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UK Renewable Electricity Subsidy Totals: 2002 to the Present Day

Summary

This study provides an estimate of the total cost of five direct and five indirect subsidies to the renewable electricity sector in the United Kingdom since 2002. We find that:

- *In the period 2002 to the present, the total cost to the electricity consumer of those renewable electricity subsidy schemes that we can quantify has amounted to approximately £220 billion (in 2024 prices), equivalent to nearly £8,000 per household.*
- *The annual subsidy cost is currently £25.8 billion a year, a sum equivalent to nearly fifty per cent of UK annual spending on defence.*
- *Subsidy to renewable electricity generators now comprises about 40% of the total cost of electricity supply in the United Kingdom (Figure 1 below).*

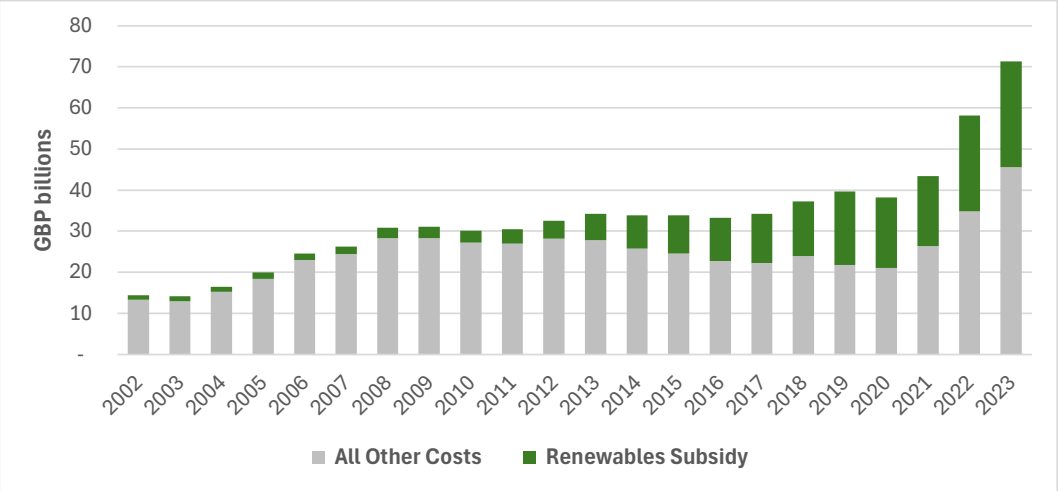

Figure 1. Renewable electricity subsidy as a share of the total cost of electricity to consumers, 2002-2023. Source: REF Estimates, DESNZ data.

- *The total subsidy cost per unit of renewable electricity generated has risen by nearly 50% in real terms since 2005 and now stands at approximately £200/MWh. This contradicts government and industry claims that renewables are becoming cheaper but is consistent with expectations from the physics of energy flows, the empirical study of the capital and operating costs of both wind and solar, and the grid expansion and reinforcement and system management costs known to be imposed by renewables.*

  We conclude that these costs in large part explain falling electricity consumption in the UK, which has declined by 23% since 2005 when the cost of the subsidy schemes first became salient.

  These findings shed valuable light, we believe, on both the cost-of-living crisis and the stagnation in UK productivity growth.

Direct Subsidies

Direct subsidies to support the introduction of renewable electricity sources in the United Kingdom date back to the Non-Fossil Fuel Obligation (NFFO) of 1990 (known as the Northern Ireland (NI) NFFO and the Scottish Renewables Obligation (SRO) in those jurisdictions). This scheme, initiated by the Conservative government of the time, was parsimonious and resulted in little development of wind or other sources, with only a few hundred megawatts of capacity deployed. As a result, the costs of the NFFO to the British electricity consumer (industrial, commercial and domestic) were almost negligible, and as soon as a more generous scheme became available, NFFO projects re-registered under the new dispensation. For these reasons, we do not consider NFFO costs in this discussion.

The successor mechanism, the Renewables Obligation (RO), was introduced in 2002 by the Blair government. The RO required suppliers to obtain a specified fraction of their sales to consumers from renewable sources or pay a fine. Compliance was demonstrated by the possession of Renewable Obligation Certificates (ROCs) purchased from renewable electricity generators at the rate of one per megawatt hour. Later iterations of the scheme introduced different levels of support via "banding", whereby a generator received more or less than one ROC per MWh depending on its technology type and date of deployment. Those interested in the details of the RO are referred to REF's discussion: "Notes on the Renewable Obligation".

The RO offered generous support to renewables developers, approximately doubling their income, per unit of electrical energy generated, over and above the wholesale price of the day. However, the original design of the scheme ensured that when the nominated target for the market share of renewable generation was met, the value of the ROC would fall to zero, thus limiting costs to the consumer. With the introduction of the European Union Renewables Directive (2009) and its related targets this principle of cost limitation was abandoned and instead target "headroom" was introduced to ensure that the value of the ROC would never fall to zero.[1] In effect, as soon as a target was met it was replaced by a higher one ensuring that more subsidy would flow. This use of unlimited subsidies to meet targets, rather than to try to accelerate cost reduction in the sector, exposed the consumer to unbounded costs.

Furthermore, headroom in the RO derisked renewables to such an extent that there was what might be described as a feeding-frenzy of development which continued until the scheme was closed to new entrants in April 2017, largely as a result of cost but also because of controversy in the planning system. By the time of the RO closure, successive revisions and adjustments to the technology groupings and number of ROCs awarded per MWh meant that the number of different allocation bands had grown from nine in 2003 to 68 in 2017. Solar PV installations alone have 9 different possible rates of ROCs per MWh depending on their size and when and where they were built.

Many small-scale schemes that registered under the RO were later able to transfer to the still more generous Feed-in Tariff (the FiT, discussed below), except in Northern Ireland where, for technical administrative reasons, they remained in the Renewables Obligation. Excluding the 22,684 generators in Northern Ireland, which

[1] https://www.gov.uk/government/publications/renewables-obligation-level-calculations-2025-to-2026/calculating-the-level-of-the-renewables-obligation-for-2025-to-2026

comprise only about 100 MW or 0.3% of all RO capacity, there are, according to Ofgem which administers the scheme, currently some 3,926 generators with a total capacity of 35.4 GW receiving subsidy under the Renewables Obligation.[2]

Subsequent governments introduced two further schemes:

- The Feed-in Tariff (FiT) for small-scale projects (< 5 MW in capacity) such as roof-top solar, which began in 2010 and to which, as noted above, many smaller RO generators were able to transfer. The scheme closed to new entrants in 2019, and there are currently nearly 870,000 generators receiving subsidy via this mechanism.[3] As with the RO, the FiT scheme has been continuously revised in an attempt to keep subsidy costs down, but with the result of ever-growing administrative complexity. Initially there were 20 different FiT tariffs, but as of today there are more than 800.
- The Feed-in Tariffs with Contracts for Difference (CfDs) for large scale renewable generators (> 5 MW), which was introduced in 2014, and remains open to projects bidding for contracts in the Allocation Rounds, of which there have been six so far with a seventh due in 2025.[4] Of the successful bidders, some 31 schemes comprising 9 GW have implemented their contracts, are in operation and receiving subsidy. Again, complications and unintended consequences have required changes in the CfD contract terms with practically every new allocation round. The lessons of the RO and the FiT do not appear to have been learned.

  A further direct subsidy is available through constraint payments to reduce output, at present mostly paid to wind power in Scotland. These are regarded as subsidies since they are notionally paid as compensation for subsidy lost when the wind farm concerned is constrained off the network. In fact, generators routinely receive more in compensation than they have lost, a matter on which REF has commented repeatedly and which we believe is an abuse of market power.

  Another direct subsidy is available through the Renewable Energy Guarantee of Origin (REGO) system, introduced in 2003. This scheme issues certificates to renewable generators, one per MWh generated, to sell on to suppliers so that they can demonstrate the renewable component in their required Fuel Mix Disclosure. This was an EU-wide scheme, and electricity suppliers were permitted to purchase Guarantees of Origin from any member state in the European Union.

  Initially the prices at auction for REGOs were very low, sometimes as little as 20p per certificate. However, after Brexit, EU certificates could not be presented in the UK, and this resulted in a shortage and a sharp price rise, with values in October 2023, for example, going as high as £24.80 per certificate.

  Prices have fluctuated since but remain at levels where the impact on consumers could be significant. Unfortunately, while the total number of REGOs issued is a matter of public record, the total cost to consumers is not. For example, while auction price data is readily available,[5] the number auctioned at any particular price is not made public. Similarly, while other sources of data relate to the average fraction of the price specified

[2] https://www.ofgem.gov.uk/publications/renewables-obligation-ro-annual-report-scheme-year-22-april-2023-march-2024.
[3] https://www.ofgem.gov.uk/publications/feed-tariffs-annual-report-scheme-year-14-april-2023-march-2024
[4] https://www.gov.uk/government/collections/contracts-for-difference
[5] https://epower.net/wp-content/uploads/2024/12/e-REGO_Track_Record.pdf

under a Power Purchase Agreement (PPA) that is to be accounted for by the REGO, the volumes contracted by such PPAs are not public data and the total cost cannot be exactly calculated.

However, we believe it is likely that all REGOs issued impose a cost on the consumer approaching that of the auction or PPA value, even in the case of renewable generators owned, usually as Special Purpose Vehicles (SPVs), by vertically integrated companies that also supply electricity to consumers. In such cases we believe that internal trading between the SPV and the parent company is likely, and the cost will be passed on to consumers.

If all certificates issued achieved the published auction results the costs to the British consumer could have been as high as £1.5 billion in some years and given that potential magnitude, and in spite of the uncertainty in exact calculation, it would be misleading to pass over it in silence.

Indeed, we are surprised that neither the regulator Ofgem nor the Office for Budget Responsibility (OBR) seems to have oversight of this potential cost to the consumer, with no figures appearing, for example and as far as we are aware, in the OBR's Economic and Fiscal Outlook.

However, we have been conservative in our approach, and for the purposes of the estimate we have assumed a zero value prior to 2015, and then a very low value of 20p per certificate, up to 2022, and used the publicly available estimate of Renewable Exchange for the average PPA REGO bid for all subsequent years.

The revenue streams of the RO, the FiT, the CfD, constraint payments, and REGOs comprise the direct subsidies available to renewables, that is to say revenue streams that result in cash transfers from electricity consumers to the renewable generation sector. While reasonably well known to most analysts they are rarely set down in one place so that their full cost can be appreciated at a glance, as here in Table 1.

Taken together these schemes have cost consumers about £113 billion pounds (in 2024 prices) over the period 2002 to 2024.

We draw particular attention to the costs of the Feed-in Tariffs for small-scale generators, which are often overlooked and indeed are not even listed in the tables of green levies published by the Office for Budget Responsibility (OBR). This scheme has resulted in cash transfers from all electricity consumers regardless of wealth to participants in the FiT scheme amounting to some £15 billion in nominal prices.

We emphasise that this coerced transfer of funds is from households unable to invest in capital-intensive small-scale renewables, for example households on low incomes or in rented accommodation, to others fortunate enough to have disposable cash or collateral against which they can borrow. Ironically, this viciously regressive policy, taking from the poor to make the rich richer, was instituted in April 2010 by the then Secretary of State Ed Miliband in the Labour Party government of Gordon Brown.

Indirect Subsidies

In addition to direct income support subsidies the UK electricity markets are also indirectly coerced in favour of renewable generation through a) Penalties on competitors to renewables, b) Avoided Costs arising when renewables are not required to pay for the system management difficulties they cause, and c) Subtle legal coercions nudging consumers, particularly industrial and commercial consumers, into Power Purchase Agreements with renewable generators that would, for economic reasons, not otherwise be undertaken. Further details under these three headings follow:

- Penalties include the EU Emissions Trading Scheme (EU ETS), and its successor the UK Emissions Trading Scheme (UK ETS), and the Climate Change Levy (CCL), a tax charged on industrial uses of non-renewable electricity. These are indirect subsidies, since they handicap sources of energy such as coal and gas, increasing the price they must charge, and thus give renewables a competitive advantage. These costs are a matter of public record and straightforwardly identifiable.
- Avoided costs arise because the UK's market structures almost entirely spare randomly intermittent (stochastic) generators such as wind and solar from the high system management costs they cause. These costs are visible in the charges incurred under three headings: 1) The Balancing Services Use of System (BSUoS) charge; 2) the Capacity Mechanism (a scheme to ensure that sufficient dispatchable conventional generation capacity is available to meet load in the absence of wind and solar), and 3) the cost of grid expansion and reinforcement necessitated by embedded and distributed renewables, paid for via the Transmission Network Use of System (TNUoS) charge. However, while the total BSUoS and TNUoS costs are a matter of public record, it is only possible to make an estimate of the fraction of the increase in these figures that is attributable to renewables. BSUoS, for example, cost consumers about £370m a year (in nominal prices) in the early 2000s but has recently risen to several billion pounds a year. While inflation accounts for some of this increase, it is not controversial to assume that the vast bulk of the rise is attributable to the presence of uncontrollable generation such as wind and solar. We have taken the cost in the period 2002/3 to 2004/5 as the base cost, and, inflating that base cost appropriately, the increase over and above that base as caused by renewables. Because this cost is socialised over the entire market we regard it as an indirect subsidy to the renewables sector.
- Subtle, market-wide, coercions of significance began in 2019 when the Conservative government of Theresa May embedded the Streamlined Energy and Carbon Reporting framework (SECR) within the Companies Act. This legislation places a requirement on companies covered by the Act and consuming more than 40 MWh of energy (a low threshold) to report their energy consumption and carbon emissions. Breaches of the Companies Act are a criminal offence and a serious concern for any listed company, or indeed any company concerned about its public reputation. Thus, SECR creates a considerable pressure on company directors and trustees to adopt low carbon energy sources through "green" supply tariffs and Power Purchase Agreements, with the scope of the legislation being in practice very broad. For example, even educational Academy Trusts fall within the net: see Education and Skills Funding Agency: "Streamlined Energy and Carbon Reporting (SECR) for academy trusts"). In effect SECR is a legislative nudge favouring the renewables sector and deprecating fossil fuels while encouraging the adoption of renewable energy sources. In our view this is an indirect subsidy. It is sometimes claimed that some wind farms or solar installations are "unsubsidised" since they are not registered under the RO, the CfD,

or the FiT, but have private Power Purchase Agreements. We suggest that this claim is false. Firstly, these projects claim REGOs, and, as we have seen, REGOs provide a direct subsidy to the generator since they have value and are charged to the consumer. Secondly, and more importantly, the Power Purchase Agreements are at least in part the result of a market coercion, the Streamlined Energy and Carbon Reporting sections of the Companies Act. The PPAs are not the result of undistorted relation between willing purchasers and sellers, with purchasers, ranging from FTSE 100 corporates to Academy Trusts, under some degree of compulsion. In essence this nudge policy conceals subsidies to renewables within the increased costs of goods and services. However, because the PPAs are confidential bilateral arrangements about which there is very little public information, we cannot readily quantity this "stealth" subsidy, and we do not attempt to do so here.

This is not an exhaustive list of indirect subsidies to renewables. For example, the Smart Export Guarantee (SEG) makes it mandatory for larger electricity suppliers to offer export tariffs to small scale renewable generators, and the Offtaker of Last Resort (OLR) scheme provides the, apparently as yet unimplemented, potential for backstop power purchase agreements for generators unable to obtain a commercial PPA. As with the SECR it is not possible to quantify the current cost to consumers of these schemes. Therefore Table 2 includes the EU ETS, UK ETS, CCL, BSUoS, and TNUoS costs, but excludes SECR, SEG, and OLR.

In addition, we have also excluded consideration of Distribution Use of System (DUoS) charges, that is charges permitted to the Distribution Network Operators (DNOs) and recovered ultimately through consumer bills. Based on statements of revenue in audited accounts we estimate that DNO revenue totals about £6bn a year in Great Britain, but due to opacity and a lack of data we cannot see how much of this is recovered through DUoS and due to the connection of renewables or associated equipment, such as batteries, and are therefore unable to investigate how much of this undoubted cost of renewables might be considered to be subsidy.

Table 1: Direct Subsidies to Renewable Electricity Generation in the United Kingdom (£bn, nominal) 2002–2024

Period	RO[6]	CfD[7]	FiT[8]	Constraints[9]	REGO[10]	Totals
2002/2003	0.3					0.3
2003/2004	0.4			-		0.4
2004/2005	0.5			-		0.5
2005/2006	0.6			-		0.6
2006/2007	0.7			-		0.7
2007/2008	0.9			-		0.9
2008/2009	1.0			-		1.0
2009/2010	1.1			-		1.1
2010/2011	1.3	0.0	0.0	-		1.3
2011/2012	1.5	0.2	0.0	-		1.6
2012/2013	2.0	0.5	0.0	-		2.5
2013/2014	2.6	0.7	0.0	-		3.3
2014/2015	3.1	0.9	0.1	0.0		4.0
2015/2016	3.7	1.1	0.1	0.0		5.0
2016/2017	4.5	0.1	1.3	0.1	0.0	6.0
2017/2018	5.3	0.5	1.4	0.1	0.0	7.4
2018/2019	5.9	1.0	1.5	0.2	0.0	8.6
2019/2020	6.3	1.8	1.6	0.2	0.0	9.9
2020/2021	5.7	2.3	1.6	0.2	0.0	9.9
2021/2022	6.4	0.3	1.3	0.2	0.1	8.2
2022/2023	6.4	0.0	1.5	0.2	0.5	8.6
2023/2024	6.8	1.8	1.8	0.4	1.0	11.7
Totals	**67.0**	**7.8**	**15.3**	**1.7**	**1.7**	**93.5**

[6] Figure 5.10 RO Annual Report 2022-2023
[7] LCCC data https://dp.lowcarboncontracts.uk/dataset/actual-cfd-generation-and-avoided-ghg-emissions
[8] Ofgem FiT annual reports
[9] REFs constraints data www.ref.org.uk/constraints
[10] Downloaded REGOS fromhttps://renewablesandchp.ofgem.gov.uk/ & REGO prices https://renewable.exchange/blog/rego-index-update-october-2023/

Table 2: Indirect Subsidies to Renewable Electricity Generation in the United Kingdom (£bn, nominal) 2002–2024. The columns giving BSUoS and TNUoS charges show REF's estimates of the total cost attributable to renewable energy, and in parentheses the total charge for that year.

Period	ETS[11]	CCL[12]	Capacity[13]	BSUoS[14]	TNUoS[15]	Totals
2002/2003	-	0.8	-	0.0 (0.4)	0.0 (0.9)	0.8
2003/2004	-	0.8	-	0.0 (0.4)	0.0 (0.9)	0.8
2004/2005	-	0.8	-	0.0 (0.4)	0.0 (0.9)	0.7
2005/2006	-	0.7	-	0.2 (0.6)	0.0 (0.9)	1.0
2006/2007	-	0.7	-	0.2 (0.7)	0.0 (1.0)	0.9
2007/2008	-	0.7	-	0.3 (0.7)	0.0 (1.0)	0.9
2008/2009	-	0.7	-	0.6 (1.0)	0.3 (1.4)	1.6
2009/2010	0.1	0.7	-	0.3 (0.8)	0.5 (1.6)	1.6
2010/2011	0.2	0.7	-	0.3 (0.7)	0.5 (1.6)	1.7
2011/2012	0.3	0.7	-	0.5 (0.9)	0.5 (1.6)	1.9
2012/2013	0.3	0.7	-	0.4 (0.9)	0.5 (1.6)	1.8
2013/2014	0.4	1.2	-	0.5 (1.0)	1.0 (2.2)	3.1
2014/2015	0.4	1.6	-	0.6 (1.0)	1.3 (2.5)	4.0
2015/2016	0.5	1.8	-	0.6 (1.1)	1.5 (2.6)	4.3
2016/2017	0.4	1.9	-	0.7 (1.2)	1.5 (2.7)	4.5
2017/2018	0.3	1.9	0.2	0.7 (1.2)	1.4 (2.6)	4.5
2018/2019	0.3	1.9	0.2	0.9 (1.4)	1.4 (2.7)	4.7
2019/2020	1.6	2.0	1.7	1.1 (1.6)	1.6 (2.8)	7.9
2020/2021	1.3	1.8	1.1	1.5 (2.0)	1.6 (2.8)	7.2
2021/2022	1.0	1.9	0.9	2.9 (3.5)	2.0 (3.3)	8.8
2022/2023	5.8	2.1	0.7	4.0 (4.6)	2.2 (3.6)	14.7
2023/2024	6.1	1.9	1.0	2.2 (2.9)	2.9 (4.4)	14.1
Totals	**19.0**	**27.9**	**5.8**	**18.5 (29.0)**	**20.4 (45.7)**	**91.5**

[11] https://obr.uk/forecasts-in-depth/tax-by-tax-spend-by-spend/emissions-trading-scheme-uk-ets/
[12] https://obr.uk/ Economic and fiscal supplementary fiscal tables: receipts and other - CCL
[13] https://obr.uk/ Economic and fiscal supplementary fiscal tables: receipts and other – environmental levies
[14] https://www.neso.energy/industry-information/charging/balancing-services-use-system-bsuos-charges
[15] https://www.neso.energy/industry-information/charging/tnuos-charges from 2013; Transmit consultation documents for 2008-2013; prior to 2008, https://www.ofgem.gov.uk/sites/default/files/docs/2004/07/7851-18204.pdf and 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

Discussion: The Economic Impact of Subsidies to Renewable Electricity

The total consumer cost of subsidies to renewable electricity generation from 2002 to 2024 amounts to some £223 billion in 2024 prices (£185 billion nominal).

Direct subsidies account for £113 billion, and indirect subsidies for £110 billion (both in 2024 prices).

The annual renewable electricity subsidy cost now amounts to about £25 billion per year (see Figure 2 below). For comparison, this is equivalent to almost half of the £54 billion per year that the UK spends on defence.[16]

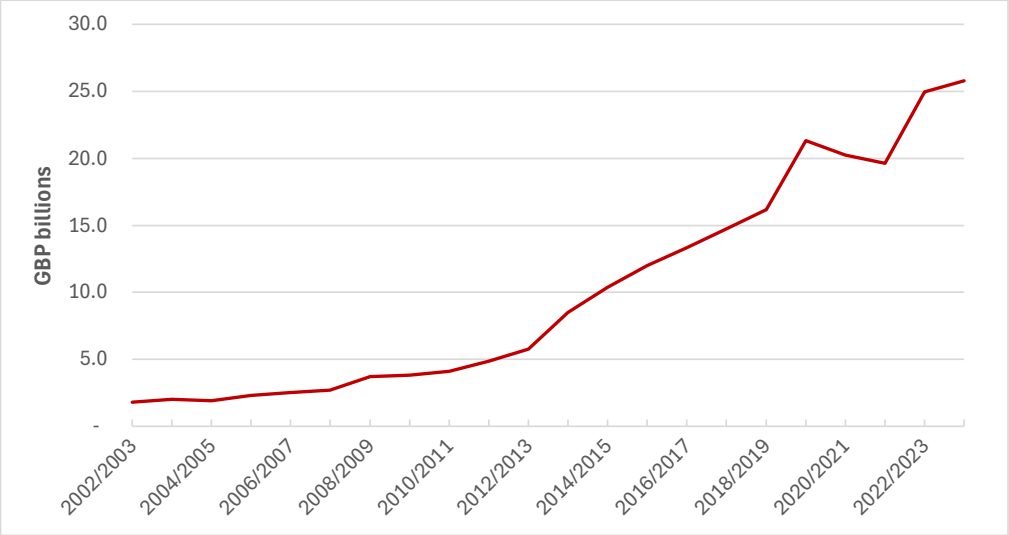

Figure 2: *Total Annual Renewable Electricity Subsidies in the United Kingdom 2002-2024: £billions (2024 prices) Source: HMG and market data: REF calculations.*

Sharp rises in renewables subsidies in recent years are in part attributable to continued expansion of such schemes as the CfD, increases in balancing and grid costs, and also to increases in the cost of the UK ETS. The Office for Budget Responsibility (OBR) has suggested that the increase in emissions trading costs results from two factors: a) market participants anticipating a major increase in the scope of the UK Emissions Trading Scheme, and also b) an increase in the marginal cost of abatement.[17] Since government remains committed to further expansion of renewable generation, and of the UK ETS, further increases in annual costs seem inevitable.

Against this background of large absolute costs and still rising annual subsidy costs it is reasonable to ask whether these market coercions have resulted in significant falls in the costs of renewable energy deployment and generation. Both industry and government claim that this is the case. However, as is shown conclusively in work conducted for Renewable Energy Foundation by Professor Gordon Hughes, the reductions in capex for both wind and solar are modest at best, and opex in some cases actually appears to be rising (See: Hughes, *Wind Power Economics – Rhetoric and Reality* 2020 and Hughes, *The Economics of Utility-Scale Solar Generation* 2023).

Indeed, if we calculate the total subsidy per MWh of renewable electricity generated since 2002, we find that the cost has been rising steadily since about 2005 and now stands at about £200/MWh on average, close to a 50% increase in real terms since 2005 (Figure 3):

[16] https://commonslibrary.parliament.uk/research-briefings/cbp-8175/
[17] https://obr.uk/docs/dlm_uploads/Emissions-working-paper.pdf

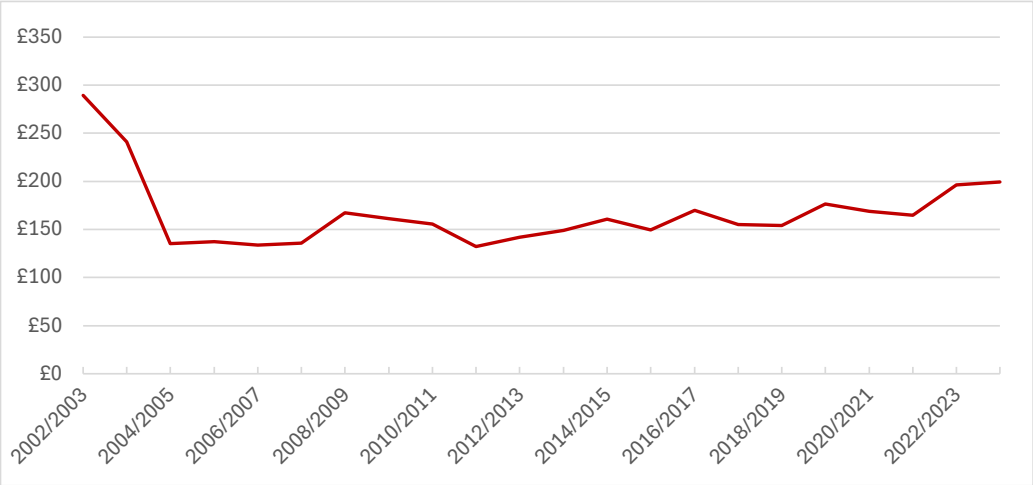

Figure 3: Total Subsidy £ (2024 prices) per MWh of Renewable Electricity Generated: 2002-2024. Source: HMG and Market data; REF calculations.

This outcome is extremely disappointing, though not unexpected to those who have reflected on the physical energy state of the fuel flows, that is wind flows, and also solar radiation as received at the earth's surface. If subsidy on this scale has not after over twenty years delivered technology cost reductions it seems unlikely to do so in the future. It therefore appears that these subsidies will have to continue in perpetuity if high levels of renewable energy are to be delivered and maintained in the UK. This implies non-trivial and extremely controversial reductions in human wellbeing and is unlikely to be politically sustainable.

Signs of the onset of this deep economic harm are already visible. For example, we believe it reasonable to infer that the very high additional costs to all consumers are the principal driver behind the otherwise inexplicably sharp decline in UK electricity consumption (see Figure 4):

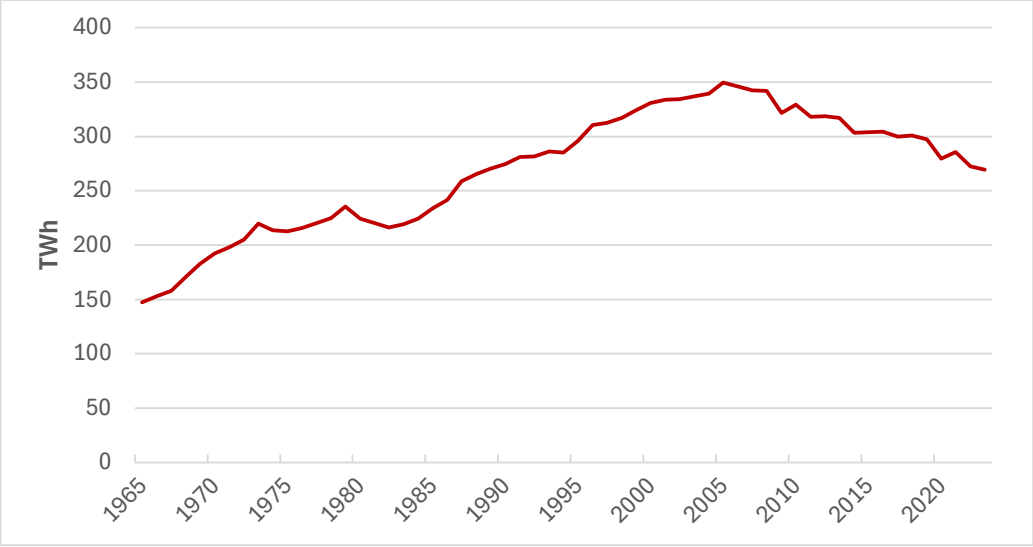

Figure 4. Electricity consumption (final users) (TWh) in the United Kingdom, 1965 to 2020. Source: Department of Energy Security and Net Zero (DESNZ). Chart by REF.

The figure indicates a 23% fall in consumption since 2005, the year in which the costs of renewables began to be salient (>£1.2bn). Those wishing to argue that energy efficiency accounts for this reduction are referred to

the literature around the Jevons Paradox, and particularly to its first publication by W. S. Jevons in *The Coal Question* (1864) where the erroneous confusion between efficiency and conservation is discussed in detail.

It should be borne in mind that about one third of this total cost, £77 billion (2024 prices) has hit households through their electricity bills, with the remaining £153 billion being first paid by industrial, commercial and public sector consumers and then passed through to households in the form of increased prices for goods and services, in taxes, and in reduced wages and rates of employment. In this context it should also be noted that subsidies to renewable generators result in an increase in the Treasury's VAT receipts and thus an increase in the general cost of living. Electricity consumed by households is charged at the reduced rate of 5% and cannot be reclaimed. Businesses also pay VAT on electricity, but we can assume that this is fully reclaimed. However, as the renewables subsidy costs are passed through to end consumers of goods and services they will become liable to VAT, unless the goods and services are exported or exempted. The precise magnitude of this VAT uplift resulting from renewables subsidies is uncertain, but the potential is significant, amounting to around £3 billion a year at present, and to around £30 billion in total since 2002 (in 2024 prices).

There can be little doubt that renewable electricity subsidies are a significant factor in the much-discussed cost of living crisis and are very likely to be an important element underlying the weak growth in productivity in the UK economy since the financial crisis of 2008.[18]

Renewable electricity generators have now enjoyed generous financial support for over twenty years without showing any significant progress towards independent economic viability. On the contrary, the requirement for such support seems to be rising. The public is surely entitled to ask when government will bring this extraordinary and insupportable level of subsidy to an end.

[18] https://commonslibrary.parliament.uk/research-briefings/sn02791/