in the public finance statistics. This reflects the fact that they would not exist without government policy having established the subsidies that the levies finance. In statistical terms, they are therefore taxes.

electricity use, whose emissions feature in the energy supply sector. Moreover, standard-rate VAT is also applied to sales of road fuels for passenger travel (but not for the majority of business travel), which relates to emissions from the surface transport sector.

3.9 These overlaps all means some unavoidable complexity in the delineation of emissions by sector and the allocation of relevant taxes to these. The purpose of this paper is to set out a high-level mapping of the UK's territorial emissions to the tax receipts that are directly or indirectly dependent on them, so we make some simplifying assumptions and focus on the most important relationships (for either emissions or tax revenue).

Surface transport sector

3.10 The surface transport sector (including road vehicles and trains) is now the largest source of territorial emissions subject to the Government's net zero targets, accounting for a quarter of total emissions in 2019. Within the sector, three forms of transport dominate emissions: passenger cars made up 61 per cent of the sector's total in 2019; heavy goods vehicles (HGVs) made up 18 per cent; and light goods vehicles (LGVs) made up 16 per cent.

3.11 Passenger car transport is taxed via fuel duty plus VAT on petrol and diesel (and on the initial cost of new car purchases), and via vehicle excise duty (VED) paid annually on vehicle ownership. Business transport via HGVs and LGVs is taxed via fuel duty (with VAT reclaimed as an input cost), VED and, for HGVs only, via the HGV levy. In all cases, fuel duty is by far the largest tax on road transport and also the one that is most directly linked to emissions from the sector. In 2022-23, fuel duty raised £24.8 billion overall, with approximately £15.2 billion estimated to have come from passenger cars, £4.5 billion from LGVs and £4.4 billion from HGVs. Of the other taxes, VAT on passenger car transport raised an estimated £7.0 billion; VED raised £7.4 billion overall; while the HGV levy has been temporarily set to zero since the pandemic to support the sector, so raised nothing.

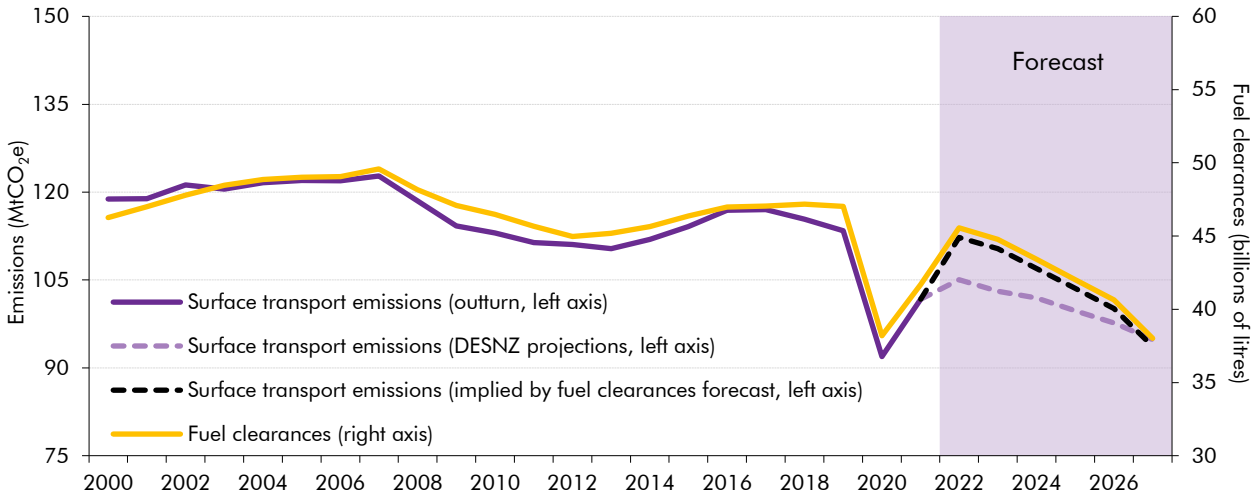
3.12 Based on a high-level categorisation of detailed emissions sub-sectors (that we use throughout this paper), fuel duty relates to 99.7 per cent of surface transport emissions, as the emissions from this sector are almost entirely from the burning of fuel in internal combustion engines, and that fuel is the subject of the tax. VAT on the fuel used in passenger cars covers 64 per cent of surface transport emissions. VED currently covers 98 per cent of emissions, again as it is applicable to all internal combustion engine vehicles, and fuel used in these vehicles is the main source of emissions in this sector.[5] So there is an almost-complete overlap between surface transport sector emissions, and changes in them, and our tax forecasts. In the sub-sections below we explore the strength of the relationship between surface transport emissions and receipts from fuel duty and VED in more detail.

[5] From April 2025, VED will be applicable to zero emissions vehicles as well as internal combustion engine vehicles, from which point we would expect to see a further weakening of the overlap between VED and emissions.

Fuel duty (and VAT on passenger car travel)

3.13 There is a strong, direct relationship between the fuel duty tax base – fuel duty 'clearances' (a tax-system measure of the volume of fuel consumed in the UK) – and emissions from the surface transport sector. This is clear in the historical data in Chart 3.1. But interestingly there is a disparity between the level of emissions implied by fuel duty receipts last year, and across our latest forecast, and the level projected by DESNZ.[6] The dashed-black line in Chart 3.1 shows that our latest fuel duty forecast would be consistent with surface transport emissions nearly fully recovering from their pandemic trough to a level of 112 $MtCO_2$ in 2022, and then falling at a rate of around 4 per cent a year thereafter (as electric vehicle sales rise). This 2022 peak is 7 per cent higher than the equivalent 2022 value for surface transport emissions in the DESNZ projections, although this gap closes over the forecast period. Setting aside these near-term forecast differences, the strength of the relationship between the tax base and emissions both in outturn and over the forecast period makes the volume of surface transport emissions on the path to net zero (and the take-up of electric vehicles that drives it) a central consideration in forecasting fuel duty revenues (see Box 3.1).

Chart 3.1: Fuel duty clearances and surface transport emissions



Note: ONS outturn emissions statistics for road transport and railways (which make up surface transport emissions in this paper) have been consistently lower than the outturn transport sector emissions reported by DESNZ since 1990. Over the past five years the average discrepancy has been 7 per cent, so DESNZ emissions projections for 2022 onwards in this chart have been scaled down by 7 per cent to get the equivalent of the surface transport emissions reported in this paper.
Source: DESNZ, HMRC, ONS, OBR

[6] Throughout this paper we use the March 2023 vintage of DESNZ's energy and emissions projections.

Box 3.1: Forecasting the fuel duty tax base and its sensitivity to net zero

Our fuel duty receipts forecast is calculated by multiplying fuel 'clearances' (the volume of fuel purchased) by the corresponding duty rate set by government. This box sets out our approach to forecasting clearances, and the sensitivity of these forecasts to improvements in the fuel efficiency of internal combustion engine (ICE) vehicles and the transition to electric vehicles (EVs).

Fuel duty is levied at the point that petrol or diesel leaves a refinery rather than being added by the retailer. This is known as a fuel duty clearance – i.e. the paperwork and tax payment have been cleared by HMRC. To estimate fuel clearances, we forecast total distances travelled using an econometric model that relates surface transport usage to household consumption, real GDP and the real price per mile travelled. We then make assumptions about trends in fuel efficiency to derive the total amount of fuel consumed to travel the number of miles predicted.

We forecast the average fuel efficiency of ICE vehicles in line with historical trends. Over time, these improvements in fuel efficiency have gathered pace, in part in response to EU-wide fuel efficiency regulations. In addition, in recent years the sale of EVs, stemming in part from the Government's commitment to ban new petrol and diesel car sales from 2030, has picked up strongly, further reducing tax revenues since EVs pay no fuel duty.[a] To account for the EV transition, we rely on information on new car registrations from the Department for Transport and the Society of Motor Manufacturers and Traders used in our vehicle excise duty forecasts, and use the share of new hybrid vehicles and EVs to project the fuel efficiency of total miles travelled. While it takes time for these flows of new cars to have a material effect on the composition of the vehicle stock and therefore the fuel efficiency of total distances travelled,[b] the loss of revenue from motoring taxes as the vehicle stock moves from petrol and diesel engine vehicles to EVs represents the single largest long-term fiscal cost of successful decarbonisation.[c] In this context, the Government has stated that motoring taxes of the future will need to keep pace with the change in the UK's vehicle stock to avoid a significant erosion of tax receipts.[d]

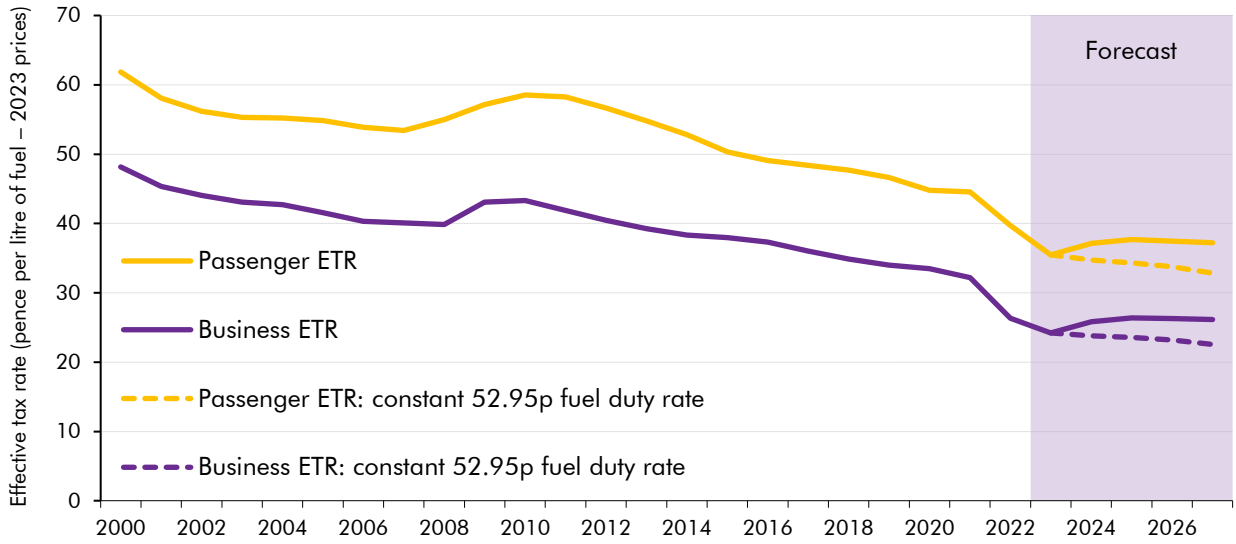
[a] See Box 3.3 in our March 2022 *Economic and fiscal outlook*. However, EV drivers do pay VAT on the electricity used to charge their vehicles. When charging at home this is at the reduced VAT rate of 5 per cent (discussed below in relation to emissions from the buildings sector), while on-street charging is subject to the full VAT rate of 20 per cent.
[b] In 2022, there were 27.4 million cars on the road (paying vehicle excise duty), while new car sales amounted to 1.6 million (6.0 per cent of the total stock) and electric vehicle sales amounted to 0.3 million (1.0 per cent of the total stock). See: The Society of Motor Manufacturers and Traders, *UK new car and van forecast – February 2023*, February 2023.
[c] See Chapter 3 of our 2021 *Fiscal risks report* for discussion.
[d] See HM Government, *The Ten Point Plan for a Green Industrial Revolution*, November 2020, and, more recently, House of Commons Transport Committee, *Road Pricing: Government Response to the Committee's Fourth Report of Session 2021-22 Third Special Report of Session 2022-23*, March 2023.

3.14 While fuel duty *clearances* are strongly linked to surface transport emissions, changes in the rate of tax levied on these mean the relationship between fuel duty *receipts* and emissions is less strong. The effective tax rate for fuel use in passenger cars includes the fuel duty rate (charged in pence per litre), plus 20 per cent VAT which is applied after fuel duty (so varies with both the rate of fuel duty and the pre-tax cost of petrol and diesel). As most businesses reclaim VAT on input costs, the typical effective tax rate for vehicles used by businesses consists only of the fuel duty rate.

3.15 Despite default government policy stating that the fuel duty rate will rise in line with RPI inflation each year, actual government policy was to freeze the rate at 57.95p a litre between 2011 and 2022, and the rate is now in the second year of a temporary 5p reduction to 52.95p a litre. Chart 3.2 shows that this means the effective tax rate (measured as the real pence of tax per litre of fuel consumed, in 2023 prices) for passenger cars has fallen from 59p in 2010 to 35p in 2023, while this figure has fallen proportionally further for business travel (from 43p to 24p). As the right panel of Chart 3.3 demonstrates, this means that, for example, real fuel duty receipts were flat or falling in the mid-2010s when emissions were rising, and they fell in 2022 when emissions recovered sharply.

3.16 While our forecasts continue to assume that fuel duty rates rise with RPI inflation in the future, in line with stated government policy, the fact that this has not happened for over a decade represents a material risk that we have highlighted in successive *Economic and fiscal outlooks*. In our March 2023 forecast, we noted that if the fuel duty rate were instead to be held flat across the forecast at its current level, receipts would be £4.0 billion lower than in our central forecast by 2027-28. Chart 3.2 shows what this would imply for the future path of the effective tax rate. On this basis, the real effective tax rate for passenger cars would fall to 33p per litre of fuel consumed by 2027, its lowest this century. This would act as a modest headwind to decarbonising surface transport – leaving emissions just 0.3 per cent higher in 2027, because fuel consumption is relatively inelastic with respect to the price of fuel (based on the historically derived elasticities in our forecast models).

Chart 3.2: The real effective tax rate on fuel for passenger and business transport

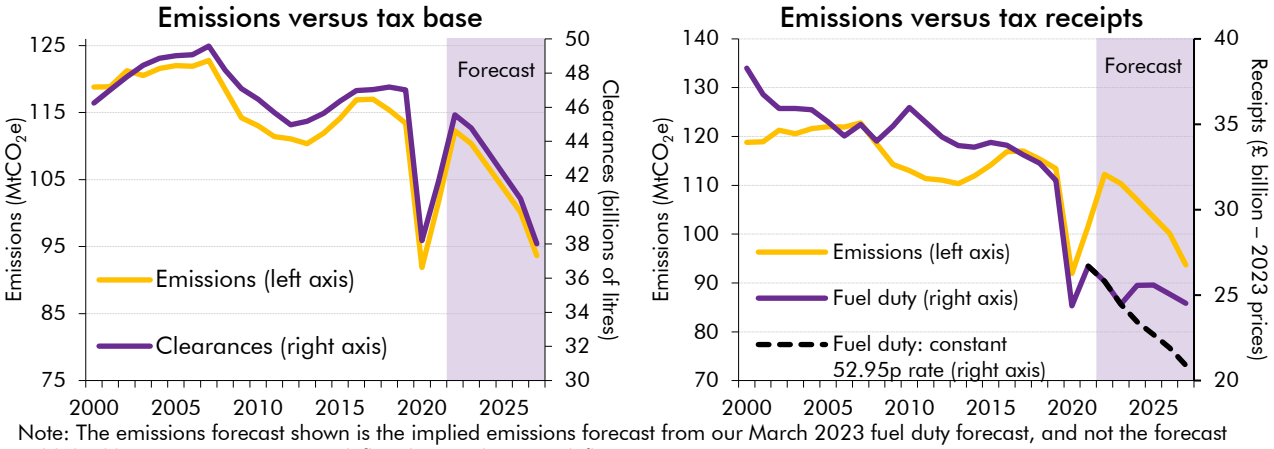


Note: This is RPI deflated, in line with how the tax rate is supposed to be uprated. The ratio between diesel and petrol usage is assumed to be the same for passenger and business travel. This analysis assumes that businesses reclaim VAT on fuel costs.
Source: OBR

3.17 In summary, the fuel duty tax base is very closely linked to surface transport emissions (left panel of Chart 3.3). The correlation between the two series between 2000 and 2021 was very high, at 97 per cent. Receipts are less closely linked since they are determined by the duty rate too (right panel of Chart 3.3, with a correlation coefficient of 84 per cent). Even

so, over the longer term, as the internal combustion engine vehicle stock is progressively replaced by electric vehicles, and fuel clearances trend towards zero, fuel duty receipts will follow surface transport emissions down to zero. Hence the Government's aspiration to ensure motoring taxes keep up with these trends to avoid a significant loss of revenue.

Chart 3.3: Surface transport emissions versus fuel duty receipts



Note: The emissions forecast shown is the implied emissions forecast from our March 2023 fuel duty forecast, and not the forecast published by DESNZ. Receipts are deflated using the GDP deflator.
Source: HMRC, ONS, DESNZ, OBR

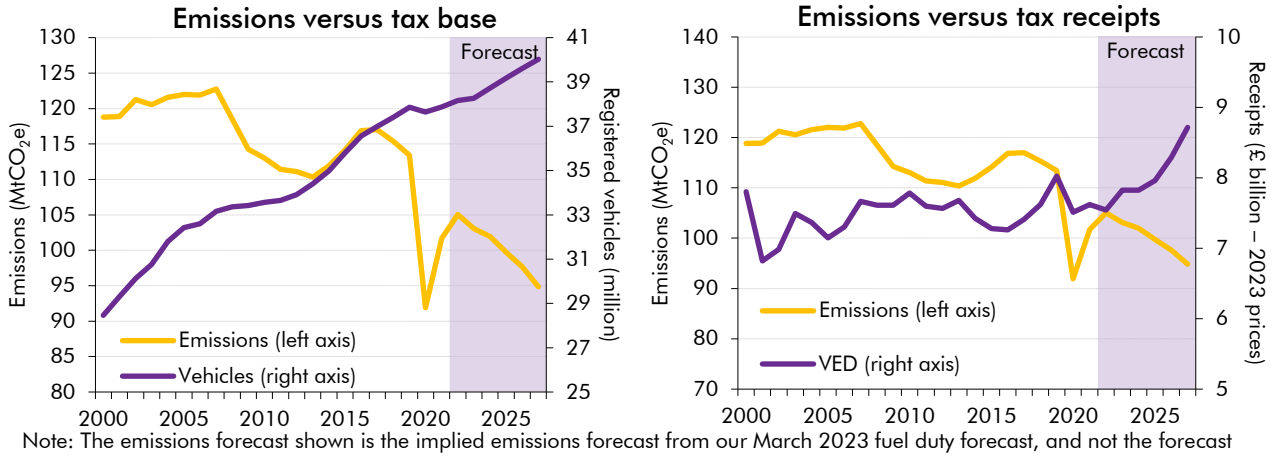
Vehicle excise duty

3.18 Vehicle excise duty is a tax currently levied on most mechanically propelled vehicles using public roads in the UK – with EVs exempt until 2025. While there is a relationship between surface transport emissions and the £7.4 billion collected in VED in 2022-23, it is much less direct than for fuel duty. The mapping from the number of cars on the road to emissions involves more steps: average distances travelled by each car and average fuel consumed per mile driven, both of which are captured in fuel clearances. And while most VED rates currently vary by CO_2 emissions, so there is a degree to which VED receipts are linked to surface transport emissions, policy changes mean that the relationship between emissions and the VED tax base (and therefore receipts) has been weakening over time.

3.19 For most cars registered prior to April 2017, the amount of VED due depends primarily on the car's official CO_2 emissions. For cars registered from April 2017 onwards, it was announced in Summer Budget 2015 that first-year VED payments would be related to CO_2 emissions, but from the second year most drivers would pay a fixed rate regardless of CO_2 emissions. In addition, at Autumn Statement 2022 it was announced that from 2025 onwards most EVs will no longer be exempt from VED, at which point nearly all vehicles regardless of emissions will be liable. This means that the VED system will no longer be incentivising the uptake of EVs to the extent that it did previously, but with the ban on the sale of ICE vehicles only seven years away, that seems unlikely to affect sales of EVs.

3.20 Both these changes mean that the tax base for VED after 2025 – all registered vehicles (left panel of Chart 3.4) – is becoming increasingly decoupled from emissions. Between 2017 and 2027, surface transport emissions are expected to fall by 19 per cent, while real VED receipts are expected to increase by 18 per cent (right panel of Chart 3.4). In comparison to fuel duty, VED receipts are much less at risk from gains in fuel efficiency and the uptake of EVs thanks to recent policy changes. This is therefore one area where the Government's goal of motoring taxes keeping up with changes in the vehicle stock is being pursued.

Chart 3.4: Surface transport emissions versus VED receipts



Note: The emissions forecast shown is the implied emissions forecast from our March 2023 fuel duty forecast, and not the forecast published by DESNZ. Receipts are deflated using the GDP deflator.
Source: DfT, HMRC, ONS, OBR

Energy supply

3.21 Energy supply is the second-largest source of emissions in the UK, contributing just over a fifth (21 per cent) of emissions in 2019. With the phasing out of coal-fired power stations having driven a large drop in emissions from this sector since 1990, those that remain come largely from gas-fired power stations (with smaller contributions from the activities of refineries, and fuel extraction and manufacture). There are two sets of taxes that relate to territorial emissions from the energy sector: the UK Emissions Trading Scheme (ETS), which raised £6.1 billion in 2022-23 (and its EU ETS predecessor); and the climate change levy (CCL) and carbon price support rate (CPS) that is set within it, which raised £2.1 billion. Both these sets of taxes also relate to emissions from other sectors on a by-source accounting basis, as discussed in more detail below. (And as set out paragraph 3.8 above, the portion of energy supply that flows through to domestic electricity use is also subject to VAT at a reduced rate, which is discussed in relation to the buildings sector, below.)

3.22 For both these sets of taxes, the relationship between the tax base and emissions is reasonably direct: for example, the tax base for the UK ETS is auctioned allowances measured in tonnes of CO_2e, while the tax base for the CCL is the volume of gas, electricity and other fuels measured in kilowatt hours. In 2019, we estimate that the EU predecessor to

the UK ETS covered 53 per cent of total emissions from the energy supply sector,[7] with the CCL and CPS overlapping these. Therefore over half of total emissions from the energy supply sector are directly linked to UK tax receipts.[8]

The emissions trading scheme (ETS)

3.23 The UK ETS is a cap-and-trade scheme that came into effect in 2021 to replace the EU ETS, largely following the structure and operation of its European predecessor. While combustion (including power generation) makes up the largest share (around two-thirds) of emissions that were covered by the EU ETS pre-pandemic in 2019, both versions of the ETS also cover some emissions from energy-intensive industries and aviation, therefore straddling three of the emissions source sectors covered in this paper. As such Box 3.2 sets out the overall parameters of the ETS and the relationship between emissions and tax receipts it embodies, and we draw on this when discussing emissions from other sectors in the sections below.

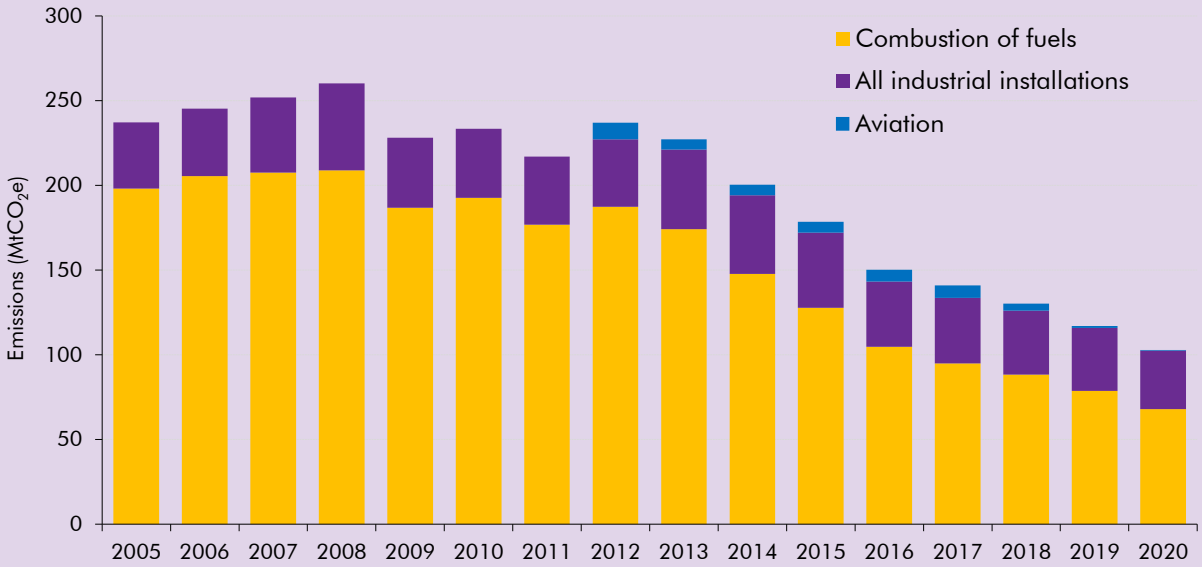
Box 3.2: The UK and EU Emissions Trading Schemes

The UK Emissions Trading Scheme (ETS) is a cap-and-trade scheme, where businesses bid for carbon allowances, with the number of allowances available (the cap) and demand setting the carbon clearing price at auction and subsequently in the secondary market (the trade). The UK ETS came into effect on 1 January 2021, when the transition period for the UK leaving the EU ended, replacing the UK's participation in the EU ETS (from its introduction in 2005). It raised £6.1 billion in 2022-23, up from £1.6 billion in 2019-20 and just £0.3 billion in 2012-13.

In the first allocation period of the UK ETS, which ends in 2025, the structure and coverage of the scheme mirrors that of the EU ETS relatively closely (so that analysis in this box focuses mainly on the UK's participation in the EU ETS, for which far more outturn data are available). Of the UK's emissions covered by the EU ETS in 2019 (Chart A), the largest share was from the combustion of fuels (68 per cent, which spans the energy and business and industry sectors in the framework used elsewhere in this paper), followed by energy-intensive industries and oil refinement (32 per cent), and aviation (1 per cent). The share of total emissions covered by the ETS that came from the combustion of fuels has fallen steadily from 84 per cent in 2006, consistent with the more rapid decarbonisation of power generation relative to other sectors.

[7] This is a smaller proportion than implied by the emissions from the 'combustion of fuels' in the ETS's sectoral accounting framework (see Box 3.2), because some of these fall within the business and industry sector in the by-source accounting framework used in this paper.
[8] VAT is also charged on electricity, for example, that is used in homes and in transport (including the charging of electric vehicles), so in principle a greater share of the energy sector's emissions are to some extent linked to receipts.

Chart A: UK emissions covered by the EU ETS



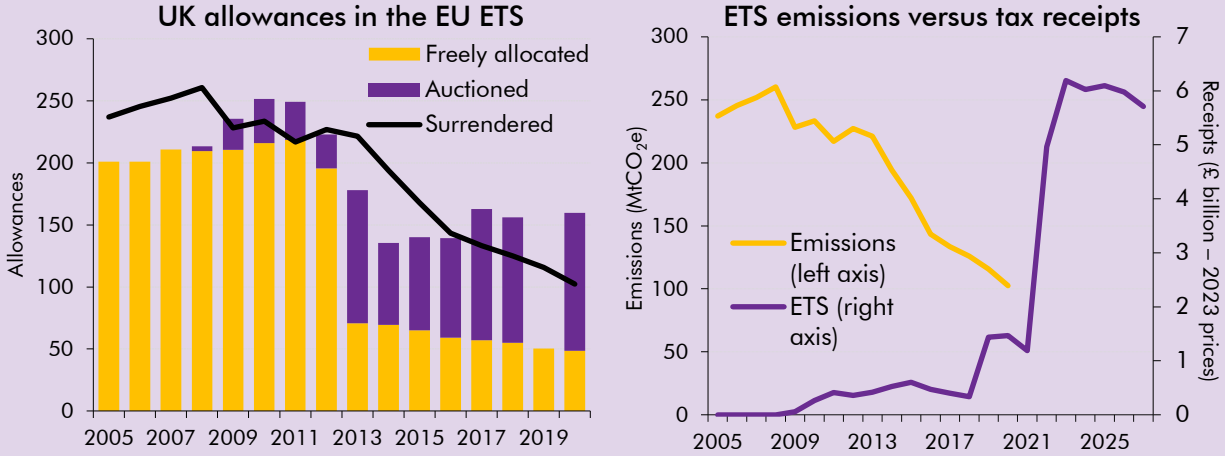
Note: This chart classifies emissions according to the sectoral definitions used in the ETS schemes, which is different to the way emissions are classified elsewhere in the paper.
Source: European Environment Agency

At face value the tax base for both incarnations of the ETS – allowances, measured in units of CO_2e – maps very closely onto emissions. However, changes in overall emissions have not historically mapped closely to tax receipts, as shown in Chart B. This reflects:

- **Emissions covered**: the scope of emissions covered by the ETS has evolved over time, for example the aviation sector was brought into scope of the EU ETS in January 2012, and a 2022 consultation that the Government is due to respond to is exploring the possibility of the UK ETS covering a greater share of emissions in the future.[a] In 2019 the EU ETS covered just over half of total UK territorial emissions from energy supply and just under three-quarters of total business and industry emissions (on the ONS sectoral accounting basis), with both shares having remained reasonably constant since the late 2000s. (Chart B shows only those emissions covered by the ETS, rather than total territorial emissions from the relevant sectors in the ONS sectoral accounting framework.)
- **Freely allocated allowances**: some ETS allowances are freely allocated rather than auctioned (and only the latter generate tax receipts). This share has fallen over time, as shown in the left panel in Chart B. For example, in phase one of the EU ETS (2005-2007) almost all allowances were given to businesses for free, while by the end of phase three (2013-2020) only two-fifths of the UK's total allowances were freely allocated. From 2021 to 2025, the UK ETS has retained similar proportions of free versus auctioned allowances. The receipts generated by auctioned allowances are recorded within the public sector finances when they are 'surrendered' (which aligns with when the emissions are generated) rather than purchased, meaning that the timing of auctions (for example, the Brexit-related hiatus in 2019) does not affect the profile of accrued tax receipts.
- **Clearing prices**: aside from these two reasons why the ETS *tax base* has not historically mapped onto emissions precisely, the ETS market mechanism means that *receipts* are

one step further removed. The number of allowances is decided by the Government, and the clearing price is determined by auctions. If the number of allowances falls faster than the demand (i.e. faster than emissions decrease), this could counterbalance a tax-based driven fall in receipts by increasing the carbon clearing price per allowance; if allowances fall more slowly, this could reduce the price per allowance. This is demonstrated in the sharp uptick in receipts from 2022 onwards in the right panel of Chart B, which reflects a surge in carbon prices that may have been driven by markets pricing in net zero policies, anticipating future ETS expansion, or the increasing marginal cost of abatement.

Chart B: Emissions in scope of the ETS versus ETS receipts



Note: Receipts are deflated usng the GDP deflator.
Source: European Environment Agency, ONS, OBR

With free allowances making up a declining share of the total as ETS schemes have matured, and the prospect of the scope of emissions covered by the ETS expanding, the UK ETS tax base is likely to remain closely linked to emissions in the future. But the price of allowances determined in the market will continue to reflect a range of factors, meaning a continued a wedge between the profile of emissions and that of receipts from the ETS.

[a] In 2022, the UK Government carried out a consultation that explored expanding the scope of emissions trading across the economy. The Government will publish a full response ahead of the 2024 scheme year. The Government also stated in its latest Carbon Budget Delivery Plan that it plans to publish a long-term pathway for emissions trading aligned to net zero targets.

The climate change levy (CCL) and carbon price support (CPS)

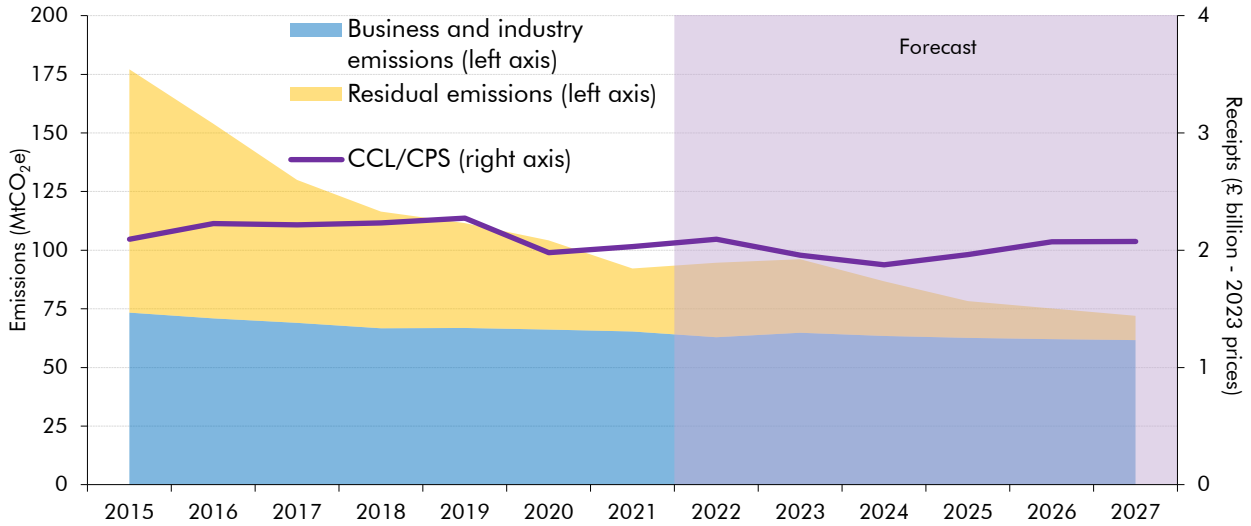
3.24 The CCL is a two-rate tax: the main rate is applicable to taxable energy commodities (electricity, natural gas, liquid petroleum gas, coal, and lignite) that are supplied to the industrial, commercial, agricultural, or public administration sectors (with large discounts for holders of a climate change agreement);[9] this is supplemented by the carbon price support rate (CPS), which is charged on fossil fuels used in electricity generation. The CPS combines with the ETS allowance price to make up the UK's 'carbon price floor' (CPF), which has been credited as a reason for the sharp reduction in coal use for power generation, although its

[9] It is up to the supplier to apply the correct levy rate to the bills of its consumers.

success here means that it is now playing a diminishing role.[10] The CCL and CPS together raised £2.1 billion in 2022-23. CCL main-rate receipts map onto emissions from the energy sector's *electricity* generation and emissions mainly from the business and industry sector from *gas* combustion.[11] This means that, like the ETS, CCL main-rate receipts span emissions from different sectors on a by-source accounting basis.

3.25 While the CCL (and CPS) tax base bears a strong relationship with emissions, tax rates have historically meant that receipts are less closely linked (Chart 3.5). This is, in part, because the CCL main rates for electricity have historically been double those applied to gas (for example, in 2020 the rate for electricity was £0.00811 per kWh, while the rate for gas was £0.00406 per kWh). Because the electricity supply has become less carbon-intensive than gas – due to the rapid increase in renewables to the grid – this tax structure has meant that higher-emissions gas supply paid a lower effective carbon tax. However, the Government narrowed the gap over successive fiscal events and at Autumn Statement 2022 made the final decision to equalise CCL main rates for electricity and gas from 1 April 2024 (at £0.00775 per kWh), which will partially address the price disincentive of electrification and strengthen the relationship between CCL receipts and emissions. A further reason for the contrasting trends in relevant emissions and receipts over the forecast period seen in Chart 3.5 is the fact that climate change agreements between UK industry and the Environment Agency, which offer a large discount on CCL main rates, are due to end in March 2027.

Chart 3.5: Relevant energy, business and industry emissions versus CCL/CPS receipts



Note: Total emissions covered by the CCL and CPS are calculated from HMRC tax base data and DESNZ conversion factors for fuels. A large share of these emissions will be released in the business and industry and agriculture sectors, however the levy is applied by the energy providers at point of sale. Business and industry emissions shown here are those from combustion and energy fuel use in the sector. Receipts are deflated using the GDP deflator.
Source: DESNZ, HMRC, ONS, OBR

[10] The carbon price floor was introduced in April 2013, consisting of two components paid by energy generators in two different ways: (i) the EU ETS allowance price; and (ii) the CPS rate within the CCL, which tops up the ETS allowance prices, as projected by the Government, to the carbon floor price target. The CPF has taxed coal-fired power generation very heavily relative to gas, and has been credited as a reason for the sharp drop in the use of coal in recent years. Receipts from the CPS peaked at £1.2 billion in 2015-16, had fallen to £0.7 billion by 2021-22, and are expected to drop to £0.2 billion by 2027-28 (reflecting the reduced emissions-intensity of energy generation and the fact that the rate was frozen in 2016 and is set to remain so until 2025). See: House of Commons Library, *Carbon Price Floor (CPF) and the price support mechanism*, January 2018.
[11] The majority of the emissions covered by the CCL (63 per cent) come from gas and other fuels, and are therefore likely to fall in the business and industry sector.

Business and industry

3.26 Business and industry is the third-largest source of sectoral emissions in the UK, producing just under a fifth (19 per cent) of territorial emissions in 2019.[12] The majority of these come from industrial and commercial combustion and electricity (51 and 13 per cent of the sector's emissions, respectively); followed by industrial processes (12 per cent); refrigeration and cooling (11 per cent); and the combustion and electricity generation associated with steel and iron production (11 per cent).

3.27 The UK ETS (and the EU ETS prior to 2021) and the CCL – both discussed in relation to energy supply in the previous section – are the main taxes related to emissions from business and industry. Accounting for both ETS emissions from industrial installations and those from the combustion of fuels that fall within the business and industry sector, the ETS covers around three-quarters of the sector's emissions. This could rise in the future if the UK ETS were to be expanded (as proposed in the Government consultation discussed above). As set out in Box 3.2, there is a reasonably direct (although imperfect) link between emissions in scope for the ETS and the tax base, because the tax base is auctioned allowances measured in tonnes of CO_2e. Around 75 per cent of business and industry emissions are covered by the CCL main rate – the share related to combustion and fuel use.

Buildings

3.28 The buildings sector, made up of residential and public sector buildings, is the fourth-largest source of territorial emissions in the UK, accounting for 16 per cent of total emissions in 2019.[13] These emissions are dominated by 'residential combustion' – largely the burning of natural gas for heating – which made up 87 per cent of the sector's emissions in 2019. Public sector buildings accounted for 11 per cent of the total, with aerosols and inhalers (such as spray-on deodorant and asthma medication) making up the majority of the remaining 2 per cent.

3.29 The main tax that overlaps with emissions from the buildings sector is reduced-rate domestic VAT, which raised approximately £2.8 billion in 2022-23. Nearly all emissions from residential combustion (so 87 per cent of total buildings sector emissions) can be considered related to the tax base. Domestic spending on the fuels used in this combustion (mainly gas) is subject to VAT at a reduced rate of 5 per cent – alongside domestic spending on electricity, which in our by-source categorisation relates to emissions from the energy supply sector rather than its end use in the buildings sector.[14] This means that as well as the

[12] In the ONS's breakdown of source emissions, 'business' and 'industrial processes' are presented as different sectors. However, there is significant overlap across the activities they cover, so in this paper we have combined them into one. The use of the ONS's sectoral breakdown in this paper means that the business and industry sector is a larger source of territorial emissions than it was in our 2021 *FRR* analysis (which used the CCC sectoral breakdown), because 'commercial and miscellaneous combustion' is classified within the business and industry sector rather than the 'non-residential buildings' sector (for which there is no equivalent in the ONS classification).
[13] The proportion of emissions accounted for by the buildings sector in this categorisation is lower than that presented in our 2021 *FRR* analysis, which was on an end-use basis and so allocated emissions associated with electricity use in homes and public sector buildings from the energy supply sector to the buildings sector.
[14] The vast majority (around 97 per cent) of reduced-rate VAT receipts relate to domestic spending on power, but reduced-rate VAT also applies to other items, including children's car seats and protective and safety equipment. For simplicity, in this analysis we present total reduced-rate VAT receipts.

majority of the buildings sector, the reduced-rate VAT receipts that we analyse here are also related to a portion of emissions from the energy supply sector, discussed above.

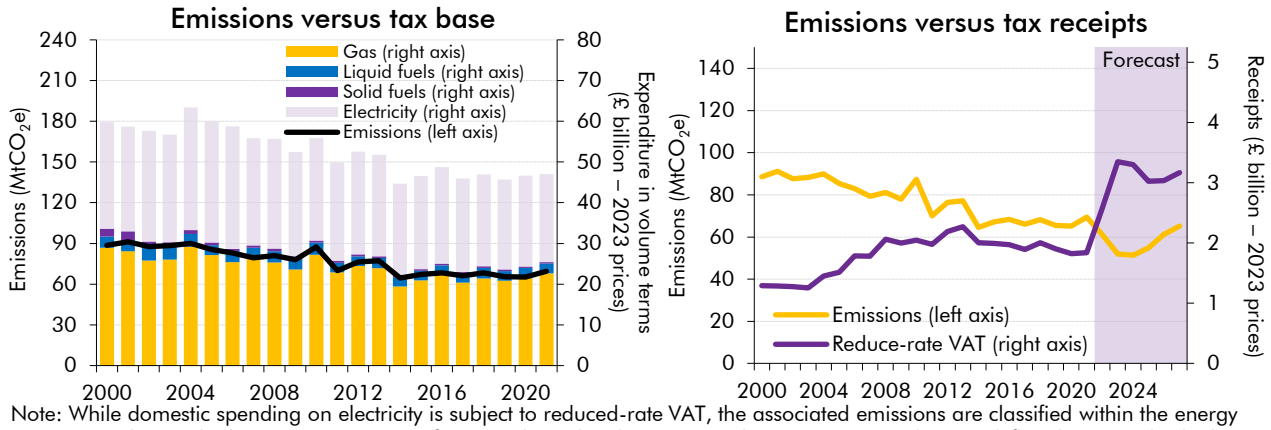
3.30 The relationship between the tax base for reduced-rate domestic VAT – i.e. the volume of fuel and power consumed by households – is reasonably directly related to buildings sector emissions. Specifically, as the left panel of Chart 3.6 shows, spending in volume terms on residential fuel excluding electricity has varied reasonably closely with emissions. This relationship is similar to that between fuel clearances and surface transport emissions, since emissions from heating residential buildings reflect the volume of gas and other fuels used, multiplied by the emissions released per unit of fuel (which is relatively stable over time). But there are then several steps between that part of the tax base that is closely linked to emissions and overall receipts from the reduced rate of VAT. These include adding back spending on electricity (the emissions from which are allocated to the energy supply sector) and converting volumes to values using appropriate energy-specific price indices (which have been particularly volatile since the Russian invasion of Ukraine last year).

3.31 As a result, the relationship between emissions and real-terms receipts (which are deflated by the whole-economy GDP deflator) is affected not only by the volumes of fuel consumed but also the *price of that fuel relative to whole economy prices*, which is sensitive to changes in global energy prices. This can be seen in the right panel of Chart 3.6, which shows that real reduced-rate VAT receipts rose in 2022 and 2023 as global energy prices spiked following the Russian invasion of Ukraine, whereas emissions are projected to have fallen as those high prices encouraged households to reduce the volume of gas consumed.[15] A similar divergence can be seen in the 2000s, when energy prices again rose much faster than whole-economy prices reflected in the GDP deflator, due to upward pressure on prices in Europe, the decline of the UK Continental Shelf gas production, wholesale electricity prices rising from unsustainably low levels, and the introduction of the EU ETS.[16]

3.32 The fact that reduced-rate VAT is charged on both electricity and gas means that a key route to decarbonising domestic heating – switching from gas boilers to electric heat pumps – is unlikely to represent a material fiscal risk via VAT receipts. Instead, one form of spending subject to reduced-rate VAT is likely to be substituted for another.

[15] During the winter of 2022-23, household gas prices were on average 200 per cent higher than in preceding years, while gas demand was 15 per cent lower (after adjusting for temperature), implying a price elasticity of demand of around -0.1. See Box 2.1 of our March 2023 *Economic and fiscal outlook*.
[16] Department for Business, Energy and Industrial Strategy, *Quarterly Energy Prices*, December 2016.

Chart 3.6: Buildings sector emissions versus reduced-rate VAT receipts



Note: While domestic spending on electricity is subject to reduced-rate VAT, the associated emissions are classified within the energy sector according to the by-source accounting framework used in this paper. Volume-terms expenditure is deflated using individual price indices for each category of spending; receipts are deflated using the GDP deflator.
Source: DESNZ, HMRC, ONS, OBR

3.33 Alongside reduced-rate VAT, the far smaller green gas levy (GGL) also relates to emissions associated with gas used in the heating of buildings.[17] The GGL was introduced in 2022-23 to provide the funds for the green gas support scheme (meaning it is fiscally neutral),[18] and was expected to have raised £65 million in its first year, rising to £165 million in 2027-28. The relationship to emissions is not one-for-one, as the charge is levied on the number of gas meters, regardless of how much gas passes through each meter. Therefore, reducing emissions from buildings will have a limited effect on revenue unless buildings fully disconnect from the gas grid when they switch to electricity-based heating.

Other sectors

3.34 Emissions from the remaining five sectors collectively accounted for just under a fifth (18 per cent) of total UK territorial emissions in 2019, and are discussed briefly in the sub-sections below. Of these emissions, over a third (37 per cent) are either directly or indirectly associated with a tax base: half of this relates to emissions from landfill, which is subject to landfill taxes; while the rest is largely a mix of fuel duty (relating to ships, farm equipment, and some aircraft) and air passenger duty (on domestic flights).

Agriculture

3.35 Agriculture accounted for 10.7 per cent of territorial emissions in 2019, mostly relating to livestock, with emissions from animal digestive processes (mainly those of cows) contributing 64 per cent of sectoral emissions. Direct and indirect soil emissions (24 per cent) and combustion such as that in tractors (9 per cent) made up most of the remainder. (Being territorial emissions, these do not include all emissions related to food consumed in the UK, much of which is imported.) There is little clear mapping from agricultural emissions to any

[17] In practice it is energy providers that pay the levy to the Exchequer, but the levy itself is more readily correlated with buildings sector emissions on a by-source accounting basis.
[18] The green gas support scheme provides financial incentives for new anaerobic digestion biomethane plants to increase the proportion of green gas in the gas grid.

UK tax bases, despite representing a large source of territorial emissions. The exceptions are the 'rebated' red diesel rate of fuel duty applicable to fuel used in farmyard appliances (around £45 million of fuel duty was raised from agricultural use of red diesel in 2021), and the CCL (discussed above) applicable to gas usage by the sector.

Waste

3.36 Waste accounted for 4.6 per cent of 2019 emissions, of which roughly three-quarters comes from landfill. These emissions have a strong relationship with volumes of waste disposed of in landfills – the tax base for landfill taxes, which raised £810 million in 2022-23. As with several of the larger taxes, the relationship between emissions and tax receipts combines the closely linked volume of waste sent to landfill (the tax base), and the tax rate set by government. The standard rate of landfill tax (which accounts for most of the revenue and applies to waste that generates emissions) is currently £102.10 per tonne of waste and is typically raised in line with RPI inflation each year.

Aviation and shipping

3.37 Domestic shipping and aviation accounted for 1.3 per cent and 0.8 per cent, respectively, of 2019 emissions (international shipping and aviation are not included in territorial emissions).[19] Emissions from domestic shipping partially map onto the fuel duty tax base, with many ships refuelling and sailing in UK waters qualifying for red diesel duty rates (although there is a 100 per cent relief for commercial seagoing vessels). Emissions from domestic aviation are indirectly related to air passenger duty (APD), which raised £3.3 billion in 2022-23 (although more than 96 per cent of these receipts relate to international travel and so only around £100 million of this figure is associated with the territorial emissions discussed here). The relationship is only considered indirect because APD is principally calculated per passenger rather than related to emissions per flight (and certain passenger flights are exempt), although the duty rate *is* divided into bands related to flight distance. In addition, from 1 April 2023 a lower-rate domestic flight band has been introduced, lowering the effective APD tax rate on domestic aviation emissions. Furthermore, domestic aviation emissions are covered by the ETS, discussed above in Box 3.2.

Land use, land use change and forestry

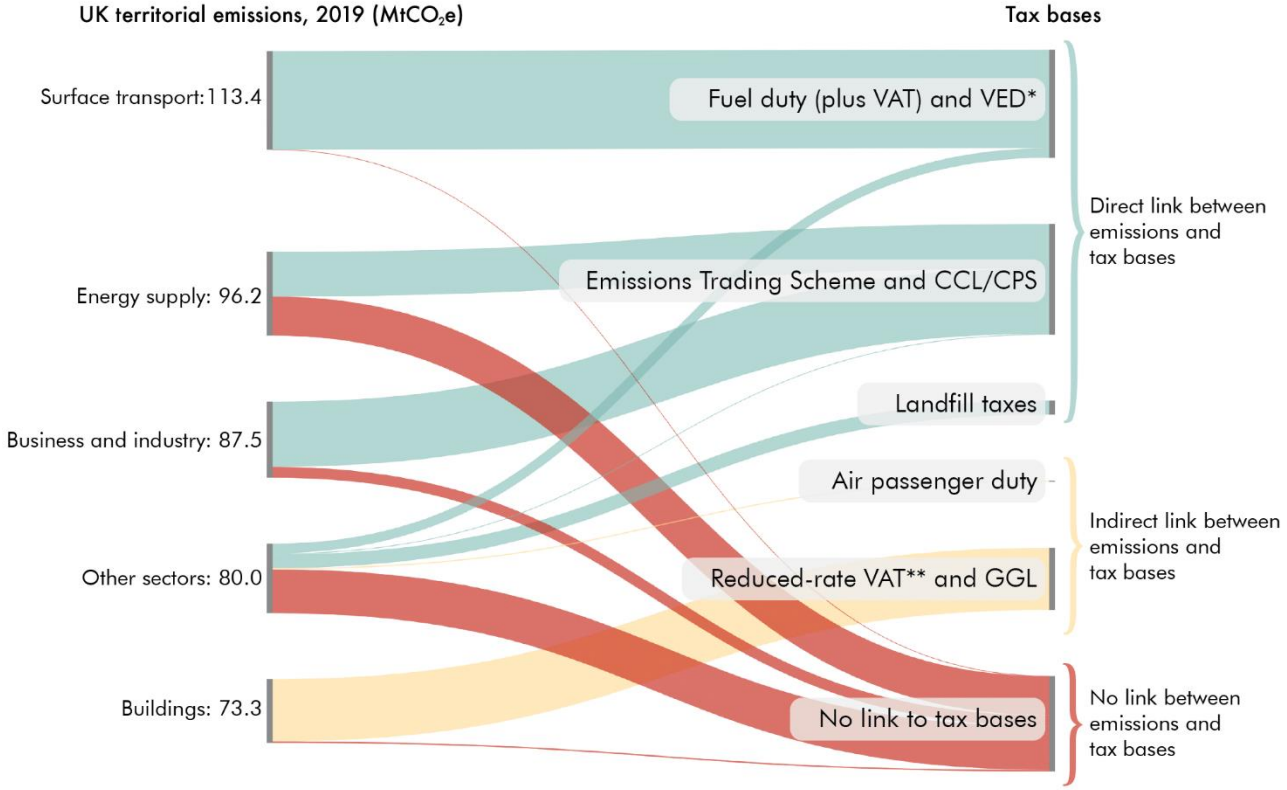
3.38 Land use, land use change and forestry (LULUCF) accounted for 0.4 per cent of UK territorial emissions in 2019. This small net contribution reflects larger gross positives and negatives from the sector, as LULUCF consists of some large source emissions (26 $MtCO_2e$, or 6 per cent of total emissions in 2019) that are largely offset by some large sinks of carbon, such as forests (sinks accounted for *minus* 24 $MtCO_2e$, or *minus* 5 per cent of total emissions). There are no obvious links between LULUCF emissions and UK tax bases.

[19] For this analysis, 'military aircraft and shipping' and 'aircraft support vehicles' have been included within the aviation sector.

4 Mapping emissions and tax forecasts

4.1 Overall, 76 per cent of UK territorial emissions map onto tax bases, and therefore tax revenues, to some extent. Chart 4.1 provides a stylised summary of these relationships, showing that over half (59 per cent) of total emissions (shown in teal) have a reasonably direct correlation with the tax bases for at least one of fuel duty, the UK Emissions Trading Scheme, landfill taxes or the climate change levy (and carbon price support rate within it). A further 16 per cent of total territorial emissions (shown in yellow) have some – but a less direct – association with the tax bases for reduced-rate household VAT, air passenger duty and the green gas levy. The final 24 per cent of total territorial emissions (shown in red) have no clear link to tax bases – mostly those from agriculture (with 91 per cent of sectoral emissions not linked to specific taxes, or 10 per cent of total territorial emissions), the energy sector (47 per cent of emissions not linked, or 10 per cent of total emissions) and business and industry (14 per cent of emissions not linked, or 3 per cent of total emissions).

Chart 4.1: The relationship between emissions and tax bases



Note: Made with SankeyMATIC.
*While fuel duty directly links to tax revenues, we judge that VED has only an indirect link.
**Reduced-rate VAT receipts also relate to those emissions from the energy supply sector used in domestic electricity (which are also covered by the ETS).
Source: ONS, OBR

4.2 The first conclusion of this paper is therefore that changes in emissions as a result of decarbonisation efforts on the path to net zero will have clear implications for the outlook for tax revenues. These efforts could take the form of public subsidies, taxation, regulation, or other policy instruments (such as public awareness campaigns). Our findings therefore underscore the value for our forecasts of being able to draw upon detailed and high-quality medium-term forecasts for emissions, and of understanding of how these develop as the UK decarbonises. Prospects for decarbonisation can be expected to become an increasingly important input for us to deliver against our core remit of forecasting the public finances.

4.3 Beyond this relatively top-down and stylised typology, the analysis in this paper demonstrates that the strength of the relationship between emissions, tax bases, and tax revenues changes over history and over our forecast due to policy and other factors. For example, recent policy changes have weakened the link between emissions and tax receipts for VED, reducing its sensitivity to the decarbonisation of motoring (in contrast to fuel duty). By contrast, the evolution of the ETS away from free allowances, and its possible expansion to cover a greater share of emissions in the future, have strengthened the relationship between emissions and receipts. So will the upcoming convergence between the CCL main rates for electricity and gas supply. And beyond the policy arena, the sharp rise in energy prices following the Russian invasion of Ukraine has weighed on emissions from residential heating but raised reduced-rate household VAT receipts (albeit at the expense of spending on items subject to the higher standard rate of VAT). The second conclusion of this analysis is therefore that monitoring these policy and contextual factors is important for understanding the risks to our receipts forecasts associated with decarbonisation.

4.4 Finally, it is possible to think of the relationships explored in this paper the other way round – where we find that over £50 billion of receipts in 2022-23 (or around 5 per cent of total receipts) have some link to emissions. This is a far smaller proportion of total tax revenues than the proportion of total emissions related to tax bases, but it is still substantial – roughly the amount spent on schools in a year, for example. There are also taxes that do not move closely with territorial emissions but whose structure and future revenues are likely to be influenced by, or are designed to be an influence on, the net zero transition. These include North Sea revenues, the electricity generator levy, and environmental levies, which together accounted for around £20 billion of receipts in 2022-23. And as our 2021 *FRR* analysis showed, the broader macroeconomic and fiscal implications of different pathways to net zero have wide-ranging implications for the public finances, touching all the major tax bases and several areas of spending. The final conclusion of this paper is therefore that as well as considering the implications of the emissions outlook for our medium-term tax forecasts, the transition to net zero will continue to be a central theme of our analysis of economic and fiscal risks and sustainability over both the medium and longer term.