TECHNICAL NOTE

Reliable Britain

What Britain's electricity would have cost on gas

Richard Lyon
richard@richardlyon.net
Independent researcher, Edinburgh, United Kingdom

Technical note to Report No. 1 · October 2026

ABSTRACT

What did Britain's climate policies since 2002 add to the cost of the electricity it used? This technical note compares two modelled supply bills for each year from 2002 to 2024: one for the actual system, and one for the same electricity on the road Britain was on in 2002, where old plant closes when it wears out, when pollution law shuts it, or when it would not have paid its way without a carbon price; the cheapest new plant holds a 7.4% margin; and fuel is bought at actual prices, with no carbon price. The gap is the difference.

All figures are for 2002–24, in 2024 prices. Valuing the actual system's electricity at reconstructed wholesale prices, with the other bill lines, gives £955.5bn, against £815.2bn, modelled, for the road; these are not audited totals of settled customer bills. The gap, the extra cost of net zero on electricity bills, is £140.3bn, modelled; changing the main judgement calls one at a time moves it between £120.8bn and £152.7bn. Of it, £82.9bn before VAT is carbon in the price, which readers may subtract.

Per household the gap is £5,298, modelled, an average share of a national gap. The households' allocated share is £2,286, modelled (§2.7). Lost value, what users gave up by using less electricity, is a labelled estimate of £9.8bn, kept apart.

KEYWORDS electricity bills · net zero · climate policy · carbon pricing · Great Britain

THIS VERSION

Preprint, open for review from publication. Version 1.0.2, 26 October 2026. Its figures come from model release v4-s43 (commit 8a5b0e1a070b561a4a964e55c5d29fbc6d03274b); figures file SHA-256 babdadb500f71fa6dfbda60a310cf8370c2044dcd2693211073ce1e5a41e3cf4. Public release details will be supplied on publication. This technical note is being peer reviewed. It will be open for six weeks of public review from publication, and every accepted correction will be logged and credited in the next version. Send corrections to corrections@richardlyon.net.

How to cite: Lyon, R. (2026). *Reliable Britain: what Britain's electricity would have cost on gas.* Technical note to Report No. 1. richardlyon.net.

Licence: text and the author's own data and figures, CC BY 4.0; code, MIT. Third-party data are copied only where their licence allows, and otherwise listed with their publishers.

Summary

The answer, modelled. From 2002 to the end of 2024 Britain paid £955.5bn for its electricity, in 2024 prices. The same electricity on the road Britain was on in 2002 would have cost £815.2bn. The gap, the extra cost of net zero on electricity bills, is £140.3bn. Changing the paper's main judgement calls one at a time moves it between £120.8bn and £152.7bn (§15.2).

What drives it. Over 2002–24, the three largest modelled differences between the two bills pull different ways. The largest, wholesale power without its carbon charges, pulls the gap down: the road pays more for it, because without wind and solar its power comes from coal and gas plant, at a

higher wholesale price (§2.2, §2.11). The next two push the gap up: the Renewables Obligation, a subsidy paid through bills, and carbon in the power price (Figure 1.1).

Did wind and solar pay for themselves? Not over 2002–24 as a whole. Renewables' subsidies and the extra system costs exceeded the saving by £47.6bn over 2002–24, modelled, in 2024 prices (between £39.5bn and £60.0bn, one choice at a time), with wind and solar credited with the whole modelled fall in the wholesale price and carbon pricing taken out of both roads without re-running the actual system. That excess is the renewables balance (§2.11). In the crisis years 2021–23 the saving exceeded the cost: the balance was −£13.4bn. Most of the saving is the modelled fall in the wholesale price, not fuel that bill-payers bought directly. The balance is an accounting check, not an estimate of every benefit of climate policy.

Per household. The gap comes to £5,298 per household over 2002–24, modelled, in 2024 prices: an average share of a national gap, not any household's own bill. Households' allocated share is £2,286 per average household; the rest is allocated to businesses and public bodies. That share is before bill support paid by taxpayers, and before the cost that exemptions for heavy industry shift onto other bills. It is not the net amount households actually paid (§2.7).

2025, provisional and apart. On the data so far, the modelled gap in 2025 is £15.3bn, or £543 per household, in 2024 prices. Full data for 2025 are not yet published, so the year sits outside the headline.

How much rests on carbon. Of the gap over 2002–24, in 2024 prices, £82.9bn before VAT is carbon in the price: £23.7bn collected as UK carbon tax and £59.2bn that was not. The paper measures cost only, and counts carbon charges as a policy charge like any other levy. A reader who takes the mainstream view that carbon pricing makes the polluter pay can subtract either part and check what remains (§2.6).

What is set aside. Lost value, what people and firms gave up by using less electricity because it was dearer, is left out of the headline: a labelled estimate of £9.8bn over 2002–24 in 2024 prices, in a range of £3.5bn to £12.2bn, kept apart (§12.6).

The paper ends with a proposed change in the law: a duty to lay before Parliament an annual statement of policy costs in electricity supply (§17).

Independence and declaration

This paper was not commissioned or paid for by anyone. Commissioned reports in this series will name their funder on their first page. Richard Lyon researched and wrote it, and he built the engine that produces its figures. His wider views are set out in his book, *The Energy Trap* (Swift Press, 2026), which argues that the proposed replacements for fossil fuels can't do the job. He writes the newsletter *The State of Britain* and runs the Subsidy Clock.

The author has no financial interests in energy companies, including through any pension or fund he directs.

Throughout this paper, the road Britain was on is a yardstick for measuring cost, not a proposal.

Review and use of AI

This paper had hostile review before release, and its register of claims is published with it. The claims were checked against their sources (unchanged claims on 21 October 2026, new or changed claims on 24 October 2026), and a sample was checked independently. The independent review of the model did neither. AI tools were used for research, model code and fact-checking, under the author's direction. The author checked the work and takes responsibility for it. The Supplementary Note, Table S1, lists each release figure with its key. Annex B lists known issues.

Rebuilding the figures

The frozen engine release behind this paper is tag v4-s43, at the commit and with the figures file named on the title page. The supplied full-input bundle can be rebuilt offline: one command rebuilds the release's figures file from the code and data at that tag and checks every key in it against the released figures file; it does not run the release's test suite. Rebuilding a public copy also requires the third-party inputs listed by the release, with their publishers. Public release details will be supplied on publication. The code at the tag is the authority wherever this paper and the code differ.

Conventions

Years are calendar years. Data published by financial year (April to March) are put on calendar years by the rule each chapter states. Money is in 2024 prices, using the Office for National Statistics' CPIH index (series L522, 2015 = 100), unless marked as cash, meaning pounds as paid at the time. The basis is Great Britain; where a source covers the United Kingdom, the text says how it is scaled. Household figures divide by Great Britain's households in the same year. Each headline number is tagged **measured**, **modelled** or **labelled estimate**, as §2.8 defines them. Figures for 2025 are provisional throughout. Full references and source versions are listed in Annex C.

Contents

	Summary	i
1	The question and the answer	1
2	What is measured: two full bills, and the gap between them	2
3	How this compares	7
4	How the engine builds the two bills	10
5	Checks: the parts of the machine can be tested; the gap cannot	12
6	Choice 1. Which plant stays open, and how hard it runs	13
7	Choice 2. What is built new, at what cost, to what standard	15
8	Choice 3. The price of power from the plant Britain had	17
9	Choice 4. The gas price	20
10	Choice 5. The grid	22
11	Choice 6. Balancing	23
12	Choice 7. Demand at actual, and lost value	25
13	Choice 8. What counts as the departure	27
14	Results: the gap in every year, and what it is made of	29
15	How sure	32
16	What is not counted	37
17	Conclusion and the proposed change	38
A	Annex A. Derived figures	40
B	Annex B. Version and known issues	45
C	Annex C. References	47

1 The question and the answer

1.1 The two bills

Every electricity bill in Britain mixes two costs: the cost of the power, and the cost of the programme that changed how the power is made. The Government last estimated the second in 2014, in the final edition of a series that the National Audit Office later said the department had failed to make into routine reporting (DECC 2014; NAO 2016, para 3.13). This technical note separates them by building a second bill. For each year from 2002 to 2024 it sets a reconstructed supply bill for the actual system, the actual bill for short, beside a modelled bill for the same electricity on the road Britain was on in 2002.

That road is the baseline, defined in §2.2: the system Britain had in 2002, carried forward, sized to a 7.4% de-rated margin derived from NESO's 2027/28 recommendation, paying the actual price of fuel and no carbon price of any kind. A de-rated margin is spare capacity as NESO measures it (§7.3). The climate-policy programme Britain followed instead is **the departure**, and §2.3 lists it instrument by instrument.

The question is then a precise one. What did the departure add to what Britain paid for the electricity it actually used, in each calendar year from 2002 to 2024? The answer is **the gap**: the actual bill less the road's bill, an amount in pounds, summed over the years.

1.2 The answer

The answer is modelled, because one of its two bills describes a Britain that did not happen. The model values electricity supplied by the actual system at reconstructed wholesale prices and adds the other bill lines. It gives £955.5bn for 2002–24, against £815.2bn for the road, in 2024 prices: a modelled difference, the gap, of £140.3bn, the extra cost of net zero on electricity bills. These are not audited totals of settled customer bills.

In 2024, the latest full year, the actual bill was £52.7bn against £39.4bn on the road, a gap of £13.3bn. For 2025 the data are not yet final, so the year is kept wholly apart from the headline and labelled provisional. On the data so far, the actual bill was £55.2bn against £39.9bn, a gap of £15.3bn. No total for 2002 to 2025 is given anywhere in this paper.

The headline rests on judgements, and eight of them are open to reasonable dispute. Each is a chapter of this paper (§6 to §13), and each chapter re-runs the headline under the other options. Changing the paper's main judgement calls one at a time moves it between £120.8bn and £152.7bn (§15.2).

Per household, the gap comes to £5,298 over 2002–24, modelled, in 2024 prices: each household's average share of a national gap. The households' allocated share is £2,286 (§2.7).

1.3 What drives it

The two bills differ line by line, so the gap can be built as a waterfall: start from the road's bill and add, one at a time, each difference that takes it to the actual bill. Figure 1.1 does that for 2002–24.

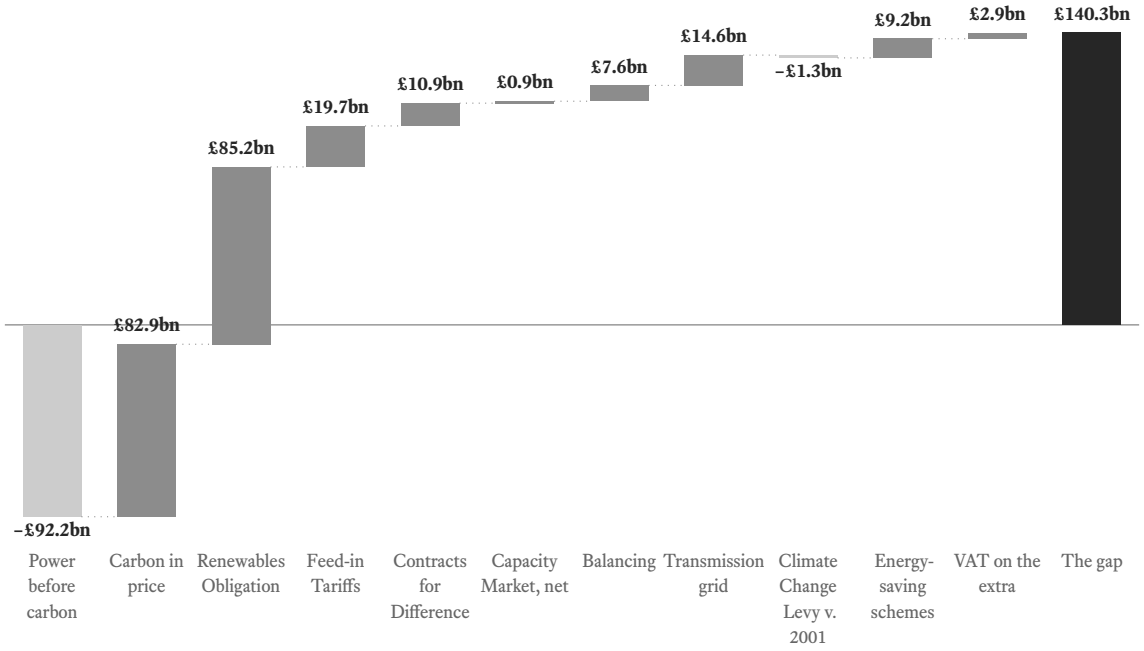


Figure 1.1 From the road's bill to the actual bill: the steps that make up the gap, 2002–24, £bn, 2024 prices. Modelled. The first bar starts from the road's bill; the last bar is the gap. Drawn from the release's waterfall table. Each bar is rounded separately.

A step can be negative where the road would have paid more on that line, and the waterfall shows such a step as it falls. Table 14.2 gives the same steps, with the formula for each.

1.4 What the paper does not do

The paper takes no position on climate science, and it puts no value on carbon dioxide. It measures what electricity cost, and it treats the carbon charges in the price as one of those costs (§2.6).

Lost output from industry moving abroad is left to a later report.

Finally, the gap is not to be added to the figure in Report No. 2 of this series, *The Price of the Climate Bill*. The two answer different questions: that report counts what was paid for climate policy, while this paper measures the departure from a road. Both read the same register of scheme costs, and this paper counts differently on purpose in five named ways: the Climate Change Levy and the Fossil Fuel Levy stay on the road at their 2001 levels (§13); it covers Great Britain, not Northern Ireland; Feed-in Tariffs are valued as the levelisation fund (§2.3); generators' share of grid and balancing charges is counted (§10.3); and the supplier energy-saving schemes, which Report No. 2 leaves out, count above EESoP's 2001 level (§13.2).

2 What is measured: two full bills, and the gap between them

2.1 The gap, two full bills, and what sits in both

The gap is an amount, never a ratio. The question is how much more Britain paid, and a bill is a sum of money, so the answer is one too. The obvious objection is that an amount means little without its scale. The answer is to print both full bills beside it every time, as the Treasury's appraisal guidance asks: costs "should usually be presented in absolute terms, rather than as incremental differences from BAU" (HM Treasury 2026, para 4.19); BAU is business as usual. A reader can then form any ratio they like; the paper itself states none.

Both bills are full bills. Some costs are the same on both roads: distribution networks, metering and suppliers' own costs. They sit in both bills at the same value, £13.0bn in 2024, and so cancel

in the gap. Holding them equal is a choice with a direction. A critic could argue that the departure raised some of these costs too; if so, the gap here is too small, not too large, because none of that is counted.

2.2 The road Britain was on, and why it is the baseline

The road Britain was on is the electricity system Britain had in 2002, carried forward year by year to 2024, at the demand Britain actually had. Nuclear, interconnectors and pumped storage are as they actually were. Coal and gas stations close at the end of their life, when pollution law requires it, or when, with the carbon price taken out, they would not have covered their costs (§6.2). When wind and solar are taken away, their output is replaced first by the fleet that remains running harder, then by the cheapest new plant, gas or coal fitted with pollution filters, priced from the Government's published generation cost reports. Fuel is bought at actual prices, 2022 included, and Britain's own gas output is as it actually was. There is no carbon price of any kind.

The author chose this as the baseline because in 2002 it was the system; the climate-policy programme is what changed. The strongest objection is that a system frozen in 2002 is a straw man, and that calling net zero "the departure" is rhetoric. The method answers both halves. The road is not frozen: it closes plant, builds plant, and meets the reliability standard every year. That is what the Treasury's **Green Book** asks of a business-as-usual case: "BAU does not mean doing nothing. It considers how individuals and organisations will act to try to achieve their objectives in the absence of new government intervention" (HM Treasury 2026, para 4.15). As for the label, the gap is the same number whichever of the two worlds is called the baseline, because it is one bill less the other.

The approach has an official precedent. The Department of Energy and Climate Change presented the impact of its policies as "the difference between an energy bill in a given year compared with what that bill would have been in the same year if the policies had never been in place (the no policy 'baseline')" (DECC 2014, para 43). The National Audit Office later recorded that it had recommended in 2013 that the department establish routine reporting of this kind and "failed to do so, with its last report on this topic in 2014" (NAO 2016, para 3.13). This paper answers DECC's question looking back, with an open model.

2.3 The departure, instrument by instrument

The departure is the climate-policy programme since 2002, measured as the lines by which the actual bill differs from the road's. Each has a line label, which §4 uses:

- the Renewables Obligation (NZ2), with its Non-Fossil Fuel Obligation contracts to 2019 (Ofgem, RO annual report 2017-18, para 2.30) counted only above the 2001 level of the Fossil Fuel Levy that funded them (HC Deb 5 November 1997, c356);
- Feed-in Tariffs, valued as the levelisation fund that suppliers pay through bills (NZ3);
- Contracts for Difference (NZ4);
- carbon in the wholesale price, from the EU and UK emissions trading schemes and Carbon Price Support (part of NZ1);
- the Climate Change Levy above its 2001 level (NZ8), a separate line, never counted as carbon;
- the energy-saving supplier schemes above the 2001 level of their predecessor (NZ10);
- the extra Capacity Market, balancing and transmission costs (NZ5, NZ6 and NZ7, each less the road's own line);
- VAT on the extra.

The Renewables Obligation line includes mutualisation payments received (payments covering failed suppliers' unpaid obligations), attributed to the obligation scheme year and then put on calendar years, not the amount billed or the year cash arrived. Charges already on bills in 2001 are

part of the road at their 2001 level, so only rises above that level count; §13 argues the rule, and why the renewables target of 2000 is not on the road.

VAT on the extra is counted in the departure. The objection is that VAT is a general tax, not climate policy. The answer is that VAT is charged on the bill, so a bill that is larger because of the departure carries more VAT, and households pay it as part of the cost. The step is shown on its own in the waterfall, £2.9bn over 2002–24, so a reader who disagrees can take it out.

2.4 The one-country rule

On the road, Britain leaves the departure while the rest of the world stays as it actually was. European wind farms are still built and still affect the gas price; continental carbon prices still sit in the price of imported power; the world market for liquefied gas is unchanged. This **one-country rule** is a choice of question: what did Britain's own programme cost Britain? The main rival estimate asks a different one, in which Europe as a whole builds less wind (§3.3). There is no run on that premise, because it would answer that other question, so no headline is shown under it, and this paper sets no bound on what such a run would give.

2.5 What "Reliable" means

The road is sized to a 7.4% de-rated margin derived from NESO's 2027/28 recommendation. That is the yardstick: the road is built to the level of security NESO recommends today. The actual system's margin on the same basis is not computed, so the paper does not claim that the two were equally reliable in every year. The title says only that the road would have kept the lights on to that standard.

Two standards could be meant, and both are stated. The legal standard is a loss-of-load expectation, or LOLE, of 3 hours per capacity year, set in the Electricity Capacity Regulations 2014. Loss-of-load expectation counts the hours in a year when, on average over the long run, demand is expected to exceed available supply.

The engine instead sizes the road's fleet to a de-rated margin of 7.4% over the gross winter peak. The National Energy System Operator (NESO) did not publish that percentage; this paper derives it from two figures that NESO did publish. For the one-year-ahead, or T-1, Capacity Market auction for delivery in 2027/28, NESO equates its recommendation with a de-rated margin in the range 4 to 5 GW (NESO 2026a, p.5). NESO's Base Case peak demand for the same year, 2027/28, is 61 GW (NESO 2026b, Data Workbook, Figure B1). The central margin is the midpoint of that range divided by that peak; the low and high options of §7 divide the two ends of the range by the same peak. The engine applies the share to the gross peak of every year from 2002.

For that auction NESO estimates that its recommendation gives a Base Case expected loss of load of "around" 0.1 hours a year, before any "future unknown" non-delivery. If the 3.5 GW of future unknown non-delivery that it models materialised, on top of the 4.3 GW of known non-delivery already in the Base Case, the figure would be 2.1 hours (NESO 2026a, p.5).

The Government's own Panel of Technical Experts has observed that, while the 3-hour LOLE Reliability Standard is defined in The Electricity Capacity Regulations 2014, its actual implementation for setting the target capacity "has allowed for a degree of discretion", and that NESO and the Secretary of State have in practice preferred a higher level of security (DESNZ 2026e, para 8). The road is therefore sized to a margin derived from the one NESO recommends, which is more secure than the legal floor, not to the legal floor itself.

One phrase helps here. Wind and solar output depends on the weather, so a system built on them needs a second system for when the wind does not blow: **two systems**, one for when it does and one for when it does not. The road has one system that runs whatever the weather.

2.6 Carbon: counted as a cost, and shown so a reader can take it out

This paper measures cost only. It treats the carbon charge in the wholesale price as a policy charge like any other levy. Its level follows from the cap and the tax rate the Government chose in order to meet its targets, not from any measured harm, so its whole effect on bills counts as a cost of the departure.

The mainstream case is different. The Climate Change Committee holds that carbon pricing "can help ensure that private incentives are aligned to the social goal of reducing emissions, through the 'polluter pays' principle" (CCC 2025a, p.116). The UK's own carbon values for appraisal are set on a "target consistent" basis, from the marginal cost of abatement needed to meet its targets, not from an estimate of damage (BEIS 2021). The Committee also notes that "carbon taxes raise funds for the Exchequer … but increase household energy bills" (CCC 2017, p.12). The disagreement is mainly about values, and partly about accounting.

So the paper shows how much rests on it. Carbon in the price is £82.9bn of the £140.3bn gap for 2002–24: £23.7bn tax collected, which went to the Treasury, and £59.2bn carbon in the power price not collected as UK carbon tax (the rest). A reader may subtract either and check the rest. §13 covers the years of free allowances, 2005–12. The Climate Change Levy at its main rates is a separate line (§13.3), not included.

2.7 Household figures

The headline is the extra cost of net zero on electricity bills. Two household figures translate it. **Extra cost of net zero on electricity bills, per household** divides each year's gap by the number of households in Great Britain that year, and sums the results. It is each household's average share of a national gap, and never "your bill". **The households' allocated share** is the part of the gap allocated to households, per average household, before bill-support transfers and the unallocated effect of industry exemptions; it is not a measure of the net amount households actually paid.

The households' allocated share is built line by line. Households' share of electricity sold by suppliers is applied to each line of the gap, with two exceptions. The Energy Company Obligation (ECO), whose costs businesses do not face (DECC 2014, para 75), is counted in full. The Climate Change Levy, a tax on non-domestic use of energy (ONS 2015, Environmental Taxes 2014, PDF p.11), is left out. VAT is then added at the domestic rate that applied throughout 2002–25, 5% (VAT Act 1994, s.29A(1)). Annex A gives the working, year by year. The two figures differ because the rest of the gap is allocated to businesses and public bodies, which buy most of the electricity sold (DUKES 2026, Tables 5.2 and 5.5.D).

The households' share counts electricity bought from suppliers only: 36.5% in 2024. That share is a United Kingdom figure, households' share of electricity sold by suppliers (DUKES 2026, Tables 5.2 and 5.5.D), applied unchanged to Great Britain. A Great Britain figure exists on a different basis: domestic meters took 39.1% of Great Britain's electricity consumption in 2024 (DESNZ, sub-national electricity consumption statistics). It is given for context and is not used. Power that households generate and use themselves, mostly from rooftop solar, is left out, because levies and network charges fall on electricity bought, not on power used at home. Households numbered 27.867 million in Great Britain in 2024 (ONS 2025, household size by regions and countries, sheets England, Wales, Scotland, 2024, summed).

One further shift makes the households' allocated share slightly too low. Energy-intensive industries in Great Britain can be exempted from the indirect costs of funding the Renewables Obligation, Feed-in Tariffs and Contracts for Difference on the electricity they use to make eligible products (DBT, EII guidance, paras 2–5), and from April 2024 from the Capacity Market (SI 2024/434, reg. 1 and explanatory note), so that cost falls on other consumers (Annex B). The exemption began

on different dates for each scheme, not in 2002 (SI 2015/721, reg. 1(2); SI 2017/1289, art. 1(1); SI 2018/1380, art. 13(4); SI 2024/434, reg. 1(2)). Until March 2024 a site's exemption was 85% of its eligible electricity (SI 2015/721, reg. 11(2)). The certified share is that percentage times the eligible share, so a site's actual exemption could be lower (SI 2015/721, reg. 11(2)). From 1 April 2024 it is 100% (SI 2024/419). A labelled estimate puts the part that falls on households at £1.0bn over 2018–24, in 2024 prices (Annex A). It moves cost between consumers and does not change the gap.

2.8 Measured, modelled and estimated

Three kinds of number appear in this paper, and each is labelled where it appears. **Measured** figures are taken from a published record: what the Renewables Obligation cost, what the Capacity Market paid, what the transmission charges were. The actual bill is built from measured, modelled and estimated lines, identified in the Supplementary Note. **Modelled** figures come from the engine: the road's bill, and therefore the gap, are modelled throughout, because the road did not happen. **Labelled estimates** are figures computed outside the gap, each with its method, kept apart and never added to it: the energy-intensive industries shift (§2.7), lost value (§12.6) and the cost to other gas users (§9.8).

2.9 The conservative rule and its exceptions

Where the evidence leaves a choice open, the paper takes the sourced option that makes the gap smaller, and says so. Most of the central settings in §6 to §13 follow that rule. A few do not, and each is argued in its own chapter. Table 2.1 lists six. In two of them, the option that would lower the gap fails a test that the central option passes. The other four depart from the rule for a reason other than a failed test, and each chapter gives that reason. Table 2.1 comes straight from the model release. It covers only options counted in the printed range; it is not a list of every assumption that could lower the result. Actual closure dates give £121.9bn over 2002–24, against £140.3bn central, as a method check outside that range (§6.5). The range is the lowest and highest headline from the release's full list of options for the range, each run alone with every other setting central.

Table 2.1 Every choice in the range with an option that lowers the headline: the lowest such option, 2002–24, £bn, 2024 prices (modelled; lowest first)

Choice	Lowest-gap option of the switch	Headline 2002–24	Change
3	Power from plant Britain had, priced at the actual market price with carbon left in	£120.8bn	−£19.5bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2024/25 energy share (70.3%)	£132.2bn	−£8.1bn
5	Grid carried forward on the price controls' own X values (RPI minus X) instead of RPI	£134.4bn	−£5.9bn
2	Capacity Market: coal stations the road keeps open also need Capacity Market payments	£139.7bn	−£0.6bn
2	Interconnectors counted at their metered flow at the peak instead of their Capacity Market contracts	£140.1bn	−£0.2bn
2	Spare plant margin of 8.2% (central 7.4%)	£140.2bn	−£0.1bn

Source: gas-counterfactual release v4-s43, figures.json key table_exceptions_register. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

In the labels, RPI is the price-control index of §10.2, and RPI minus X is that index less the X values Ofgem set for each period.

2.10 Every choice the author made

Table 2.2 lists each choice the author made that a reader might dispute, where it is argued, and where the headline under the other option is shown, or why it is not.

Table 2.2 Every choice the author made that a reader might dispute

Choice	In brief	Strongest objection	Other option
The road as baseline	The 2002 system carried forward (§2.2)	A straw man; the label is rhetoric	None: the gap is the same either way
The gap, not a ratio	An amount, with both bills beside it (§2.1)	Meaningless without scale	Both bills printed
Same-in-both lines	Distribution, metering, supplier costs equal (§2.1)	The departure raised them too	Not taken; would raise the gap
VAT on the extra	Counted in the departure (§2.3)	VAT is not climate policy	Waterfall step, §1.3
One-country rule	Britain alone leaves the road (§2.4)	Europe moved together	Not run: a different question (§3.3)
Reliability standard	De-rated margin derived from NESO's recommendation, gross peak (§2.5)	"Reliable" implies the real system was not	§7
Carbon stance	A policy charge, counted in full (§2.6)	Polluter pays for real harm	Subtract the carbon line
No value on carbon	Cost only (§1.4)	Ignores the benefit	Outside scope
Demand at actual	Both roads buy the same electricity (§12)	Cheaper power means more use	Not calculated: price and quantity both change; a per-MWh gap is given (§12.5)
Choices 1 to 8	§6 to §13	Stated in each chapter	In each chapter and §15

Source: the author's choices, as argued in the sections named. The table holds no figures.

2.11 Did wind and solar pay for themselves?

The renewables balance compares the specified renewables and supporting-system bill costs with the power-price saving in the same model, with carbon pricing out of both roads, wind and solar credited with the whole modelled fall in the wholesale price (§8), and 2021–23 counted. It is an accounting check, not a separate estimate of all benefits of climate policy.

The renewables balance counts only the specified cost bundle: the subsidies (Renewables Obligation, Feed-in Tariffs, Contracts for Difference), the extra grid, balancing and Capacity Market, and generators' share of grid and balancing charges, with VAT on households' share as in the headline. The Climate Change Levy and the energy-saving schemes are not in it. Against those costs it sets the power-price saving, before carbon, at the market rule of §8.

Over 2002–24, before VAT, costs are £147.4bn and savings £100.7bn. Net VAT on their difference is £0.9bn. Including that net VAT, the renewables balance is £47.6bn, modelled, or £1,811 per household. Its range, one choice at a time, runs from £39.5bn (Balancing: the NAO′s £642m for 2005/06 as the baseline in every year, with the FY2024/25 energy share (70.3%)) to £60.0bn (Gas-price feedback at Krichene′s world long-run pair, supply 0.16 plus demand 0.45 (smaller feedback)). The row that prices kept output at the actual price is left out of that range: it puts carbon pricing back into one road, and the renewables balance is defined with carbon out of both (Annex A gives the low end with it in).

Three limits come first. In 2021–23 the saving exceeded the cost: the renewables balance was −£13.4bn over those years. Most of the saving, £99.8bn, is the modelled effect on the price, not fuel that bill-payers bought directly. And it does not re-estimate the actual fleet or demand without carbon pricing.

3 How this compares

The answer has rivals, and a reader should meet them before the method, so that each later chapter can show where a difference arises. This chapter compares on a matched basis where the engine can

produce one, explains each difference in the order scope, period, price basis and method, and then stops. Which method is better is argued in the chapters that follow.

3.1 The mainstream case: bills fell

The strongest mainstream statement on bills comes from the Climate Change Committee:

> "Household bills in 2016 were below 2008 levels as higher prices resulting from low-carbon policies and network costs were more than offset by reductions in energy use"
> Committee on Climate Change, *Energy Prices and Bills – impacts of meeting carbon budgets*, March 2017, p.7, Executive Summary

The Committee's figure is not an electricity bill. It is a dual-fuel bill, for households that use "gas for heating and hot water and electricity for lights and appliances", the large majority of UK households (p.7). It compares 2016 with 2008, in the Committee's real 2016 prices (GDP deflator; p.14, note 3): bills were about £115 lower in real terms than in 2008, after a larger rise from 2004 to 2008 "as international gas prices rose" (p.7). And it is net of falling use. On the Committee's figures, lower use of gas and electricity since 2008 saved the average household £290 a year. Around £105 of the 2016 bill "resulted from the shift towards a UK-based low-carbon electricity supply and support for energy efficiency improvements in homes" (p.7). It credits the saving to "improved appliance, lighting and boiler efficiency driven through minimum standards" (p.7). The Committee calls for "an effective policy package … with strong product standards" to deliver further savings (p.38). On its account, climate policy both raised prices and cut use, and the second outweighed the first.

The two findings can both be true: a fall in bills over time is compatible with a gap between roads in every year. This paper does not dispute the arithmetic. It answers a different question, on a different measure: the Committee's is a dual-fuel bill in 2016 prices, net of lower use of both fuels; this paper's gap is for electricity alone, in 2024 prices, with use held at actual. Both of its bills buy the electricity Britain actually used, so a saving from appliance and boiler standards sits in both bills and cancels in the gap: the road gets the efficient fridge too. What remains is what the departure added to the cost of the electricity that was used. The Committee's comparison runs across time, from 2008 to 2016; this paper's runs across roads, in the same year. §12 argues the choice to hold demand at actual and states its strongest objection.

3.2 The case that gas drives the cost

A second mainstream case holds that the rise in bills was driven by the price of gas, not by climate policy. The Climate Change Committee puts it in the same report: bills rose sharply from 2004 to 2008 "as international gas prices rose" (CCC 2017, p.7), and price pressures "have largely been driven by higher wholesale energy prices" (CCC 2017, p.14, chapter 1 key messages). The report dates from March 2017. The Committee's more recent advice includes the Seventh Carbon Budget (CCC 2025a, February 2025), which §2.6 cites on carbon pricing. The Government's 2022 consultation on electricity market arrangements states: "Gas plants are frequently the marginal plant in GB, meaning the price of gas generation often sets the wholesale electricity price" (BEIS 2022, REMA consultation, p.73). A study of Europe's power markets concludes: "Hence, Europe's electricity markets are highly exposed to the geopolitical risk of gas supply and natural gas price volatility, and the economic risk of currency exchange" (Zakeri and others 2023, p.2778).

The paper accepts the premise and builds it in. The road pays the actual price of gas in every month, 2022 included. A rise in the gas price raises both bills, and raises the road's more, because over 2002–24 the road burns more gas; so the gas price lowers the gap rather than causing it. Gas can still remove the gap in one way: the road burns more gas than Britain did, and so may pay more for it. §9.5 measures that effect, and §15.3 asks how large it would have to be for the gap to vanish.

3.3 Earlier estimates

Two earlier estimates address the same territory. Kathryn Porter (Watt-Logic, 2025) reaches a higher figure than this paper's, over a shorter period and for households. The methods differ. She takes the gap between household retail and wholesale electricity prices before 2006, assumes it held from 2006 on, and counts everything above it as the cost of the transition, in 2025 money. This paper instead models a second system, year by year, and credits wind and solar with the fall they cause in the wholesale price. Her estimate therefore includes any widening of that gap, whatever its cause, and leaves the wholesale saving out. No figure of hers is printed here. For full disclosure, Kathryn Porter provided an endorsement for the author's book, *The Energy Trap* (Swift Press, 2026, publisher's page).

O'Shea, Horne and Maslin (2025), of University College London (O'Shea, Maslin) and COMAC Capital LLP (O'Shea, Horne), reach the opposite conclusion. They find that wind delivered a net benefit of £104.3bn to UK consumers over the 14 years from 2010 to 2023 (preprint, version 1, p.1); the parts of their Table 10 add to £109.2bn (pp.31–32). The differences, in order, are these.

In scope, Europe builds less wind as well as Britain, so the gas price rises across the regional market, and gas consumers' bills are counted beside electricity bills. In period, they cover 2010 onwards. In price basis, their paper states none for its £bn figures. In method, most of their benefit, by their own account, comes from a long-run rise in the European gas price, which this paper's one-country rule excludes by design (§2.4). Over the same years, 2010–23, this paper's gap is £83.8bn in cash, modelled. Their figure is compared on that basis because its inputs, market prices and scheme payments with no deflator named, point to money of the day; that is inferred, not stated. In 8 places in Tables 1, 9 and 10 their printed totals differ from the sum of their printed cells by more than rounding: more than half the last printed digit of every figure involved (Table 3.1). The two figures answer different questions and are not offered as confirming or refuting each other.

Table 3.1 Where O'Shea, Horne and Maslin's printed totals differ from the sum of their printed cells by more than rounding, £bn as printed (no price year stated)

Table (page)	Cell	Printed	Sum of the printed cells	Printed less sum
Table 1 (p.4)	Row 2022, Total column: CFD plus RO	£3.9bn	£4.7bn	−£0.8bn
Table 1 (p.4)	Total row, CFD column: 2017–23	£5.2bn	£5.9bn	−£0.7bn
Table 9 (p.31)	Total row, column (4) = (1) + (2) − (3)	£104.3bn	£104.6bn	−£0.3bn
Table 10 (p.32)	Total row, column (1): 2010–23	£138.3bn	£133.4bn	£4.9bn
Table 10 (p.32)	Total row, column (3): 2010–23	£41.8bn	£47.6bn	−£5.8bn
Table 10 (p.32)	Total row, column (6): 2010–23	£12.8bn	£18.7bn	−£5.9bn
Table 10 (p.32)	Total row, column (7): 2010–23	£96.4bn	£85.6bn	£10.8bn
Table 10 (p.32)	Total row, column (9): 2010–23	£96.4bn	£85.6bn	£10.8bn

Source: O'Shea, Horne and Maslin (2025), UCL Open: Environment Preprint 290, version 1, Tables 1, 9 and 10, printed pages 4, 31 and 32; £bn as printed, no price year stated. Measured: the cells as printed, and their sums. Column (9) of Table 10 repeats column (7), because column (8) is nil in every year.

What both studies show, and this paper does not contradict, is that wind and solar lower the wholesale price when they run, by pushing dearer plant out of the merit order. That effect is real. The road loses it, and §8 prices the loss into the road's bill.

A wider literature estimates the system costs of integrating wind and solar: Ueckerdt and others (2013), Hirth, Ueckerdt and Edenhofer (2015), the studies for the Committee by NERA and Imperial College (2015) and for DECC by Frontier Economics (2016), and the review by Heptonstall and Gross (2021). Most of it works per megawatt-hour, in modelled future systems, to compare technologies; Frontier Economics (2016) sets out a framework for those costs and gives no estimates. This paper measures something else: a reconstructed supply bill for the actual system, set against a

modelled bill for the same years. The two are complements. Report No. 3 will survey those estimates as part of its forward comparison with the CCC's costs.

4 How the engine builds the two bills

4.1 The machine in one pass

The engine builds the road's bill half-hour by half-hour, year by year, from published data, and sets it against the actual bill line by line. Figure 4.1 shows the order of the steps. The Supplementary Note, Section S.C, gives the engine's equations, parameters and settings.

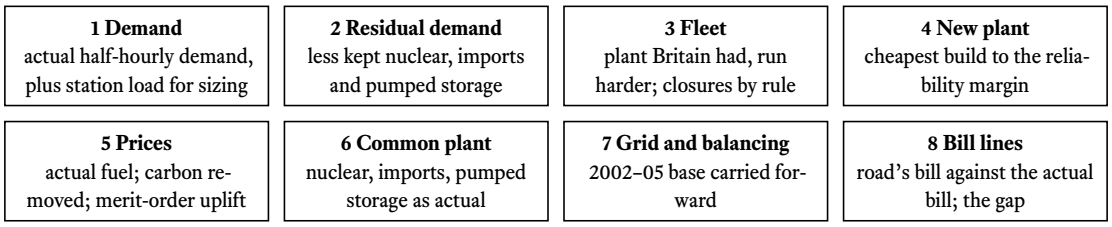


Figure 4.1 The engine in one pass

It starts from the electricity Britain actually used, half-hour by half-hour, from the system operator's demand data. The road's **residual demand** is use plus station load, pumping and exports, less kept nuclear, imports and pumped-storage output. Subtracting the actual renewable output from that residual gives the actual fossil-load comparator. Power used inside power stations, **station load**, is in residual demand for sizing and running the fleet, because the road's stations must generate it, but it is not billed, because customers do not buy it. That keeps the volume priced on the two roads the same. Station load on the road averages 4.7 TWh a year over 2002–24.

Residual demand is met first by the coal and gas plant Britain had in 2002; nuclear, interconnectors and pumped storage run as they actually did. The coal and gas stations that remain on the road run harder than they did, and some stay open beyond their actual closure dates (§6). Where they cannot meet the demand and the reliability margin, the engine builds the cheapest new plant, sized afresh each year (§7).

The **merit order** sets the price: plant runs in order of running cost, and the last plant needed sets the price for all. In the actual system, wind and solar push the dearer plant out of the merit order when they run. On the road Britain was on, they are not there, so the price is higher. That rise is the **merit-order uplift**. Power from the plant Britain had is valued at the actual wholesale price with the carbon taken out, plus the merit-order uplift (§8). **Kept output**, the power from plant that runs on both roads (nuclear, imports and pumped storage), is valued in the same way. New plant is paid its full cost from the Government's generation cost reports. Fuel is bought at actual prices, with a rise in the gas price for the road's extra burn (§9).

Grid and balancing costs on the road start from their level in 2002–05, the **base window**, before the departure had changed them much, and are carried forward by the price controls' own rules and an allowance for renewal (§10, §11).

4.2 The bill lines and the identities

Each bill is a set of labelled lines. The actual bill's lines carry the label NZ, the road's lines GO, and lines the same on both roads S. Table 4.1 lists every line for 2024 with its value on each road. The Supplementary Note, Tables S2 to S5, gives each line's tag: measured, modelled or labelled

estimate. Biomass support is counted: biomass Contracts for Difference are their own line, and the Renewables Obligation line covers every technology, biomass included.

Table 4.1 Every bill line on both roads, 2024, £bn, 2024 prices (modelled)

Line	What it is	Bill	2024, £bn
NZ1	Power: wholesale energy	Actual	£20.5bn
NZ2	Renewables Obligation	Actual	£7.3bn
NZ3	Feed-in tariffs (levelisation cost)	Actual	£1.7bn
NZ4	Contracts for Difference (wind, solar, other)	Actual	£2.0bn
NZ4b	Contracts for Difference: biomass	Actual	£0.4bn
NZ5	Backup: Capacity Market extra over the road's own backup	Actual	£0.2bn
NZ6	Running the grid (balancing)	Actual	£3.0bn
NZ7	High-voltage grid	Actual	£3.2bn
NZ8	Climate Change Levy, electricity	Actual	£0.0bn
NZ10	Energy-saving schemes (EEC, CERT, CESP, ECO, GBIS), electricity share	Actual	£0.7bn
NZ11	VAT, 5%, on households' share of the lines above	Actual	£0.7bn
NZ1c	*of which carbon in the wholesale price*	*Actual*	*£5.6bn*
NZ1c_tax	*of which carbon price receipts*	*Actual*	*£1.3bn*
NZ1c_price	*of which carbon in the price, the rest*	*Actual*	*£4.3bn*
GO1	Power: the actual plant less carbon, renewables' output replaced by fossil	Road	£17.4bn
GO1k	Kept nuclear, imports and pumped storage, priced as actual less carbon	Road	£5.4bn
GO2	*Backup payments (inside GO1)*	*Road*	*£0.0bn*
GO3	Carbon	Road	£0.0bn
GO4	Running the grid (balancing)	Road	£1.4bn
GO5	High-voltage grid	Road	£1.8bn
GO6	CCL, subsidies, taxes	Road	£0.0bn
GO7	VAT, 5%, on households' share of the lines above	Road	£0.5bn

Source: gas-counterfactual release v4-s43, figures.json key table_lines_2024. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

In the labels, EEC is the Energy Efficiency Commitment; CERT, the Carbon Emissions Reduction Target; CESP, the Community Energy Saving Programme; ECO, the Energy Company Obligation; and GBIS, the Great British Insulation Scheme.

Two identities hold in every year and are tested in the release. The waterfall steps add up to the gap. Both bills price the same volume of electricity.

4.3 A worked half-hour

Two half-hours from 2024 show the machine at work: the half-hour with the highest residual demand, and the half-hour at the median. The median is shown beside the peak, so that the example is not the extreme half-hour alone. Prices are in pounds per megawatt-hour in cash.

At the peak, 15 January 2024, 12:00–12:30 (settlement period 25), residual demand was 44.5 GW. In the actual market, Elexon's market index price for that half-hour, the short-term price it publishes for each half-hour, was £78.1 per MWh. On the road, the last plant running was a new open-cycle gas turbine, with a running cost of £179.1 per MWh. The merit-order uplift in that half-hour was £231.3 per MWh: the engine's own estimate from the shape of the road's fleet in that half-hour, scaled so that over the year it matches the yearly estimate described in §8.

At the median, 15 August 2024, 10:00–10:30 (settlement period 21), residual demand was 22.0 GW. The last plant running on the road was a combined-cycle gas station, at £62.6 per MWh, and the uplift was £51.7 per MWh. Elexon's market index price was £18.9 per MWh.

The two half-hours show where the road's costs come from. At the peak, the road runs its dearest plant, and the gap in that half-hour depends mainly on how much that plant costs to hold in reserve.

At the median, the road runs the plant Britain had, and the gap depends mainly on the price at which its power is valued.

5 Checks: the parts of the machine can be tested; the gap cannot

5.1 What calibration can and cannot show

No test can validate the gap, because the road never happened. That is the first limit of this paper, and it is stated before the method is described. What can be tested is each part of the machine. The actual bill can be checked against published statements. The road's bill can be checked in the early years, when the two roads had barely parted. And the mechanisms and identities can be checked against data. The ranges in §15 carry what calibration cannot.

5.2 The actual side and its sources

The release states that the actual side is calibrated against published outturns: the Renewables Obligation against Ofgem's printed scheme value (Ofgem's annual reports), Feed-in Tariffs against Ofgem's levelisation notices 2015-16 to 2022-23, Contracts for Difference and the Capacity Market against the Subsidy Clock's series, and balancing against the NESO workbook outturn on the overlap. The asserted source checks are not reproduced here.

5.3 The early years

In 2002 the two roads had only just parted: the Renewables Obligation began in April 2002 (Ofgem 2004a, RO first annual report, PDF p.2). So in the early years the two bills should differ by little more than the climate-policy charges then in force: if the engine's road differed from the actual system by much more than that, something in the machine would be wrong. This is the early-years check.

The check is judged pooled over 2002–04. The difference between the two bills, other than the climate-policy lines, is measured as a share of those climate-policy lines. Two limits apply, both in 2025 prices: 30.0% of the climate-policy lines, and £25.00 a household. Year by year the result is 19.1% in 2002, 21.3% in 2003 and 12.3% in 2004. The test was first set year by year. It was changed to the pooled form after the results were seen, because the climate-policy lines in 2002 were small, so a few pounds moved the percentage a lot; the paper says so, and prints every year.

In this run, the pooled check passes. Calibration money in §5.3 is exceptionally in 2025 prices, matching the release's tests. Pooled, the difference is −£3.29 a household in 2025 prices, 16.8% of the climate-policy lines in size, against limits of £25.00 and 30.0%. One rule set out in §13 bears on it: charges already on bills in 2001 stay on the road at their 2001 level, so only rises count. That rule takes £664m (2025 prices) out of the climate-policy lines over 2002–04, which makes the climate-policy lines smaller and so raises the percentage.

Table 5.1 The early-years check, by year and pooled over 2002–04, £ a household, 2025 prices (modelled)

Year	Difference outside the climate-policy lines, £ a household	Climate-policy lines, £ a household	Difference as % of the lines	Within £25.00	Within 30.0%
2002	−£2.13	£11.12	19.1%	yes	yes
2003	−£4.50	£21.16	21.3%	yes	yes
2004	−£3.24	£26.29	12.3%	yes	yes
2002–04, pooled	**−£3.29**	**£19.54**	**16.8%**	**yes**	**yes**

Source: gas-counterfactual release v4-s43, figures.json key table_calibration_early. Modelled, £ a household in 2025 prices (CPIH), and percentages; figures rounded separately.

Two more readings come from the same window. The pricing difference inside 2002–05 is positive, £285m in 2025 prices: the road must replace the renewable output there was, and that outweighs the uplift on kept output. Grid and balancing lines net to about nil inside 2002–05, −£0.7m and £13m (2024 prices), as they should, since the road's grid and balancing costs start from that window.

5.4 Three checks on the machine's parts

Three further checks test the machine's parts. The running cost of the fleet is compared with the actual day-ahead price in half-hours when gas set the price, which tests the price rules; it passes as a release test, exporting no result. The engine's method for residual demand before 2016 is compared with the settlement data by fuel type available from 2016, which tests the early years where data are thinnest. And the identities of §4.2 are tested in every year. The release's test suite records no failed test: 1,778 passed.

Table 5.2 Residual demand from 2016: Elexon's half-hourly generation data against NESO's demand data, by year (measured; each difference is NESO's figure less Elexon's, as a share of Elexon's)

Year	Energy difference	Peak difference	Passes (loosened rule)
2016	1.7%	2.4%	yes
2017	0.4%	−1.1%	yes
2018	0.7%	0.6%	yes
2019	0.6%	−1.8%	yes
2020	0.4%	0.5%	yes
2021	0.3%	−1.4%	yes
2022	0.1%	0.9%	yes
2023	−0.2%	−1.0%	yes
2024	−0.6%	−3.9%	yes
2025	−1.1%	−1.2%	yes

Source: gas-counterfactual release v4-s43, figures.json key table_calibration_residual. Measured, percentages; figures rounded separately.

6 Choice 1. Which plant stays open, and how hard it runs

6.1 The question

When wind and solar are taken away, which of the coal and gas stations Britain had stay open on the road, and how hard do they run?

6.2 The options

The central option closes stations by rule. A station closes on the road when it reaches the end of its life, when pollution law requires it, or when it fails a margin test with the carbon price taken out, run at the load factor the station would have had on the road and repeated until the list of closures stops changing: a station whose earnings before carbon would not have covered its costs closes when it actually did. Kept coal receives only the fixed cost not covered by the market margin assigned to its output on the road, never less than nil, and the running cost of its pollution filters is in its price, counted once. In this run the top-up is nil in every year. It can run harder than it did, but never above the coal capacity that actually existed, never above a maximum load factor of 65.0%, and always within its permit-derived energy limits: an energy budget from the permitted hours, not a station-by-station schedule (Large Combustion Plant Directive opt-out, Directive 2001/80/EC, Art. 4(4); from 1 July 2020, the Industrial Emissions Directive's limited-hours route, Directive 2010/75/EU, Annex V; Environment Agency permits for Drax units 5 and 6 and West Burton Power Station, condition 2.3.6).

The critic's option closes every station on its actual date. A third option closes one class of closure at a time on its real dates. The classes are: converted to biomass (Drax units 1–4, Lynemouth); closed by the coal phase-out deadline (West Burton A, Drax units 5–6, Ratcliffe-on-Soar); and mixed reasons (the rest). These are method checks only: closure classes, kept-coal payments as paid in this section, life extension and the alternative coal-hours reading. They do not set the range. §7's kept-coal Capacity Market option is in the range; on this release it sets neither end. Life extension is a cost assumption borrowed from gas plant (CEPA and GHD 2025, Table 2.2).

6.3 The evidence

The register of closures lists 51 stations. On the road, 9 stay open beyond their actual closure date, and 5 pass the margin test without carbon. By 2024 the road keeps 6.2 GW of coal open, de-rated; in the actual system the last coal station, Ratcliffe-on-Soar, closed on 30 September 2024 (CCC 2025b, Progress report, PDF p.92; Uniper, Annual Report 2024, p.38).

Two stations show the test at work. Longannet, in Fife, closed on 24 March 2016 (ScottishPower, 24 March 2016). In its last year before closure, its modelled margin before carbon was −£0.8m in cash. Rugeley, in Staffordshire, closed in 2016 (DUKES 2026, Table 5.11; Lichfield and Cannock Chase District Councils 2018, para 1.2); Reuters and The Energyst reported Engie's announcement on 8 and 9 February 2016. Its modelled margin before carbon in its last year was £9.8m in cash. The engine takes its capacity from the DUKES editions of 2004 to 2016 and its transmission charging zone from National Grid's statement for 2013/14 (doc 50671). The test asks a narrow question of each: with the carbon price removed, would the station have earned enough to stay open? It does not ask whether the owner would have chosen to, which no model can know.

Nuclear closes on its actual dates, and interconnectors and pumped storage run as they actually did.

6.4 The choice made, and why

The author chose closures by rule. The road is the system Britain had, carried forward without the departure; closing stations whose closure the carbon price caused would carry part of the departure into the road. Keeping those stations open makes the road cheaper, because old plant costs less to run than new plant costs to build, so the central option raises the gap compared with closing every station on its actual date.

The strongest objection is that the road keeps coal burning without capture, in a dirtier Britain whose pollution is not counted. The answer has two parts. The road's coal output stays within its permit-derived energy limits, and the road pays for the filters the law of each year required. The wider costs of air pollution are outside the scope of a paper about electricity bills, and §16 lists them as not counted.

6.5 The headline under each option

Table 6.1 The headline under each fleet option, 2002–24, £bn, 2024 prices (modelled; grey rows are method checks, outside the range)

Choice	Option	Row	Headline 2002–24	Change
1	Demand left for fossil plant from 2016 measured from Elexon's half-hourly generation data instead of NESO's demand data	range	£141.0bn	+£0.7bn
1	Kept coal not capped at its highest recorded load factor	method check	£169.1bn	+£28.8bn
1	Every power station closes on its real date	method check	£121.9bn	−£18.4bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice1. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

Closing one class of station at a time on its real dates gives £127.2bn (biomass conversions), £137.6bn (closures at the coal phase-out deadline) and £134.3bn (closures with mixed causes). A life-extension cost on kept coal gives £140.3bn; paying kept coal the road's Capacity Market rate from 2014, in place of its fixed-cost pay in the road's power line, gives £139.6bn; the other coal-hours reading, £135.9bn. All are modelled, 2002–24, in 2024 prices.

With every station closed on its actual date, the gap for 2002–24 is £121.9bn, against £140.3bn at the central setting: a method check, outside the range.

6.6 The check

The margin test was designed with the stations it classifies in view. Its results are therefore a consistency check, not an independent validation: they show the rule does what it says, not that owners would have behaved that way.

6.7 What would settle it

Station-level accounts for the closure decisions would settle it, and they are not published. For Rugeley, the owner's own closure statement would replace the reports of it.

7 Choice 2. What is built new, at what cost, to what standard

7.1 The question

Where the plant Britain had cannot meet demand and the reliability margin, what does the road build, at what cost, to what margin, and what does it pay for backup?

7.2 The options

The central option builds the cheapest new plant, sized each year from the shape of residual demand, at costs from the Government's generation cost reports, using the edition current at the time. It holds the fleet to a de-rated margin on the gross winter peak, derived from NESO's recommendation (§2.5), and counts interconnectors at the capacity they were contracted to provide in the Capacity Market.

The other options are these. A low and a high margin are computed, and so is a case in which all new plant is gas. A high plant-cost case, DESNZ's published high capital cost and hurdle rate (DESNZ 2026g, Tables 7 and 9), is a method-check row. Interconnectors counted at the imports actually metered at the peak, rather than their contracted capacity, are computed. So is a case in which coal kept open on the road takes Capacity Market payments.

7.3 The evidence

New plant and its cost

New plant is sized afresh each year, not built once and kept, so the figure for any year is what stands that year. In 2024 the road's new plant comes to 8.7 GW, excluding the spare plant held for the margin; by type, all open-cycle gas turbines, with no new combined-cycle gas or coal plant. The road builds no new combined-cycle gas plant in any year to 2024, so the disputed cost of new combined-cycle plant does not touch the headline. Costs for 2024 come from DESNZ's 2023 edition, whose earliest estimates are for projects commissioning in 2025.

The margin

The road's fleet equals the gross winter peak, plus the margin, less contracted imports. NESO measures its de-rated margin as the expected excess supply after Average Cold Spell peak demand and reserve requirements have been met, and expresses it as a percentage of that peak demand (NESO 2026c, Winter Outlook 2026-27: Early View, pp.5–6). That makes the road's fleet slightly

larger than a margin on the net peak would, by 0.4 GW in 2024, built as open-cycle gas turbines; the gap falls as a result. The gross peak is the year's highest half-hour of demand that the road's fleet and imports together must meet; the net peak is that less contracted imports. The central margin is 7.4%, the low option 6.6% and the high option 8.2%: the midpoint and the two ends of NESO's de-rated margin range for the T-1 auction for 2027/28, each divided by NESO's Base Case peak for 2027/28 (§2.5). These are this paper's percentages, not NESO's. In 2024 the fleet is sized on the half-hour of 18 January 2024 (settlement period 26), which is not the half-hour of highest residual demand used in §4.3, because sizing uses the gross series.

Interconnectors, nuclear and the Capacity Market

Interconnectors are counted at their de-rated Capacity Market contracts, the basis the actual Capacity Market uses (NESO 2026a, p.19). That applies both when the road's fleet is sized and in its Capacity Market line. Contracts start in calendar 2016, at nil that year; before then the road uses metered imports. The Capacity Market runs in delivery years from October to September (SI 2014/2043, reg. 2, "capacity year"), so each calendar year takes nine months of one delivery year and three of the next. In 2024 that gives 5,673 MW. In 2019, for example, the time-weighted figure is 722 MW, while the delivery year in force at the 2019 sizing peak, 2019/20, had 2,887 MW contracted. The figure for delivery year 2017/18 comes from the delivery body's results for the early auction (EMR Delivery Body 2017, Table 1).

A fleet sized net of contracted imports could fall short in some half-hours of the residual demand actually metered, and the shortfall would then be met by contracted imports called on, priced like kept output. On this release it never happens: 0.0 TWh over 0 half-hours in 2016–24, because the road's fleet is dispatched to the metered residual demand.

Nuclear in the Capacity Market split is counted at its de-rated obligations after secondary trading, less the agreements NESO's register flags as suspended. Against counting nuclear at its output at the peak, that treatment changes the Capacity Market line by –£0.1bn over 2002–24. Counting nuclear at the obligation won at auction instead gives £140.2bn, a change of –£0.1bn, a method-check row.

The Capacity Market line in the gap is the actual Capacity Market less what the road's own fleet would have needed: £0.9bn over 2002–24. Payments deferred during the market's suspension in 2018–19, £987.3m in cash for Delivery Year 2018/19, were due from suppliers on 21 November 2019 (ESC 2020, p.8 and the text above Table 1). The Secretary of State had told Parliament that "the vast majority of the back-payments will reach capacity providers in January 2020" (HCWS38, 24 October 2019).

7.4 The choice made, and why

The author chose the central option. Contracted interconnector capacity puts both roads on the basis the Capacity Market itself uses.

The strongest objection is to the title: that "Reliable" implies the real system was not reliable, and that the paper should show it. The paper makes no such claim. Reliability is the standard the road is built to, not a finding about the actual system. The road's modelled de-rated fleet in 2024 would have been 58.7 GW, sized to the margin of §2.5: the capacity credited as available after the engine's availability factors. What the paper shows is the cost of the road meeting that standard, set against the actual bill.

7.5 The headline under each option

Table 7.1 The headline under each new-build, standard and Capacity Market option, 2002–24, £bn, 2024 prices (modelled; grey rows are method checks)

Choice	Option	Row	Headline 2002–24	Change

2	Spare plant margin of 6.6% (central 7.4%)	range	£140.4bn	+£0.1bn
2	Spare plant margin of 8.2% (central 7.4%)	range	£140.2bn	−£0.1bn
2	Interconnectors counted at their metered flow at the peak instead of their Capacity Market contracts	range	£140.1bn	−£0.2bn
2	Capacity Market: coal stations the road keeps open also need Capacity Market payments	range	£139.7bn	−£0.6bn
2	Capacity Market: its whole cost counted as a cost of net zero	range	£146.9bn	+£6.6bn
2	New plant gas only, no new coal	method check	£140.3bn	£0.0bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice2. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

At the low margin the gap is £140.4bn. With interconnectors at metered imports it is £140.1bn. If kept coal took Capacity Market payments, counted against the actual system's Capacity Market line (floored at nil, which binds in 2018–20), it would be £139.7bn, an option in the range; the §6 method check pays the same rate in the road's power line instead. The high margin and the all-gas build are in Table 7.1; the all-gas build leaves the headline unchanged, because the road builds no new coal. At DESNZ's high capital cost and hurdle rate the gap is £140.2bn, a change of −£0.1bn; like the nuclear row, it is not one of the rows that set the range (Table 15.4).

7.6 The check

The de-rated fleet is sized each year to meet the model's peak requirement plus margin, counting interconnectors on the same basis on both sides, so the check passes by construction and exports no result.

7.7 What would settle it

A sourced series of de-rated Capacity Market obligations by technology and calendar year would settle the Capacity Market split. The delivery body's results for each auction give the pieces; no single official series joins them.

8 Choice 3. The price of power from the plant Britain had

8.1 The question

At what price is power from the plant Britain had valued on the road?

8.2 The options

The central option values it at the actual wholesale price with the carbon taken out, plus the merit-order uplift. The uplift is estimated by the method of Shao and others (2022) in every year except May 2021 to December 2023, which uses the effect of wind and solar on the price estimated on that period's own data (§8.3). Kept output, from plant that runs on both roads, is valued the same way.

The critic's option removes the uplift altogether. A second option uses the engine's own estimate from the fleet's running costs instead. A third values kept output at the full actual price, carbon included. A fourth applies to the crisis years 2021–23 only, and replaces the wind part of the uplift with the estimate from the short-term model of O'Shea, Horne and Maslin (2025, Table 4), keeping the solar part. Two further rules are run as method checks (Table 8.1): the smaller of the two estimates in each year, and the larger of the two, the rule of an earlier release.

8.3 The evidence

Taking carbon out of the price

On the road there is no carbon price, so the actual price must have its carbon removed. From 1 January 2009 the engine finds the plant that set the price in each half-hour, from its own merit order of the actual fleet at real carbon prices. It then removes, month by month, a blend of those plants' carbon costs: emissions per megawatt-hour, times the allowance price, plus Carbon Price Support. Each month's blend weights coal and gas by the share of half-hours each set the price. Before 2009 it removes carbon at the intensity of gas plant. Until 12 September 2016 prices are monthly (Ofgem 2015, Figure 8, 2003 to May 2010). From then, Elexon's free half-hourly market index spreads Ofgem's monthly price across the half-hours (Elexon, BMRS MID). That applies to the road's fossil output paid the market price, extra running included, and to the actual wholesale bill. Kept output stays on a monthly base price. Why carbon counts at all is argued in §13; this is the mechanics.

The merit-order uplift

Wind and solar have almost no running cost, so when they run they push the dearest plant out of the merit order and lower the price. The effect is well established. Shao and others (2022), at Swansea University and Peking University, estimated it for Britain from daily data between April 2009 and March 2021. This paper applies their method to wind and solar output in every year except May 2021 to December 2023. The result is the paper's own estimate, not a figure Shao and others published. Over 2002–24 the uplift adds £81.3bn to the road's bill. The Shao-method estimate is the larger of the two in 22 of the years 2002–24.

Kept output

Kept output, 71.0 TWh in 2024 from nuclear, imports and pumped storage net of exports and pumping, is sold into the same market as every other plant. In any half-hour there is one market price. On the road that price has no carbon in it, so kept output is valued at the road's price, from a monthly base price.

The crisis years

In 2021–23 the gas price rose to extremes, and the uplift with it. Using the Shao method, the uplift in 2022 was £15.9 per MWh in cash, a time-weighted average. For May 2021 to December 2023 the effect is re-estimated with Shao and others' equation on that period's own daily data (Elexon, NESO; National Gas and ONS, System Average Price). That estimate, not Shao's, is applied to the engine's wind and solar output in those months. The re-estimate sets the size of each year's uplift, and the engine's half-hourly pattern spreads it through the year. Each year's size is the average uplift the re-estimated equation gives for that year's average wind and solar output. It does not observe the road's prices.

O'Shea, Horne and Maslin give two estimates. Their short-term model (Table 4, p.22) puts their total effect in 2021–23 at 1.6 to 3.5 times the Shao-method estimate, and their wind effect at 2.2 to 4.9 times; they say it "produces results which do not appear reasonable" (p.24). It is behind the method check in Table 8.1. Their headline rests on their long-term model (Table 5, p.25): its effect on the price in 2022, −£18.18 per MWh, is larger than the Shao-method uplift, but it is smaller in 2021 and 2023. Run as a sensitivity for 2021–23, it gives £164.7bn, a change of £24.4bn, a sensitivity that does not set the range (Table 15.4).

8.4 The choice made, and why

The author chose the central option. Against the engine's own estimate, the Shao method gives the road the higher price, and so lowers the gap. The rule of the earlier release, the larger of the two estimates in each year, lowers it slightly further; it is shown as a method check in Table 8.1.

Valuing kept output at the road's price, without carbon, is an exception to the conservative rule: valuing it at the full actual price would lower the gap. A critic will say that pricing kept nuclear without carbon makes the gap bigger, which is the opposite of erring low. The answer is that there is one price in a half-hour, and on the road that price contains no carbon. Paying nuclear a carbon price on a road with no carbon price would charge the road for the departure. The full actual price, which sets the low end of the range, is still defensible: imported power did carry carbon prices from abroad (§2.4). The exception is listed in Table 2.1, with its size.

For 2021–23 the Shao estimate is not central, because it comes from data between April 2009 and March 2021. O'Shea, Horne and Maslin's estimates come from a preprint not yet peer reviewed: their short-term model, which they discount (p.24), is a method check, and their long-term model a sensitivity.

8.5 The headline under each option

Table 8.1 The headline under each power-price option, 2002–24, £bn, 2024 prices (modelled; grey rows are method checks)

Choice	Option	Row	Headline 2002–24	Change
3	Wholesale price before mid-2010: the lower published series instead of Ofgem's chart	range	£140.3bn	£0.0bn
3	Wholesale price before mid-2010: the engine's own modelled price instead of Ofgem's chart	range	£140.3bn	£0.0bn
3	Power from plant Britain had, priced at the actual market price with carbon left in	range	£120.8bn	−£19.5bn
3	Power from plant Britain had, priced at the fossil fleet's average cost	range	£133.1bn	−£7.2bn
3	No merit-order uplift (the engine specification's §15.3 rule)	method check	£222.2bn	+£81.9bn
3	Merit-order uplift: the larger of the engine's estimate and Shao et al.	method check	£137.0bn	−£3.3bn
3	Merit-order uplift: the smaller of the engine's estimate and Shao et al.	method check	£182.8bn	+£42.5bn
3	Merit-order uplift in 2021-23 scaled to UCL's short-run estimate (preprint)	method check	£138.8bn	−£1.5bn
3	Merit-order uplift from the engine's own estimate instead of Shao et al. (2022)	method check	£179.5bn	+£39.2bn
3	Extra running of the plant Britain had charged its fuel, running and transport cost, not the market price	method check	£162.0bn	+£21.7bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice3. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

With no uplift the gap is £222.2bn; with kept output at the full actual price it is £120.8bn. With the engine's own estimate of the uplift alone, from its four-block supply stack, it is £179.5bn, a change of £39.2bn: a method check, outside the range, kept as a sensitivity row (Table 15.2). For 2021–23, the gap is £14.8bn at the central setting, £39.3bn with the Shao method in every month, and £13.3bn with the wind effect of O'Shea and others' short-term model.

8.6 The check

Gas plants' running costs are compared with the actual day-ahead price in half-hours when gas set the price (§5.4). In those half-hours the two should be close, because the same kind of plant sets the price on both roads.

8.7 What would settle it

A peer-reviewed merit-order series for Britain covering 2021–23 would settle the crisis years. So would the version of record of O'Shea, Horne and Maslin, if peer review confirms their estimates.

9 Choice 4. The gas price

9.1 The question

What does the road pay for gas, given that over 2002–24 it burns more gas than Britain did?

9.2 The options

The central option buys gas at the actual price each month, plus a rise for the road's extra burn, the **gas feedback**. When one buyer wants more gas, the price rises until suppliers produce more and other buyers use less. The rise is the extra burn, as a share of the market's gas use, divided by the sum of two **elasticities**: the percentage rise in supply and the percentage fall in other buyers' use for a one per cent rise in price. The central sum is 0.23: supply 0.06 plus demand 0.17. The feedback works both ways: in years when the road burns less gas than Britain did, the price falls.

A high option takes Krichene's world long-run pair, 0.61, which gives a smaller rise. A sensitivity takes his long-run pair estimated over 1974–2004 instead. A case with no feedback is a method check, outside the range (Table 9.1). Two further options are not run, and are answered in words: the Europe-wide premise of O'Shea, Horne and Maslin (§2.4), and a gas price based on contracts rather than the day-ahead market.

9.3 The evidence

The gas price series

Both bills use Ofgem's day-ahead gas price: Wholesale Market Indicators from October 2009, and before that Ofgem 2015, Figure 5. This release does not provide a matching run on the contract-price series.

Generators often buy gas under contracts rather than day-ahead. The Government's quarterly energy prices show what major power producers paid for gas: over 2010–25 it averaged 1.065 times the day-ahead price, ranging from 0.738 in 2021 to 1.406 in 2020 (DESNZ, Quarterly Energy Prices, Table 3.2.1; Ofgem, Wholesale Market Indicators, day-ahead gas). There is no engine run on contract prices, because there is no matching contract price for power: pricing the road's gas on contracts while the actual bill stays on the day-ahead market would mix two bases.

The feedback

The road burns 189.5 TWh more gas than Britain did in 2024. At the central pair, that raises the road's gas price in 2024 by 17.7%. The pair is the one Albrizio and others use to price a twelve-month cut in Europe's gas supply, dividing the shift in supply by the sum of the two elasticities (Albrizio and others 2022, IMF Working Paper 22/143, equation 5, pp.13–14). For the demand half, this paper weights their four sector elasticities (Table 2, p.12) by the EU shares of gas use in the same table. That gives 0.169, rounded to 0.17; the Supplementary Note, Table S1, sets out the sum. The authors name no source or year for those shares. The supply half, 0.06, they take from Krichene's 2002 paper in *Energy Economics*. Krichene prints the same short-run figure for world gas supply in a 2005 paper (IMF Working Paper 05/32, Table 5, p.20). The high option is Krichene's long-run estimate in Table 2 (1918–2004): demand 0.45, and a larger supply elasticity. Casoli, Manera and Valenti put the short-run supply elasticity for the euro area at a median of 0.34 (FEEM working paper 045.2022, updated 2023).

The central pair is a twelve-month pair, but the road's extra burn builds up over two decades, long enough for supply and demand to respond more fully, which would mean a smaller feedback and a larger gap. The long-run pair, the high end of the range, shows by how much.

2022 and bill support

Both bills price gas and power on the day-ahead market in 2022, as in every year, so the basis is matched. The gap in 2022 is £2.9bn.

The Energy Price Guarantee and the Energy Bills Support Scheme are left out of both bills. The gap measures the cost of supplying the electricity, whoever paid it, bill-payer or taxpayer (§16); the households' allocated share (§2.7) is before them.

Britain's own gas output is held at what actually happened. On the road, higher prices might have drawn out more British gas, which would damp the feedback and raise the gap. No source sizes that response, so its direction is stated and no figure is given.

9.4 The choice made, and why

The author chose the central pair. Its source sets out the formula that combines the two halves (Albrizio and others, equation 5), it is for the European market whose gas use the engine counts, and of the paired options it gives the smaller gap, as the conservative rule asks (§2.9). Its weakness is stated in §9.3.

9.5 The headline under each option

Table 9.1 The headline under each gas option, 2002–24, £bn, 2024 prices (modelled; grey rows are method checks)

Choice	Option	Row	Headline 2002–24	Change
4	No gas transport cost added to the road's fuel	range	£140.4bn	+£0.0bn
4	Gas-price feedback at Krichene's world long-run pair, supply 0.16 plus demand 0.45 (smaller feedback)	range	£152.7bn	+£12.4bn
4	No gas-price feedback	method check	£160.1bn	+£19.8bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice4. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

At Krichene's long-run pair, 0.61, the gap is £152.7bn, a change of £12.4bn; this is the high end of the range. At Krichene's pair for 1974–2004 the gap is £143.3bn, a change of £3.0bn, a sensitivity that does not set the range. For the gap in 2024 to vanish, the road's gas price would have to rise by 95.7% (§15.3).

9.6 The check

Every line of the road's bill that buys gas uses the same raised price. That includes the energy part of the road's balancing costs, which carries the feedback too; doing so moves the headline by −£0.6bn.

9.7 What would settle it

A pair of supply and demand elasticities from one source, for the gas market Britain buys in over 2002–24, would settle the central value. A sourced estimate of how much more gas Britain would have produced on the road would size the damping, and a matched contract price for power would allow a run on contract prices.

9.8 Beside the gap: other gas users

The road's higher gas price would fall on homes and industry as well as on power stations. That cost is outside the electricity bill, so it is not in the gap. A labelled estimate puts it at £9.5bn over 2002–24, in 2024 prices, net of the gain to UK gas producers, or £18.2bn before that gain. At Krichene's

long-run pair (§9.3) it is £3.6bn. For 2025 (provisional) it is £1.3bn. It is kept apart and never added to the gap; Annex A gives the method.

10 Choice 5. The grid

10.1 The question

What would the transmission grid have cost on the road?

10.2 The options

The central option starts from the grid's cost in the base window, 2002–05, and carries it forward by the price-control index, adding an allowance for renewing the assets as they age, counted in full above its 2002–05 level. A second option leaves the renewal allowance out altogether. A third carries the base forward at the price controls' own allowed changes, the X values Ofgem set for each period, instead of the index alone. A fourth would test other base windows, such as 2002–04 or 2003–06; this paper does not test that option, and §16 lists it.

10.3 The evidence

Why 2002–05

The window is set by dated changes in the rules, not by the results. Ofgem's final proposals set National Grid's transmission price control to apply from 1 April 2001 (Ofgem 2000, TPCR final proposals, PDF p.6). The Renewables Obligation began in April 2002. The transmission price controls set from 1 April 2007 took in investment already approved to connect renewable generation in Scotland under the Transmission Investment for Renewable Generation (TIRG) mechanism, but left links to the Scottish Islands out, with competition for them to be consulted on during 2007 (Ofgem 2006, TPCR4 final proposals). The window test in §5.3 checks the choice: inside 2002–05 the grid lines on the two roads net to about nil.

The generators' share

Generators pay part of the transmission charges out of the wholesale price and, for renewables, out of their subsidy income, both of which are already counted. So the generators' share, 27%, is removed from the grid line on both roads, to avoid counting the same money twice. The part of generators' grid and balancing charges that the departure added is counted all the same: it is taken out of the road's market price, because the road's generators would not have paid it. Annex A.8 gives its balancing and transmission parts before VAT; VAT on households' share is accounted for separately. That share is confirmed from primary sources for England and Wales in 2003/04 (Ofgem and DTI 2003, para 4.16, p.17) and 2004/05 (Ofgem 2004b, 241/04, para 4.118). For 2001/02 and 2002/03 it is inferred from Ofgem's later working paper (Ofgem 2017, p.36).

No source gives a Scottish share before April 2005. The same share is applied to Scotland, and the paper says so; the 1999 consultation of OFFER, the Office of Electricity Regulation, on the Scottish transmission price control noted that ScottishPower's split of infrastructure charges between generation and demand "can differ from that of NGC", the National Grid Company (OFFER 1999, para 6.10, p.43). The choice barely touches the gap, £0.1m over 2002–05 under the other treatment, because it moves both roads' grid lines together, each by about £260m; both figures are in 2024 prices.

The Scottish starting point

The Scottish grid enters the base at its non-load-related allowance for 2005/06, £55.9m in 2002/03 prices: £44.8m for SP Transmission and £11.1m for Scottish Hydro-Electric Transmission Limited, or SHETL (Ofgem 2004c, 279/04, Appendices 5 and 6). The £2.8m in Appendix 8 of the same

document is a British trading arrangements (BETTA) incremental adjustment to SP Transmission's 2005/06 non-load-related spending for the post-Vesting upgrades to the England–Scotland interconnector. It sits outside the two companies' renewal allowances, so it is left out.

The lines

Over 2002–24 the actual grid line, the demand share of transmission charges, is £50.6bn, and the road's is £36.0bn, of which £4.0bn is the allowance for renewal. The grid step in the gap is £14.6bn.

10.4 The choice made, and why

The author chose the central option. Two objections carry weight. The first is that the grid of 2002–05 was ageing, so carrying its cost forward understates what renewal would have needed. The renewal allowance answers it: the road's grid pays to replace its assets as they wear out, at £4.0bn over the period. The second is that the window was picked after the fact. The dated rule changes above fix it independently of the results, and the window test checks it.

The price controls' own X values are a sensitivity, not the central case. Ofgem's one-year reset for 2012/13 is left out of that sensitivity; counting the whole reset would credit the road with grid spending the departure caused.

10.5 The headline under each option

Table 10.1 The headline under each grid option, 2002–24, £bn, 2024 prices (modelled)

Choice	Option	Row	Headline 2002–24	Change
5	Grid renewal allowance not counted at all	range	£145.5bn	+£5.2bn
5	Grid renewal allowance at its high setting, which equals central	range	£140.3bn	£0.0bn
5	Grid carried forward on the price controls' own X values (RPI minus X) instead of RPI	range	£134.4bn	–£5.9bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice5. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

In the labels, RPI is the price-control index of §10.2, and RPI minus X is that index less the X values Ofgem set for each period.

Without the renewal allowance the road's grid costs less, so the gap rises (Table 10.1). The table's other renewal row, the allowance at its high setting, is the central setting itself, so it leaves the headline unchanged at £140.3bn. With the price controls' own X values the gap is £134.4bn, a change of –£5.9bn (rounded separately). This paper does not test other base windows.

10.6 The check

Inside the window, the two roads' grid lines net to –£0.7m (§5.3).

10.7 What would settle it

Transmission spending split by its cause, renewal or new connections, would settle the renewal allowance; only totals by company and year are published. The Scottish companies' charging statements for 2001/02 to 2004/05 would settle the Scottish share; none has been found online.

11 Choice 6. Balancing

11.1 The question

What would balancing the system have cost on the road?

11.2 The options

The central option starts from National Grid's own measure of its balancing costs in the base window, the incentivised cost, and applies NESO's share of energy costs in 2018/19 to every year.

The lowest-gap option starts instead from the National Audit Office's figure for 2005/06, £642m (NAO 2014, para 2.2), carried forward by CPIH, and applies NESO's energy share for 2024/25. The NAO does not state that figure's price basis, so it is treated as cash.

11.3 The evidence

The actual balancing line is the demand share of the balancing charge: £23.1bn over 2002–24. The generators' share is removed on both roads, for the reason given for the grid in §10.3: generators pay it out of income that is already counted. From 2017 the line is summed from NESO's half-hourly data by calendar year (NESO, Current BSUoS Charges, RF files). Before 2017, financial-year totals are put on calendar years: each calendar year takes a quarter of one financial year and three quarters of the next.

The road's balancing starts from the incentivised cost in the base window. That measure covers only the costs National Grid paid outside its own business, so it is raised to the basis of the balancing charge, which also recovers the operator's own costs, by a factor of 1.198, and from England and Wales to Great Britain by a factor of 1.1086. The share of constraint and energy-imbalance costs in NESO's 2018/19 outturn, 54.8% (NESO 2025, Annual Balancing Costs workbook), is applied to the external part of the base, and that energy part carries the road's own gas price (§9.6). The incentivised cost in the window runs above the actual cost, by between £70.7m and £102.6m a year in cash over 2001/02 to 2004/05 (National Grid 2005, p.2, "Historical performance" table; National Grid 2010, Table 1, p.9). Over 2002–24 the road's balancing line is £15.5bn, and the balancing step in the gap is £7.6bn.

11.4 The choice made, and why

The central option is an exception to the conservative rule, and the author chose it openly. The base window exists to fix the road's balancing cost at a time when the two roads had barely parted, so the test of any base is whether the two roads' balancing lines agree inside the window. The central option passes it. The lowest-gap option fails it. Inside 2002–05 it gives the road a higher balancing cost than the actual system in every year, −£329m in all, when the two should be about equal. It does so because it carries two things into the road that belong to neither the window nor the road: the gas price spike of 2005/06, and the share of wind constraint costs in 2024/25 (NESO's 2024/25 energy share, 70.3%, includes constraints; NESO 2025, Annual Balancing Costs workbook, "Total outturn", row 2024/25).

The low end is shown beside the central. At the lowest-gap option the balancing step is £3.1bn, and the exception costs the headline £8.1bn over 2002–24, and £0.5bn in 2025 (provisional). The exception is listed in Table 2.1.

11.5 The headline under each option

Table 11.1 The headline under each balancing option, 2002–24, £bn, 2024 prices (modelled)

Choice	Option	Row	Headline 2002–24	Change
6	Balancing: National Grid's incentivised-cost baseline, with the FY2022/23 energy share (41.9%)	range	£142.1bn	+£1.8bn
6	Balancing: National Grid's incentivised-cost baseline, with the FY2024/25 energy share (70.3%)	range	£138.2bn	−£2.1bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2018/19 energy share (54.8%)	range	£134.8bn	−£5.5bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2022/23 energy share (41.9%)	range	£136.9bn	−£3.4bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2024/25 energy share (70.3%)	range	£132.2bn	−£8.1bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice6. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

Energy shares: NESO 2025, Annual Balancing Costs workbook, "Total outturn", rows 2022/23 and 2024/25.

11.6 The check

Inside the window, the central option nets to £13m over 2002–05, against −£329m for the lowest-gap option.

11.7 What would settle it

A published series of balancing costs for Great Britain before 2005, on one basis, would settle the base. None exists; the England and Wales figures must be grossed up.

12 Choice 7. Demand at actual, and lost value

12.1 The question

Should the road buy the electricity Britain actually used, or the larger amount it would have used at the road's lower prices?

12.2 The options

The central option holds demand at what Britain actually used, on both roads. A second option would size the road to a growing Britain, using more power at lower prices. It changes both price and quantity, and is not calculated here because this paper compares the cost of a fixed quantity; a separate study could report those effects separately. A third would credit the road with the electricity the energy-saving schemes saved; it is not taken.

12.3 The evidence

Two bills for different quantities of electricity cannot be subtracted without mixing a difference in price with a difference in volume. The gap would then measure partly what the departure added to the cost of power and partly how much more power Britain would have bought, which is not a cost of the departure but a choice consumers would have made. DECC's series held the same distinction, separating the effect of policies on prices from the effect of lower consumption on bills (DECC 2014, Annex D, Table D1, p.72).

The schemes' savings cannot be credited for a plainer reason: none was measured. So the savings are not counted.

The schemes line is therefore one-sided. The actual bill carries the successor schemes' line, £9.2bn over 2002–24, already net of the EESoP baseline carried forward (EESoP: the supplier energy-saving scheme on bills in 2001, §13.2). Both bills are priced on actual demand, which the schemes lowered. So the road has their savings without their cost (Table 15.2, the row on the schemes line).

12.4 The choice made, and why

The author chose demand at actual. The strongest objection is that cheaper power would have meant more demand, so the road needed more plant and more grid, and the paper understates its cost. The answer is that extra use at lower prices is a gain to those who choose it, not a cost; what the departure took from them is the value of the electricity they did not use. That is the second cost, below, and it is kept apart from the gap.

12.5 The headline under the other option

None (§12.2). At actual demand, the gap per megawatt-hour billed averages £19.9 per MWh over 2002–24; Table 12.1 gives it by year.

Table 12.1 The gap per megawatt-hour billed, by year, 2002–24 with 2025 provisional, £ per MWh, 2024 prices (modelled)

Year	Gap, £bn	Billed volume, TWh	Gap per MWh, £
2002	£0.2bn	333.3	£0.6
2003	£0.4bn	338.0	£1.2
2004	£0.5bn	342.9	£1.6
2005	£4.1bn	342.6	£11.8
2006	£3.5bn	341.0	£10.2
2007	£1.3bn	334.1	£3.8
2008	£5.4bn	335.5	£16.1
2009	£5.9bn	320.2	£18.4
2010	£5.7bn	326.5	£17.3
2011	£3.7bn	313.6	£11.7
2012	£0.7bn	315.2	£2.1
2013	£2.5bn	314.5	£8.1
2014	£6.3bn	302.8	£21.0
2015	£8.9bn	302.4	£29.5
2016	£10.7bn	295.9	£36.2
2017	£12.1bn	290.1	£41.7
2018	£12.8bn	291.1	£44.1
2019	£14.5bn	284.2	£51.2
2020	£13.0bn	268.9	£48.3
2021	£6.7bn	274.9	£24.3
2022	£2.9bn	263.0	£11.1
2023	£5.2bn	257.2	£20.2
2024	£13.3bn	261.8	£50.8
2025 (provisional)	£15.3bn	264.9	£57.9

Source: gas-counterfactual release v4-s43, figures.json key table_gap_per_mwh_by_year. Modelled, £bn and £ per MWh in 2024 prices (CPIH); billed volume in TWh, measured; figures rounded separately.

12.6 Lost value: a second cost, kept out of the gap

Dearer electricity leads people and firms to use less of it. What they give up by doing so is **lost value**: the value of the electricity they would have used at the road's prices and did not, less what it would have cost them. It is not lost GDP. Lost value is a labelled estimate, computed outside the gap and never added to it. The two costs add in principle and never offset, so leaving it out makes the headline smaller than the full cost.

The estimate needs to know how strongly demand responds to price. For households it uses the United Kingdom's long-run residential elasticity, −0.607 (Pellini 2021, Table 4). For non-households it uses −0.52, the Table 3 long-run simple average for electricity in an international review (Labandeira, Labeaga and López-Otero 2016, working paper RSCAS 2016/25); the review has no figure for industrial electricity alone; its long-term average for industrial consumers covers all energy goods (Table 3). Weighted by who uses the power, the central elasticity is −0.55. The range runs from −0.203, the review's short-run average for electricity (Table 3), to −0.677, the upper response, its Table 4 long-run meta-regression estimate. The two long-run figures are different summaries, not two names for one average, and the range mixes a short-run response with a long-run one.

The price rise is measured against the whole bill customers pay, network and supply costs included, because people respond to the price they pay. The estimate uses a demand curve of constant elasticity, anchored on actual demand at actual prices; a straight-line curve would give a figure 16.6% higher. Long-run elasticities applied from 2002 overstate the response in the early years.

Over 2002–24, lost value comes to £9.8bn in 2024 prices, in a range of £3.5bn to £12.2bn. In 2025 (provisional) it is £1.4bn (£0.5bn to £1.7bn). Annex A gives the working.

12.7 What would settle it

Measured electricity savings from the supplier schemes, year by year, would allow a credit; none exists. The second option is outside this paper's design; a separate study with a sourced demand path could build it.

13 Choice 8. What counts as the departure

13.1 The question

Which costs belong to the departure, and which were already part of the road?

13.2 The options

The central option puts no carbon price of any kind on the road. Three charges that were already on bills in 2001, the Climate Change Levy, the supplier energy-saving scheme then running (EESoP) and the Fossil Fuel Levy that funded the Non-Fossil Fuel Obligation, stay on the road at their 2001 levels, carried forward in real terms, so only rises count.

The critic's strongest option puts the EU emissions trading scheme on the road and removes only Carbon Price Support. Directive 2003/87/EC was adopted on 13 October 2003 and bound the United Kingdom from its entry into force on 25 October 2003, the day of its publication in the Official Journal (Article 32), with national laws due by 31 December 2003 (Article 31) and permits required of installations from 1 January 2005 (Article 4), so, the critic says, the road Britain was on included it. Further options put both the trading scheme and Carbon Price Support on the road; count the 2001 levels of the three old charges as part of the departure; hold those levels flat in cash rather than in real terms; and value the Fossil Fuel Levy's 2001 level at the estimate of payments from the obligation and comparable arrangements in Scotland in 2001–02, £85.5m in cash (HC Deb 18 April 2002, c1139W), rather than at the £92m in cash of central-government receipts from the levy in 2001/02.

13.3 The evidence

The trading scheme

The Directive set up the scheme "in order to promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner" (Article 1). The United Kingdom ran its own scheme from 2002 (NAO 2004, HC 517, para 2), before the Directive bound it.[1]

A referee will spot a tension, and the paper states it. The one-country rule keeps continental carbon prices inside the price of imported power, yet takes Britain out of a scheme it was legally bound to join. The paper's answer is that the road is a road of policy, not a forecast of law. A reader who rejects that answer can subtract the carbon line (§2.6).

[1]Defra's results for 2006 list £198.13m in cash of incentive payments for participants still in the scheme, without saying how much was paid or still due (Defra 2007, p.2).

Free allowances

Carbon in the price in 2005–12 was £20.4bn, against £1.3bn of tax collected. The cost reached bills, even though the generators paid little or nothing for the allowances.

Power's share of the trading scheme's auction revenue is set by its share of verified emissions, an assumption no source publishes. Attributing revenue instead by each sector's shortfall of free allowances gives £14.5bn of tax collected over 2013–20. These rules move money between the two parts of the carbon line, not the headline.

The Climate Change Levy

The levy began in April 2001, charged on non-domestic use of energy (ONS 2015, Environmental Taxes 2014, PDF p.11), with a cut in employers' National Insurance to 11.9% (SI 2001/477). Its 2001 rate for electricity, carried forward by CPIH, is 0.766p per kilowatt-hour in 2024 prices. The main rate for the financial years 2023/24 and 2024/25 was 0.775p in cash (HMRC, Environmental taxes: historical rates, Table 1, electricity, rows April 2023 and April 2024). So the 2024 levy is close to its 2001 level in real terms. The road carries the 2001 level, £18.3bn over 2002–24, and the gap counts only the difference from it, −£1.3bn. The difference is negative because, over 2002–24 as a whole, the levy on electricity ran below its 2001 level in real terms. That fall is a real saving to bill-payers, and the gap counts it.

Renewable power was exempt from the levy until August 2015 (HMRC 2016, Excise Notice CCL1/4, para 1.2). On the road, which has less renewable power, the exemption is capped each year at the road's own volume of replaced renewables, which is worth £1.2bn; with the exemption uncapped the headline is £140.0bn, a change of −£0.3bn. The reduced rate for firms with climate change agreements is named, not counted; this paper does not test that option.

EESoP and the Fossil Fuel Levy

The road takes each at its 2001/02 cash level, then holds it flat in real terms. The Fossil Fuel Levy is £92m for Great Britain (ONS, series CIQY); it did not extend to Northern Ireland (ONS, Economic Trends 609, 2004). For EESoP, 44.8% of its energy-saving target was electricity (Ofgem and EST 2003, Figure 3.1, p.14). The Fossil Fuel Levy's level is netted against the obligation's contracts inside the Renewables Obligation line until 2019, when those contracts ended; EESoP's against all its successor schemes, whose line, already net of the carried-forward EESoP baseline, is £9.2bn over 2002–24. Years below the 2001 level count as negative. The netting changes the gap by −£4.1bn: −£1.1bn on the schemes and −£3.0bn on the Renewables Obligation. The stated netting is already included in those lines, not a further subtraction. A target is not a charge, so the renewables target of 2000 is not on the road.

13.4 The choice made, and why

The author chose the central option, for three reasons. The road is a road of policy, not a forecast of law, so it carries no carbon price of any kind. The United Kingdom chose emissions trading before it was bound to, with its own scheme from 2002. And the three old charges were on bills when the road began, so only their rises belong to the departure.

13.5 The headline under each option

Table 13.1 The headline under each 'what counts' option, 2002–24, £bn, 2024 prices (modelled)

Choice	Option	Row	Headline 2002–24	Change
8	Climate Change Levy counted above its 2001 rate held in cash, not raised with inflation	range	£144.3bn	+£4.0bn
8	Fossil Fuel Levy and EESoP 2001 levels held in cash, not raised with inflation	range	£141.1bn	+£0.7bn

8	Fossil Fuel Levy 2001 level set at the £85.5m NFFO payments estimate instead of £92m	range	£140.5bn	+£0.2bn

Source: gas-counterfactual release v4-s43, figures.json key table_choice8. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

NFFO is the Non-Fossil Fuel Obligation (§2.3).

This paper does not test the trading scheme on the road, or the 2001 levels counted in the departure.

13.6 The check

Carbon is counted once, in the wholesale price, and no printed carbon figure includes the Climate Change Levy.

13.7 What would settle it

Power's share of the UK trading scheme's revenue in 2025, and HMRC's next estimate of receipts from the Carbon Price Floor for 2025, in the Environmental Taxes Bulletin tables due in March 2027, would settle the provisional carbon figures for 2025. The actual spending of EESoP and its split between fuels would settle the 2001 level of the schemes.

14 Results: the gap in every year, and what it is made of

14.1 The two bills by year

Every figure in Table 14.1 and Figure 14.1 is modelled, because the gap is. Years in which the gap falls below nil would be shown as they fall; there are none. The Supplementary Note, Tables S5 to S8, gives every line in cash and each year's data basis.

Table 14.1 Both bills and the gap by year, 2002–24, with 2025 provisional apart, 2024 prices (modelled)

Year	Actual bill, £bn	Road's bill, £bn	Gap, £bn	Gap per household, £	of which carbon in the price, £bn	CCL against its 2001 level, £bn
2002	£17.2bn	£17.0bn	£0.2bn	£8.66	£0.0bn	£0.0bn
2003	£22.8bn	£22.5bn	£0.4bn	£16.04	£0.0bn	£0.0bn
2004	£24.3bn	£23.8bn	£0.5bn	£22.20	£0.0bn	−£0.1bn
2005	£34.3bn	£30.2bn	£4.1bn	£165	£3.3bn	−£0.1bn
2006	£36.0bn	£32.6bn	£3.5bn	£141	£2.6bn	−£0.1bn
2007	£28.9bn	£27.6bn	£1.3bn	£51.10	£0.1bn	−£0.1bn
2008	£51.2bn	£45.8bn	£5.4bn	£214	£3.2bn	−£0.1bn
2009	£32.0bn	£26.1bn	£5.9bn	£233	£3.7bn	−£0.1bn
2010	£34.2bn	£28.5bn	£5.7bn	£221	£3.5bn	−£0.1bn
2011	£36.2bn	£32.6bn	£3.7bn	£143	£2.6bn	−£0.2bn
2012	£36.3bn	£35.6bn	£0.7bn	£25.84	£1.4bn	−£0.2bn
2013	£40.2bn	£37.7bn	£2.5bn	£97.76	£1.6bn	−£0.3bn
2014	£37.1bn	£30.7bn	£6.3bn	£244	£2.6bn	−£0.3bn
2015	£37.3bn	£28.3bn	£8.9bn	£340	£4.2bn	−£0.1bn
2016	£39.9bn	£29.2bn	£10.7bn	£407	£3.9bn	£0.0bn
2017	£41.8bn	£29.7bn	£12.1bn	£457	£3.7bn	£0.0bn
2018	£47.1bn	£34.3bn	£12.8bn	£479	£4.6bn	£0.0bn
2019	£43.5bn	£28.9bn	£14.5bn	£537	£5.4bn	£0.2bn
2020	£41.8bn	£28.8bn	£13.0bn	£479	£5.0bn	£0.2bn
2021	£72.2bn	£65.5bn	£6.7bn	£244	£7.1bn	£0.2bn
2022	£91.9bn	£88.9bn	£2.9bn	£107	£11.4bn	£0.1bn
2023	£56.6bn	£51.5bn	£5.2bn	£188	£7.4bn	£0.0bn

2024	£52.7bn	£39.4bn	£13.3bn	£477	£5.6bn	£0.0bn
2002–24	**£955.5bn**	**£815.2bn**	**£140.3bn**	**£5,298**	**£82.9bn**	**–£1.3bn**
2025 (provisional)	£55.2bn	£39.9bn	£15.3bn	£543	£6.6bn	£0.0bn

Source: gas-counterfactual release v4-s43, figures.json key table_results_by_year. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

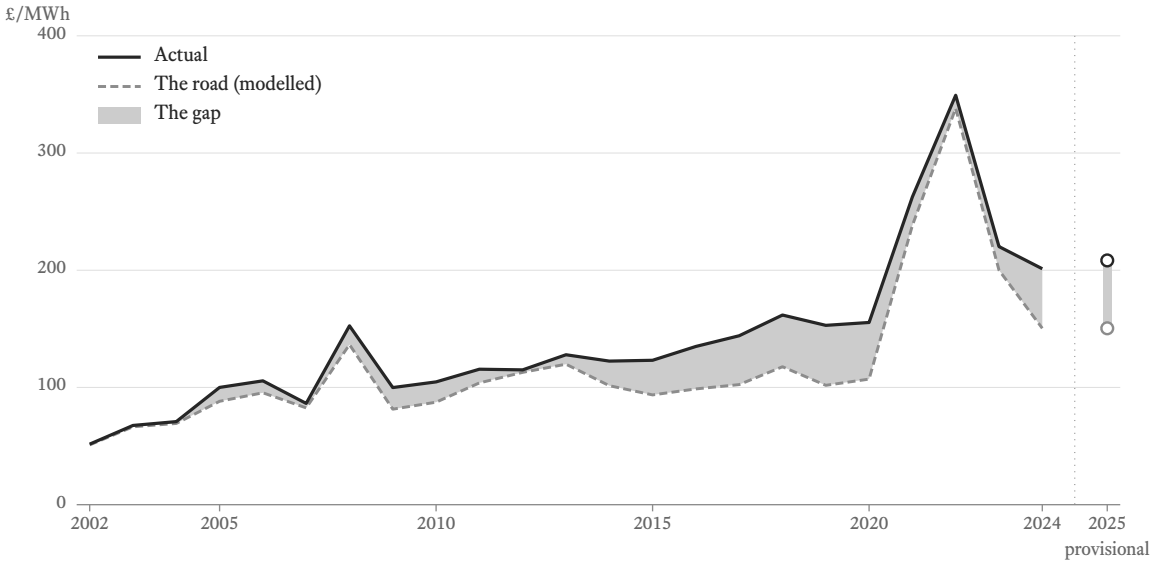


Figure 14.1 The actual bill and the road's bill per MWh billed, 2002–24, £/MWh, 2024 prices. Modelled. Shading marks the gap; 2025, provisional, stands apart.

Source: model release v4-s43. Both lines are modelled, in 2024 prices, per MWh billed. 2025 is provisional and drawn apart.

14.2 The waterfall, households and the carbon split

Table 14.2 gives the steps of Figure 1.1 for 2002–24 as a whole, and Table 14.4 year by year. Each step's formula is the engine's own (set out in the release's code): NZ lines are the actual bill's, GO lines the road's, and a minus sign means the line is subtracted. Carbon in the wholesale price (NZ1c) is part of the actual wholesale line NZ1, so the power step takes it out and the carbon step shows it on its own; it is counted once. The carbon step is split as in §2.6 (Table A.2). Table 14.3 gives both household figures by year.

Table 14.2 The waterfall steps, 2002–24, £bn, 2024 prices (modelled)

Step	Engine formula (signed bill lines)	2002–24, £bn
Power before carbon	NZ1 – NZ1c – GO1 – GO1k	–£92.2bn
Carbon in price	NZ1c	£82.9bn
of which tax collected		*£23.7bn*
of which carbon in the power price not collected as UK carbon tax (the rest)		*£59.2bn*
Renewables Obligation	NZ2	£85.2bn
Feed-in Tariffs	NZ3	£19.7bn
Contracts for Difference	NZ4 + NZ4b	£10.9bn
Capacity Market, net	NZ5	£0.9bn
Balancing	NZ6 – GO4	£7.6bn
Transmission grid	NZ7 – GO5	£14.6bn
Climate Change Levy v. 2001	NZ8	–£1.3bn
Energy-saving schemes	NZ10	£9.2bn
VAT on the extra	NZ11 – GO7	£2.9bn

The gap	£140.3bn

Source: gas-counterfactual release v4-s43, figures.json key table_waterfall_2002_24. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

Table 14.3 Households, the extra cost of net zero on electricity bills per household and the households' allocated share, by year, 2002–24 with 2025 provisional, £ a household, 2024 prices (modelled; households and their share of electricity bought are measured)

Year	Households, million	Extra cost of net zero on electricity bills, per household, £	Households' allocated share, £ a household	Households' share of electricity bought
2002	24.1	£8.66	£4.57	37.5%
2003	24.3	£16.04	£8.38	37.9%
2004	24.3	£22.20	£11.14	38.4%
2005	24.5	£165	£69.44	37.9%
2006	24.7	£141	£60.91	37.9%
2007	24.9	£51.10	£25.80	37.3%
2008	25.2	£214	£93.06	36.1%
2009	25.3	£233	£107	37.8%
2010	25.5	£221	£104	37.1%
2011	25.7	£143	£72.39	36.2%
2012	25.9	£25.84	£28.51	37.0%
2013	25.9	£97.76	£53.30	36.8%
2014	26.0	£244	£110	36.8%
2015	26.3	£340	£143	36.8%
2016	26.4	£407	£167	37.0%
2017	26.4	£457	£184	36.8%
2018	26.8	£479	£192	37.0%
2019	27.0	£537	£210	36.8%
2020	27.1	£479	£204	40.2%
2021	27.4	£244	£107	39.7%
2022	27.5	£107	£51.42	37.5%
2023	27.6	£188	£82.71	36.0%
2024	27.9	£477	£197	36.5%
2025 (provisional)	28.3	£543	£223	36.5%

Source: gas-counterfactual release v4-s43, figures.json key table_household_by_year. Modelled, £ a household in 2024 prices (CPIH); households in millions, and their share of electricity bought as a percentage, are measured; figures rounded separately.

Table 14.4 The waterfall steps by year, 2002–24 with 2025 provisional, £bn, 2024 prices (modelled)

Year	Power before carbon	Carbon price	Renewables Obligation	Feed-in Tariffs	Contracts for Difference	Capacity Market, net	Balancing	Transmission grid	Climate Change Levy	Energy-saving schemes	VAT on the extra
									v. 2001		
2002	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
2003	−0.1	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
2004	−0.1	0.0	0.6	0.0	0.0	0.0	0.0	0.0	−0.1	0.1	0.0
2005	−0.1	3.3	0.8	0.0	0.0	0.0	0.0	0.0	−0.1	0.1	0.1
2006	−0.3	2.6	0.9	0.0	0.0	0.0	−0.1	0.2	−0.1	0.2	0.1
2007	−0.3	0.1	1.1	0.0	0.0	0.0	0.1	0.2	−0.1	0.2	0.0
2008	0.2	3.2	1.3	0.0	0.0	0.0	0.1	0.3	−0.1	0.4	0.1
2009	−0.3	3.7	1.4	0.0	0.0	0.0	0.2	0.3	−0.1	0.6	0.1

2010	−0.4	3.5	1.6	0.0	0.0	0.0	0.0	0.3	−0.1	0.7	0.1
2011	−1.7	2.6	1.8	0.2	0.0	0.0	0.0	0.3	−0.2	0.6	0.1
2012	−4.5	1.4	2.3	0.6	0.0	0.0	0.0	0.5	−0.2	0.6	0.0
2013	−3.9	1.6	3.1	0.9	0.0	0.0	−0.1	0.6	−0.3	0.5	0.1
2014	−2.3	2.6	3.7	1.1	0.0	0.0	0.1	0.8	−0.3	0.5	0.1
2015	−2.8	4.2	4.5	1.4	0.0	0.0	0.2	1.0	−0.1	0.5	0.2
2016	−2.3	3.9	5.4	1.6	0.0	0.0	0.4	1.1	0.0	0.5	0.2
2017	−2.0	3.7	6.3	1.7	0.5	0.0	0.3	1.0	0.0	0.4	0.2
2018	−3.3	4.6	7.0	1.8	1.1	0.0	0.2	0.9	0.0	0.4	0.2
2019	−4.3	5.4	7.3	1.9	1.8	0.1	0.5	0.9	0.2	0.4	0.3
2020	−6.7	5.0	7.2	1.9	2.8	0.1	0.9	0.9	0.2	0.4	0.3
2021	−13.5	7.1	7.4	1.6	1.2	0.2	0.8	1.1	0.2	0.4	0.1
2022	−19.6	11.4	6.9	1.6	−0.4	0.1	1.1	1.2	0.1	0.5	0.1
2023	−15.9	7.4	6.7	1.7	1.4	0.1	1.5	1.6	0.0	0.6	0.1
2024	−7.9	5.6	7.3	1.7	2.4	0.2	1.6	1.4	0.0	0.7	0.3
2025 (prov.)	−8.4	6.6	7.4	1.8	2.5	0.2	2.3	1.8	0.0	0.8	0.3

Source: gas-counterfactual release v4-s43, figures.json key table_waterfall_by_year. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

Two items in the carbon split for 2025 are provisional estimates, and both are labelled so. Carbon Price Support for 2025 is taken as £428m in cash (2025 money), with a range up to £468m.[2] Power's share of the UK trading scheme's 2025 revenue is estimated as £900m in cash: the 2025 auction revenue times power's 2024 share, scaled to Great Britain. Both will be replaced by final figures when they are published (§13.7), with an entry on the corrections page.

15 How sure

15.1 One choice at a time

Table 15.1 shows the options in the range and, in grey, the release's method checks; §6.5 reports further method checks on the fleet. Figure 15.1 draws the options that set the range as bars, ranked by how far each moves the headline.

Options this paper does not test are named in their chapters. Table 15.3 gives each option's gap for 2025 (provisional), so a reader can see whether its effect is growing or fading.

Table 15.1 Options in the range and method checks, and their headlines, one at a time, 2002–24, £bn, 2024 prices (modelled; grey rows are method checks, outside the range)

Choice	Option	Row	Headline 2002–24	Change
3	Wholesale price before mid-2010: the lower published series instead of Ofgem's chart	range	£140.3bn	£0.0bn
3	Wholesale price before mid-2010: the engine's own modelled price instead of Ofgem's chart	range	£140.3bn	£0.0bn
3	Power from plant Britain had, priced at the actual market price with carbon left in	range	£120.8bn	−£19.5bn
3	Power from plant Britain had, priced at the fossil fleet's average cost	range	£133.1bn	−£7.2bn
2	Spare plant margin of 6.6% (central 7.4%)	range	£140.4bn	+£0.1bn
2	Spare plant margin of 8.2% (central 7.4%)	range	£140.2bn	−£0.1bn

[2] HMRC's Environmental Taxes Bulletin of 31 March 2026 (Table 1b) prints a much higher provisional figure for 2025. It is not used. From April 2025 HMRC's estimated split of receipts between the Climate Change Levy and Carbon Price Support reversed while total receipts barely moved. HMRC itself says the split is an estimate to be treated with caution.

1	Demand left for fossil plant from 2016 measured from Elexon's half-hourly generation data instead of NESO's demand data	range	£141.0bn	+£0.7bn
2	Interconnectors counted at their metered flow at the peak instead of their Capacity Market contracts	range	£140.1bn	−£0.2bn
2	Capacity Market: coal stations the road keeps open also need Capacity Market payments	range	£139.7bn	−£0.6bn
2	Capacity Market: its whole cost counted as a cost of net zero	range	£146.9bn	+£6.6bn
6	Balancing: National Grid's incentivised-cost baseline, with the FY2022/23 energy share (41.9%)	range	£142.1bn	+£1.8bn
6	Balancing: National Grid's incentivised-cost baseline, with the FY2024/25 energy share (70.3%)	range	£138.2bn	−£2.1bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2018/19 energy share (54.8%)	range	£134.8bn	−£5.5bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2022/23 energy share (41.9%)	range	£136.9bn	−£3.4bn
6	Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2024/25 energy share (70.3%)	range	£132.2bn	−£8.1bn
5	Grid renewal allowance not counted at all	range	£145.5bn	+£5.2bn
5	Grid renewal allowance at its high setting, which equals central	range	£140.3bn	£0.0bn
4	No gas transport cost added to the road's fuel	range	£140.4bn	+£0.0bn
4	Gas-price feedback at Krichene's world long-run pair, supply 0.16 plus demand 0.45 (smaller feedback)	range	£152.7bn	+£12.4bn
5	Grid carried forward on the price controls' own X values (RPI minus X) instead of RPI	range	£134.4bn	−£5.9bn
8	Climate Change Levy counted above its 2001 rate held in cash, not raised with inflation	range	£144.3bn	+£4.0bn
8	Fossil Fuel Levy and EESoP 2001 levels held in cash, not raised with inflation	range	£141.1bn	+£0.7bn
8	Fossil Fuel Levy 2001 level set at the £85.5m NFFO payments estimate instead of £92m	range	£140.5bn	+£0.2bn
3	No merit-order uplift (the engine specification's §15.3 rule)	method check	£222.2bn	+£81.9bn
3	Merit-order uplift: the larger of the engine's estimate and Shao et al.	method check	£137.0bn	−£3.3bn
3	Merit-order uplift: the smaller of the engine's estimate and Shao et al.	method check	£182.8bn	+£42.5bn
3	Merit-order uplift in 2021-23 scaled to UCL's short-run estimate (preprint)	method check	£138.8bn	−£1.5bn
4	No gas-price feedback	method check	£160.1bn	+£19.8bn
1	Kept coal not capped at its highest recorded load factor	method check	£169.1bn	+£28.8bn
1	Every power station closes on its real date	method check	£121.9bn	−£18.4bn
2	New plant gas only, no new coal	method check	£140.3bn	£0.0bn
3	Merit-order uplift from the engine's own estimate instead of Shao et al. (2022)	method check	£179.5bn	+£39.2bn
3	Extra running of the plant Britain had charged its fuel, running and transport cost, not the market price	method check	£162.0bn	+£21.7bn

Source: gas-counterfactual release v4-s43, figures.json key table_one_at_a_time. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

In the labels, RPI is the price-control index of §10.2, and RPI minus X is that index less the X values Ofgem set for each period. NFFO is the Non-Fossil Fuel Obligation (§2.3).



Figure 15.1 How far each option that sets the range moves the headline, 2002–24, £bn, 2024 prices. Modelled. Row labels are the release's plain-English labels.

15.2 What the range is

The printed range runs from £120.8bn to £152.7bn. The low end is set by kept output at the full actual price (§8) and the high end by gas-price feedback at Krichene's world long-run pair, 0.61 (§9).

Method checks sit outside the range; Table 15.1 shows them in grey. One is the row on O'Shea, Horne and Maslin's short-term model (their Table 4), which gives £138.8bn over 2002–24; Table 15.2 shows the same run. A method row changes how one part of the machine is estimated for a few years, not what the road is; it tests the machine, as §5 does, rather than offering another answer to the question.

The range is the lowest and highest of the one-at-a-time results from the release's full list of options for the range. The range is not a confidence interval, because no probability attaches to a judgement. Nor is it the result of changing several choices at once, which is a different exercise. Setting every choice at its lowest-gap option at once is not shown: some of those options fail tests that the central options pass, as the balancing option does in §11.

Table 15.2 states each judgement call raised in the independent review of the model as a sensitivity row: the headline under the other option, every other choice at its central setting. Some rows repeat options in Table 15.1; two appear only here.

Table 15.2 The judgement calls of the model review as sensitivity rows: the headline 2002–24 under the other option and its change from the central, £bn, 2024 prices (modelled)

Row	Sensitivity	Headline 2002–24	Change
1C	Extra running of the plant Britain had at its fuel, running and transport cost, not the market price	£162.0bn	+£21.7bn
2B	Gas-price feedback at Krichene's world long-run pair, supply 0.16 + demand 0.45 = 0.61	£152.7bn	+£12.4bn
3B	Merit-order uplift for 2021-23 from the UCL short-run estimate, a preprint	£138.8bn	−£1.5bn
4	Merit-order uplift from the engine's own four-block supply stack (a method check, out of the range)	£179.5bn	+£39.2bn
5bB	Partial wider-economy accounting: tax receipts and VAT excluded; the road's other-gas-user cost included.	£104.2bn	−£36.1bn
7B	Energy-saving schemes line (EEC to GBIS) taken out of the gap	£131.1bn	−£9.2bn

Source: gas-counterfactual release v4-s43, figures.json key table_sensitivity_rows_0144. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

EEC to GBIS are the energy-saving schemes named under Table 4.1.

Table 15.4 gives four rows the author's rulings keep out of the range: two method checks and two sensitivities.

Table 15.3 Every option's gap in 2025 (provisional) and its change from the central 2025 gap, £bn, 2024 prices (modelled; grey rows are method checks)

Option	Row	Gap 2025 (provisional)	Change from central 2025
Wholesale price before mid-2010: the lower published series instead of Ofgem's chart	range	£15.3bn	£0.0bn
Wholesale price before mid-2010: the engine's own modelled price instead of Ofgem's chart	range	£15.3bn	£0.0bn
Power from plant Britain had, priced at the actual market price with carbon left in	range	£13.8bn	−£1.6bn
Power from plant Britain had, priced at the fossil fleet's average cost	range	£14.7bn	−£0.7bn
Spare plant margin of 6.6% (central 7.4%)	range	£15.3bn	£0.0bn
Spare plant margin of 8.2% (central 7.4%)	range	£15.3bn	£0.0bn
Demand left for fossil plant from 2016 measured from Elexon's half-hourly generation data instead of NESO's demand data	range	£15.2bn	−£0.1bn
Interconnectors counted at their metered flow at the peak instead of their Capacity Market contracts	range	£15.5bn	+£0.1bn
Capacity Market: coal stations the road keeps open also need Capacity Market payments	range	£15.1bn	−£0.2bn
Capacity Market: its whole cost counted as a cost of net zero	range	£16.5bn	+£1.2bn

Balancing: National Grid's incentivised-cost baseline, with the FY2022/23 energy share (41.9%)	range	£15.5bn	+£0.1bn
Balancing: National Grid's incentivised-cost baseline, with the FY2024/25 energy share (70.3%)	range	£15.2bn	−£0.2bn
Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2018/19 energy share (54.8%)	range	£15.1bn	−£0.3bn
Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2022/23 energy share (41.9%)	range	£15.2bn	−£0.1bn
Balancing: the NAO's £642m for 2005/06 as the baseline in every year, with the FY2024/25 energy share (70.3%)	range	£14.9bn	−£0.5bn
Grid renewal allowance not counted at all	range	£15.8bn	+£0.4bn
Grid renewal allowance at its high setting, which equals central	range	£15.3bn	£0.0bn
No gas transport cost added to the road's fuel	range	£15.4bn	£0.0bn
Gas-price feedback at Krichene's world long-run pair, supply 0.16 plus demand 0.45 (smaller feedback)	range	£17.3bn	+£2.0bn
Grid carried forward on the price controls' own X values (RPI minus X) instead of RPI	range	£15.0bn	−£0.4bn
Climate Change Levy counted above its 2001 rate held in cash, not raised with inflation	range	£15.7bn	+£0.4bn
Fossil Fuel Levy and EESoP 2001 levels held in cash, not raised with inflation	range	£15.4bn	£0.0bn
Fossil Fuel Levy 2001 level set at the £85.5m NFFO payments estimate instead of £92m	range	£15.3bn	£0.0bn
No merit-order uplift (the engine specification's §15.3 rule)	method check	£21.1bn	+£5.8bn
Merit-order uplift: the larger of the engine's estimate and Shao et al.	method check	£15.3bn	£0.0bn
Merit-order uplift: the smaller of the engine's estimate and Shao et al.	method check	£17.8bn	+£2.5bn
Merit-order uplift in 2021-23 scaled to UCL's short-run estimate (preprint)	method check	£15.3bn	£0.0bn
No gas-price feedback	method check	£18.5bn	+£3.1bn
Kept coal not capped at its highest recorded load factor	method check	£17.2bn	+£1.8bn
Every power station closes on its real date	method check	£13.6bn	−£1.8bn
New plant gas only, no new coal	method check	£15.3bn	£0.0bn
Merit-order uplift from the engine's own estimate instead of Shao et al. (2022)	method check	£17.8bn	+£2.5bn
Extra running of the plant Britain had charged its fuel, running and transport cost, not the market price	method check	£15.1bn	−£0.2bn

Source: gas-counterfactual release v4-s43, figures.json key table_options_2025p. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

In the labels, RPI is the price-control index of §10.2, and RPI minus X is that index less the X values Ofgem set for each period. NFFO is the Non-Fossil Fuel Obligation (§2.3).

Table 15.4 Rows kept out of the range by ruling: the headline 2002–24 and its change from the central, £bn, 2024 prices (modelled)

Row	Placed	Headline 2002–24	Change
plant costs at the editions' high case: capital and hurdle	method check	£140.2bn	−£0.1bn
nuclear in the Capacity Market at its auction obligation	method check	£140.2bn	−£0.1bn
merit-order uplift 2021-23: UCL long-run (preprint)	sensitivity	£164.7bn	+£24.4bn
gas-price feedback (Krichene world long-run pair 1974-2004, 0.21 + 0.06 = 0.27)	sensitivity	£143.3bn	+£3.0bn

Source: gas-counterfactual release v4-s43, figures.json key table_ruled_rows. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

15.3 What would have to be true for the gap to vanish

The case that gas drives the cost (§3.2) meets its number here. For the gap in 2024 to vanish, the gas price the road pays would have to be 95.7% higher than the price Britain actually paid. At the central elasticity, the road's extra burn raises it by 17.7% (§9.3).

16 What is not counted

The gap leaves out some costs and some offsets. They are grouped by what can be said of each.

One item moves cost between consumers and does not change the gap: the energy-intensive industries shift would raise the households' allocated share; it is not allocated to them (§2.7; Annex B).

16.1 Possible changes to this bill comparison

- **More British gas.** Lower road gas prices from a British supply response would raise the gap: higher prices on the road might have drawn out more British gas and damped the feedback (§9.3). No source sizes it.
- **Electricity saved by the supplier schemes.** Credited, it would lower the gap; it is not credited to the road, because no scheme measured it. The largest official figures are deemed or forecast, not measured: about 6.1 TWh a year by 2010 for the first two Energy Efficiency Commitments (Lees for DECC 2008, p.33), and a forecast of 7.78 TWh a year in 2012 for the Carbon Emissions Reduction Target, CERT (DECC 2009, impact assessment, para 38). No measured series exists to credit.
- **Local wires.** The share of distribution reinforcement that the departure caused is not counted, because no free source gives a defensible share year by year. Leaving it out makes the gap smaller.

16.2 Not run, with no measured sign

- **Other base windows** for grid and balancing are not tested (§10).
- **Imports.** The road holds imports at their actual level. No run measures their response to a different price, so no sign is given.
- **Coal's exclusion from the Capacity Market.** About 11 GW of older coal can no longer take part in the Capacity Market's four-year-ahead auctions, because of "CM emissions limits which apply from 1st October 2024 for Capacity in operation before July 2019" (Ofgem, Capacity Market annual report 2020/21 and 2021/22, para 3.49, p.37). That may have raised the clearing price. No source separates the effect, so it is not counted.

16.3 Other questions

- **Lost value** (§12.6): a separate cost, a labelled estimate of £9.8bn over 2002–24, kept apart.
- **Other gas users.** The road's higher gas price would have cost homes and industry more (§9.8): a labelled estimate of £9.5bn over 2002–24, kept apart.

- **Air pollution.** The road keeps coal plant open and burns more gas in 2011–15 and 2018–24. The costs of the extra air pollution are outside the scope of a paper about bills.
- **Contracts for Difference after 2024.** Payments under contracts already signed run on well beyond 2024 and are outside the period.
- **Bill support.** The Energy Price Guarantee cost about £23,999m in cash across the United Kingdom, for gas and electricity together, from October 2022 to March 2024 (from November 2022 in Northern Ireland) (NAO 2024, HC 232, pp.6–7). The Energy Bills Support Scheme cost about £11,364m in cash in Great Britain from October 2022 to March 2023 (NAO 2024, HC 232, pp.6–7). Neither is scaled to Great Britain's electricity: both are transfers between taxpayers and bill-payers, left out of both bills, because the gap measures the cost of supply whoever paid it.
- **The Electricity Generator Levy.** It raised £1.473bn in 2023/24 and £0.749bn in 2024/25, in cash (HMRC 2026a, Table 1A). It is a question of who pays, and it is netted off neither bill.

17 Conclusion and the proposed change

17.1 What is known, and how surely

Over 2002–24 the departure added £140.3bn, in 2024 prices, to the reconstructed supply bill for the electricity Britain used, against the same electricity on the road Britain was on (bills of £955.5bn and £815.2bn). The figure is modelled, because the road did not happen, and no test can validate it directly. The machine's parts are tested against data (§5.4), and the early-years check, whose form was changed after its first results were seen, passes (§5.3). The release implements the stated central switches (as each chapter, §6–§13, states them). Passing its accounting identities does not independently validate the counterfactual, the coal operating schedule or the causal price estimates. The asserted source checks of the actual bill are not reproduced here (§5.2).

The answer rests most on two choices, the price of power from the plant Britain had (§8), where the headline moves by −£19.5bn with kept output at the full actual price, and the gas price (§9), where it moves by +£12.4bn with gas-price feedback at Krichene′s world long-run pair, 0.61. Changing any one of the choices in the range (§2.9) on its own keeps the gap between £120.8bn (kept output at the full actual price) and £152.7bn (gas-price feedback at Krichene′s world long-run pair, 0.61), each figure rounded separately. A method check on O'Shea, Horne and Maslin's short-term model, whose results the authors say "do not appear reasonable" (p.24), gives £138.8bn (§15.2).

17.2 The change: a duty to publish what each policy adds

No official figure now says what the departure has cost, instrument by instrument, and some of the series this paper needed do not exist at all: transmission spending by its cause, and measured savings from the energy-saving schemes (§10.7, §16.1).

The Climate Change Act 2008 already requires the Secretary of State to lay before Parliament, in respect of each year, a statement of the United Kingdom's emissions (section 16). A matching duty would require a statement of what Britain pays to cut them. Draft wording for a new section 16A follows.

Annual statement of policy costs in electricity supply

After section 16 of the Climate Change Act 2008 insert—

"16A Annual statement of policy costs in electricity supply

(1) It is the duty of the Secretary of State to lay before Parliament in respect of each year, beginning with the year 2026, a statement containing the following information.

(2) For each relevant scheme, the statement must state the amount paid in the year by or on behalf of electricity consumers in Great Britain, whether through charges made by electricity suppliers, network or balancing charges, or the wholesale price of electricity.

(3) In this section "relevant scheme" means— (a) a renewables obligation imposed by an order under section 32 of the Electricity Act 1989; (b) feed-in tariffs under arrangements made by virtue of section 41 of the Energy Act 2008; (c) contracts for difference under Chapter 2 of Part 2 of the Energy Act 2013; (d) capacity agreements under Chapter 3 of Part 2 of that Act; (e) any greenhouse gas emissions trading scheme, and carbon price support under paragraph 42A of Schedule 6 to the Finance Act 2000, to the extent reflected in the wholesale price of electricity; (f) climate change levy charged on supplies of electricity; (g) any other scheme which the Secretary of State considers adds to the cost of supplying electricity for the purpose of reducing greenhouse gas emissions.

(4) The statement must also state the Secretary of State's estimate of the amounts paid in the year for— (a) balancing the national electricity transmission system, (b) reinforcing electricity transmission networks, and (c) capacity held in reserve, that are attributable to the connection and operation of generating stations powered by wind or sunlight.

(5) The statement must— (a) state each amount in the prices of the year and in the prices of a base year stated in the statement; (b) state the value added tax charged on those amounts; and (c) identify the methods and data used.

(6) The first statement must also contain the information required by subsections (2) to (5) for each year from 2002 to 2025.

(7) The statement must be laid before Parliament not later than 30th September in the year following that to which it relates.

(8) The Secretary of State must publish, at the same time as each statement, the data and calculations used in a form that allows the amounts to be reproduced."

Each part of the clause follows from a finding. Subsection (3) lists the instruments of the departure as §2.3 defines them. Subsection (4) asks for the extra balancing, grid and backup costs that §7, §10 and §11 had to rebuild. Subsection (5) asks for the price basis and the VAT, which §2 shows matter. Subsection (8) requires the data and calculations to be published, so that anyone can rerun the figures.

17.3 Decision point, models and the objection

The vehicle is the Energy Independence Bill. The King's Speech of 13 May 2026 said: "My Ministers will therefore introduce an Energy Independence Bill" (GOV.UK, "The King's Speech 2026", www.gov.uk/government/speeches/the-kings-speech-2026). The Government answered on 28 July 2026 that "The Bill will be introduced as soon as parliamentary time allows" (Lords written question HL2076), and on 15 September 2026 that its scope and content "will be set out in due course when it is introduced to Parliament" (Commons written question 27409, Department for Energy Security and Net Zero). Parliament's bills search found no such Bill on 21 October 2026. The clause could be offered as a new clause to that Bill, or as a private member's bill.

An existing body shows how such a duty can be met. The Office for Budget Responsibility has a statutory duty "to examine and report on the sustainability of the public finances" (Budget Responsibility and National Audit Act 2011, s.4(1)), with "complete discretion in the performance of its duty under section 4 (but subject to subsections (2) and (3) of this section and sections 6 and 7)" (s.5(1)); it "must perform that duty objectively, transparently and impartially" (s.5(2)) and "may not consider what the effect of any alternative policies would be" (s.5(3)(b)).

The strongest objection is that the duty is a costly burden, and that an official baseline back to 2002 would be contested and politicised. The answer is that DECC produced such estimates for years, so the work can be done; that section 16 already requires the matching statement on emissions;

and that subsection (8) lets anyone check the figures, so a contested baseline would be contested in the open.

17.4 Two smaller changes also considered

Two smaller changes were also considered. One would end Carbon Price Support a year earlier than the Government plans (HCWS1519, 16 April 2026, first sentence). The other would let any refurbishing power station, not only low-carbon plant, bid for nine-year Capacity Market agreements (DESNZ 2024, Clean Power 2030, PDF p.89).

Corrections: corrections@richardlyon.net

A Derived figures

The working for each figure derived from model output: the household figures, their divisor and the household share; VAT on the extra; the carbon split; the 2001 levels and their netting; the three labelled estimates, the energy-intensive industries shift, lost value and the cost to other gas users; and the renewables balance. Each comes from the release's run file, in 2024 prices (CPIH), summed over 2002–24, with 2025 apart as provisional.

A.1 The household figures

Each year's gap is divided by the number of households in Great Britain that year (ONS) and the results are summed: £5,298 over 2002–24 and £477 in 2024. The households' allocated share (§2.7) applies households' share of electricity sold by suppliers (DUKES 2026, Tables 5.2 and 5.5.D) to each line of the gap, counts the Energy Company Obligation in full, leaves out the Climate Change Levy and adds VAT at the domestic rate (§2.7): £2,286 over 2002–24 and £197 in 2024. Table 14.3 gives the divisor, both figures and the households' share for every year.

A.2 VAT on the extra

VAT on each bill is the domestic rate on households' share of the bill's lines, plus VAT on the energy-saving schemes, which households pay in full (Supplementary Note, Table S16). VAT on the extra is the actual bill's VAT less the road's: £2.9bn over 2002–24. Table A.1 gives it by year.

Table A.1 VAT on the extra by year, 2002–24 with 2025 provisional, £bn, 2024 prices (modelled)

Year	Households' share of supply	VAT rate	VAT on the actual bill (NZ11)	VAT on the road's bill (GO7)	VAT on the extra
2002	37.5%	5.0%	£0.2bn	£0.2bn	£0.0bn
2003	37.9%	5.0%	£0.3bn	£0.3bn	£0.0bn
2004	38.4%	5.0%	£0.3bn	£0.3bn	£0.0bn
2005	37.9%	5.0%	£0.5bn	£0.4bn	£0.1bn
2006	37.9%	5.0%	£0.5bn	£0.4bn	£0.1bn
2007	37.3%	5.0%	£0.4bn	£0.3bn	£0.0bn
2008	36.1%	5.0%	£0.8bn	£0.7bn	£0.1bn
2009	37.8%	5.0%	£0.4bn	£0.3bn	£0.1bn
2010	37.1%	5.0%	£0.5bn	£0.4bn	£0.1bn
2011	36.2%	5.0%	£0.5bn	£0.4bn	£0.1bn
2012	37.0%	5.0%	£0.5bn	£0.5bn	£0.0bn
2013	36.8%	5.0%	£0.5bn	£0.5bn	£0.1bn
2014	36.8%	5.0%	£0.5bn	£0.3bn	£0.1bn
2015	36.8%	5.0%	£0.5bn	£0.3bn	£0.2bn
2016	37.0%	5.0%	£0.5bn	£0.3bn	£0.2bn
2017	36.8%	5.0%	£0.6bn	£0.3bn	£0.2bn

2018	37.0%	5.0%	£0.7bn	£0.4bn	£0.2bn
2019	36.8%	5.0%	£0.6bn	£0.3bn	£0.3bn
2020	40.2%	5.0%	£0.6bn	£0.3bn	£0.3bn
2021	39.7%	5.0%	£1.2bn	£1.0bn	£0.1bn
2022	37.5%	5.0%	£1.5bn	£1.4bn	£0.1bn
2023	36.0%	5.0%	£0.8bn	£0.7bn	£0.1bn
2024	36.5%	5.0%	£0.7bn	£0.5bn	£0.3bn
2025 (provisional)	36.5%	5.0%	£0.8bn	£0.5bn	£0.3bn

Source: gas-counterfactual release v4-s43, figures.json key table_vat_working. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

A.3 The carbon split

Carbon in the wholesale price, £82.9bn over 2002–24, is split into carbon prices collected as tax on power, £23.7bn, and the rest, £59.2bn (§2.6). Table A.2 gives the split by year.

Table A.2 Carbon in the wholesale price and its split, by year, 2002–24 with 2025 provisional, £bn, 2024 prices (modelled)

Year	Carbon in the price (NZ1c)	of which tax collected	of which the rest
2002	£0.0bn	£0.0bn	£0.0bn
2003	£0.0bn	£0.0bn	£0.0bn
2004	£0.0bn	£0.0bn	£0.0bn
2005	£3.3bn	£0.0bn	£3.3bn
2006	£2.6bn	£0.0bn	£2.6bn
2007	£0.1bn	£0.0bn	£0.1bn
2008	£3.2bn	£0.1bn	£3.1bn
2009	£3.7bn	£0.3bn	£3.4bn
2010	£3.5bn	£0.4bn	£3.1bn
2011	£2.6bn	£0.3bn	£2.2bn
2012	£1.4bn	£0.2bn	£1.2bn
2013	£1.6bn	£0.6bn	£1.0bn
2014	£2.6bn	£1.4bn	£1.2bn
2015	£4.2bn	£1.9bn	£2.4bn
2016	£3.9bn	£1.6bn	£2.3bn
2017	£3.7bn	£1.6bn	£2.1bn
2018	£4.6bn	£2.0bn	£2.6bn
2019	£5.4bn	£1.1bn	£4.3bn
2020	£5.0bn	£2.0bn	£3.0bn
2021	£7.1bn	£3.0bn	£4.1bn
2022	£11.4bn	£3.7bn	£7.7bn
2023	£7.4bn	£2.3bn	£5.1bn
2024	£5.6bn	£1.3bn	£4.3bn
2025 (provisional)	£6.6bn	£1.3bn	£5.3bn

Source: gas-counterfactual release v4-s43, figures.json key table_carbon_split_by_year. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

A.4 The 2001 levels and their netting

The Fossil Fuel Levy at its 2001 level is netted against the Renewables Obligation until 2019, −£3.0bn; EESoP at its 2001 level, times its electricity share, against the energy-saving schemes, −£1.1bn; and the Climate Change Levy at its 2001 rate against the levy, £18.3bn. The FFL and EESoP figures here are reductions in the gap including their VAT effects. The CCL figure is instead the baseline carried on the road; the remaining CCL gap line is reported separately in §13.3. They are not three comparable netting-effect figures. Table A.3 gives each by year.

Table A.3 The 2001 levels netted on the road, by year, 2002–24 with 2025 provisional, £m, 2024 prices (modelled)

Year	Fossil Fuel Levy at its 2001 level (in NZ2)	its VAT	EESoP at its 2001 level (in NZ10)	its VAT	CCL at its 2001 rate (NZ8)
2002	£164m	£3.1m	£44m	£2.2m	£1,081m
2003	£164m	£3.1m	£44m	£2.2m	£1,078m
2004	£164m	£3.1m	£44m	£2.2m	£990m
2005	£164m	£3.1m	£44m	£2.2m	£925m
2006	£164m	£3.1m	£44m	£2.2m	£912m
2007	£164m	£3.1m	£44m	£2.2m	£875m
2008	£164m	£3.0m	£44m	£2.2m	£894m
2009	£164m	£3.1m	£44m	£2.2m	£847m
2010	£164m	£3.0m	£44m	£2.2m	£769m
2011	£164m	£3.0m	£44m	£2.2m	£774m
2012	£164m	£3.0m	£44m	£2.2m	£663m
2013	£164m	£3.0m	£44m	£2.2m	£444m
2014	£164m	£3.0m	£44m	£2.2m	£358m
2015	£164m	£3.0m	£44m	£2.2m	£439m
2016	£164m	£3.0m	£44m	£2.2m	£779m
2017	£164m	£3.0m	£44m	£2.2m	£863m
2018	£164m	£3.0m	£44m	£2.2m	£908m
2019	£164m	£3.0m	£44m	£2.2m	£869m
2020	£0.0m	£0.0m	£44m	£2.2m	£759m
2021	£0.0m	£0.0m	£44m	£2.2m	£766m
2022	£0.0m	£0.0m	£44m	£2.2m	£779m
2023	£0.0m	£0.0m	£44m	£2.2m	£756m
2024	£0.0m	£0.0m	£44m	£2.2m	£775m
2025 (provisional)	£0.0m	£0.0m	£44m	£2.2m	£765m

Source: gas-counterfactual release v4-s43, figures.json key table_2001_levels_working. Modelled, £m in 2024 prices (CPIH); figures rounded separately.

A.5 The energy-intensive industries shift

The exemption moves part of the cost of the Renewables Obligation, Feed-in Tariffs and Contracts for Difference, and from 1 April 2024 of the Capacity Market (SI 2024/434), off exempt sites and onto other electricity (§2.7). If a volume E is exempt from total supply S, each charge falls on S – E, so households' part of each line is larger by the factor E ÷ (S – E). The shift is the engine's household amount for those lines times that factor, for each year 2018–24, summed. S is United Kingdom consumption by final users (DESNZ, Historical electricity data), scaled to Great Britain. E is the exempt electricity of energy-intensive industries for each obligation year from 2018/19 (BEIS and, from 2024/25, DESNZ, Calculating the level of the Renewables Obligation). The notes give E as the amount already exempt, not the eligible supply: 85% of eligible supply until March 2024 (for example, BEIS, Calculating the level of the Renewables Obligation for 2020/21, p. 6, "Estimates of exempt electricity"), and 100% from April 2024. The same volumes are applied to Feed-in Tariffs and Contracts for Difference, and to the Capacity Market from April 2024; that is inferred, not sourced. This gives £1.0bn. The shift changes the households' allocated share, not the gap.

Table A.4 The energy-intensive industries shift by year, 2018–24, £m, 2024 prices (labelled estimate)

Year	UK final consumption, TWh	GB share	Households' share	Exempt volume, TWh (obligation year)	RO, FiT and CfD lines	CM line	Shift, reading B
2018	300.6	97.3%	37.0%	10.4	£9,877m	£39m	£101m
2019	297.4	97.3%	36.8%	10.7	£11,051m	£98m	£157m

2020	279.8	97.2%	40.2%	9.9	£11,925m	£120m	£182m
2021	285.4	97.2%	39.7%	11.5	£10,158m	£186m	£170m
2022	272.6	97.2%	37.5%	9.5	£8,085m	£97m	£118m
2023	269.3	97.2%	36.0%	8.8	£9,878m	£142m	£126m
2024	272.5	97.2%	36.5%	11.6	£11,351m	£196m	£181m

Source: gas-counterfactual release v4-s43, figures.json key table_eii_shift_working. Labelled estimate, £m in 2024 prices (CPIH); volumes in TWh, and shares; figures rounded separately.

A.6 Lost value

The price rise, r, is the year's gap as a share of the road's whole bill, each line counted once (§12.6). On a demand curve of constant elasticity e, anchored on actual demand at actual prices, lost value as a share of the year's gap is (1 + r) ÷ (r(1 + e)) × (1 − (1 + r)^−(1 + e)) − 1. The central elasticity weights −0.607 for households and −0.52 for every other user by households' share of electricity used that year; across 2002–24 it gives −0.55. The range applies −0.203 and −0.677 to every user. A straight-line curve gives a central figure 16.6% higher; the smaller, constant-elasticity figure is quoted. Over 2002–24 lost value is £9.8bn (£3.5bn to £12.2bn); in 2025 (provisional) it is £1.4bn. Table A.5 gives it by year.

Table A.5 Lost value by year, 2002–24 with 2025 provisional, £bn, 2024 prices (labelled estimate, kept apart from the gap)

Year	Households' share (s)	Central elasticity	Price rise (r)	Lost value, constant elasticity (quoted)	Lost value, straight line
2002	35.9%	−0.55	1.2%	£0.0bn	£0.0bn
2003	36.5%	−0.55	1.7%	£0.0bn	£0.0bn
2004	36.6%	−0.55	2.3%	£0.0bn	£0.0bn
2005	36.0%	−0.55	13.4%	£0.1bn	£0.1bn
2006	36.1%	−0.55	10.7%	£0.1bn	£0.1bn
2007	36.0%	−0.55	4.6%	£0.0bn	£0.0bn
2008	35.0%	−0.55	11.8%	£0.2bn	£0.2bn
2009	36.8%	−0.55	22.6%	£0.3bn	£0.4bn
2010	36.1%	−0.55	19.8%	£0.3bn	£0.3bn
2011	35.1%	−0.55	11.3%	£0.1bn	£0.1bn
2012	36.0%	−0.55	1.9%	£0.0bn	£0.0bn
2013	35.8%	−0.55	6.7%	£0.0bn	£0.0bn
2014	35.6%	−0.55	20.7%	£0.3bn	£0.4bn
2015	35.5%	−0.55	31.5%	£0.7bn	£0.8bn
2016	35.5%	−0.55	36.7%	£0.9bn	£1.1bn
2017	35.2%	−0.55	40.7%	£1.1bn	£1.4bn
2018	35.3%	−0.55	37.5%	£1.1bn	£1.3bn
2019	35.0%	−0.55	50.2%	£1.6bn	£2.0bn
2020	38.5%	−0.55	45.1%	£1.3bn	£1.6bn
2021	37.4%	−0.55	10.2%	£0.2bn	£0.2bn
2022	35.0%	−0.55	3.3%	£0.0bn	£0.0bn
2023	34.4%	−0.55	10.1%	£0.1bn	£0.1bn
2024	34.6%	−0.55	33.8%	£1.1bn	£1.2bn
2025 (provisional)	34.9%	−0.55	38.5%	£1.4bn	£1.6bn

Source: gas-counterfactual release v4-s43, figures.json key table_lost_value_by_year. Labelled estimate, £bn in 2024 prices (CPIH); shares and the price rise; figures rounded separately.

A.7 The cost to other gas users

The estimate prices the road's gas price on gas bought by everyone in Great Britain other than power stations. The price rise is the one the road's own bill carries (§9.2), so it is negative in years when the

road burns less gas. The gross cost is that rise, times the year's actual gas price, times UK gas demand less the gas used to generate electricity (DUKES 2026, Table 4.1), times Great Britain's share of UK gas consumption (DESNZ, sub-national consumption statistics, Table 7.2). The net cost takes off the part paid to UK producers, the gross cost times UK production over UK demand (DUKES 2026, Table 4.1). The rise is assumed to reach these users in full in the same year. Over 2002–24 the gross cost is £18.2bn, UK producers' gain £8.7bn and the net cost £9.5bn at the central pair, £3.6bn at Krichene's long-run pair. For 2025 (provisional) the net cost is £1.3bn, with producers' gain £1.2bn. Table A.6 gives each year.

Table A.6 The cost to other gas users by year, 2002–24 with 2025 provisional, £bn, 2024 prices (labelled estimate, kept apart from the gap)

Year	Non-power gas, GB, TWh	Price rise	Gas price, £/MWh	Gross cost	UK producers' gain	Net cost (central)	Net cost (Krichene pair)
2002	774.1	−0.4%	£5.4	£0.0bn	£0.0bn	£0.0bn	£0.0bn
2003	777.2	−0.4%	£6.9	£0.0bn	£0.0bn	£0.0bn	£0.0bn
2004	778.2	−1.4%	£8.3	−£0.2bn	−£0.2bn	£0.0bn	£0.0bn
2005	762.3	−1.5%	£13.9	−£0.3bn	−£0.2bn	£0.0bn	£0.0bn
2006	710.9	−0.2%	£14.3	£0.0bn	£0.0bn	£0.0bn	£0.0bn
2007	689.5	−0.8%	£10.2	−£0.1bn	−£0.1bn	£0.0bn	£0.0bn
2008	701.2	−3.1%	£19.8	−£0.7bn	−£0.5bn	−£0.2bn	−£0.1bn
2009	647.4	−4.0%	£10.6	−£0.4bn	−£0.3bn	−£0.1bn	−£0.1bn
2010	704.6	−3.9%	£14.5	−£0.6bn	−£0.3bn	−£0.2bn	−£0.1bn
2011	595.8	0.1%	£19.2	£0.0bn	£0.0bn	£0.0bn	£0.0bn
2012	633.6	12.2%	£20.4	£2.2bn	£1.1bn	£1.1bn	£0.4bn
2013	641.2	8.5%	£23.2	£1.7bn	£0.8bn	£0.9bn	£0.3bn
2014	554.4	5.3%	£17.1	£0.7bn	£0.4bn	£0.3bn	£0.1bn
2015	581.1	4.4%	£14.6	£0.5bn	£0.3bn	£0.2bn	£0.1bn
2016	584.3	−3.6%	£11.8	−£0.3bn	−£0.2bn	−£0.2bn	−£0.1bn
2017	578.8	−3.5%	£15.4	−£0.4bn	−£0.2bn	−£0.2bn	−£0.1bn
2018	593.1	0.8%	£20.6	£0.1bn	£0.1bn	£0.1bn	£0.0bn
2019	573.6	6.7%	£11.8	£0.6bn	£0.3bn	£0.3bn	£0.1bn
2020	579.1	14.4%	£8.5	£0.9bn	£0.5bn	£0.4bn	£0.2bn
2021	578.9	12.3%	£39.5	£3.4bn	£1.5bn	£1.9bn	£0.7bn
2022	529.0	14.6%	£72.2	£6.2bn	£3.3bn	£2.9bn	£1.1bn
2023	490.6	14.7%	£33.9	£2.5bn	£1.4bn	£1.2bn	£0.4bn
2024	499.7	17.7%	£29.0	£2.6bn	£1.3bn	£1.3bn	£0.5bn
2025 (provisional)	480.5	17.6%	£30.4	£2.5bn	£1.2bn	£1.3bn	£0.5bn

Source: gas-counterfactual release v4-s43, figures.json key table_npg_working. Labelled estimate, £bn in 2024 prices (CPIH); volumes in TWh, and the price rise; figures rounded separately.

A.8 The renewables balance

The parts of the specified cost bundle (§2.11), over 2002–24, before VAT: the Renewables Obligation £85.2bn, Feed-in Tariffs £19.7bn, Contracts for Difference £10.9bn, the extra Capacity Market £0.9bn, extra balancing £7.6bn, the extra grid £14.6bn, and generators' share of balancing, £4.5bn, and of grid charges, £4.1bn. Together they are £147.4bn, each figure rounded separately. Net VAT on households' share of the difference between cost and saving is £0.9bn.

The saving, £100.7bn, splits into the price effect, the merit-order uplift and the gas-price feedback, £99.8bn; energy, the market value before carbon of the power from the road's new plant (whose cost is in the next part), and, mostly, the effect of pricing each road's power on its own half-hour pattern from September 2016, −£1.9bn; and the road's own extra plant and its running, £2.8bn,

each figure rounded separately. The renewables balance, the cost less the saving plus that net VAT, is £47.6bn.

The headline less the renewables balance is £92.7bn. Of it, carbon in the price with its VAT is £84.4bn. Before VAT it is £82.9bn (§2.6): £23.7bn collected as carbon tax on power and £59.2bn of carbon in the power price not collected as UK carbon tax (the rest).

With the row that prices kept output at the actual price kept in, the low end of the renewables balance would be £28.1bn. It is not in the range of the renewables balance: that row prices the road's kept output at the actual price including carbon, so it puts carbon pricing back into one road, and the renewables balance is defined with carbon out of both. Table A.7 gives the renewables balance and its parts by year.

Table A.7 The renewables balance and its parts by year, 2002–24, £bn, 2024 prices (modelled)

Year	Specified cost bundle	VAT on it	Saving: price effect	Saving: energy	Saving: own plant	Saving, total	Renewables balance
2002	£0.3bn	£0.0bn	£0.1bn	£0.0bn	£0.0bn	£0.1bn	£0.2bn
2003	£0.5bn	£0.0bn	£0.1bn	£0.0bn	£0.0bn	£0.1bn	£0.4bn
2004	£0.6bn	£0.0bn	£0.0bn	£0.0bn	£0.0bn	£0.1bn	£0.5bn
2005	£0.6bn	£0.0bn	£0.0bn	£0.0bn	£0.0bn	£0.1bn	£0.6bn
2006	£1.1bn	£0.0bn	£0.3bn	£0.0bn	£0.0bn	£0.3bn	£0.7bn
2007	£1.5bn	£0.0bn	£0.4bn	£0.0bn	£0.1bn	£0.4bn	£1.1bn
2008	£1.8bn	£0.0bn	£0.0bn	£0.0bn	£0.0bn	£0.0bn	£1.8bn
2009	£2.2bn	£0.0bn	£0.5bn	£0.0bn	£0.0bn	£0.6bn	£1.7bn
2010	£2.0bn	£0.0bn	£0.5bn	£0.0bn	£0.0bn	£0.5bn	£1.6bn
2011	£2.4bn	£0.0bn	£1.8bn	£0.0bn	£0.0bn	£1.8bn	£0.6bn
2012	£3.5bn	£0.0bn	£4.6bn	£0.0bn	£0.0bn	£4.6bn	−£1.2bn
2013	£4.7bn	£0.0bn	£4.0bn	£0.0bn	£0.0bn	£4.0bn	£0.6bn
2014	£6.1bn	£0.1bn	£2.7bn	£0.0bn	£0.0bn	£2.7bn	£3.5bn
2015	£7.5bn	£0.1bn	£3.3bn	£0.0bn	£0.0bn	£3.3bn	£4.3bn
2016	£9.1bn	£0.1bn	£2.9bn	−£0.1bn	£0.1bn	£2.9bn	£6.3bn
2017	£10.3bn	£0.1bn	£2.4bn	£0.0bn	£0.1bn	£2.5bn	£8.0bn
2018	£11.4bn	£0.1bn	£3.5bn	£0.0bn	£0.2bn	£3.6bn	£7.9bn
2019	£13.1bn	£0.2bn	£4.8bn	−£0.1bn	£0.1bn	£4.9bn	£8.4bn
2020	£14.7bn	£0.1bn	£7.6bn	−£0.1bn	£0.2bn	£7.6bn	£7.2bn
2021	£13.4bn	£0.0bn	£14.3bn	−£0.4bn	£0.6bn	£14.5bn	−£1.2bn
2022	£11.8bn	−£0.2bn	£21.2bn	−£0.6bn	£0.4bn	£20.9bn	−£9.3bn
2023	£13.8bn	−£0.1bn	£16.5bn	−£0.3bn	£0.5bn	£16.7bn	−£2.9bn
2024	£15.0bn	£0.1bn	£8.1bn	−£0.3bn	£0.5bn	£8.3bn	£6.9bn

Source: gas-counterfactual release v4-s43, figures.json key dup_c_by_year. Modelled, £bn in 2024 prices (CPIH) unless stated; figures rounded separately.

B Version and known issues

This is version 1.0.2 of the technical note. Its figures come from engine release v4-s43, cut at commit 8a5b0e1a070b561a4a964e55c5d29fbc6d03274b; its figures file is named, with its SHA-256, on the title page. The release's test suite ran in full at that commit: 1,778 tests passed and none failed. Corrections received after publication will be logged on the public corrections page and credited in the next version.

B.1 Known issues

Each point below is open, and each is stated so that a reader can weigh it.

How the final check is run. The final check of this paper is made by an AI fact-checker running on Claude Opus, the same family of model as the AI agents that built the engine and that reviewed

it. The fact-checker's seeded test, a run against copies of a paper and release with errors planted in them, was passed on a different model, Grok, not on Opus.

Known issues listed for version 1.1. None of the points below is an input that differs from its saved source; each is a choice or a check still open. Sizes are 2002–24 totals in 2024 prices. Those marked measured come from runs on an unsealed copy of the release; the rest are first-order estimates. None is a release figure.

- **Aviation in auction income.** Income from aviation allowance auctions is counted in 2020 but not in 2013–18. Counting it in every year (measured) leaves the headline unchanged; it changes only how the carbon line splits between tax collected and the rest.
- **Aviation in the emissions share.** The share of auction income credited to power counts aviation emissions, while the income counts aviation only in 2020. Matching the two leaves the headline unchanged, because it only divides the carbon line.
- **The coal carbon factor.** Coal's carbon factor is the first row of HMRC's Carbon Price Support table, and the later rows differ. On DESNZ's 2026 factor, the basis used for gas (measured), the headline falls by £0.059bn but its print does not change; the high end prints £152.6bn, the carbon line £82.8bn, and 26 printed figures move.
- **Coal efficiency in 2024.** The 2024 efficiency of coal plant is one station's figure. On the 2015–23 mean (measured), the headline falls by £0.113bn, all in 2024, and would print £140.2bn; the low end would print £120.7bn and the high end £152.6bn, and 44 printed figures move.
- **The three measured items together** give a headline of £140.1bn and a range of £120.7bn to £152.5bn.
- **Renewables Obligation, 2010/11 to 2014/15.** Certificate counts are read from a summary figure in Ofgem's later annual report, printed to the nearest hundred thousand; each year's own report, with the exact count, is saved. Using them lowers the headline by about £0.007bn, and no printed figure moves.
- **Mutualisation.** The Renewables Obligation line counts mutualisation payments received, not the amount billed (§2.3); the difference is about £0.001bn, and no printed figure moves.
- **Great Britain's share of UK consumption, 2002–14.** The published table starts in 2015, so each of these years takes the 2015 share. The bound on the headline is −£0.13bn to +£0.16bn; either end could change its print.
- **Balancing, 2011/12.** The year rests on one published source; a second, National Grid's monthly balancing services summary for March 2012, could not be found. No effect is expected.
- **Carbon Price Support, 2025.** The 2025 receipts are the engine's own provisional record until HMRC's final figures (gas-counterfactual release v4-s43, data/raw/s36/cps/cps-2025-provisional.csv; HMRC 2026b, Table 1b); only 2025 is affected.
- **One input series not identified.** The input check of 21 October could not check eight series, and one of them cannot be identified from its record. Both candidates are 2025/26 estimates awaiting outturn, so no 2002–24 figure moves.

Release wording this paper does not print as it stands. For six figures, the label or unit in the Supplementary Note, Table S1, is this paper's wording, not the release's. Table labels also follow the wording changes declared in the Supplementary Note, Section S.A. The keys and values are unchanged.

Checks not reproduced. The asserted source checks of the actual bill against its published sources are not reproduced here (§5.2).

Costs not counted. The energy-saving schemes' own savings are not counted (§12.3).

The renewables balance. Carbon is taken out of both roads without re-running the actual system as if it had never faced a carbon price (§2.11).

Provisional figures. Every figure for 2025 is provisional, and two parts of the 2025 carbon split will be replaced when final data are published (§14.2).

Households, 2002–14. The divisor for these years is from ONS ad hoc table 005374 (Labour Force Survey, 1996 to 2017), which Annex C does not list; entry 91 covers 2015 to 2025 only.

The energy-intensive industries shift. No saved source states that the exemption from the Renewables Obligation, Feed-in Tariffs and Contracts for Difference moves cost onto other electricity; it is this paper's reading of how those levies are recovered (Annex A.5).

Annex C, entry 63. The date, December 2005, and reference 12409 are read from the address of Ofgem's file; no Ofgem catalogue record for the document was found.

C References

Every source the note cites, in author and year order. Each entry gives where the note cites it, the copy used (the file kept with the note's sources, and the date it was taken) and, where only part of a source is held, which part. Where one author has more than one item in a year, the items are lettered as the text cites them.

1. Albrizio, S., Bluedorn, J., Koch, C., Pescatori, A. and Stuermer, M. (2022). "Market Size and Supply Disruptions: Sharing the Pain of a Potential Russian Gas Shut-off to the European Union". IMF Working Paper WP/22/143. International Monetary Fund, July 2022. https://doi.org/10.5089/9798400215223.001. https://www.imf.org/-/media/Files/Publications/WP/2022/English/wpiea2022143-print-pdf.ashx
   Cited at: §9.3, equation 5, pp.13–14; Table 2, p.12; p.12 (supply elasticity taken from Krichene 2002). Supplementary Note, Table S1: Table 2.
   Accessed 21 Oct 2026 (the Internet Archive capture of 14 Mar 2026).
   Held: full.
2. BEIS (2021). *Valuation of greenhouse gas emissions: for policy appraisal and evaluation*. Policy paper, HTML only. Published 2 Sep 2021 and never updated. https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation
   Cited at: §2.6 ("BEIS 2021"). The page has no page or paragraph numbers. Locators: section "Methodology", subsection "Aproach taken to updating the values" (sic), the paragraph after the list of criteria (the "target-consistent" approach); section "Introduction", subsection "Previous reviews of the value of carbon", para 1 (abatement cost rather than a social cost of carbon).
   Accessed 17 Oct 2026.
3. BEIS (2022). *Review of Electricity Market Arrangements: Consultation Document*. July 2022; closing date 10 Oct 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1098100/review-electricity-market-arrangements.pdf
   Cited at: §3.2, p.73 ("REMA consultation").
   Accessed by 19 Oct 2026.
4. Casoli, C., Manera, M. and Valenti, D. (2022; updated July 2023). "Energy shocks in the Euro area: disentangling the pass-through from oil and gas prices to inflation". FEEM Working Paper (Nota di Lavoro) 045.2022, "Updated version (July 2023)". Fondazione Eni Enrico Mattei. https://feem-media.s3.eu-central-1.amazonaws.com/wp-content/uploads/NDL2022-045-Update.pdf (landing page: https://www.feem.it/en/publications/energy-shocks-in-the-euro-area-disentangling-the-pass-through-from-oil-and-gas-prices-to-inflation/)
   Cited at: §9.3. Supplementary Note, Table S1: Figure 3, Panel 8 (the posterior median, printed

by key in §9.3).
Accessed 16 Oct 2026.

5. CEPA and GHD (2025). *Electricity Generation Cost Study – Extending the Life of Existing Generation Assets*. Final report for DESNZ, May 2025. https://assets.publishing.service.gov.uk/media/68137e3770b095d0d7011858/electricity-generation-cost-study.pdf
Cited at: §6.2, Table 2.2. Supplementary Note, Table S1 (the cost per five years of life extension).
Accessed 21 Oct 2026.
6. Climate Change Committee (2025a). *The Seventh Carbon Budget: Advice for the UK Government*. February 2025 (landing page: published 26 Feb 2025). https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf
Cited at: §2.6, p.116; §3.2 ("CCC 2025a, February 2025").
Accessed 17 Oct 2026.
7. Climate Change Committee (2025b). *Progress in reducing emissions – 2025 report to Parliament*. June 2025 (published 25 June 2025). https://www.theccc.org.uk/wp-content/uploads/2025/06/Progress-in-reducing-emissions-2025-report-to-Parliament.pdf
Cited at: §6.3, PDF p.92 ("CCC 2025b, Progress report").
Accessed 17 Oct 2026.
8. Committee on Climate Change (2017). *Energy prices and bills – impacts of meeting carbon budgets*. 16 March 2017. https://www.theccc.org.uk/wp-content/uploads/2017/03/Energy-Prices-and-Bills-Committee-on-Climate-Change-March-2017.pdf
Cited at: §2.6, p.12; §3.1, p.7 (Executive Summary), p.14 note 3, p.38; §3.2, p.7 and p.14 (chapter 1 key messages), cited as "CCC 2017". Supplementary Note, Table S1: p.7, "Current bills" bullet and its sub-bullets.
Accessed 17 Oct 2026.
Held: full.
9. DBT (2024). *Explanatory Memorandum to the Electricity Supplier Obligations (Excluded Electricity) (Amendment) Regulations 2024* (2024 No. 419). Department for Business and Trade; PDF created 25 Mar 2024. https://www.legislation.gov.uk/uksi/2024/419/pdfs/uksiem_20240419_en_001.pdf
Cited at: Supplementary Note, Table S1, para 6.2.
Accessed 17 Oct 2026.
10. DBT (2026). *Energy Intensive Industries (EIIs): Guidance for applicants seeking a certificate for an exemption from the indirect costs of funding Contracts for Difference (CFD), the Renewables Obligation (RO), the small-scale Feed in Tariff (FIT), and GB Capacity Market (CM)*. May 2026 (revised). https://assets.publishing.service.gov.uk/media/69fc5886cd2e0e8b5b20b21e/energy-intensive-industries-certificate-for-exemption-funding-contracts-for-difference-renewables-obligation-feed-in-tariff.pdf
Cited at: §2.7, paras 2–5 ("DBT, EII guidance").
Accessed 17 Oct 2026.
11. DECC (2009). *Impact Assessment of the Electricity and Gas (Carbon Emissions Reduction) (Amendment) Order 2009*. Final proposal, v2a, 25 Jun 2009, annexed to the Explanatory Memorandum to SI 2009/1904. https://www.legislation.gov.uk/uksi/2009/1904/pdfs/uksiem_20091904_en.pdf
Cited at: §16.1, para 38. Supplementary Note, Table S1: para 38, PDF p.23.
Accessed 17 Oct 2026.
12. DECC (2014). *Estimated impacts of energy and climate change policies on energy prices and bills*. November 2014, URN 14D/386; published 6 Nov 2014, supplementary tables added

10 Dec 2014. https://assets.publishing.service.gov.uk/media/5a7e1f8940f0b62302689526/Prices__Bills_report_2014.pdf
Cited at: §1.1; §2.2, para 43; §2.7, para 75; §12.3, Annex D, Table D1, p.72; §17.3.
Accessed 17 Oct 2026.

13. Defra (2007). *UK Emissions Trading Scheme: 2006 results* ("Results of the 2006 commitment period"), dated 18 May 2007. Original URL http://www.defra.gov.uk/environment/climatechange/trading/uk/pdf/ukets-2006results.pdf Internet Archive capture of 14 Aug 2007: https://web.archive.org/web/20070814120000/http://www.defra.gov.uk/environment/climatechange/trading/uk/pdf/ukets-2006results.pdf
Cited at: §13.3 footnote, p.2. Supplementary Note, Table S1: p.2, column "2002 - 2006 Incentive Payments", row "Totals".
Accessed 17 Oct 2026.
14. DESNZ (formerly BEIS) (2017–2025). *Calculating the level of the Renewables Obligation*, the annual notes for the obligation years 2018/19 to 2026/27. BEIS published the notes for 2018/19 to 2023/24 (2017 to 2022); DESNZ published those for 2024/25 to 2026/27 (2023 to 2025). GOV.UK collection "Annual renewables obligation level calculations"; each note's exact address is given against its obligation year below.
Cited at: Annex A.5 ("E is the exempt electricity of energy-intensive industries for each obligation year from 2018/19 (BEIS and, from 2024/25, DESNZ, Calculating the level of the Renewables Obligation)"); Annex A.5, the 2020/21 note, p. 6, "Estimates of exempt electricity".
Accessed 23 Oct 2026. The notes by obligation year:
– 2018/19: "The Renewables Obligation for 2018/19" (BEIS, 29 Sep 2017), https://assets.publishing.service.gov.uk/media/5a74d6aae5274a59fa715568/Renewables_Obligation_2018_19_FINAL.pdf; and the corrected explanatory note on the revised 2018/19 level (page updated 5 Jan 2018), https://assets.publishing.service.gov.uk/media/5a8215e7e5274a2e87dc110f/Corrected_Explanatory_note_on_revised_2018-19_obligation_level.pdf
– 2019/20 (BEIS, 28 Sep 2018). https://assets.publishing.service.gov.uk/media/65d31ebde1bdec773732220d/renewables-obligation-level-2019-2020.pdf
– 2020/21 (BEIS, 27 Sep 2019). https://assets.publishing.service.gov.uk/media/5d8b47a140f0b6098d33fee6/renewable-obligation-calculating-level-2020-2021.pdf
– 2021/22 (BEIS, 1 Oct 2020). https://assets.publishing.service.gov.uk/media/610c00d08fa8f506c58e7835/Note_for_Publication_on_RO_setting_2021-22.pdf
– 2022/23 (BEIS, 29 Sep 2021). https://assets.publishing.service.gov.uk/media/615440fae90e077a2e2adca6/calculating-level-renewables-obligation-2022-23.pdf
– 2023/24 (BEIS, 30 Sep 2022). https://assets.publishing.service.gov.uk/media/65af7a8afd784b000de0c6c0/calculating-level-renewables-obligation-2023-2024.pdf
– 2024/25 (DESNZ, 27 Sep 2023). GOV.UK HTML page; no PDF published. https://www.gov.uk/government/publications/renewables-obligation-level-calculations-2024-to-2025/calculating-the-level-of-the-renewables-obligation-for-2024-to-2025 Viewer-only: the page furniture changes per request; the text is identical. The revision of 26 Mar 2024 is entry 17.
– 2025/26 (DESNZ, 30 Sep 2024). GOV.UK HTML page; no PDF published. https://www.gov.uk/government/publications/renewables-obligation-level-calculations-2025-to-2026/calculating-the-level-of-the-renewables-obligation-for-2025-to-2026 Viewer-only, as for 2024/25.
– 2026/27 (DESNZ, 29 Sep 2025). GOV.UK HTML page; no PDF published. https://www.gov.uk/government/publications/renewables-obligation-level-calculations-2026-

to-2027/calculating-the-level-of-the-renewables-obligation-for-2026-to-2027 Viewer-only, as for 2024/25.
Held: full, for every obligation year from 2018/19 to 2026/27.

15. DESNZ (2023). *Electricity Generation Costs 2023* (report and Annex A). First published August 2023, updated November 2023. Report https://assets.publishing.service.gov.uk/media/6556027d046ed400148b99fe/electricity-generation-costs-2023.pdf ; Annex A https://assets.publishing.service.gov.uk/media/6555cb6d046ed4000d8b99bb/annex-a-additional-estimates-and-key-assumptions.xlsx
Cited at: §7.3 (the edition in force for 2024, printed from the release as "2023 edition"); §2.2, §4.1, §7.2 ("the Government's generation cost reports").
Accessed 10–11 Oct 2026. The gas-plant cost editions the release uses, by the years each one costs (each year takes the latest edition published by the end of that year; 2002–09, before the first edition, take the earliest set, Mott MacDonald 2010; §7.2):
– 2002–10: Mott MacDonald for DECC, *UK Electricity Generation Costs Update*, June 2010, for combined-cycle plant; open-cycle plant in these years takes Parsons Brinckerhoff's 2012 update, labelled an estimate. https://assets.publishing.service.gov.uk/media/5a797fe840f0b642860d89de/71-uk-electricity-generation-costs-update-.pdf
– 2011: Parsons Brinckerhoff for DECC, *Electricity Generation Cost Model – 2011 Update*, Revision 1, August 2011. https://assets.publishing.service.gov.uk/media/5a790645ed915d0422067327/2127-electricity-generation-cost-model-2011.pdf
– 2012: Parsons Brinckerhoff for DECC, *Electricity Generation Cost Model – 2012 Update of Non Renewable Technologies*, August 2012. https://assets.publishing.service.gov.uk/media/5a79dc8ce5274a684690ca17/6884-electricity-gen-cost-model-2012-update.pdf
– 2013–15: Parsons Brinckerhoff for DECC, *Electricity Generation Cost Model – 2013 Update of Non-Renewable Technologies*, April 2013. https://assets.publishing.service.gov.uk/media/5a7c9687e5274a7b7e321727/2013_Update_of_Non-Renewable_Technologies_FINAL.pdf The hurdle rate for every year to 2015 is DECC's, *Electricity Generation Costs (December 2013)*. https://assets.publishing.service.gov.uk/media/5a7c71fde5274a5255bceb16/131217_Electricity_Generation_costs_report_December_2013_Final.pdf
– 2016–19: BEIS, *Electricity Generation Costs*, November 2016, with its Annexes. https://assets.publishing.service.gov.uk/media/5a8155f2e5274a2e87dbd11b/BEIS_Electricity_Generation_Cost_Report.pdf ; Annexes https://assets.publishing.service.gov.uk/media/5ce55ca0ed915d247979f938/Generation_Costs_Report_2016_Annexes.xlsx
– 2020–22: BEIS, *Electricity Generation Costs 2020*, August 2020, with its key data workbook. https://assets.publishing.service.gov.uk/media/5f450b9be90e07529c25a9c5/electricity-generation-cost-report-2020.pdf ; workbook https://assets.publishing.service.gov.uk/media/5f450d378fa8f55de885e1b8/GC20_Key_Data_and_Assumptions.xlsx
– 2023–25: this entry, the 2023 edition. The 2025 edition (entry 26) costs no year to 2025; it carries the high case of §7.2 and §7.5.
Held: the 2023 edition. The other editions listed are held with the release's data.

16. DESNZ (2024a). *Clean Power 2030 Action Plan: A new era of clean electricity*. December 2024. https://assets.publishing.service.gov.uk/media/677bc80399c93b7286a396d6/clean-power-2030-action-plan-main-report.pdf (landing page: https://www.gov.uk/government/publications/clean-power-2030-action-plan)
Cited at: §17.4, PDF p.89.
Accessed 17 Oct 2026.

17. DESNZ (2024b). "Revising the level of the Renewables Obligation for Great Britain for 2024 to 2025 to implement an increased exemption for energy intensive industries". GOV.UK, in the collection "Renewables obligation level calculations 2024 to 2025", published 26 March 2024. https://www.gov.uk/government/publications/renewables-obligation-level-calculations-2024-to-2025/revising-the-level-of-the-renewables-obligation-for-great-britain-for-2024-to-2025-to-implement-an-increased-exemption-for-energy-intensive-industries
Cited at: Annex A.5 ("DESNZ, Calculating the level of the Renewables Obligation"; the exemption from April 2024, printed by key in §2.7).
Accessed 17 Oct 2026.
Held: full. The other obligation years' notes are entry 14.
18. DESNZ (2025a). *Subnational electricity consumption, Great Britain, 2005–2024*. Official statistics, published 18 December 2025; next update December 2026. https://www.gov.uk/government/statistics/regional-and-local-authority-electricity-consumption-statistics
Cited at: §2.7 ("DESNZ, sub-national electricity consumption statistics"). Supplementary Note, Table S1 ("GB incl. unallocated").
Accessed 11 Oct 2026.
19. DESNZ (2025b). *Subnational Electricity and Gas Consumption Statistics: Regional and Local Authority, Great Britain, 2024*. Published 18 Dec 2025. https://assets.publishing.service.gov.uk/media/6945728a033693d5d50eb83d/subnational-electricity-and-gas-consumption-summary-report-2024.pdf
Cited at: Annex A.7, Table 7.2 ("DESNZ, sub-national consumption statistics, Table 7.2").
Accessed by 21 Oct 2026.
20. DESNZ (2026a). *Digest of UK Energy Statistics (DUKES) 2026*, Table 4.1, "Natural gas commodity balance". Published 30 Jul 2026. https://assets.publishing.service.gov.uk/media/6a69f4332c4b5ba9d1242a68/DUKES_4.1.xlsx
Cited at: Annex A.7 ("DUKES 2026, Table 4.1").
Accessed 17 Oct 2026.
21. DESNZ (2026b). *DUKES 2026*, Tables 5.2 ("Electricity public distribution system and other generators commodity balances") and 5.5 ("Electricity supply, … and electricity sales"; section 5.5.D). Published 30 Jul 2026. https://assets.publishing.service.gov.uk/media/6a6a35e4bf4a7aca8f8976c2/DUKES_5.2.xlsx ; https://assets.publishing.service.gov.uk/media/6a6a36088319ab05f7caa1da/DUKES_5.5.xlsx
Cited at: §2.7 (twice); Annex A.1. Supplementary Note, Table S1 ("DUKES 2026 5.2 / 5.5.D").
Accessed 10 Oct 2026.
22. DESNZ (2026c). *DUKES 2026*, Table 5.7 (plant capacity) and Table 5.10 (plant loads, demand and efficiency; Table 5.10.B, on sheet "5.10.B and 5.10.C"). Published 30 Jul 2026. https://assets.publishing.service.gov.uk/media/6a6a3622cceb23e8678976bf/DUKES_5.7.xlsx ; https://assets.publishing.service.gov.uk/media/6a6a364b0ddb7e4831c629f2/DUKES_5.10.xlsx
Cited at: Supplementary Note, note to Table S15 ("DUKES 2026, Table 5.7, sheet 5.7"). Supplementary Note, Table S1, coal load-factor cap ("highest DUKES 5.10.B coal load factor").
Accessed 10 Oct 2026.
23. DESNZ (2026d). *DUKES 2026*, Table 5.11, "Power stations in the United Kingdom" (data as at the end of May 2026), including the sheet "Changed and converted stations" and the edition sheets "DUKES 2004" to "DUKES 2016". Published 30 Jul 2026. https://assets.publishing.service.gov.uk/media/6a6a365b0ddb7e4831c629f3/DUKES_5.11.xlsx
Cited at: §6.3 (Rugeley closed 2016; the engine's capacities from "the DUKES editions of 2004

to 2016").
Accessed 17 Oct 2026.
Held: the 2026 workbook only. The DUKES editions of 2004 to 2016 are held only as the edition sheets inside it, not as the editions themselves.

24. DESNZ (2026e). *Panel of Technical Experts Report on the NESO Electricity Capacity Report 2026* (PDF title: "NESO Electricity Capacity Report 2026: Findings of the Panel of Technical Experts"). Panel of Technical Experts for DESNZ, July 2026 (PDF created 20 Jul 2026). https://assets.publishing.service.gov.uk/media/6a5e1a5013cf36b2315a5e6e/panel-of-technical-experts-report-on-the-NESO-electricity-capacity-report-2026.pdf (landing page: https://www.gov.uk/government/publications/neso-electricity-capacity-report-2026-findings-of-the-panel-of-technical-experts)
Cited at: §2.5, para 8 ("DESNZ 2026e").
Accessed by 19 Oct 2026.
25. DESNZ (2026f). *Quarterly Energy Prices*, Table 3.2.1, "Average prices of fuels purchased by the major UK power producers". Publication date 29 Sep 2026. Landing https://www.gov.uk/government/statistical-data-sets/prices-of-fuels-purchased-by-major-power-producers ; file https://assets.publishing.service.gov.uk/media/6ab54240734e2435f202f060/table_321.xlsx
Cited at: §9.3 ("DESNZ, Quarterly Energy Prices, Table 3.2.1"). Supplementary Note, Table S1 (the QEP ratio labels).
Accessed 17 Oct 2026 (the file) and 21 Oct 2026 (the landing page).
26. DESNZ (2026g). *Electricity Generation Costs 2025* (report and Annex A, "Additional estimates and key assumptions"). First published 14 January 2026 (the cover reads "first published January 2026"); GOV.UK page updated 18 March 2026; report PDF created 17 March 2026. Report https://assets.publishing.service.gov.uk/media/69ba657326909a14239612e3/electricity-generation-costs-report-2025.pdf ; Annex A https://assets.publishing.service.gov.uk/media/69d8efec96c86b7513170229/annex-a-additional-estimates-and-key-assumptions-2025.xlsx
Cited at: §7.2 and §7.5 ("DESNZ's published high capital cost and hurdle rate"). Supplementary Note, Table S1 ("the high hurdle is printed in EGC 2025"; the 2023 edition, entry 15, has no such case).
Accessed 23 Oct 2026.
Held: full. Read: partial (cover; Section 6, Tables 6 to 9, PDF pp.35–39).
27. DESNZ (2026h). *Historical electricity data: 1920 to 2025*, workbook "Electricity since 1920" (part of the Digest of UK Energy Statistics), sheet "Supply, Availability & Consumpt", column "Total consumption by final users [note 5]". Published 30 July 2026; next update 29 July 2027. Page https://www.gov.uk/government/statistical-data-sets/historical-electricity-data ; file https://assets.publishing.service.gov.uk/media/6a69e449229c578debc1a84d/Electricity_since_1920.xlsx
Cited at: Annex A.5 ("S is United Kingdom consumption by final users (DESNZ, Historical electricity data)").
Accessed 23 Oct 2026.
Held: full.
28. Elexon (2016–2025). Balancing Mechanism Reporting Service (BMRS), FUELHH: generation by fuel type, half-hourly, 2016–2025. Yearly CSVs as pivoted by the engine, not as Elexon publishes them. Endpoint, one request a month, with settlementDateFrom and settlementDateTo set to the month's first and last days: https://data.elexon.co.uk/bmrs/api/v1/datasets/FUELHH/stream. The request for January 2016: https://data.elexon.co.uk/bmrs/api/v1/datasets/FUELHH/stream?settlementDateFrom=2016-01-01&settlementDateTo=2016-01-31

Cited at: §5.4 and Table 5.2 caption ("Elexon's half-hourly generation data", "settlement data by fuel type available from 2016").
Accessed 10 Oct 2026 and 23 Oct 2026.

29. Elexon (2016–2026). Balancing Mechanism Reporting Service (BMRS), Insights API, dataset MID (Market Index Data), half-hourly, from 12 Sep 2016. https://data.elexon.co.uk/bmrs/api/v1/datasets/MID/stream
Cited at: §4.3, the two worked half-hours; §8.3, "From then, Elexon's free half-hourly market index spreads Ofgem's monthly price across the half-hours". Supplementary Note, Table S1 ("Elexon BMRS MID, free").
Accessed 23 Oct 2026; the two worked days, 21 Oct 2026.
Held: 12 Sep 2016 to 31 Dec 2025, data provider APXMIDP. The other provider, N2EXMIDP, is held only in the Sep 2016 sample. 2026 is not held.
30. Electricity Settlements Company (2020). *Annual Report and Accounts for Electricity Settlements Company Ltd 2019/20*. Published 30 Sep 2020. https://www.lowcarboncontracts.uk/documents/22/ESC_Annual_Report_2019-20.pdf
Cited at: §7.3, p.8 and the text above Table 1 ("ESC 2020"). Supplementary Note, Table S1: "Key outcomes in 2019/20" table, fn 7, PDF p.8; text above Table 1, PDF p.18.
Accessed 17 Oct 2026.
31. EMR Delivery Body (2017). *Final Auction Results: EA Capacity Market Auction for 2017/18* (the early auction). PDF created 27 Feb 2017. https://nationalgrid-emr.my.salesforce.com/sfc/p/8d000002dUGC/a/J70000004CbM/GMnDw7Hte3tKFV72d3f62Q1RU79bf3SgPQGpwqLQYzw (link "EA (DY 2017/18) Final Auction Results Report v1.0" on https://emrdeliverybody.nationalenergyso.com/IG/s/article/Auction-Results)
Cited at: §7.3, Table 1 ("EMR Delivery Body 2017, Table 1"; Table 1 is "Breakdown of Awarded Capacity by CMU Classification").
Accessed by 17 Oct 2026.
32. Environment Agency (2020). Permit variation and consolidation notices under the Environmental Permitting (England & Wales) Regulations 2016: Drax Power Station, EPR/VP3530LS/V018 (issued 18 Jun 2020); West Burton Power Station, EPR/SP3935LW/V011 (issued 21 Jan 2020). Drax: https://assets.publishing.service.gov.uk/media/5ef32001d3bf7f71439e881d/Variation_Notice_VP3530LS-V018.pdf (decision document https://assets.publishing.service.gov.uk/media/5ef3201f86650c1294cf2304/Decision_Document_VP3530LS-V018.pdf); West Burton: https://assets.publishing.service.gov.uk/media/5e2e9882ed915d1f20f73a9b/Variation_Notice_SP3935LW-V011.pdf (decision document https://assets.publishing.service.gov.uk/media/5e2e989ced915d1f1fc94b0d/Decision_Document_SP3935LW-V011.pdf)
Cited at: §6.2 ("Environment Agency permits, condition 2.3.6").
Accessed 21 Oct 2026.
Held: both permits, in full. Read: condition 2.3.6 in each (PDF p.11), which sets the limited-hours cap.
33. European Parliament and Council (2001). Directive 2001/80/EC of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants. OJ L 309, 27.11.2001. As adopted. https://www.legislation.gov.uk/eudr/2001/80/pdfs/eudr_20010080_adopted_en.pdf
Cited at: §6.2, Art. 4(4) ("Large Combustion Plant Directive opt-out").
Accessed 21 Oct 2026.

34. European Parliament and Council (2003). Directive 2003/87/EC of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. OJ L 275, 25.10.2003, pp.32–46. Original text as published. https://publications.europa.eu/resource/oj/JOL_2003_275_R_0032_01
Cited at: §13.2, Articles 4, 31 and 32; §13.3, Article 1.
Accessed 17 Oct 2026.
35. European Parliament and Council (2010). Directive 2010/75/EU of 24 November 2010 on industrial emissions (integrated pollution prevention and control). OJ L 334, 17.12.2010. https://www.legislation.gov.uk/eudr/2010/75/pdfs/eudr_20100075_adopted_en.pdf
Cited at: §6.2, Annex V ("the Industrial Emissions Directive's limited-hours route").
Accessed by 21 Oct 2026.
36. Frontier Economics (2016). *Whole power system impacts of electricity generation technologies*. Report for DECC, February 2016. https://assets.publishing.service.gov.uk/media/5a81e0dae5274a2e8ab564f9/Whole_Power_System_Impacts_of_Electricity_Generation_Technologies__3_.pdf
Cited at: §3.3.
Accessed 20 Oct 2026.
37. Heptonstall, P. J. and Gross, R. J. K. (2021). "A systematic review of the costs and impacts of integrating variable renewables into power grids". *Nature Energy* 6, 72–83. Published online 2 Nov 2020. https://doi.org/10.1038/s41560-020-00695-4.
Cited at: §3.3.
Copy used: the authors' accepted version, from Imperial's Spiral repository. Accessed 20 Oct 2026.
Held: the authors' accepted manuscript, not the publisher's version.
38. Hirth, L., Ueckerdt, F. and Edenhofer, O. (2015). "Integration costs revisited – An economic framework for wind and solar variability". *Renewable Energy* 74, 925–939. https://doi.org/10.1016/j.renene.2014.08.065.
Cited at: §3.3.
Copy used: the publisher-typeset PDF from the first author's company site. Accessed 20 Oct 2026.
39. HM Revenue and Customs (2016). *Excise Notice CCL1/4: electricity from renewable sources*. April 2016 edition (now withdrawn). https://www.gov.uk/government/publications/excise-notice-ccl14-electricity-from-renewable-sources/excise-notice-ccl14-electricity-from-renewable-sources
Cited at: §13.3, para 1.2 ("HMRC 2016").
Accessed 21 Oct 2026.
40. HM Revenue and Customs (2026a). *Corporation Tax Statistics 2026*, data tables, Table 1A "Corporate Tax receipts by tax type", row 13 "Electricity Generator Levy (EGL)". Published 24 Sep 2026. https://assets.publishing.service.gov.uk/media/6aabc7c52f29b38884818639/corporation_tax_data_tables_2026.ods
Cited at: §16.3, Table 1A ("HMRC 2026"). Supplementary Note, Table S1: Table_1A, row 13, columns 2023-24 and 2024-25.
Accessed 17 Oct 2026.
41. HM Revenue and Customs (2026b). *Environmental Taxes Bulletin tables (April 2025 to February 2026 provisional data update)*, Table 1b "Climate Change Levy and Carbon Price Floor receipts and clearances data by calendar year". Published 31 March 2026, 9:30am; next tables March 2027. https://assets.publishing.service.gov.uk/media/69ca4948b66990e31f67e8e

3/2026_March_env_tabs_test.ods
Cited at: §14.2 footnote (31 March 2026, Table 1b); §13.7 (next tables due March 2027).
Accessed 11 Oct 2026.

42. HM Revenue and Customs (2026c). *Environmental Taxes Bulletin historical rates*, Table 1 (Main Climate Change Levy rates). Updated 31 March 2026. https://www.gov.uk/government/statistics/environmental-taxes-bulletin/environmental-taxes-bulletin-historical-rates
Cited at: §13.3, Table 1, electricity, rows April 2023 and April 2024. Supplementary Note, Table S1 (main rate from 1 April 2024).
Accessed 17 Oct 2026.
43. HM Revenue and Customs (2026d). *VAT Notice 701/19: fuel and power*. First published 28 Apr 2016; last updated 8 Sep 2026. https://www.gov.uk/guidance/vat-on-fuel-and-power-notice-70119
Cited at: Supplementary Note, Table S1, s.2.1.
Accessed between 8 Sep 2026 and 19 Oct 2026.
44. HM Treasury (2026). *The Green Book – UK government guidance on appraisal* (2026 edition). Published 5 Feb 2026. https://assets.publishing.service.gov.uk/media/698dbcd17da91680ad7f4308/The_Green_Book_2026.pdf
Cited at: §2.1, para 4.19; §2.2, para 4.15.
Accessed 17 Oct 2026.
45. House of Commons (1997). HC Deb 5 November 1997, vol 300, cc343–64, "Fossil Fuel Levy Bill [Lords]", second reading. https://api.parliament.uk/historic-hansard/commons/1997/nov/05/fossil-fuel-levy-bill-lords
Cited at: §2.3, c356.
Accessed 17 Oct 2026.
46. House of Commons (2002). HC Deb 18 April 2002, vol 383, cc1139–40W, "Renewable Energy" (written answer, Brian Wilson, DTI). https://api.parliament.uk/historic-hansard/written_answers/2002/apr/18/renewable-energy
Cited at: §13.2, c1139W. Supplementary Note, Table S1, c1139W.
Accessed 17 Oct 2026.
47. House of Commons (2019). Written statement HCWS38, "Energy Policy", Andrea Leadsom, 24 October 2019. https://questions-statements.parliament.uk/written-statements/detail/2019-10-24/HCWS38
Cited at: §7.3.
Accessed 17 Oct 2026.
48. House of Commons (2026a). Written statement HCWS1519, "Carbon Price Support", Exchequer Secretary to the Treasury, 16 April 2026. https://questions-statements.parliament.uk/written-statements/detail/2026-04-16/hcws1519
Cited at: §17.4, first sentence.
Accessed 21 Oct 2026.
49. House of Commons (2026b). Written question 27409, tabled 7 Sep 2026, answered 15 Sep 2026 (Department for Energy Security and Net Zero). https://questions-statements-api.parliament.uk/api/writtenquestions/questions?uIN=27409 (a search by question number, which also returns earlier questions with that number); this question alone: https://questions-statements-api.parliament.uk/api/writtenquestions/questions/1938641?expandMember=true
Cited at: §17.3.
Accessed 17 Oct 2026 and 23 Oct 2026.

50. House of Lords (2001). HL Deb 19 February 2001, vol 622, cc574–83, Social Security (Contributions) (Re-rating and National Insurance Fund Payments) Order 2001. https://api.parliament.uk/historic-hansard/lords/2001/feb/19/social-security-contributions-re-rating
Cited at: Supplementary Note, Table S1 (the employers' National Insurance cut recycles Climate Change Levy revenue).
Accessed 17 Oct 2026.

51. House of Lords (2026). Written question HL2076, tabled 14 Jul 2026, answered 28 Jul 2026 (Baroness Curran, Department for Energy Security and Net Zero). https://questions-statements-api.parliament.uk/api/writtenquestions/questions/1927995?expandMember=true
Cited at: §17.3.
Accessed 21 Oct 2026 and 23 Oct 2026.

52. Krichene, N. (2005). "A Simultaneous Equations Model for World Crude Oil and Natural Gas Markets". IMF Working Paper WP/05/32. International Monetary Fund, February 2005. https://www.imf.org/external/pubs/ft/wp/2005/wp0532.pdf
Cited at: §9.3, Table 5, p.20, and Table 2 (1918–2004 and 1974–2004). Supplementary Note, Table S1: Table 2, PDF p.13; Table 5, printed p.20 (PDF p.21).
Accessed 16 Oct 2026.
Held: full.

53. Labandeira, X., Labeaga, J. M. and López-Otero, X. (2016). "A meta-analysis on the price elasticity of energy demand". EUI Working Paper RSCAS 2016/25, Robert Schuman Centre for Advanced Studies, Florence School of Regulation – Climate, European University Institute. April 2016. https://hdl.handle.net/1814/40870
Cited at: §12.6, Table 3 and Table 4. Supplementary Note, Table S1: Table 3, PDF p.15; Table 4, PDF p.16 (printed p.8).
Accessed 17 Oct 2026. The journal version (*Energy Policy* 102, 2017) is paywalled; the note cites the working paper.

54. Lees, E. W. (Eoin Lees Energy) (2008). *Evaluation of the Energy Efficiency Commitment 2005-08*. Final report to DECC, submitted 14 December 2008. Original URL http://www.defra.gov.uk/environment/climatechange/uk/household/supplier/pdf/eec-evaluation-0508.pdf archived at https://web.archive.org/web/20090318213351/http://www.defra.gov.uk/environment/climatechange/uk/household/supplier/pdf/eec-evaluation-0508.pdf.
Cited at: §16.1, p.33 ("Lees for DECC 2008"). Supplementary Note, Table S1: s.4.1 summary, p.33.
Accessed 17 Oct 2026.

55. Cannock Chase District Council and Lichfield District Council (2018). *Rugeley Power Station Development Brief, Supplementary Planning Document*. Adopted 20 February 2018. https://www.cannockchasedc.gov.uk/sites/default/files/site-old/rugeley_power_station_spd_0.pdf
Cited at: §6.3, para 1.2 ("Lichfield and Cannock Chase District Councils 2018").
Accessed 21 Oct 2026.
Held: full.

56. Lyon, R. (2026a). *The Energy Trap*. Swift Press. Hardback ISBN 9781800757356, published 24 September 2026. Publisher's page https://swiftpress.com/book/the-energy-trap/
Cited at: Independence and declaration; §3.3.
Accessed 21 Oct 2026.
Held: the publisher's page only. The book itself was not obtained.

57. Lyon, R. (2026b). *gas-counterfactual*, model release v4-s43: the model release the note cites. Git tag v4-s43; the release was cut at commit 8a5b0e1a070b561a4a964e55c5d29fbc6d03274b; release date 24 October 2026. Figures file figures.json, sha256 babdadb500f71fa6dfbda60a310cf8370c2044dcd2693211073ce1e5a41e3cf4; run file 2026-10-24-s43.json, sha256 dccd97d56efa9b4b26bc68604b8ae7f0204e40a9c1126a653886e268d28b49e4. Public address: none is given until one is verified.
Cited at: every release table's source line ("gas-counterfactual release v4-s43, figures.json key …"); title page; "Rebuilding the figures"; Annex B.
Accessed 24 Oct 2026, from the sealed release bundle.
58. National Audit Office (2004). *The UK Emissions Trading Scheme: A New Way to Combat Climate Change*. Report by the Comptroller and Auditor General, HC 517, Session 2003–2004, 21 April 2004. NAO page https://www.nao.org.uk/reports/the-uk-emissions-trading-scheme-a-new-way-to-combat-climate-change/ ; copy used: https://web.archive.org/web/20161025204700/https://www.nao.org.uk/wp-content/uploads/2004/04/0304517.pdf
Cited at: §13.3, para 2 ("NAO 2004, HC 517, para 2").
Accessed 17 Oct 2026.
59. National Audit Office (2014). *Electricity Balancing Services*. Briefing for the House of Commons Energy and Climate Change Select Committee, May 2014. https://www.nao.org.uk/wp-content/uploads/2014/05/Electricity-Balancing-Services.pdf
Cited at: §11.2, para 2.2 ("NAO 2014"). Supplementary Note, Table S1: para 2.2.
Accessed 17 Oct 2026.
60. National Audit Office (2016). *Controlling the consumer-funded costs of energy policies: The Levy Control Framework*. Report by the Comptroller and Auditor General, HC 725, Session 2016–17, 18 October 2016. https://www.nao.org.uk/wp-content/uploads/2016/10/Controlling-the-consumer-funded-costs-of-energy-policies-The-Levy-Control-Framework-1.pdf
Cited at: §1.1 and §2.2, para 3.13 (printed p.39, PDF p.41).
Accessed 17 Oct 2026.
61. National Audit Office (2024). *Energy bills support: an update*. Report by the Comptroller and Auditor General, HC 232, Session 2023-24, 14 November 2024. https://www.nao.org.uk/wp-content/uploads/2024/11/energy-bills-support-an-update.pdf
Cited at: §16.3, pp.6–7 ("NAO 2024, HC 232"). Supplementary Note, Table S1: summary table, printed pp.6–7 (PDF p.8); Figure 6, p.24 (PDF p.25).
Accessed 17 Oct 2026.
Held: full.
62. National Gas Transmission (dataset). "SAP, Actual Day" (System Average Price), publication PUBOB603, daily, p/kWh. National Gas Data Portal API. No public GET URL: the API answers POST only. Request: POST to https://api.nationalgas.com/operationaldata/v1/publications/gasday with JSON body keys fromDate and toDate (the dates in each saved file's name), publicationIds (PUBOB603) and latestValue (Y), as in the v4-s43 engine's src/gascf/sap.py. Re-requested 23 Oct 2026: each reply is byte-identical to the saved file.
Cited at: §8.3 ("National Gas and ONS, System Average Price"; the daily data behind the May 2021 to December 2023 re-estimate).
Accessed 23 Oct 2026. For 1 January to 17 October 2021: ONS, "System Average Price (SAP) of gas", published 23 December 2021, sheet "System Average Price". Definition: Joint Office of Gas Transporters, Uniform Network Code, Transportation Principal Document, Section F, version 6.27, 14 September 2026, para 1.2.1(c) (the current version, not the one in force in 2021–23).

Held: National Gas, 18 October 2021 to 31 December 2023; the API holds nothing earlier, although the first file's name starts at May. ONS edition: 1 January 2018 to 19 December 2021. Together they cover May 2021 to December 2023. For 1 May to 17 October 2021 the copy held is ONS's republication, not National Gas's own.

63. National Grid Electricity Transmission (2005). *System Operator Incentive Performance*. Ofgem document library, December 2005 (ref 12409); the document itself is undated. https://www.ofgem.gov.uk/sites/default/files/docs/2005/12/12409-ngetincentive-_0.pdf
Cited at: §11.3, p.2, "Historical performance" table ("National Grid 2005"). Supplementary Note, Table S1: PDF p.2.
Accessed 17 Oct 2026.
64. National Grid (2010). *SO Incentives Review: Electricity SO Incentives: Initial Proposals for 1st April 2011*. Issue 1, 24 November 2010 (NESO document 46611). https://www.neso.energy/document/46611/download
Cited at: §11.3, Table 1, p.9 ("National Grid 2010"). Supplementary Note, Table S1: Table 1 "Summary of historic BSIS parameters", p.9.
Accessed 17 Oct 2026.
65. National Grid (2012). *Explanation of TNUoS tariffs for 2012/13* (final TNUoS tariffs for 2012/13). PDF created 31 Jan 2012 (NESO document 50676). https://www.neso.energy/document/50676/download
Cited at: Supplementary Note, Table S1 only (for the generators' share; "doc 50676, 2012/13").
Accessed 17 Oct 2026.
66. National Grid (2013). *TNUoS Tariff Statement: TNUoS tariffs for 2013/14*. January 2013 (PDF created 31 Jan 2013; NESO document 50671). https://www.neso.energy/document/50671/download
Cited at: §6.3 (the transmission charging zone, "National Grid's statement for 2013/14 (doc 50671)"). Supplementary Note, Table S1: §2.1, PDF p.4.
Accessed 17 Oct 2026.
67. NERA Economic Consulting and Imperial College London (2015). (a) NERA, *System Integration Costs for Alternative Low Carbon Generation Technologies – Policy Implications*, 19 October 2015; (b) Imperial College London, *Value of Flexibility in a Decarbonised Grid and System Externalities of Low-Carbon Generation Technologies*, October 2015. Both for the Committee on Climate Change. https://www.theccc.org.uk/wp-content/uploads/2015/10/NERA-Final-Report-21-Oct-2015.pdf ; https://www.theccc.org.uk/wp-content/uploads/2015/10/CCC_Externalities_report_Imperial_Final_21Oct20151.pdf
Cited at: §3.3 ("the studies for the Committee by NERA and Imperial College (2015)").
Accessed 20 Oct 2026.
68. NESO (2025). *2025 Annual Balancing Cost Report Data Workbook*, sheet "Total outturn". https://www.neso.energy/document/362571/download (the report is document 362561)
Cited at: §11.3 ("NESO 2025, Annual Balancing Costs workbook"); §11.4 ("Total outturn", row 2024/25); note to Table 11.1 (rows 2022/23 and 2024/25). Supplementary Note, Table S1: rows FY 2018/19 and FY 2024/25.
Accessed 17 Oct 2026.
69. NESO (2026a). *Electricity Capacity Report 2026*. National Energy System Operator, as EMR Delivery Body. May 2026 (PDF created 6 Jul 2026). https://nationalenergyso-emr.my.salesforce.com/sfc/p/8d000002dUGC/a/Sr0000027ROv/SmmxZT4oauSSnfe1kS_OVwVq5_L_YAirVt2XzNMVEBk (link "2026 Electricity Capacity Report (ECR)" on https://emrdeliverybody.nationalenergyso.com/IG/s/article/Electricity-Capacity-Report-ECR)

Cited at: §2.5, p.5 (“NESO 2026”). Supplementary Note, Table S1: p.5 (PDF p.5), both columns.
Accessed by 19 Oct 2026.

70. NESO (2026b). *NESO Electricity Capacity Report 2026 Data Workbook*, sheet “Figure B1”. https://nationalenergyso-emr.my.salesforce.com/sfc/p/8d000002dUGC/a/Sr0000027RS9/y1YRskgortbec5.Y8Hvhs7FtOx6MMpgoLV4rhBOTQ70 (link “ECR 2026 Data Workbook”, same page as entry 69)
Cited at: §2.5 (“NESO 2026b, Data Workbook, Figure B1”). Supplementary Note, Table S1: sheet “Figure B1”, row “Base Case 2026”, column 2027/28.
Accessed 10 Oct 2026.
71. NESO (2026c). *Winter Outlook 2026/27: Early View*. June 2026 (PDF created 22 Jun 2026). https://www.neso.energy/document/383451/download
Cited at: §7.3, pp.5–6.
Accessed 21 Oct 2026.
72. NESO (dataset). *Capacity Market Register*, CMU file cmu_20261014.csv (resource last modified 14 Oct 2026). https://api.neso.energy/dataset/0b3ab475-5622-4465-8825-9d35d03bb28b/resource/25a5fa2e-873d-41c5-8aaf-fbc2b06d79e6/download/cmu_20261014.csv
Cited at: §7.3 (“the agreements NESO’s register flags as suspended”).
Accessed 17 Oct 2026.
73. NESO (dataset). *Current Balancing Services Use of System (BSUoS) Charges*, “RF” (final reconciliation) files 2016-2023-rf.csv, 2023-2024-rf.csv and 2024-2025-rf.csv, half-hourly, from 1 April 2016 to 31 March 2025. Package https://api.neso.energy/dataset/d6a4bf54-c63f-4014-a716-49fd3878ca52
Cited at: §11.3, “From 2017 the line is summed from NESO’s half-hourly data by calendar year”.
Accessed 23 Oct 2026.
74. NESO (dataset). *Historic Demand Data*, 2001–2025, one CSV a year. https://api.neso.energy/dataset/historic-demand-data
Cited at: §4.1 (“the system operator’s demand data”); Table 5.2 caption (“NESO’s demand data”).
Accessed 10–11 Oct 2026.
75. O’Shea, C., Horne, P. and Maslin, M. (2025). “Modelling the long-term financial benefits of UK investment in wind energy generation”. *UCL Open: Environment Preprints*, preprint 290, version 1, 23 October 2025. Not peer reviewed. https://doi.org/10.14324/ucloepreprints.290.v1
Cited at: §8.3 and §17.1, p.24; §3.3, p.1 and pp.31–32; Table 3.1, Tables 1, 9 and 10 (printed pp.4, 31, 32); §8.2 and §8.3, Table 4 (p.22) and Table 5 (p.25). Supplementary Note, Table S1: abstract PDF p.3 (printed p.1); Table 1 PDF p.6; Table 5 PDF p.27; Table 9 PDF p.33; Table 10 PDF p.34. Printed page = PDF page minus 2.
Accessed 17 Oct 2026; no version of record on Crossref, 21 Oct 2026.
76. OFFER (1999). *Reviews of Public Electricity Suppliers 1998 to 2000: Scottish Transmission Price Control Review: Consultation Paper*. June 1999 (PDF author field: Office of Electricity Regulation). https://www.ofgem.gov.uk/sites/default/files/docs/1999/06/review-of-pess-1998-to-2000-scottish-29-06.pdf
Cited at: §10.3, para 6.10, p.43 (“OFFER 1999”; the text calls it the consultation of OFFER).
Accessed 17 Oct 2026.
77. Ofgem (2000). *The transmission price control review of the National Grid Company from 2001: Transmission asset owner – Final proposals*. September 2000. https://www.ofgem.gov.uk/sites/default/files/docs/2000/09/transmission-price-control-review-of-ngc-from-2001---

transmission-owner-final-proposals-2709_0.pdf
Cited at: §10.3, PDF p.6 ("Ofgem 2000, TPCR final proposals").
Accessed 17 Oct 2026.

78. Ofgem and DTI (2003). *Transmission Charging and the GB Wholesale Electricity Market*, Part 1. August 2003. https://www.ofgem.gov.uk/sites/default/files/docs/2003/08/4411-betta_transcharging1.pdf
Cited at: §10.3, para 4.16, p.17 ("Ofgem and DTI 2003"). Supplementary Note, Table S1: "Ofgem/DTI 86/03 §4.16, p.17".
Accessed 17 Oct 2026.
79. Ofgem and Energy Saving Trust (2003). *A review of the Energy Efficiency Standards of Performance 1994 – 2002*. July 2003. https://www.ofgem.gov.uk/sites/default/files/docs/2003/07/4211-eesop_report_july03.pdf
Cited at: §13.3, Figure 3.1, p.14 ("Ofgem and EST 2003"). Supplementary Note, Table S1: Figure 3.1, PDF p.14; Appendix 5, pp.63–64 (PDF pp.69–70).
Accessed 17 Oct 2026.
80. Ofgem (2004a). *The Renewables Obligation: Ofgem's first annual report*. February 2004. https://www.ofgem.gov.uk/sites/default/files/docs/2004/02/6193-renewables_obligation_0.pdf
Cited at: §5.3, PDF p.2 ("Ofgem 2004a, RO first annual report").
Accessed 17 Oct 2026.
81. Ofgem (2004b). *The proposed transmission charging methodologies of the GB system operator: An Ofgem consultation and Impact Assessment*. October 2004, ref 241/04. https://www.ofgem.gov.uk/sites/default/files/docs/2004/10/8601-24104.pdf
Cited at: §10.3, para 4.118 ("Ofgem 2004b, 241/04").
Accessed 17 Oct 2026.
82. Ofgem (2004c). *Transmission price controls and BETTA: Final proposals and impact assessment*. December 2004, ref 279/04. https://www.ofgem.gov.uk/sites/default/files/docs/2004/12/9122-27904_0.pdf
Cited at: §10.3, Appendices 5 and 6, and Appendix 8 ("Ofgem 2004c, 279/04"). Supplementary Note, Table S1: Appendix 5, printed p.86 (PDF p.91); Appendix 6, printed p.88 (PDF p.93); Appendix 8, printed pp.92–93 (PDF pp.97–98).
Accessed 17 Oct 2026.
83. Ofgem (2006). *Transmission Price Control Review: Final Proposals*. Ref 206/06, 4 December 2006. https://www.ofgem.gov.uk/sites/default/files/docs/2006/12/16342-20061201_tpcr-final-proposals_in_v71-6-final_0.pdf
Cited at: §10.3 ("Ofgem 2006, TPCR4 final proposals").
Accessed 17 Oct 2026.
84. Ofgem (2015). *Wholesale Energy Markets in 2015*. Published 9 September 2015. Figure 5, "Monthly average wholesale gas prices (NBP Day-ahead), 2003-2015" (PDF p.19); Figure 8, "Monthly average wholesale power prices (baseload Day-ahead), 2003-2015" (PDF p.23). https://www.ofgem.gov.uk/sites/default/files/docs/2015/09/wholesale_energy_markets_in_2015_final_0.pdf
Cited at: §9.3, for gas before October 2009; §8.3, for power from January 2003 to May 2010.
Accessed 23 Oct 2026. Ofgem prints no table of these values; the release reads the two lines from the PDF's vector paths.
85. Ofgem (2017). *Targeted Charging Review: update on approach to reviewing residual charging arrangements*. November 2017. https://www.ofgem.gov.uk/sites/default/files/docs/2017/11/tcr_working_paper_nov17_final.pdf

Cited at: §10.3, p.36 (“Ofgem’s later working paper (Ofgem 2017, p.36)”).
Accessed 17 Oct 2026.

86. Ofgem (2019). *Renewables Obligation Annual Report 2017-18* (PDF title “RO Annual Report 17-18 (FINAL)”; PDF created 25 Mar 2019). https://www.ofgem.gov.uk/sites/default/files/docs/2019/03/ro_annual_report_2017-18_final_v1_1.pdf
Cited at: §2.3, para 2.30 (“Ofgem, RO annual report 2017-18”).
Accessed 17 Oct 2026 and 22 Oct 2026.
87. Ofgem (2022). *Annual Report on the Operation of the Capacity Market in 2020/21 and 2021/22*. One combined report, publication date 22 August 2022. https://www.ofgem.gov.uk/sites/default/files/2022-08/Annual%20Report%20on%20the%20Operation%20of%20CM%202020-21%20and%202021-22_Final_with_Accessibility-Adressed.pdf
Cited at: §16.2, para 3.49, p.37. Supplementary Note, Table S1: para 3.49, PDF p.37.
Accessed 17 Oct 2026.
88. Ofgem (2026). *Wholesale market indicators*, two charts, both “Ofgem analysis of broker data”, “Information correct as of August 2026”: (a) “Gas Prices: Day Ahead Contracts - Monthly Average (Great Britain)” (everviz chart YFsS4g98P), p/therm; (b) “Electricity Prices: Day Ahead Baseload Contracts - Monthly Average (Great Britain)” (everviz chart n9WSDfgxc), £/MWh. https://www.ofgem.gov.uk/news-and-insight/data/data-portal/wholesale-market-indicators
Cited at: §8.3 (“Ofgem’s monthly price”, power); §9.3 (“Ofgem’s day-ahead gas price: Wholesale Market Indicators from October 2009”), (“Ofgem, Wholesale Market Indicators, day-ahead gas”).
Accessed (a) 17 Oct 2026; (b) 23 Oct 2026; the page, 21 Oct 2026.
Held: (a) gas, October 2009 to June 2026; (b) power, June 2010 to June 2026. The release takes the months before these from Ofgem (2015), Figures 5 and 8 (the gas months before October 2009; the power months from January 2003 to May 2010).
89. ONS (2004). Lin, E. and Francis, P., “Industrial analysis of environmental taxes”. *Economic Trends* 609, August 2004. Office for National Statistics. Copy used: https://www.cbd.int/financial/fiscalenviron/uk-taxanalysis.pdf (a third-party host, not ONS).
Cited at: §13.3 (“ONS, Economic Trends 609, 2004”). Supplementary Note, Table S1: PDF p.4.
Accessed 17 Oct 2026.
90. ONS (2015). *Environmental Taxes – 2014*. 1 June 2015. Copy used: https://backup.ons.gov.uk/wp-content/uploads/sites/3/2015/06/Environmental-Taxes-2014.pdf
Cited at: §2.7 and §13.3, PDF p.11 (“ONS 2015, Environmental Taxes 2014”).
Accessed 17 Oct 2026.
91. ONS (2026). *Households by household size, regions of England and Great Britain constituent countries, 2025* (Labour Force Survey). https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/householdsbyhouseholdsizeregionsofenglandandgbconstituentcountries/2025/householdsizebyregionscountries2025.xlsx
Cited at: §2.7 (sheets England, Wales, Scotland, 2024, summed); Annex A.1 (“ONS”). Supplementary Note, Table S1: row “All households”, 2024 column.
Accessed 10 Oct 2026.
Note: the workbook itself is headed “Households by size” (date published 17 April 2026); the title above is the ONS dataset’s own title, from the file’s URL.
92. ONS (2026a). Series CIQY, “CG receipts: taxes on expenditure: fossil fuel levy”. EDP dataset, released 22 Sep 2026 (a Blue Book version, released 31 Oct 2025, is saved beside it). https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/publicspending/timeseries/ciqy/

edp (CSV https://www.ons.gov.uk/generator?format=csv&uri=/economy/governmentpublicsectorandtaxes/publicspending/timeseries/ciqy/edp); Blue Book version https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/publicspending/timeseries/ciqy/bb (CSV https://www.ons.gov.uk/generator?format=csv&uri=/economy/governmentpublicsectorandtaxes/publicspending/timeseries/ciqy/bb)
Cited at: §13.3 ("ONS, series CIQY"). Supplementary Note, Table S1: quarters 2001 Q2 to 2002 Q1, CSV lines 310–313.
Accessed by 17 Oct 2026.

93. ONS (2026b). CPIH index, series L522 (dataset MM23), "CPIH INDEX 00: ALL ITEMS 2015=100". Release of 16 September 2026. https://www.ons.gov.uk/generator?format=csv&uri=/economy/inflationandpriceindices/timeseries/l522/mm23
Cited at: Conventions. Supplementary Note, Table S1 (the 2001 CCL rate carried by CPIH).
Accessed 10–11 Oct 2026.

94. Pellini, E. (2021). "Estimating income and price elasticities of residential electricity demand with Autometrics". *Energy Economics* 101, 105411. https://doi.org/10.1016/j.eneco.2021.105411.
Cited at: §12.6, Table 4. Supplementary Note, Table S1: Table 4, PDF p.15 (printed p.14).
Copy used: the accepted version from City Research Online, https://openaccess.city.ac.uk/id/eprint/26961/ its page numbers differ from the journal's. Accessed 17 Oct 2026.
Held: the accepted version, not the journal's typeset version.

95. Porter, K. (2025). *The true affordability of net zero*. Watt-Logic, May 2025 (launched 19 May 2025). Consultancy report, not peer reviewed. https://watt-logic.com/wp-content/uploads/2025/05/Affordability-of-net-zero-FINAL-SPREAD.pdf
Cited at: §3.3 ("No figure of hers is printed here"). Locators: her figure, against a continued "legacy gas-based power system", Executive Summary, margin note, printed p.4 (PDF p.3); her method, the earlier margin of household retail over wholesale electricity prices held constant, and the households' saving it gives, "The true costs of the energy transition", printed pp.8–9 (PDF p.5); household prices from the Office for National Statistics' household expenditure, "Note on data", printed p.8 (PDF p.5); the figure restated, "Conclusions", printed p.46 (PDF p.24).
Accessed 17 Oct 2026, 19 Oct 2026 and 23 Oct 2026.

96. Prime Minister's Office, 10 Downing Street (2026). "The King's Speech 2026". GOV.UK speech, delivered 13 May 2026. https://www.gov.uk/government/speeches/the-kings-speech-2026
Cited at: §17.3.
Accessed 17 Oct 2026.

97. Reuters (2016). Chestney, N., Britain's Rugeley coal plant to close this summer - Engie (syndicated on Yahoo News), 8 February 2016. https://www.yahoo.com/news/britains-rugeley-coal-plant-close-182329491.html
Cited at: §6.3 ("Reuters … reported Engie's announcement on 8 … February 2016").
Accessed 17 Oct 2026.
Note: the headline wording above is from the URL slug; the record does not give the headline.

98. ScottishPower (2016). "Longannet Closure Marks the end of Coal-Fired Electricity Generation in Scotland". News release, 24 March 2016. Original URL http://www.scottishpower.com/news/pages/longannet_closure_marks_the_end_of_coal_fired_electricity_generation_in_scotland.asp ; copy used: Internet Archive capture of 28 Mar 2016, https://web.archive.org/web/20160328230254id_/http://www.scottishpower.com:80/news/pages/longannet_closure_marks_the_end_of_coal_fired_electricity_generation_in_scotland.asp

Cited at: §6.3 (“ScottishPower, 24 March 2016”).
Accessed 21 Oct 2026.

99. Shao, J., Chen, H., Li, J. and Liu, G. (2022). “An evaluation of the consumer-funded renewable obligation scheme in the UK for wind power generation”. *Renewable and Sustainable Energy Reviews* 153, 111788, January 2022. https://doi.org/10.1016/j.rser.2021.111788.
Cited at: §8.2 and §8.3 (“Shao and others (2022)”). Supplementary Note, Table S1 (the uplift labels).
Copy used: the authors’ accepted manuscript, Swansea University’s Cronfa record 58360. Accessed by 20 Oct 2026.
Held: the authors’ accepted manuscript, not the publisher’s version.

100. The Energyst (2016). Coyne, B., “Engie to close 1GW Rugeley coal-fired power station”, 9 February 2016. https://theenergyst.com/engie-to-close-1gw-rugeley-coal-fired-power-station/
Cited at: §6.3 (“The Energyst reported Engie’s announcement on … 9 February 2016”).
Accessed 17 Oct 2026.
Note: the title above is from the URL slug; the record does not give the headline.

101. Ueckerdt, F., Hirth, L., Luderer, G. and Edenhofer, O. (2013). “System LCOE: What are the costs of variable renewables?”. *Energy* 63, 61–75.
Cited at: §3.3 (“Ueckerdt and others (2013)”).
Copy used: author copy in journal layout, https://neon.energy/Ueckerdt-Hirth-Luderer-Edenhofer-2013-System-LCOE-Costs-Renewables.pdf. Accessed 17 Oct 2026.

102. UK Government (2001). The Social Security (Contributions) (Re-rating and National Insurance Funds Payments) Order 2001, SI 2001/477. Made 20 Feb 2001; in force 6 Apr 2001. As made. https://www.legislation.gov.uk/uksi/2001/477/made
Cited at: §13.3 (“SI 2001/477”). Supplementary Note, Table S1: art. 2 and the explanatory note.
Accessed 17 Oct 2026.

103. UK Government (2014). The Electricity Capacity Regulations 2014, SI 2014/2043. Reg. 6, as made and as revised (amendments of 2016 and 2025 leave reg. 6(1) unchanged); reg. 2, revised. https://www.legislation.gov.uk/uksi/2014/2043/regulation/6 ; https://www.legislation.gov.uk/uksi/2014/2043/regulation/2/data.xml
Cited at: §2.5 (reg. 6, the reliability standard); §7.3, reg. 2 (“capacity year”). Supplementary Note, Table S1: reg. 6(1).
Accessed 19 Oct 2026 (reg. 6) and 21 Oct 2026 (reg. 2).

104. UK Government (2015). The Electricity Supplier Obligations (Amendment & Excluded Electricity) Regulations 2015, SI 2015/721. Made 14 Mar 2015; in force 1 Apr 2015. As made; reg. 11 as at 31 Mar 2024. https://www.legislation.gov.uk/uksi/2015/721/made ; https://www.legislation.gov.uk/uksi/2015/721/regulation/11/2024-03-31/data.xml
Cited at: §2.7, reg. 1(2) and reg. 11(2). Supplementary Note, Table S1: reg. 11(2).
Accessed 17 Oct 2026 and 21 Oct 2026.

105. UK Government (2017). The Renewables Obligation (Amendment) (Energy Intensive Industries) Order 2017, SI 2017/1289. As made. https://www.legislation.gov.uk/uksi/2017/1289/made
Cited at: §2.7, art. 1(1).
Accessed 21 Oct 2026.

106. UK Government (2018). The Feed-in Tariffs (Closure, etc.) Order 2018, SI 2018/1380. As made. https://www.legislation.gov.uk/uksi/2018/1380/made
Cited at: §2.7, art. 13(4).
Accessed 21 Oct 2026.

107. UK Government (2024a). The Electricity Supplier Obligations (Excluded Electricity) (Amendment) Regulations 2024, SI 2024/419. As made; in force 1 April 2024. https://www.legislation.gov.uk/uksi/2024/419/made
Cited at: §2.7. Supplementary Note, Table S1: reg. 1, reg. 6 and the explanatory note.
Accessed 19 Oct 2026.
108. UK Government (2024b). The Electricity Capacity (Supplier Payment etc.) (Amendment and Excluded Electricity) Regulations 2024, SI 2024/434. As made; in force 1 April 2024. https://www.legislation.gov.uk/uksi/2024/434/made/data.xml
Cited at: §2.7, reg. 1, reg. 1(2) and the explanatory note; Annex A.5.
Accessed 21 Oct 2026.
109. UK Parliament (1989). Electricity Act 1989 (c. 29), s.32, "The renewables obligation". Revised text, version valid from 24 Jul 2026. https://www.legislation.gov.uk/ukpga/1989/29/section/32
Cited at: §17.2, draft clause, subsection (3)(a).
Accessed 20 Oct 2026.
110. UK Parliament (1994). Value Added Tax Act 1994 (c. 23), s.29A ("Reduced rate"). Revised text. https://www.legislation.gov.uk/ukpga/1994/23/section/29A
Cited at: §2.7, s.29A(1). Supplementary Note, Table S1: s.29A(1).
Accessed 19 Oct 2026.
111. UK Parliament (2000). Finance Act 2000 (c. 17), Schedule 6 (climate change levy): para 42(1), as enacted; para 42A, revised text (version valid from 7 Apr 2026). https://www.legislation.gov.uk/ukpga/2000/17/pdfs/ukpga_20000017_en.pdf ; https://www.legislation.gov.uk/ukpga/2000/17/schedule/6/paragraph/42A
Cited at: §17.2, draft clause, subsection (3)(e) (para 42A). Supplementary Note, Table S1: Sch. 6 para 42(1) (the 2001 electricity rate).
Accessed 17 Oct 2026 (the Act as enacted; para 42 on PDF pp.173–174) and 20 Oct 2026 (para 42A).
112. UK Parliament (2001). Finance Act 2001 (c. 9), s.99, "VAT: re-enactment of reduced-rate provisions". As enacted (revised text saved beside it). https://www.legislation.gov.uk/ukpga/2001/9/section/99/enacted
Cited at: Supplementary Note, Table S1 only ("Value Added Tax Act 1994, s.29A(1) (inserted by Finance Act 2001 s.99)").
Accessed 23 Oct 2026.
Held: full.
113. UK Parliament (2008a). Climate Change Act 2008 (c. 27), s.16, "Annual statement of UK emissions". Revised text. https://www.legislation.gov.uk/ukpga/2008/27/section/16
Cited at: §17.2 ("section 16"; the draft clause inserts s.16A after it).
Accessed 17 Oct 2026.
114. UK Parliament (2008b). Energy Act 2008 (c. 32), s.41, "Power to amend licence conditions etc: feed-in tariffs". Revised text, version valid from 19 Jun 2025. https://www.legislation.gov.uk/ukpga/2008/32/section/41
Cited at: §17.2, draft clause, subsection (3)(b).
Accessed 20 Oct 2026.
115. UK Parliament (2011). Budget Responsibility and National Audit Act 2011 (c. 4), ss.4 and 5. Revised text. https://www.legislation.gov.uk/ukpga/2011/4/section/4 ; https://www.legislation.gov.uk/ukpga/2011/4/section/5
Cited at: §17.3, s.4(1), s.5(1), s.5(2), s.5(3)(b).
Accessed 17 Oct 2026.

116. UK Parliament (2013). Energy Act 2013 (c. 32), Part 2, Chapter 2 (“Contracts for Difference”) and Chapter 3 (“Capacity Market”). Revised text, version valid from 1 Oct 2024. https://www.legislation.gov.uk/ukpga/2013/32/part/2/chapter/2 ; https://www.legislation.gov.uk/ukpga/2013/32/part/2/chapter/3
Cited at: §17.2, draft clause, subsection (3)(c) and (d).
Accessed 20 Oct 2026.

117. UK Parliament (2026). Bills API search, “Energy Independence”, 21 October 2026. https://bills-api.parliament.uk/api/v1/Bills?SearchTerm=Energy%20Independence
Cited at: §17.3 (“Parliament’s bills search found no such Bill on 21 October 2026”).
Accessed 21 Oct 2026.

118. Uniper SE (2025). *Annual Report 2024* (“Financial Results Annual Report 2024”). February 2025 (PDF created 24 Feb 2025). Uniper URL https://www.uniper.energy/system/files/2025-03/2025_02_25_FY_2024_Uniper_Annual_Report.pdf (blocks scripts); copy used: https://www.annualreports.com/HostedData/AnnualReportArchive/u/uniper-se_2024.pdf
Cited at: §6.3, p.38 (“Uniper, Annual Report 2024, p.38”; printed p.38 is PDF p.42).
Accessed 21 Oct 2026.

119. Zakeri, B., Staffell, I., Dodds, P. E., Grubb, M., Ekins, P., Jääskeläinen, J., Cross, S., Helin, K. and Castagneto Gissey, G. (2023). “The role of natural gas in setting electricity prices in Europe”. *Energy Reports* 10, 2778–2792. https://doi.org/10.1016/j.egyr.2023.09.069. Open access (CC BY). Copy used: https://pure.iiasa.ac.at/id/eprint/19109/1/1-s2.0-S2352484723013057-main.pdf
Cited at: §3.2, p.2778 (“Zakeri and others 2023”).
Accessed by 19 Oct 2026.

C.1 Not saved

The note cites this source, but no copy of it is held.

Krichene, N. (2002). “World crude oil and natural gas: a demand and supply model”. *Energy Economics* 24(6), 557–576, November 2002. https://doi.org/10.1016/S0140-9883(02)00061-0.
Status: not saved (closed access); only the Crossref record is held. The values used are from Krichene (2005), entry 52: Table 5, p.20, for the short-run supply elasticity, and Table 2, p.12, for the long-run pair.
Cited at: §9.3, as the source Albrizio and others give for their supply elasticity (Albrizio and others 2022, p.12). Supplementary Note, Table S1.