

Appendix 8A. Calculating implicit tax rates and subsidies

This appendix sets out the methodology underpinning Figures 8.5, 8.6 and 8.7 of the 2021 IFS Green Budget.

8A.1 Implicit carbon tax rates

In this section, we set out the methodology underpinning the calculation of the implicit tax rates on carbon presented in Figures 8.5 and 8.6. The purpose of the implicit tax rates presented in these figures is to demonstrate the combined marginal rate of tax per tonne of CO₂ equivalent (tCO₂e) associated with various forms of consumption.

For all taxes other than the UK Emissions Trading Scheme (UK ETS) and Carbon Price Support (CPS) – both of which are explicitly designed as taxes per tCO₂e – the first stage in the calculation of implicit rates is to establish the rate of tax implied by policy on the various forms of activity analysed. The complexity of achieving this varies by policy:

- **Climate Change Levy (CCL):** charged at a rate of 0.775p/kWh on electricity and 0.465p/kWh on gas consumed by non-energy-intensive businesses in 2021–22 (HMRC, 2016). We assume that all energy-intensive businesses hold climate change agreements (which provide a CCL discount in return for a commitment to reduce emissions) and are in receipt of the relevant discounts (92% for electricity and 83% for gas), giving rates of 0.062p/kWh for electricity and 0.0791p/kWh for gas.
- **Renewables Obligation (RO):** each year the obligation rate (the number of Renewables Obligation Certificates (ROCs) that must be surrendered by suppliers for each MWh of electricity supplied) is set such that the expected total demand for ROCs (that is, the number of ROCs that would need to be surrendered to cover the expected level of electricity supply) exceeds the expected total supply (that is, the number of ROCs that are expected to be awarded to renewable electricity generators) by 10%. Suppliers who fail to surrender a sufficient number of ROCs are required to pay a centrally set ‘buyout price’ for each ROC that they fall short of their obligation. At the end of the obligation period, the buyout fund is redistributed to suppliers in proportion to the number of ROCs surrendered. In expectation, therefore, a supplier surrendering a ROC will receive a reimbursement worth 10% of the buyout price. In equilibrium, suppliers should be indifferent between paying the buyout

price and buying a ROC on the secondary market. The expected equilibrium price of ROCs will, therefore, be 10% above the buyout price. However, because the 10% premium is expected to be reimbursed, the additional cost imposed on suppliers for each ROC they are required to surrender is equal to the buyout price.¹ In 2021–22 the ROC buyout price was £50.80 and the obligation was 0.492 ROCs/MWh (Ofgem, 2021). This implies that the RO imposes an additional cost of 2.5p/kWh of electricity supplied. Electricity supplied to energy-intensive businesses receives an 85% discount under the RO; for this group of end users, we therefore adjust the cost to 0.375p/kWh.

- **Contracts for Difference (CFDs):** the ‘interim levy’ that funds CFDs is charged on a £/MWh basis, with rates adjusted quarterly. We use 0.861p/kWh, the rate for 2021Q3 (the latest figure available), to capture the cost imposed on electricity by CFDs (Low Carbon Contracts Company, 2021b). As with the RO, an 85% discount is applied to electricity supplied to energy-intensive businesses, giving a rate of 0.13p/kWh.
- **Feed-In Tariffs (FITs):** the overall cost of FITs is ultimately shared between electricity suppliers on a market share basis. We therefore take the ratio of the overall cost of the scheme (£1.52 billion² in 2019–20³ (Ofgem, 2020a)) to the total quantity of electricity consumed in Great Britain,⁴ excluding 85% of the electricity supplied to energy-intensive businesses from the denominator to account for the FIT discount applied to these supplies of electricity⁵ (giving a final denominator of 276,644GWh⁶ in 2019–20). This provides an estimate of the per-unit tax on electricity supply as a result of FITs at 0.547p/kWh in 2019–20.⁷ To account for the fact that only 2019–20 figures are available for the overall cost of FITs, we uprate this figure by the percentage change in the CPI between 2019Q2 and

¹ Although it should be noted that deviations in electricity demand and renewable electricity supply from their expected levels will mean that, in practice, the price of ROCs will vary from year to year.

² Specifically, we calculate the overall cost of the scheme as: FIT generation payments + (Total deemed export payments – Value of deemed export) + (Total metered export payments – Value of metered export).

³ The latest year for which figures are available.

⁴ FITs are not available in Northern Ireland. We adjust the UK electricity consumption total given by Department for Business, Energy & Industrial Strategy (2021a) using the geographical electricity consumption shares provided by Department for Business, Energy & Industrial Strategy (2021c).

⁵ In doing this we make use of the estimates for electricity consumption by energy-intensive industries given in Department for Business, Energy & Industrial Strategy (2018a).

⁶ Total UK electricity consumption in 2019–20 was 295,312GWh (Department for Business, Energy & Industrial Strategy, 2021a). In 2019 Northern Ireland accounted for 2.8% of total UK electricity consumption (Department for Business, Energy & Industrial Strategy, 2021c). We therefore estimate total GB consumption to be: $(1 - 0.028) \times 295,312 \text{GWh} = 287,044 \text{GWh}$. Total electricity consumption of energy-intensive businesses is estimated at 10,400GWh (Department for Business, Energy & Industrial Strategy, 2018a), giving a final denominator of $(287,044 - 10,400) = 276,644 \text{GWh}$. Note that, throughout, calculations in the footnotes may not equate to estimates given in the text due to rounding.

⁷ It should be noted that this calculation will somewhat underestimate the per-unit tax imposed on electricity supply subject to the FIT because only suppliers with 250,000 or more domestic customers in Great Britain are obliged to make FIT payments.

2021Q2 (2.69% (Office for National Statistics, 2021)), to reach a final estimate of 0.562p/kWh for 2021–22.

- **Warm Home Discount (WHD):** we make use of estimates of the average impact of the WHD on household energy prices provided by the Department of Energy & Climate Change (2014), which place the cost of the WHD at 0.05p/kWh and 0.2p/kWh for gas and electricity respectively. Because the government ceased publication of the estimated impact of environmental measures on household bills after 2014, these estimates are uprated to a 2021–22 basis by adjusting both for changes in the overall cost of the scheme (Ofgem, 2020b) and for changes in the overall quantity of energy supplied to domestic customers⁸ (Department for Business, Energy & Industrial Strategy, 2021a, 2021b). More precisely, we multiply the 2014 estimates by the 6.9%⁹ increase in the nominal cost of WHD to suppliers between 2014–15 and 2019–20 and then divide by the 0.7%¹⁰ decrease in total energy consumption (to account for the change in the total amount of energy supplied across which the cost of the scheme can be spread). We then uprate by the change in the CPI between 2019Q2 and 2021Q2 (see FITs methodology above) to give final policy costs of 0.055p/kWh and 0.221p/kWh for gas and electricity respectively.¹¹
- **Energy Company Obligation (ECO):** we repeat the approach taken for the WHD. The 2014 estimates for the impact of the ECO on energy prices are 0.1p/kWh and 0.4p/kWh for gas and electricity respectively. In the case of the ECO, overall scheme costs in 2019–20 were 44.5%¹² of those in 2014–15. Undertaking the same calculation as for the WHD, we therefore obtain 2020–21 estimates of the tax imposed by the ECO on electricity of 0.046p/kWh for gas and 0.184p/kWh for electricity.
- **VAT discounts:** we estimate the average price of energy purchased by domestic customers in 2021–22 to be 3.93p/kWh and 20.72p/kWh for gas and electricity respectively.¹³ Household energy consumption incurs a discounted 5% rate of VAT, translating to subsidies

⁸ Supplier liability is determined on the basis of market share of domestic electricity as opposed to total electricity.

⁹ The WHD provided £326 million of support in 2014–15 compared with £348 million in 2019–20 (Ofgem, 2015, 2020b), giving a ratio of 1.069.

¹⁰ Combined domestic gas and electricity consumption decreased from 407,244GWh in 2014–15 to 404,549GWh in 2019–20, giving a ratio of 0.993 (Department for Business, Energy & Industrial Strategy, 2021a, 2021b).

¹¹ Gas: $0.05 \times (1.069 \div 0.993) \times 1.0269$. Electricity: $0.2 \times (1.069 \div 0.993) \times 1.0269$.

¹² The National Audit Office estimates the total cost of the ECO to suppliers between 1 January 2013 and 31 December 2015 to have been £3 billion (National Audit Office, 2016). We assume the 2013–14 cost of the scheme to be half this estimate. The average annual cost of ECO to suppliers between October 2018 and March 2022 is estimated to be £667 million in 2019–20 prices (Department for Business, Energy & Industrial Strategy, 2018b).

¹³ Official estimates of energy prices for the 2020 calendar year (the most recent year for which figures are available) are 4.1p/kWh for gas and 19.64p/kWh for electricity (Department for Business, Energy & Industrial Strategy, 2021d). We then uprate these figures by the May 2020 to May 2021 (May 2021 being the most recent figure available at the time of calculation) change in the consumer price index for domestic energy prices (Department for Business, Energy & Industrial Strategy, 2021h) – which gives a 4.1% fall in gas prices and a 5.5% rise in electricity prices – to obtain 2021 estimates.

of 0.561p/kWh and 2.96p/kWh¹⁴ on energy and gas respectively relative to the liability at the standard VAT rate of 20%. In the case of aviation (which is zero-rated for VAT) we use the cheapest available one-way fare available on Skyscanner for a flight departing in September 2021 on 9 August 2021 for which both economy and business class seats were provided.¹⁵ We then simply apply the standard 20% VAT rate to this price in order to estimate the magnitude of the effective VAT subsidy. As noted in the chapter, this assumes the purchaser of the flights to be an individual as opposed to a business (as the latter would be able to reclaim any VAT paid on flights).

- **Renewable Transport Fuels Obligation (RTFO):** the RTFO obligates fuel suppliers to surrender Renewable Transport Fuel Certificates (RTFCs) for each litre of fossil fuel supplied. There are two primary classes of RTFC, those used to meet the ‘main obligation’ (0.10679 of which must be surrendered for each litre of fossil fuel supplied in the 2021 calendar year) and those used to meet the ‘development fuels’ obligation (0.00556 of which must be surrendered for each litre of fossil fuel supplied in the 2021 calendar year). Our estimate for the cost of meeting the main obligation is the average traded price of main obligation certificates between 14 May 2021 and 20 August 2021¹⁶ as quoted by the price reporting agency Energy Census (2021). This gives an estimated cost of 31.80p per certificate for meeting the main obligation. No traded price data were available for the development fuels obligation; we therefore apply the development fuels buyout price (80p in 2021–22) to these certificates. This allows us to estimate the overall cost imposed by the RTFO at 3.84p/litre of petrol and diesel supplied.¹⁷
- **Landfill tax:** charged at either a lower or standard rate, with the former applying to ‘inert’ waste (such as ceramics). Given that inert waste generates very few emissions, Figure 8.6 refers purely to waste chargeable at the standard rate of landfill tax, which incurs a tax of £96.70/tonne in 2021–22 (HMRC, 2021a).
- **Fuel duties:** on petrol and diesel, fuel duties are charged at a rate of 57.95p/litre in 2021–22 (HMRC, 2021b).
- **Air passenger duty (APD):** we apply 2021–22 APD Band B rates¹⁸ to the London to New York flights (£82/passenger for economy class and £180/passenger for business class) and

¹⁴ These estimates are obtained by multiplying our estimates for the 2021–22 price of electricity and gas by $((1.2-1.05)/1.05)$.

¹⁵ The flights selected were London to Paris (British Airways) – economy class £52, business class £173; and London to New York (British Airways) – economy class £292, business class £3,161.

¹⁶ The three most recent months of available data.

¹⁷ $(31.8p \times 0.10679) + (80 \times 0.00556)$.

¹⁸ Band B rates apply to all countries whose capital city is more than 2,000 miles from London. Washington DC is around 3,700 miles from London.

Band A rates to the London to Paris flights (£13/passenger for economy class and £26/passenger for business class) (HMRC, 2021c).

Having calculated the above rates, these are then converted to £/tCO_{2e} basis using the conversion factors provided by the Department for Business, Energy & Industrial Strategy (2021e).¹⁹ These conversion factors are given in Table 8A.1 and allow us to convert tax rates to a £/tCO_{2e} basis (by dividing the total £/unit tax by the relevant conversion factor). In the case of electricity, all figures provided are for the carbon content of electricity generated by burning natural gas. In the case of aviation, we rely on per-passenger carbon emissions estimates for flights from London to Paris and London to New York provided by the International Civil Aviation Organization (2021).²⁰

Table 8A.1. Conversion factors

Consumption type	Conversion factor
Electricity (gas generated)	0.00037 tCO _{2e} /kWh
Natural gas	0.00018316 tCO _{2e} /kWh
Petrol	0.00219352 tCO _{2e} /litre
Diesel	0.00251233 tCO _{2e} /litre
Landfill (standard waste)	0.72675 tCO _{2e} /tonne

Having converted the taxes discussed above to a £/tCO_{2e} basis, we then add the cost imposed by taxes levied explicitly on a tCO_{2e}:

- **UK Emissions Trading Scheme (UK ETS):** firms operating in energy-intensive industries must purchase UK ETS permits for each tonne of CO_{2e} emitted. We estimate the cost of meeting this obligation by taking the mean traded price of UK ETS certificates between 19 May 2021 and 11 August 2021,²¹ giving a permit price of £45.97 (ICE, 2021).
- **Carbon Price Support (CPS):** charged at a flat £18/tCO_{2e} on emissions produced by electricity generators. We apply this cost to all supplies of gas-generated electricity.

¹⁹ In the case of landfill, the emissions factor is obtained by taking a simple average of food and garden, paper and board, textiles, and wood waste emissions. See table 14 of Waste & Resources Action Programme (2021).

²⁰ ICAO estimates assume aircraft to be entirely configured with economy class seats and apply an average load factor when estimating per-passenger emissions. This results in estimates of 0.0563t/CO_{2e} and 0.311t/CO_{2e} for the London to Paris and London to New York routes respectively. In line with ICAO methodology, these figures are doubled for business class seats (which occupy more space than those in economy class).

²¹ The most recent three months of data at the time of calculation.

Finally, in the case of energy, landfill of commercial waste, and transport fuels, we increase the aggregate cost of tax charged per t/CO₂e by a further 20% to reflect the additional VAT charged on final sales as a result of the tax-induced increase in the pre-VAT price. This procedure is not undertaken for either flights (which are zero-rated for VAT) or landfill of household waste (as councils can reclaim VAT paid on purchases and do not charge households directly for waste disposal).

The above methodology refers to the calculation of figures for 2021–22. Figure 8.5 also includes comparative figures for 2013–14. These numbers are primarily sourced from Advani et al. (2013). They account for the same set of policies as those described above with the addition of the Carbon Reduction Commitment (CRC), which was no longer in place in 2021–22, and the exception of CFDs, which did not exist in 2013–14. A number of minor adjustments are made to the Advani et al. estimates:

- Figures for non-energy-intensive businesses correspond to Advani et al. (2013) estimates for ‘medium businesses’.
- Conversion of taxes on electricity from a £/kWh basis to a £/tCO₂e is undertaken using a conversion factor for electricity generated through the burning of natural gas (as opposed to the composite conversion factor used by Advani et al. (2013)).
- As described above, taxes are augmented to account for the VAT charged on the additional cost of electricity. This adjustment is not undertaken by Advani et al. (2013).
- All figures are updated to 2021–22 prices using the overall increase in the CPI between April 2013 and April 2021 (Office for National Statistics, 2021).

8A.2 Average net subsidies

In this section, we set out the methodology underpinning the calculation of the net average subsidies to subsidised renewable electricity generation by technology type shown in Figure 8.7.

We begin by calculating the gross average subsidy per MWh provided to each technology type under the three subsidy schemes of interest:

- **For the RO**, figures for the number of ROCs issued by technology type in 2020–21 is sourced from the Department for Business, Energy & Industrial Strategy (2021f). As discussed above, the expected equilibrium price of ROCs will be 10% above the buyout price. The subsidy provided to generators per ROC issued is therefore assumed to be 10%

above the buyout price for 2020–21 (equating to a £55.88/ROC subsidy). The resulting gross average subsidies provided by the RO are shown in Table 8A.2.

Table 8A.2. Gross average RO subsidies, 2020–21

Technology type	RO-eligible generation (GWh)	ROCs allocated	Average gross subsidy (£/MWh)
Onshore wind	27,436,000	27,240,009	55.48
Offshore wind	23,339	44,083,339	105.55
Hydro	2,567	2,595,140	56.49
Solar	6,849	9,779,631	79.79
Anaerobic digestion	877	2,274,672	144.92
Biomass	14,729	18,356,759	69.65
Landfill gas	2,994	2,947,519	55.01
Sewage gas	910	750,054	46.04
Wave & tidal	10	48,655	279.40

Note: Exact figures may not be obtainable from table due to rounding.

- **For CFDs**, figures for the quantity of electricity supplied and total subsidy received by technology type are sourced from the Low Carbon Contracts Company (2021a). We obtain the gross average subsidy for CFD-subsidised generation by taking the ratio of CFD generation and CFD payments received, as shown in Table 8A.3.

Table 8A.3. Gross average CFD subsidies, 2020–21

Technology type	CFD-eligible generation (GWh)	Total CFD payments made (£ '000)	Average gross subsidy (£/MWh)
Onshore wind	1,575	81,401.6	51.69
Offshore wind	13,952	1,639,545.2	117.52
Solar	32	1,547.2	48.70
Biomass	8,308	630,639.7	75.91

Note: Exact figures may not be obtainable from table due to rounding.

- For FITs, the quantity of electricity subsidised (9,133GWh) and the value of the subsidy provided (£1.52 billion) in 2019–20²² are taken from Ofgem (2020a).

Having calculated the gross per-kWh subsidy by scheme and technology type, we take an average for each technology type across the three schemes, weighting by the quantity of electricity supplied under each.

The next stage of our calculations is to subtract the implicit tax levied on electricity in 2020–21 as a result of the CCL, WHD, ECO and the levies on electricity suppliers resulting from the RO, FIT and CFD schemes.²³ This netting off of taxes is important because the incentive to produce renewable electricity is impacted not only by subsidies received but also by taxes on the supply of electricity (which act as a disincentive to supply/consume electricity in general). Because (as described above) the taxes levied on electricity supply vary by customer group, we calculate the net subsidy on renewable electricity supply by technology type separately for households, energy-intensive businesses and non-energy-intensive businesses.

Finally, we augment the net subsidy figures by 20% in all cases to account for the impact of VAT (which will increase subsidies as a result of the additional VAT avoided, just as the impact of taxes is augmented by the additional VAT charged). We then take an average of this VAT-adjusted net subsidy for each technology type across the three groups of end users, weighting by each user-group's share of electricity consumption,²⁴ to reach our final net subsidy figure for each technology type.

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²² The most recent figures available.

²³ Note that there is no UK ETS charge on the supply of zero-carbon electricity.

²⁴ The relevant weights for households, non-energy-intensive businesses and energy-intensive businesses are 0.39, 0.57 and 0.04 respectively. It should be noted that these weights are approximate as the definition of energy-intensive businesses varies between taxes. See Department for Business, Energy & Industrial Strategy (2018a, 2021g).

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