RealClear Foundation

The Folly of Climate Leadership

Net zero and Britain's DISASTROUS ENERGY POLICIES

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ABOUT THE AUTHOR

Rupert Darwall is a senior fellow of the RealClearFoundation, researching such issues as energy and environmental policy and corporate governance. He previously worked as an investment analyst and in corporate finance, as well as serving as a special advisor to the UK's Chancellor of the Exchequer. The author of two books—*Green Tyranny and The Age of Global Warming*—and numerous think-tank reports, Darwall has also written for the *Wall Street Journal*, *The Hill*, and *Daily Telegraph*, among others. This is his third report for the RealClearFoundation, the first being "Capitalism, Socialism and ESG" (May 2021) followed by "Climate-Risk Disclosure: A Flimsy Pretext for a Green Power Grab" (November 2021).

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Dedicated to the memory of **Lord Lawson of Blaby (**1932–2023)

No British politician did more for a market-based approach to energy policy and the cause of energy realism than the late Lord Lawson. As energy secretary (1981–83) in the first Thatcher government, Nigel Lawson oversaw a huge buildup of coal stocks in anticipation of a coal miners' strike, which was decisive in defeating the 1984–85 miners' strike. As Chancellor of the Exchequer, Lawson laid the groundwork for Britain's pioneering privatization of its electricity sector, which led to major improvements in capital efficiency and labor productivity. Those gains began to be reversed with the adoption of renewables targets and then obliterated with the Electricity Market Reform program (2013) initiated by David Cameron's Coalition government. In 2008, Lawson wrote *An Appeal to Reason: A Cool Look at Global Warming*; the following year, he founded the Global Warming Policy Foundation (GWPF), which remains today the only think tank in Britain advocating energy realism.

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FOREWORD

BY ANDY PUZDER

Rupert Darwall's timely report is a much needed warning to America. It shows what would happen if Democrats and Progressives get their way and inflict net zero climate policies on the country. Britain has been going down this path since 2008, when Parliament wrote an 80 percent decarbonization target into law, which it raised in 2019 to 100 percent, i.e., net zero.

The results have been a disaster. Even before the recent surge in energy costs, in 2020, Britons were paying about 75 percent more for electricity than Americans; and during the energy crisis in 2022, electricity rates for British businesses were more than double the average paid by US businesses. High and rising energy costs have locked Britain into economic decline. British politicians' boasts of climate leadership by cutting greenhouse gas emissions faster than any other major economy ignore the unfortunate fact that the British economy has been stagnating since 2008. This luxury net zero policy, which only the rich can afford, has been devastating for ordinary Britons just trying to heat their homes and get to work.

Surging energy costs are the result of a double whammy of cap-and-trade policies and carbon taxes, on the one hand, and renewable subsidies, on the other. Cap-and-trade imposts made the energy crisis following Putin's invasion of Ukraine far worse. In 2022, government-imposed carbon costs amounted to an average $128 per megawatt hour (MWh) for electricity generated from coal and $51 per MWh for electricity generated from natural gas. These come on top of the actual fuel costs of coal and natural gas, which averaged $150 per MWh for electricity generated from coal and $160 per MWh for natural gas—far higher than the cost of electricity generation in America. For comparison, in 2022, the fuel cost per MWh of electricity generated from coal in the US was $27 per MWh and $61 per MWh for natural gas. It is no wonder that the energy crisis is causing such hardship to ordinary British people.

Britons also have to pay the cost of subsidizing politically favored wind and solar, which massively over-reward renewable investors. Analysis of the renewable portfolios of Britain's Big Six energy companies shows that the average price for wind- and solar-generated electricity between 2009 and 2020 was well over £100 per MWh, whereas the price for reliable electricity from gas- and coal-fired power stations fell from £60 per MWh in 2013 to less than £50 per MWh in 2020. That year, the scale of the consumer subsidies of renewables helped them to profit £61 per MWh of electricity on average for their intermittent, non-demand responsive and therefore less valuable output. Looked at objectively, it's completely crazy.

On the other hand, rising carbon costs forced the Big Six to take massive write-downs on their coal- and gas-fired power stations, collectively recording a staggering £1.6bn loss in 2014 for providing the reliable generating capacity that Britain's households and businesses depend on.

Unsurprisingly, these policies have led to overinvestment in renewables and underinvestment in the new generating capacity needed to keep the lights on—and costs down. Britain's non-intermittent, reliable generating capacity peaked in 2010, at 88.0 gigawatts (GW). It then fell by 25.1 GW over the next decade, mainly as coal-fired generation was shuttered. Over the same period, wind and solar capacity rose by 33.5 GW. Because wind and solar are both inherently inefficient and intermittent, the amount of electricity generated per GW of capacity has fallen by 28 percent since 2009. Deploying capital on renewables is an extremely inefficient use of capital investment, which means that as interest rates go up, so do energy costs. It's the very last thing that struggling American—or British—families need.

Britain managed to keep its lights on only because demand has been driven down by higher electricity prices. Between 2010 and 2019, economy-wide electricity consumption fell by 10.8 percent. Even so, there has been a widening gap between consumption and domestic generation that has been filled by a surge in imported electricity from its European neighbors. These options, it should be emphasized, are not an option for the US. We cannot import the equivalent of two-fifths of Canada's electricity output.

Energy prices comparable with those in Britain—and across much of Europe—would tear the heart out of the US economy, which relies on cheap, abundant energy. The impact on working- and middle-class Americans would be intolerable.

Americans are fortunate to live under our Constitution's system of checks and balances. There is no way Congress would pass legislation like Britain's Climate Change Act, which made net zero the law of the land after an 88-minute debate in the House of Commons. Nonetheless, the threat of net zero is as real as it is dangerous. Net zero is the policy of the Biden administration. It has set the goal of entirely decarbonizing electricity generation by 2035. Earlier this year, the Environmental Protection Agency issued a proposed regulation on greenhouse gas emissions from fossil fuel power generators that, if implemented, would go a long way toward achieving this economically devastating goal.

Two years previously, in May 2021, the White House issued an Executive Order on the adoption of a whole-of-government approach to climate financial risk disclosure, demonstrating how an alliance between the administrative state and woke ESG investors on Wall Street would bring about net zero. Additionally, Congress passed the misbegotten energy bill misnamed the Inflation Reduction Act, which provides for budget-busting, fiscally irresponsible uncapped subsidies of wind and solar, which will wreak havoc on the economics of reliable generating capacity, just as it has in Britain. Even highly subsidized wind and solar cannot keep the lights on, and they destroy the economic viability of the power plants that do.

If that's not enough, Mike Bloomberg announced in September that he is giving a further $500m to fund his Beyond Carbon campaign to close down America's remaining coal-fired power stations and halve gas-fired generation by 2030 through Astroturf campaigning and litigation. When cap-and-trade failed in Congress, Bloomberg writes, his team refused to let politics trump progress, showing his utter contempt for our representative democracy and free-market economy. Clearly, net zero elites like Bloomberg will stop at nothing to impose their vision of energy poverty on the rest of American people.

Renewable energy is not a low-cost substitute for fossil fuels. Renewables are not cheap, nor can they provide the reliability that modern societies expect and on which they depend. This report convincingly demonstrates how Britain was conned into net zero by deceptive and illusory promises of cheap wind power. The bursting of the wind-power bubble this summer came too late for Britain. It has come just in time to save America from making a similar calamitous error. It's not too late to heed Britain's warning, and we should all thank Rupert Darwall for warning us.

This report is the first comprehensive analysis of Britain's climate and energy policies and their impact on electricity generation and costs, as well as on energy security. It shows how increasingly stringent climate policies have been justified on the basis of false claims of low and falling renewable energy costs, especially of offshore wind, so that net zero was adopted in ignorance of its likely costs. Subsequent official analyses of net zero paint an optimistic picture based on economic make-believe.

- **Part I** *places Britain's claim to climate leadership in context and notes how accelerating reductions in carbon dioxide emissions have been accompanied by unprecedentedly weak economic growth.*
- **Part II** *is a critical examination of the evolution of energy policy since 2015 and demonstrates how politicians and civil servants were willingly duped by climate-lobby claims of low wind costs; it contrasts these claims with actual offshore wind cost data and goes on to examine the flawed assessments of the economic consequences of net zero by the Treasury and the Office for Budget Responsibility. It ends with a brief analysis of public opinion, which broadly—albeit weakly—accepts Britain's net zero policy consensus.*
- **Part III** *comments on Britain powering past coal, which worsened the 2022 energy crisis by raising costs and sacrificed coal as the best hedge against threats to energy security.*
- **Part IV** *is an overview of the electricity sector, and*
- **Part V** *is a deep dive into the Big Six energy companies' segmental data, illustrating the importance of data transparency.*
- **Part VI** *offers some concluding thoughts on the antidemocratic gambit of legislating a net zero target, with the aim of putting net zero beyond politics. It tables two policy recommendations: de-legislating net zero; and opening the books on all publicly supported renewable energy projects as a necessary condition to having a properly informed debate on energy policy.*

Overview

Since the 2008 financial crisis, the British economy has performed badly; it has been afflicted by unprecedently poor productivity growth. The same year, Britain's political elite decided to turn Britain into a test bed for radical climate policies when Parliament wrote an 80 percent decarbonization target into law. The Climate Change Act was presented as Britain showing climate leadership ahead of the 2009 Copenhagen climate conference, one of many UN climate conferences that was going to save the planet. In 2019, the target was raised to the elimination of 100 percent of net emissions by 2050 and became law after an 88-minute debate in the House of Commons.

Net zero had been sold to politicians on the basis that the falling costs of renewable energy meant that the costs of net zero would fall within the envelope of the previous 80 percent target. The narrative of a dramatic and sustained fall in the costs of renewable energy also underpinned governmental analyses of the economic consequences of net zero that promoted the fiction that the cost of net zero is trivial and could even act as fairy dust boosting Britain's abysmal lack of productivity growth.

Thus, Britain's decision to adopt net zero was based on false claims about the cost of offshore wind and wishful—indeed, nonsensical—optimism about the economic consequences of net zero. At a virtual UN climate summit in December 2020, then–prime minister Boris Johnson spoke of turning Britain into the Saudi Arabia of wind power.[1] It is delusory to equate production of a commodity that yields more government revenues than any other with one that, as the International Energy Agency's May 2021 Net Zero by 2050 Pathway shows, requires more inputs of labor, capital, and land to produce less energy.[*] Net zero therefore constitutes an antigrowth economic strategy that near-zero-growth Britain can ill afford.

This, then, is a story of a massive deception practiced by Britain's governing class, leading to the biggest resource misallocation in British history—done in the name of saving a planet, which the vast majority of its inhabitants has no intention of emulating.

Its relevance to the United States is that in April 2021, the Biden administration followed Britain and set the goal of completely decarbonizing electricity generation by 2035 and achieving the economy-wide net zero by 2050.[2] Britain therefore offers a preview of what aggressive decarbonization would look like if President Biden succeeds in doing by regulation what even a Democratic Congress refused to pass between 2021 and 2023.

As in Britain, the Biden administration is spinning claims of ever-falling renewable energy costs. While specific climate policies and institutional arrangements differ among countries, how generating technologies—thermal (coal and natural gas–fired power stations), nuclear, and renewable (wind and solar)—interact is common across markets, as they reflect the physics and economics of each technology. At least, America has the example of Britain's disastrous energy policies and looking before it leaps.

* See EPRINC, *A Critical Assessment of the IEA's Net Zero Scenario, ESG, and the Cessation of Investment in New Oil and Gas Fields* (June 2023).

PART I. BRITAIN'S CLIMATE JINGOISM

Key Points

British politicians boast about the country's climate leadership and reducing its emissions of carbon dioxide, but much of this reflects fundamental structural features of the British economy.

- Britain's territorial carbon dioxide emissions peaked in 1973, decades before climate became a concern. Consumption emissions (i.e., including emissions embedded in net imports) peaked 31 years later, in 2004 (Fig. 2).
- The pace of decarbonization accelerated following the 2007–08 financial crisis. Compared with the 18 years to 2008, the 14 years from 2008 to 2022 saw the average decadal reduction in greenhouse gas emissions almost double, from 86.5m tonnes CO_2e in 1990–2008 to 166.7m tonnes CO_2e in 2008–22, while the rate of GDP growth halved, from 2.18 percent a year to 1.08 percent a year (Table 1).
- Post-2008 emissions reductions occurred during a period when Britain had the lowest peacetime growth rate since 1780, a factor behind its decarbonization "success" (Section 1.1).

1. A hollow boast

In October 2021, the UK hosted the COP26 UN climate conference in Glasgow. Earlier that month, the British government announced that it was bringing forward the target date to fully decarbonize electricity generation by 15 years, from 2050 to 2035. Britain's homes and businesses, the government claimed, would be powered by "affordable, clean and secure electricity."[3] A year on and two prime ministers later, the newly appointed prime minister Rishi Sunak attended the COP27 climate conference in Egypt, where he declared his intention to make Britain a clean energy superpower and boasted that the UK has cut its carbon emissions faster than any other G7 country.[4]

Britain's climate jingoism is succinctly summarized in an answer that Rishi Sunak gave during Prime Minister's Questions on May 10, 2023:

> Since the benchmark was established, emissions in this country have fallen by nearly 50%, and we have also grown the economy by two thirds…. At the same time, because of the way in which we regulate new and renewable energies, we have seen the price of renewables such as offshore wind decline from £140 an hour to about £40. That shows a regulatory system that is working in delivering lower-cost, renewable energy to British families.[5]

The prime minister is making two distinct claims. The first is with respect to the compatibility of decarbonization and economic growth. Placed in context, the conclusion is the opposite of what the prime minister wishes to imply. The second—that the cost of offshore wind has fallen from £140 per megawatt-hour (MWh) to £40 per MWh—is untrue (further discussed in Section 3.3 of this report). Yet the economic justification for net zero rests on this falsehood.

1.1 Decarbonization and growth

The year 1990 is the baseline established in the United Nations Framework Convention on Climate Change (UNFCCC). Between 1990 and 2022, the gross domestic product of the British economy (output measure) increased by 71.4 percent. Over the same period, greenhouse gas (GHG) emissions fell by 48.3 percent. At first blush, a 71.4 percent economic expansion sounds impressive; but as a former investment banker, the prime minister would be the first to acknowledge that what is relevant is the compound annual growth rate (CAGR), especially over such a long period, which turns out to be an underwhelming 1.7 percent a year.

Even this is an overstatement. Britain's economic performance has showed a marked deterioration since the global financial crisis and remains far below its pre-2008 trend. In a November 2022 paper, Professor Nicholas Crafts, one of Britain's leading economic historians until his death in October of this year, shows that 2007–19 saw Britain achieve the lowest peacetime growth rate since 1780; and only one previous period (1899–1913) had weaker total factor productivity growth.[6] Compared with other periods of very low growth in labor productivity, the deterioration in productivity since 2007 has been much larger. "The post-2007 slowdown relative to what previous trend performance would have delivered is unprecedented," Crafts says.[7]

As shown in Table 1, the growth rate of the British economy halved over 2008–22, compared with 1990–2008. Recall that 2008 is the year the Climate Change Act became law in the UK. Prior to 2008, decarbonization policies were, in the main, low-cost and light-handed. Nonetheless, GHG emissions fell at an average rate of 86.5 million tonnes carbon dioxide equivalent (MtCO$_2$e) per decade. Post-2008, they fell at 166.7 MtCO$_2$e per decade. In percentage terms, the rate of emissions decrease more than doubled, from 10.7 percent per decade to 25.6 percent per decade.

TABLE 1: UK GDP COMPOUND ANNUAL GROWTH RATES AND GREENHOUSE GAS EMISSIONS REDUCTIONS

	1990–2008	2008–22
GDP—CAGR	2.18%	1.08%
Change in GHG emissions per decade	–86.5 MtCO$_2$e	–166.7 MtCO2e
	–10.7%	–25.6%

Source: Office for National Statistics (ONS), "Gross Domestic Product: Chained Volume Measures: Seasonally Adjusted £m" (May 12, 2023); Dept. for Business, Energy and Industrial Strategy (BEIS), "Final UK Greenhouse Gas Emissions National Statistics 1990–2020" (Feb. 1, 2022); Dept. for Energy Security and Net Zero (DESNZ), "2022 UK Greenhouse Gas Emissions, Provisional Figures" (Mar. 30, 2023)

While there is not an inverse linear relationship between output growth and the pace of GHG reductions,** a substantial part of Britain's success in increasing the speed of emissions reductions since 2008 reflects unprecedently poor economic performance. That is nothing to boast about. Moreover, the direction of causality between changes in output growth and GHG emissions reductions runs both ways, as increasingly tight decarbonization policies exert a downward drag on output growth.

1.2 Decarbonization in perspective

The boast that Britain has decarbonized more rapidly than any other major economy also needs further context. Between 1990 and 2019, UK GHG emissions fell by 358.4 MtCO$_2$e, a fall of 44.4 percent. So far, so good. But these are territorial emissions—those occurring within the UK's borders. These are not the same as Britain's consumption emissions (its carbon footprint), as they exclude emissions embedded in its net imports.

The British government's series of consumption emissions statistics only goes back to 1996. These show that consumption emissions moved in the opposite direction to territorial emissions and peaked in 2004, at 1,110 MtCO$_2$e, plateaued for three years to 2007, and fell in the next two years by 190 MtCO$_2$e, as part of the sharp contraction in world trade following the financial crisis (Table 2).

** If GDP growth fell to zero, GHG reductions would not fall by 100 percent; but if GDP went to zero, they would.

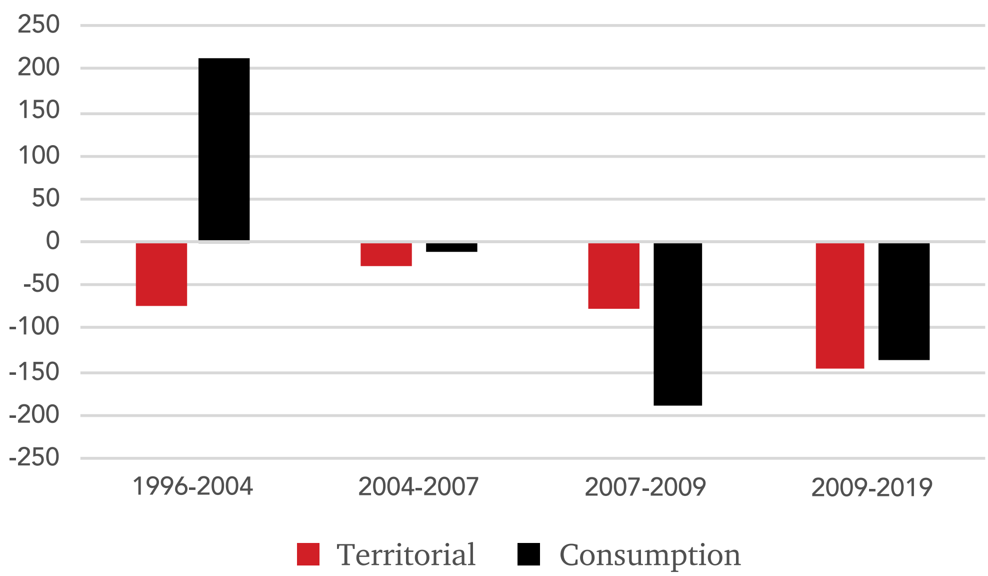
TABLE 2: UK TERRITORIAL AND CONSUMPTION GREENHOUSE GAS EMISSIONS (MTCO2e)

	1996	2004	2007	2009	2019
Territorial	775	701	672	594	448
Consumption	896	1,110	1,100	910	774

Source: DESNZ, "UK Greenhouse Gas Emissions Statistics," updated Feb. 8, 2023, https://www.gov.uk/government/collections/uk-greenhouse-gas-emissions-statistics; Dept. for Environment, Food, and Rural Affairs (Defra), "Official Statistics Carbon Footprint for the UK and England to 2019," Nov. 3, 2022, https://www.gov.uk/government/statistics/uks-carbon-footprint/carbon-footprint-for-the-uk-and-england-to-2019

The only time when consumption emissions fell faster than territorial emissions was during the financial crisis, when consumption emissions fell by a massive 190 MtCO2e, well over twice the 78 MtCO2e fall in territorial emissions (Fig. 1). In the subsequent decade to 2019, territorial emissions declined slightly faster than consumption emissions, but because Britain's consumption emissions in 2009 were over 50 percent larger than its territorial emissions, the percentage fall over the period at 15.0 percent was considerably less than the 24.5 percent fall in territorial emissions.

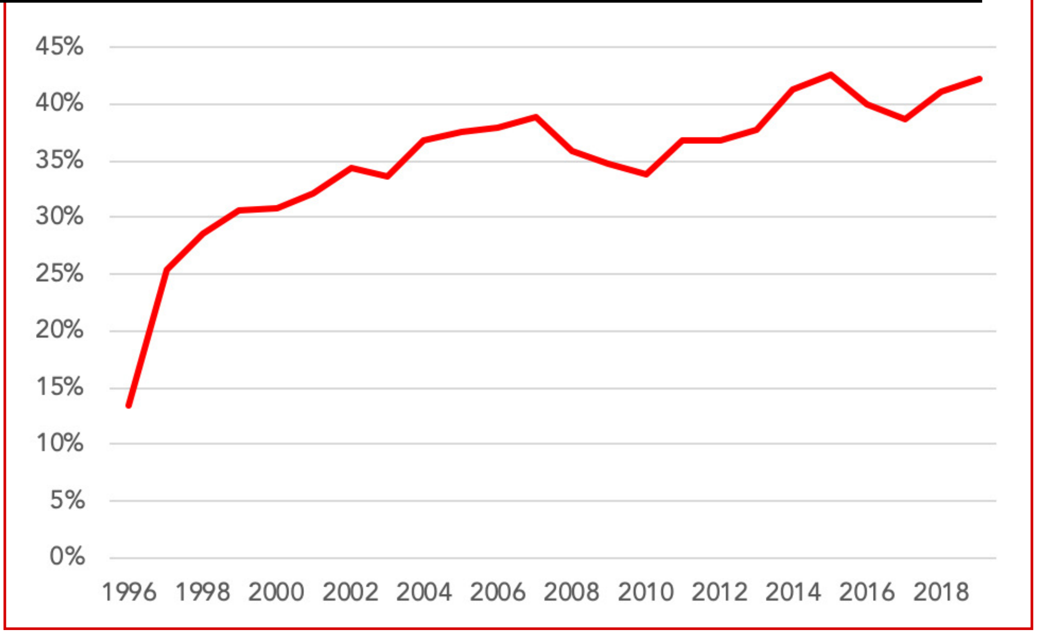
FIGURE 1: CHANGE IN UK TERRITORIAL AND CONSUMPTION GREENHOUSE GAS EMISSIONS (MtCO2e)



Source: DESNZ, "UK Greenhouse Gas Emissions Statistics," updated Feb. 8, 2023; Defra, "Official Statistics Carbon Footprint for the UK and England to 2019," Nov. 3, 2022

The outcome is that territorial emissions account for a declining share of consumption emissions, falling from 65 percent in 2009 to 58 percent in 2019. Or, turning it around, net imports account for a growing share of Britain's carbon footprint, highlighting the relationship between decarbonization and deindustrialization (Fig. 2).

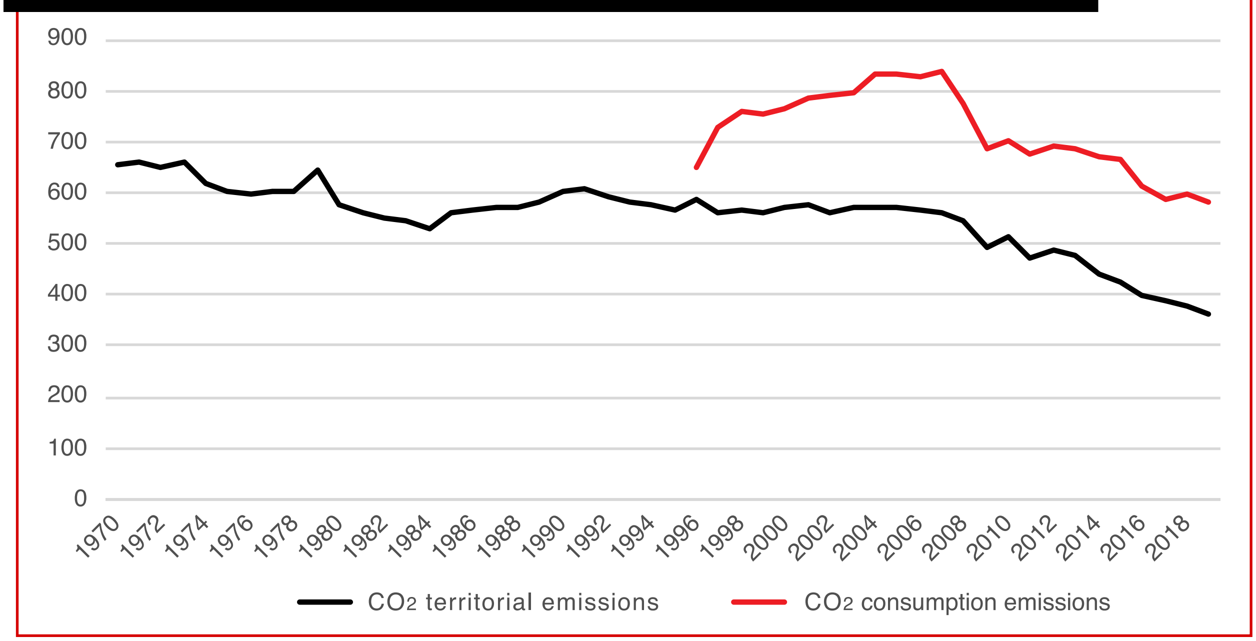
FIGURE 2: NET IMPORTS AS % UK GHG CONSUMPTION EMISSIONS



Source: DESNZ, "UK Greenhouse Gas Emissions Statistics," updated Feb. 8, 2023; Defra, "Official Statistics Carbon Footprint for the UK and England to 2019," Nov. 3, 2022

Even that is only part of the story. Britain's carbon dioxide emissions from fossil fuel combustion peaked in 1973, 19 years before the UNFCCC was signed in 1992 and 34 years before consumption emissions peaked in 2007 (Fig. 3). From 1973 to 1985, territorial CO_2 emissions fell by 19.8 percent, subsequently growing by 13.8 percent in the five years to 1990 as the British economy picked up speed, thanks to the Thatcherite economic reforms of the 1980s.[8]

FIGURE 3: UK TERRITORIAL AND CONSUMPTION CO_2 EMISSIONS ($MTCO_2$)



Source: "Data on CO_2 and Greenhouse Gas Emissions by Our World in Data; DESNZ, "UK Greenhouse Gas Emissions Statistics," updated Feb. 8, 2023; Defra, "Official Statistics Carbon Footprint for the UK and England to 2019," Nov. 3, 2022

Manufacturing output also peaked in 1973 and, by 1982, had shrunk by 18.1 percent, reflecting the poor productivity of British manufacturing industry; it would surpass its 1973 level of output only in 1988.[9] Although manufacturing accounted for a declining share of Britain's gross domestic product, a trait the nation shared with the US, over the next 20 years manufacturing output rose by 51.5 percent, representing a fairly respectable average growth rate of 2.1 percent a year, while carbon dioxide emissions still fell by 25.4m tonnes (4.4 percent), despite the absence of stringent climate policies.

Since 2008, manufacturing output has been weak, growing at an average rate of only 0.8 percent a year from 2008 to 2022.[10] The extent to which this reflects the ongoing fallout from the banking crisis as distinct from the tightening impact of climate policies on Britain's industrial competitiveness is hard to disentangle. What can be safely asserted is that the weak performance of Britain's manufacturing sector has meant that the UK's territorial emissions of greenhouse gases are lower than they otherwise would be and that rising energy prices put downward pressure on Britain's manufacturing output and diminish the attractiveness to manufacturers of the UK as a location for their operations.

PART II. POLICY CRITIQUE

2. How Britain's energy policy was captured

Key Points

During David Cameron's Coalition government (2010–15), energy policy took a sharply statist turn when Liberal Democrat energy ministers drove a radical climate and energy agenda, culminating in Electricity Market Reform (EMR). It turned the state into the central buyer of generating capacity, an option that the previous Labour government had rejected as too statist.

- In November 2015, the new energy secretary, Amber Rudd, set out a new direction for energy policy—phasing out coal if there was investment in new gas-fired capacity and requiring that wind and solar bear the costs of their intermittency (Section 2.1).
- Investment in new gas did not materialize, and Rudd's successor ditched her pledge on wind and solar internalizing their intermittency costs, as it threatened the government's offshore wind industrial strategy—demonstrating why having an industrial strategy, like the Biden administration's, is a bad idea, as it is a mechanism for vested interests to capture policy (Section 2.2).
- Commissioned to carry out a cost-of-energy review, Dieter Helm backed Rudd's call on renewables' intermittency costs, estimated the costs of decarbonization at well over £100bn, and warned of policy capture by vested interests (Section 2.3).

Electricity Market Reform (EMR), enacted in 2013, changed the subsidy mechanism for new renewable energy projects from requiring energy suppliers to purchase Renewable Obligations Certificates (ROCs) to a system of feed-in tariffs set at a strike price in a contract for difference (CfD). Under CfDs, wind and solar are paid a guaranteed price (the strike price) whatever the wholesale price they obtain for their output, the difference being made up by (or repaid to, if the wholesale price is higher than the strike price in their CfDs) the government-owned Low Carbon Contracts Company, which, in turn, is funded by electricity consumers via levies on electricity suppliers.

The importance of this change is that it removed market-price risk from wind and solar investors and transferred it to consumers. Moreover, CfDs are indexed against inflation. Annual adjustments to CfD strike prices also include specific compensation for increases in transmission and balancing charges. Since these are where intermittency costs show up, CfDs ensure that such additional costs are passed on to consumers.

Liberal Democrat participation in government came to an end in the May 2015 general election, which saw the Conservatives win their first outright majority in 23 years and Amber Rudd succeed Ed Davey as energy and climate-change secretary. This opened a brief window of energy realism that closed after the Brexit referendum. Despite warnings in an official report by Sir Dieter Helm, one of Britain's best-known energy economists, ministers plowed on regardless, culminating in the adoption of net zero in 2019, which was based on false claims about the falling cost of wind energy.

2.1 Amber Rudd (2015–16)

In November 2015, one month before the Paris climate conference, Rudd gave a speech billed as a "new direction for UK energy policy." In retrospect, it might well have been the last chance to put energy policy on a more rational and sustainable trajectory. Had the free-market precepts that Rudd articulated been turned into action, many of the disastrous outcomes that ensued would have been avoided or mitigated.

"No government should ever take a risk on security," Rudd declared. "Energy security has to be the number one priority."[11] She praised Nigel Lawson, quoting from his 1982 speech on energy policy, in which Lawson had aimed to break the dirigiste mind-set of the Department of Energy, which, Rudd said, had returned after Tony Blair signed the EU renewable energy target in 2007—implicit criticism of her Liberal Democrat predecessors for their statist policies.

In his 1982 speech, Lawson criticized the wisdom of "guessing the unguessable"—predicting UK energy consumption decades into the future and allocating investment to supply it between different primary fuel sources, i.e., exactly the approach adopted by EMR. "We now have an electricity system where no form of power generation, not even gas-fired power stations, can be built without government intervention," Rudd observed.

> I inherited a department where policy costs on bills had spiralled. Subsidy should be temporary, not part of a permanent business model.... We need to work towards a market where success is driven by your ability to compete in a market, not by your ability to lobby government.[12]

Yet Rudd's avowal of free-market purity was the energy policy version of Saint Augustine's prayer on chastity. "We want to see a competitive electricity market, with the government out of the way as much as possible, by 2025." Before then—with one important exception—policy was deep in the fleshpots of dirigisme. "Unabated coal is simply not sustainable in the longer term," Rudd said, announcing a proposal to close coal-fired plants by 2025 and restrict coal's use from 2023. The closure of coal was conditional: "We'll only proceed if we're confident that the shift to new gas can be achieved within these timescales."

Rudd's envisaged increase in gas capacity never happened. Between 2015 and 2020, 2.3 GW of net gas-fired capacity was added to the grid, less than one-fifth of the coal capacity that came off the grid over the same period.[13] Another broken promise: Rudd noted the fall in domestic production of natural gas. "That's why we're encouraging investment in shale gas exploration"—but the encouragement didn't extend to lifting Ed Davey's anti-fracking regulations (discussed further in Section 9.3 below).

The exception was Rudd's comment on wind and solar intermittency. Just as hydrocarbon generators were internalizing the externality of their emissions, so should wind and solar generators internalize the costs that they impose on the rest of the system:

> In the same way generators should pay the cost of pollution, we also want intermittent generators to be responsible for the pressures they add to the system when the wind does not blow or the sun does not shine. Only when different technologies face their full costs can we achieve a more competitive market.[14]

Beyond her market rhetoric, this was the sole pro-market proposal in Rudd's speech. Markets are cost-discovery mechanisms, but transferring the intermittency costs of wind and solar to the rest of the grid means that their true costs remain hidden. Applying the same principle of internalizing externalities to wind and solar as to other generators would show the world that the economics of renewables are not as advertised and would threaten renewable investors with losing billions of pounds of subsidies. Changing the rules of the game to promote investment efficiency and protecting consumers would require an enormous amount of political will to face down the wind and solar lobby.

2.2 Greg Clark (2016–19)

Political will was in short supply from Rudd's successor. Following the June 2016 Brexit referendum, Theresa May succeeded David Cameron as prime minister. Rudd was promoted to the Home Office and her old department transformed into a new Department for Business, Energy and Industrial Strategy (BEIS), headed by Greg Clark.

During her leadership campaign, May emphasized the importance of affordable energy. "I want to see an energy policy that emphasizes the reliability of supply and lower costs for users," she said, launching her campaign in Birmingham.[15] Two days later, she was the newly appointed prime minister, speaking on the steps of Downing Street. May used her remarks to address what became known as the JAMS—people just about managing:

> If you're from an ordinary working-class family, life is much harder than many people in Westminster realise.... You have your own home, but you worry about paying a mortgage. You can just about manage but you worry about the cost of living.... If you're one of those families, if you're just managing, I want to address you directly.... The government I lead will be driven not by the interests of the privileged few, but by yours.[16]

Clark took little time signaling his intention to drop Rudd's proposal that wind and solar bear the costs of their intermittency. In a November 2016 speech, Clark acknowledged that wind and solar were creating "new challenges" for the grid, but dismissed fears about their impact as being "overblown." Britain, he claimed, had the most reliable electricity supply in Europe. "We must recognise this intermittency does add some costs," Clark conceded.

> So the challenge for government and regulators is to design a system that can both better manage intermittency and take advantages of the innovations in storage, demand-side response, interconnection and IT to create a truly smart energy system.[17]

In other words, Clark, who holds a PhD from the London School of Economics, hoped that the issue of wind and solar intermittency costs would disappear into the ether and that the putative technologies that might solve the intermittency costs of renewables would be funded by anyone other than the wind and solar investors that created those costs and profit from not having to bear them.

2.3 Helm, *Cost of Energy Review*

Clark, however, had a problem. In furtherance of May's pro-JAMS objective and to make energy affordable, the Conservatives' June 2017 general election manifesto pledged delivery of "competitive and affordable energy costs following a new independent review into the cost of energy."[18] If Clark had hoped that his choice of Sir Dieter Helm to lead the review would make for an easy ride, he would be disappointed.

Announced on August 6, 2017, Helm's report was published 80 days later, on October 25. Not only did Helm break records for speed. Few, if any, government-commissioned reports have been as critical of government policy. "The status quo is not going to be a good place to be in the medium and longer term. It is not sustainable, and therefore it will not be sustained," Helm warned. He did not pull his punches. His review is a coruscating critique of the government's energy policy and the risk of policy capture by vested interests (Box 1).[19]

BOX 1: HELM COST OF ENERGY REVIEW, CRITICISMS OF POLICY

- "[T]he cost of energy is significantly higher than it needs to be to meet the government's objectives." (p. xi)
- "[E]nergy policy, regulation and market design are not fit for the purposes of the emerging low-carbon energy market." (p. xi)
- The cost of decarbonization will amount to "well over £100bn by 2030." (p. xi)
- The burden on households and businesses would have been even greater but for the 2007/08 financial crisis cutting energy demand. (p. xi)
- "[T]he UK has flirted with dangerously low capacity margins despite the GDP effect, and this drives up prices as the more expensive marginal plant is drawn into the system to match demand." (p. xii)
- "A mass of [governmental] interventions, and especially technology-specific contracts, in turn attracts vested interests. The implication of the state determining almost all investments is that the state—and not the consumer—is now the major client. Energy policy has been partly captured, with the result that our decarbonization is slower and more costly than it need be; our security of supply is weaker than it should be; and households and industry pay too much for their energy." (p. 3)
- "The sheer number of interventions in the UK energy market is so great that few if any participants in the markets, few regulators, ministers or civil servants can have grasped them all…. [T]he greater the complexity, the greater the scope for capture by rent-seeking lobbyists and interest groups." (p. 35)
- On guessing the unguessable: "If the government is going to get deeply involved in being the central contractor … it needs to try to second-guess the results the market would otherwise have produced. It needs to forecast the future. Conversely, if the government gets out of many of these activities, it does not need to be in the forecasting and modelling business." (pp. 41–42)
- In discharging its central planning functions under Electricity Market Reform, DECC/BEIS used "ever rising" wholesale electricity price scenarios based on high assumptions for gas and coal prices. (pp. 45–46)
- Lower fossil fuel price projections would have:
  - increased the relative costs of renewables;
  - raised the total estimated costs of subsidies to renewables. (p. 46)
- "Since the [price] assumptions impact on the policy interventions, they are also a focus for lobbying…. There is a long track record of using forecasts and assumptions as part of lobbying activities. It is a way in which apparently 'technical analysis' can lead to capture." (p. 48)
- "It is tempting for governments and regulators to go beyond the generic and start predicting future winners and creating scenarios…. It is something governments should avoid. Their track record is typically bad, and sometimes very bad, and they are always vulnerable to capture by vested interests trying to sell their technologies to government and capture subsidies and economic rents." (p. 72)
- "There is no good reason to assume that a fixed-price contract for electricity generated, tied to a CfD, backed by government, is a least-cost way of meeting the carbon objectives." (p. 110)
- Because there is always a carbon cost whether or not it is made explicit, "the implicit price of carbon from the numerous second-best measures identified in section 4 [of the report] … is almost certainly higher, and probably much higher. The additional burden has never been calculated in UK energy policy." (pp. 167–68)
- "The economic incidence of the various carbon measures on households is therefore not confined to their electricity and other energy bills. The impacts come in the basket of goods and services they buy and, if they work in internationally traded industries, in their job prospects and pay too. The conclusion is that the cost of decarbonizing is not simply the price of the ROCs, FiTs [Feed-in Tariffs], and low-carbon CfDs and the capacity and networks' additional costs to support the renewables identified in earlier sections." (p. 168)

Source: Dieter Helm, Cost of Energy Review (Oct. 25, 2017), https://www.gov.uk/government/publications/cost-of-energy-independent-review

In addition to his trenchant criticism of existing policy, Helm laid out a comprehensive roadmap to achieve Rudd's goal of a competitive electricity market that operationalized the principle that Rudd had enunciated two years earlier of wind and solar internalizing the costs of their intermittency through Equivalent Firm Power (EFP) capacity auctions.[20] Helm noted:

> Intermittent generators … do not face the full transmission, distribution and back-up capacity costs they impose on the system. These costs do not go away simply by being disguised within the system. In the current model, the intermittent generators have no incentive to minimize these costs. Indeed, they are so opaque that the exact size and impacts are matters of hypothesis rather than fact.[21]

Rudd wanted to make the switch from coal to gas conditional on new gas. But according to Helm, EMR's consumer subsidization of renewables through CfDs had left the prospect for investment in new gas capacity "exposed," as intermittent generation had "undermined the economics of CCGTs [combined-cycle gas turbines] in particular."[22] EFP auctions would give wind and solar investors strong incentives to do deals with those that offer backup capacity.[23]

Helm also recognized what would happen if any politician proposed EFP or similar mechanisms. They would come up against "the full force of lobbying, for exposing the true cost of renewables would create some clear and obvious losers."[24] Would Helm's report stiffen Clark's backbone, or would he capitulate?

2.4 Greg Clark's response

The answer came in a speech the following year. It has not aged well. Five years on, amid an energy shock, what comes across is its astonishing complacency. "Green energy is increasingly cheap energy. This is amazing news," Clark said.[25] He referred to Lawson's and Rudd's speeches as an exercise in pass-the-parcel and declared:

> I have the good fortune of being able to say to you all here today: Look! Here is the present we have all been hoping for. Cheap power is now green power.[26]

It was likely that by the mid-2020s, green power would be the cheapest power. "It can be zero subsidy," Clark claimed. Perhaps Clark foresaw Putin's invasion of Ukraine and Europe's cessation of gas deliveries from Gazprom driving up prices? What he had to say about gas suggests that this was far from his thinking, which was that "the UK has consistently enjoyed a high level of gas security over the last decade," while not mentioning that the increase in CCGT capacity that Rudd reckoned was needed to keep the lights on had failed to materialize. (In his 2016 speech, Clark thought that simply announcing that unabated coal was coming off the grid would be sufficient to provide a clear signal for investors in new gas-fired power stations.)

Clark's predecessors had wrestled with the energy trilemma: sustainability (meeting decarbonization targets); security of supply; and affordability. "Trilemma well and truly over. Shout it from the rooftops," Clark declared.[27] It was Mission Accomplished.

As for Helm's proposal of firm power auctions, Clark said that despite Helm's "extremely cogent" reasoning, other considerations had led him to reject it. "There is a question of industrial strategy—our current support system for offshore wind, for example, has produced great benefits," Clark said. "It would be unwise to disturb this ecosystem right now with a major reorganization."[28] Clark had been captured. As Helm had warned in his review:

> Government has got into the business of "picking winners." Unfortunately, losers are good at picking governments, and inevitably—as in most such picking-winners strategies—the results end up being vulnerable to lobbying, to the general detriment of household and industrial customers.[29]

Five years before Bidenomics and the enactment of the Inflation Reduction Act, Britain shows how industrial strategy becomes a charter for lobbying and vested interests. Once a sector secures a starring role in an industrial strategy, it has policymakers in its pocket.

2.5 Lawson's reaction

Clark's speech elicited a crushing response from Nigel Lawson. "Greg Clark is repeating all the mistakes of the 1950s, 1960s and 1970s. As Dieter Helm's excellent report shows, government planning, picking losers and second-guessing the market is a disaster in the making," his Conservative predecessor said. "In particular I take exception to Mr. Clark's shameless misrepresentation of my views to falsely assert that high energy costs are good for business competitiveness."[30]

Clark's rejection of carbon pricing because it needed carbon border adjustments to avoid "decimating our important industries" was illogical, Lawson added. "As Mr. Clark well knows, the costs of decarbonization haven't gone away and his green energy policies impose a higher shadow carbon price, making these industries even more uncompetitive and accelerating their rundown."[31]

Lawson's criticism illustrates a further consequence of industrial strategy–type policies. Against the benefits accruing to politically favored sectors must be set the disbenefits to non-favored sectors and the detriments to the overall performance of the economy.

3. The cheap wind deception

Key Points

Making offshore wind central to Britain's energy strategy did not cut its cost. It did mean that there was no objective scrutiny of wind-power costs and that the government got suckered by lowball estimates produced by the climate lobby.

- Industry-curated data on wind-power cost and performance have been a strategic tool in policy capture (Section 3). Policymakers were further deceived by falling CfD strike prices in successive allocation rounds in bids for low carbon project subsidies as evidence of falling wind-power costs, when the industry was treating auction bids as valuable options being given away for no financial consideration (Section 3.2).
- A 2012 top-down analysis by Gordon Hughes estimated that, on favorable assumptions, using wind power to reduce CO_2 emissions would cost £409 ($507) per tonne of CO_2 and produce a return on investment of less than 0.5 percent a year (Section 3.1).
- Three studies analyzing offshore wind power indicate that offshore wind costs are about double those assumed by ministers (Section 3.3), findings confirmed in July 2022 when Siemens Energy, a leading wind-turbine manufacturer, issued a €1bn profits warning that blew apart the cheap wind-power myth (Section 3.4).

Despite Helm's and Lawson's warning, the outcome is that Britain put a huge bet on offshore wind. Politicians were told—and politicians like Greg Clark believed—that the cost of wind power had been falling rapidly and would likely become the lowest-cost source of electricity. This assertion always lacked plausibility and should have invited a great deal of hardheaded due diligence by ministers and civil servants. As Helm warned in his *Cost of Energy Review*, there is a long track record of using forecasts and assumptions as part of lobbying activities, so that apparently "technical analysis" is a means of policy capture by interest groups.

A 2015 paper on offshore wind costs commented on the unreliability of cost data derived from press reports and commercial databases, as "it is difficult to detect whether the figures were massaged."[32] Similarly, a 2019 paper (Aldersey-Williams et al.) presenting estimates of wind-power costs from audited accounts noted that BEIS calculations for levelized cost of electricity (LCOE) for renewable energy technologies were derived from

> a "broad mix of public, internal and stakeholder sources" and involving "manufacturers, projects developers and utility companies." However, it is clear that such data can be susceptible to manipulation by participants, who might be expected to be concerned to shape policymakers' opinions in favour of future projects.[33]

The authors comment that other commercial consultants such as Lazard, which produces widely cited LCOE estimates for wind and solar, and Ernst & Young are "even less specific about their data gathering approaches." Lazard's LCOE numbers are based on "Lazard estimates," while Ernst & Young's are based on publicly available information and average input data (whatever that means), which, "if derived from public statements, may again be vulnerable to 'massaging' or selective presentation by developers."[34]

3.1 Hughes 2012 Wind Scenario

Notwithstanding the blizzard of industry crafted and curated wind data, it would have been possible for ministers and their advisers to assess the underlying economics of their wind strategy. A 2012 top-down analysis by Gordon Hughes of Edinburgh University indicated an extremely poor return on investment of the British government's wind-power strategy. The same year, Hughes wrote an analysis of Danish and UK wind-farm performance. The analysis shows that average load factors for UK onshore wind farms declined from 24 percent in their first year of operation to 11 percent in their fifteenth.[35]

Hughes, who specializes in applied statistics and economics and advised the World Bank on environmental standards for power plants, estimated that meeting the government's 2020 renewable energy target would require 36 GW of wind capacity backed up by 13 GW of open-cycle gas turbine (OCGT) plant. Including investment in additional grid infrastructure and allowing for the shorter life of wind turbines, this would require £120bn of capital investment. This, Hughes suggested, constitutes a plausible Wind Scenario.

On a comparative basis, the same electricity demand could be met by 21.5 GW of CCGT plant at a capital cost of £13bn. Wind farms have relatively high operating and maintenance costs, but no fuel costs. "Overall, the net saving in fuel, operating and maintenance costs for the Wind Scenario relative to the Gas Scenario is less than £500m per year," Hughes concludes, "a very poor return on an additional investment of over £105bn."[36] A prospective return on investment of less than half of 1 percent a year is spectacularly poor, by any standard.

Moreover, it is not guaranteed that the Wind Scenario reduces carbon dioxide emissions. OCGTs are typically used to provide peaking capacity, and their thermal efficiency is inferior to that of CCGTs used efficiently in Hughes's Gas Scenario. Whether the Wind Scenario reduces CO_2 emissions compared with the Gas Scenario depends on whether wind displaces gas during peak load demand, where wind reduces CO_2 emissions; in the middle of the demand curve, where it might go either way; or displaces base-load demand, where wind power increases emissions.

On the most favorable assumption for wind, the Wind Scenario would reduce CO_2 emissions at an average cost of £270 per tonne in 2009 prices (£409 per tonne in 2023 prices). "If this is typical of the cost of reducing carbon emissions to meet the UK's 2020 target, then the total cost of meeting the target would be £78bn in 2020, or 4.4 percent of projected GDP," comments Hughes, "far higher than the estimates that are usually given."[37]

3.2 Wind power costs and the CfD fairy tale

Rather than analyze the economics of wind as Hughes had done, ministers were led up the garden path by falling CfD strike prices for offshore wind projects under the CfD regime. Initially, strike prices—the contractually guaranteed price that renewable investors get for their electricity—were determined administratively; but in later allocation rounds, they were set by auctions. Despite the large proportion of sunk capital costs, as renewables don't have fuel input costs, CfD strike prices are inflation-proof and are linked to movements in the Consumer Prices Index (CPI). Between the first allocation round in 2015 and AR4 in 2022, offshore wind CfD strike prices fell by 75 percent, from £205 to £51 (2023 prices) (Table 3).

TABLE 3: OFFSHORE WIND CFD STRIKE PRICES (£ PER MWH)

	2015	2017	2019	2022
Allocation round	AR1	AR2	AR3	AR4
Strike price (2012 prices)	£114–£150	£57.50 / £74.75	£40.67	£37.35
Strike price (2023 prices)	£156–£205	£78.56 / £102.13	£55.57	£51.03

Source: Hughes et al., Offshore Wind Strike Prices (2017), p. 1; Low Carbon Contracts Co., auction outcomes data set, https://www.lowcarboncontracts.uk/data-portal/dataset/auction-outcomes

"I'll tell everybody who thinks hydrocarbons are the only answer and we should get fracking and all that," gushed Boris Johnson in one of his final public appearances as prime minister. "Offshore wind is now the cheapest form of electricity in this country. Offshore wind is nine times cheaper than gas because of the insanity of what Putin has done."[38]

Johnson's claim that offshore wind is nine times cheaper than gas (omitting mention of the government-imposed Emissions Trading Scheme (ETS) and Carbon Price Support (CPS) components of the cost of gas) came from a July 2022 post by Carbon Brief, a climate website funded by the European Climate Foundation, in turn funded by billionaire foundations, including Bloomberg Family Foundation, ClimateWorks Foundation, Rockefeller Brothers Fund, and the William and Flora Hewlett Foundation.[39] Hailing the outcome of CfD allocation round 4 in a "spike the football" manner, Carbon Brief's Simon Evans triumphantly wrote:

> With strike prices so far below the levels seen in the open market and with high gas prices now expected to persist for years, the projects secured in this week's auction are due to pay back considerable sums to consumers.[40]

So it's game-set-match? Not so fast. The statement contains two falsehoods:

- CfDs give wind investors a one-way bet. If they believe that electricity wholesale prices are likely to remain above the CfD strike price, they will not enter into a binding contract to give away their upside. Why would wind investors pay consumers vast sums when they can keep the money for themselves?
- Nothing was *secured* in AR4. Winning a CfD bid does not legally compel investors to build anything.

"Essentially, they got themselves a free option," writes energy consultant Kathryn Porter of the successful AR4 bidders.[41] CfDs are options written by the government-owned Low Carbon Contracts Company (LCCC) that oblige the LCCC to top up payments to the strike price. CfDs remain options unless and until they are exercised by wind investors allocated CfDs when they sign binding contracts far later in the process.

Politicians such as Greg Clark understand the nature of optionality. "Everyone in finance knows this—but when you hold an option, the next decision you face is whether to exercise it," Clark said in his November 2018 energy trilemma speech.[42] Private investors exercise options only if they believe that it is profitable for them to do, i.e., the option is "in the money" and the CfD strike price is likely to remain above the market price at which they can sell their electricity.

And, as everyone in finance knows, options have value. Because CfDs are allocated for zero financial consideration, the only variable that investors have to increase the probability of their obtaining a free CfD is to lower the strike price in successive allocation rounds. In this way, moral hazard was designed into the CfD allocation mechanism. It is this dynamic that explains falling CfD strike prices. Wind lobbyists then used these spurious data to deceive politicians and the media—willing dupes of the spin—and the public, who pick up the tab, that there has been a dramatic fall in the costs of offshore wind. It was a fairy tale spun out of straw.

3.3 Wind power costs—the reality

Those inclined to dig a little deeper found a very different reality. A 2017 paper by Gordon Hughes, Capell Aris, and John Constable analyzing a wide set of published offshore wind cost data found that unit costs rose by 6.1 percent a year between 2005 and 2013 (i.e., a real-term increase of 60.6 percent in eight years) and had been falling 4 percent a year since 2013.[43] However, this fall was being offset by the move to deeper waters for new and larger wind farms (Table 4). "The unavoidable shift to deeper waters is a strong counterbalance to cost reductions," the paper concluded.[44]

TABLE 4: OFFSHORE WIND FARM, AVERAGE DEPTH (METERS)

Completion date	2000–2009	2009–14	2000 and after
Average depth (m)	15	21	42

Source: Hughes et al., Offshore Wind Strike Prices (2017), p. 6

Two years later, in the 2019 paper cited earlier, John Aldersey-Williams of Aberdeen Business School and coauthors Ian Broadbent and Peter Strachan analyzed trends in offshore wind LCOE from cost data derived from the audited accounts of offshore wind Special Purpose Vehicles (SPVs). Their analysis shows an upward trend in LCOE for offshore wind projects from £100 per MWh (2012 prices) in 2003 up to and including the Thanet wind project, which commenced operations in 2010, to a maximum of about £150 per MWh (2012 prices), after which there was a gradual decline, although considerable dispersal of project LCOEs:

> A review of the trends would suggest that new wind farms are now achieving LCOEs of around £100 per MWh, which is still considerably above the most recent CfD bids of £57.50 per MWh.[45]

A 2021 analysis of published data by the GWPF's Andrew Montford concluded that, with the possible exception of the shallow-water Dogger Bank projects—Dogger Bank itself was a large area of dry land 6,000 years ago—the LCOE of most wind farms remains in the range of £125–£150 per MWh (£91.50–£110 per MWh in 2012 prices), a result similar to that of Aldersey-Williams et al. (2019).[46]

In 2020, Hughes published a study based on data from more than 350 onshore and offshore wind SPVs filing accounts since 2005. The results are the clearest possible falsification of the falling/cheap offshore wind claims promoted by the renewables lobby and parroted by politicians:

- Average offshore capex for UK projects has increased by 15 percent for each doubling in European installed capacity
- Year 1 opex for a shallow-water wind farm (2008) was £17 per MWh, compared with £44 for a deepwater project (2018)
- Year 12 opex for the 2008 project rises to £30 per MWh and will be £82 per MWh for the 2018 deepwater project
- At an average market price of £35 per MWh for wind power, without subsidies, deepwater wind projects cannot even cover operating expenses at Year 1, let alone recover their capital costs
- The average Year 12 deepwater opex of £82 per MWh equals or exceeds the CfD strike price for all offshore project from AR2 onward
- Offshore turbines are less reliable than onshore turbines, and smaller (less than 1 MW) turbines are much more reliable than newer 2+ MW turbines that dominate wind farms constructed since 2005
- The average load factor for onshore turbines declines at about 3 percent a year; for offshore turbines, the rate of decline is 50 percent faster, at 4.5 percent a year
- Incorporating these decline rates sees Year 12 offshore opex of £125 per MWh. Without additional subsidy, expected revenues will not cover opex after 12–15 years of operation.[47]

In addition to capex and opex data, Hughes analyzed the system costs of wind (its negative externality that Rudd and Helm wanted to internalize) and the decline in the value of its output as output rises. The latter arises because wind output does not vary with demand but with the weather. Because weather patterns tend to be regional and subcontinental in scale, the outcome is that windy weather pushes output down the demand curve, thereby reducing its price and its value.

Hughes estimates the cost of balancing various levels of wind output at £11–£31 per MWh in 2019-20.

When plotted against the market prices obtained for wind output, Hughes finds that 50 percent of all wind output in that year had a net value of less than £13 per MWh, and 20 percent of all output had a negative net value. "In stark terms a significant portion of wind output is expensive to produce and of no value in terms of its contribution to national wellbeing," Hughes comments. "The government is creating a situation in which it will have no option other than to bail out failed and failing projects simply to ensure continuity of electricity supply."[48]

3.4 The wind bubble bursts

The AR4 CfD results were announced on July 7, 2022, and offshore wind investors had to sign their nonbinding CfD contracts by July 22. Sixteen days before the CfD winners were announced, the Office for National Statistics announced that CPI inflation had reached 8.7 percent in the 12 months to May. In response to rising inflation, the Bank of England had started raising interest rates the previous November, and on July 7, it raised interest rates by a quarter point. Supply-chain-driven inflation was well under way when wind investors submitted their CPI-linked strike-price bids.

Six months later, in February 2023, the *Financial Times* reported that several big wind-farm developers were seeking tax breaks or enhanced subsidies from the government. "There is a real jeopardy right with that [AR4 offshore wind] capacity," a wind lobbyist told the *FT*.[49] In June, Ørsted, prospective developer of Hornsea 3, part of the world's largest offshore wind farm, was briefing the *FT* that the electricity prices that the UK government was offering developers, i.e., the strike prices that Ørsted had bid for its CfDs the previous year, were not high enough.[50] As Kathryn Porter noted in her blog, "the issue of cost inflation was already established when the auction took place."[51]

Then on June 22, Siemens Energy, Europe's second-largest wind turbine manufacturer, issued a shock profits warning: a substantial increase in failure rates of components in its latest generation of onshore wind turbines would lead it to incur costs in excess of 1 billion euros; anticipated productivity improvements were not materializing, and there were "ramp-up challenges" in offshore.[52] As a result, it was scrapping its earning guidance for the year. Siemens Energy shares plunged 37 percent in a single trading day.[53]

Commenting on the profits warning, Hughes noted that manufacturers' performance warranties have a time limit, often five to eight years, "but the higher failure rates will persist and affect performance over the remainder of the life of the wind farms where the turbines have been installed." Future opex costs will be higher, and their output will be significantly lower, shortening their economic lives.

> The whole justification for the falling costs of wind generation rested on the assumption that much bigger turbines would produce more output at lower capex cost per megawatt, without the large costs of generational change. Now we have confirmation that such optimism is entirely unjustified.… The consequence is that both capital and operating costs for wind farms will not fall as rapidly as claimed and may not fall significantly at all. It follows that current energy policies in the UK, Europe and the United States are based on foundations of sand—naïve optimism reinforced by enthusiastic lobbying divorced from engineering reality.[54]

Within a month of the Siemens Energy profits warning, Sweden's state-owned Vattenfall announced that it was suspending development of the first phase of the 1.4 GW Norfolk Boreas wind project, for which Vattenfall had been awarded a CfD a year earlier. Two other Vattenfall offshore projects "may be able to get higher government contracts," the *Financial Times* reported. "We will now look into the situation and find the best way forward for all these projects," Vattenfall CEO Anna Borg said. "The energy is desperately needed."[55]

It was. Offshore wind had been exposed as a dead-end technology. This was confirmed with the results of AR5 in September 2023, when no offshore wind projects had qualified for CfD subsidies, which the wind lobby blamed on the government's budget parameters being "too low and too tight."[56] No offshore wind investors had submitted bids because the CfD ceiling set by the government was too low. Their bluff had been called, and they folded their hands.

4. Britain commits to net zero

Key Points

The bursting of the offshore wind bubble came four years too late for Britain. In 2019, the statutory Climate Change Committee (CCC) persuaded the outgoing prime minister, Theresa May, to write net zero into law.

- The CCC falsely claimed that rapid falls in renewable energy costs meant that the cost of net zero could be accommodated within the original cost envelope of the 80 percent target (Section 4.1).
- Net zero became law after an 88-minute debate in the House of Commons, with no cost estimates and no vote (Section 4.2).

Net zero was presented as a fait accompli, required to meet Britain's commitments under the Paris climate agreement. In fact, net zero by 2050 was a target set by the Intergovernmental Panel on Climate Change (IPCC).

Article 2 of the 2015 Paris climate agreement defines the agreement's objective as:

> Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and *pursuing efforts* to limit the temperature increase to 1.5°C above pre-industrial levels.[57]

Article 4 then outlines an emissions trajectory to achieve "the long-term temperature goal" set out in Article 2:

> Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the *second half of this century*.[58]

The Paris climate conference also invited the IPCC to provide a scientific rationale for what the politicians and diplomats had already decided. However, the IPCC went much further. In its *Special Report: Global Warming of 1.5° Celsius*, published in 2018, it brought forward the date for net zero from the second half of the twenty-first century to 2050 and declared that climate change presented the opportunity for "intentional societal transformation"—an ideological, not a scientific, rationale for net zero.[59]

4.1 The Committee on Climate Change

Following the IPCC special report on 1.5°C, Britain's Committee on Climate Change (CCC, subsequently renamed the Climate Change Committee) issued a report in May 2019, urging the government to adopt a legally binding net zero target by increasing the 2050 emissions reduction target in the 2008 Climate Change Act from 80 percent to 100 percent. "The UK is one of the largest historical contributors to climate change," CCC chair Lord Deben wrote. "And there is the prospect of real benefits to UK citizens: cleaner air, healthier diets, improved health and new economic opportunities from clean growth."[60]

The CCC acknowledged that net zero goes beyond the Paris agreement and argued that attempting a cost-benefit justification for net zero "is not a sensible approach." Why? Because "the link from increased UK effort to reduced global warming is complicated."[61] Complicated? In other words, the CCC couldn't demonstrate a linkage where none exists. It would be all cost and less than net zero benefit.

The CCC also asserted that cost development is "much more dynamic" than a static cost assessment would suggest, implying that renewable energy costs were on a downward trajectory.[62] Indeed, illusory cost reductions in wind power formed a key part of the CCC's case for net zero. "There have been rapid cost reductions during mass deployment for key technologies," the CCC claimed, pointing to offshore wind and batteries for electric vehicles.[63] Costs for renewable energy had fallen faster than the CCC had assumed in 2008, when it had given its advice on the 80 percent reduction target.[64]

Referring to the most recent allocation round, the CCC claimed that offshore wind contracts had been "procured" at about £69 per MWh—40 percent lower than what the CCC had expected the cost of offshore wind would be by 2030.[65] As we've seen, these nonexistent reductions in offshore wind costs are nothing more than an artifact of a flawed bidding process that embedded moral hazard and rewarded opportunistic bidding by wind investors. "These cost reductions," the CCC concluded, "have made tighter emissions targets achievable at the same costs as previous looser targets."[66] It was green snake oil.

4.2 The politicians

The CCC net zero report came at a febrile period in British politics. Within three weeks of its publication on May 24, Theresa May announced that she would be resigning as leader of the Conservative Party less than two weeks later on June 7, thereby triggering a race to succeed her. Two days before her preannounced resignation was due to take effect, the *Financial Times* ran a report on a leaked letter from the Chancellor of the Exchequer, Philip Hammond, warning the prime minister that the cost of net zero was likely to be "well in excess of a trillion pounds."[67] Hammond cautioned that net zero would also render industries such as steelmaking "economically uncompetitive" without huge government subsidies.

Hammond urged the prime minister to agree to a Treasury review on how to minimize and prevent "potentially damaging impacts." He also suggested that the government should give itself an "explicit review," or a get-out clause, to reconsider the target if other countries did not follow suit.[68] As we shall see, Hammond's proposal of a Treasury review was acted on, but in such dilute form as to have zero impact.

While eminently sensible, his idea of a get-out clause runs up against the Climate Change Act. Section 2 of the act enshrines unilateralism by limiting the scope for amending the target to "significant developments" in either scientific knowledge or European/international law or policy, after taking into account advice from the CCC. It means that the target can't be changed, irrespective of what other countries do and whether global GHG emissions continue to rise.[69]

Having resigned as Tory leader but still prime minister, May announced on June 12 that the government was introducing legislation to make the UK the first major economy to set net zero into law. "Standing by is not an option," the soon-to-be ex–prime minister said. "Reaching net zero by 2050 is an ambitious target, but it is crucial that we achieve it to ensure we protect our planet for future generations."[70] Tellingly, May's net zero statement made no mention of the JAMS, the Just About Managing folk whose interests she had said at the start of her premiership would drive every decision she'd make as prime minister.

May had been forced to resign for failing to deliver Brexit. In legislating net zero, May's last act as prime minister would ensure that Brexit would be a flop. (The implications of net zero on Brexit are discussed in Section 16 below.) A week earlier, Boris Johnson—the politician most likely to succeed her—tweeted that if he became prime minister, he would enforce the net zero target and "embrace" the opportunity of green growth.[71]

On June 24, only 12 days after May's announcement, the House of Commons held a debate on the statutory instrument amending the Climate Change Act target from 80 percent to 100 percent. The draft order was moved by Chris Skidmore, the minister for energy and clean growth, at 5:43 PM.

On the cost of net zero, Skidmore stated that the CCC

> recommended that the overall cost envelope of reaching net zero be the same as the 80 percent envelope, because since the original 80 percent target was set out, the costs of renewables and other technology have come down.[72]

Challenged by Labour's Graham Stringer on why the government had not presented a regulatory impact assessment for the new target, Skidmore replied: "We did not have an impact assessment when we moved from 60 percent to 80 percent."[73] This was untrue, as Skidmore should have known. The impact assessment on the 80 percent target, released in March 2009, gave a range of £324–£404bn for the capitalized costs of meeting the target but warned that this figure did not include the full range of costs, particularly the short-term transition costs, and that costs could be higher than those estimated by the long-term modeling.[74]

According to the 2009 impact assessment, the principal policy objective of the Climate Change Act is to avoid dangerous climate change in an economically sound way by "demonstrating the UK's leadership in tackling climate change."[75] It also contains a rare warning about the potential costs and risks to Britain of climate leadership:

> Where the UK acts alone, though there would be a net benefit for the world as a whole the UK would bear all the cost of the action and would not experience any benefit from reciprocal reductions elsewhere. The economic case for the UK continuing to act alone where global action cannot be achieved would be weak.[76]

Nonetheless, the political rhetoric on climate leadership remained blissfully unconcerned about this reality. Skidmore told the House of Commons that through Britain's decarbonization journey, "we show global leadership and demonstrate to other countries that are not cutting their carbon emissions the need to do so" but didn't explain what this curious formulation actually meant.[77]

How had Britain's first attempt at climate leadership worked out? The metric of leadership success is followship. In the 11 years from the passage of the Climate Change Act in 2008 to adoption of net zero, Britain cuts its carbon dioxide emissions by 180 million tonnes—very nearly a one-third reduction. Over the same period, the rest of the world increased CO_2 emissions by 5,177 million tonnes, a rise of 16.4 percent (Table 5).

TABLE 5: UK AND WORLD CO_2 FOSSIL FUEL EMISSIONS (M TONNES)

	2008	2019	Change	
UK	545	365	–180	–33.1%
World ex-UK	31,541	36,718	5,177	+16.4%

Source: Our World in Data, https://ourworldindata.org

The outcome of the opposing emissions trends is that the UK's share of global emissions had fallen from 1.70 percent in 2008 to 0.98 percent by 2019. Ironically for a climate leader, shrinking your emissions when the rest of the world is growing theirs makes you less important in the international climate talks, as you have less to offer—other than providing more money in climate aid.

At 7:11 pm on June 24—88 minutes after moving the draft order—Skidmore concluded the House of Commons debate. "Resolved, That the draft Climate Change Act 2008 (2050 Target Amendment) Order 2019, which was laid before this House on 12 June, be approved."[78] There was no vote.

5. Whitehall's net zero advice

Key Points

The Treasury and the Office for Budget Responsibility (OBR) share responsibility for propagating fantasy economics on the likely costs and consequences of net zero.

- The OBR fabricated a scenario of spiraling public debt reaching 289 percent of GDP in 2100 out of unevidenced climate catastrophes caused by tipping points such as a complete melting of the Greenland ice sheet, which the IPCC reckons might happen over several millennia.
- The OBR analysis demonstrates that net zero creates a fiscal black hole, principally from the loss of revenues from fuel duties, leading to a structural deficit of 1.1 percent in 2050–51, thereby debunking the IMF's claim about the existence of huge fossil fuel subsidies (Section 5.1).
- The OBR and Treasury's optimistic net zero analyses share three errors:
  - They see the economy plagued by market failure when, as Helm had argued, the dangers are policy capture and government failure (Section 5.3.1).
  - The only climate scenario not analyzed is Britain and the West decarbonizing and the rest of the world carbonizing, so the UK bears the costs of decarbonization for zero climate benefit, i.e., what's happening in the real world (Section 5.3.2).
  - Most seriously, they argue that net zero is an opportunity for innovation that will boost growth, committing the fallacy that there is no opportunity cost to innovation and therefore no negative impact on growth-enhancing innovation (Section 5.3.3).
- As part of an all-of-government approach to net zero, the Energy Act 2023 imposes a legal duty on the energy regulator Ofgem to support the government's net zero policies, fatally compromising Ofgem's independence and ability to protect consumer interests.
- To mitigate reliance on intermittent wind and solar generation, the Energy Act 2023 gives ministers wide-ranging powers to make regulations requiring energy-smart appliances and EVs to respond to load control signals, i.e., be switched off by the network operators (Box 3).

It wasn't only Britain's elected politicians who fell for net zero. As official sources of advice to ministers, the independent Office for Budget Responsibility (OBR), Britain's equivalent of the Congressional Budget Office, and the Treasury issued separate reports that indulge in unwarranted and unevidenced climate catastrophism and, apart from one limited exception, downplay possible adverse economic consequences of net zero. Instead, both the OBR's and Treasury's treatment of the economics of net zero is suffused with wishful thinking.

5.1 Office for Budget Responsibility

"Unmitigated climate change would ultimately have catastrophic economic and fiscal consequences," the OBR opined in its July 2021 "Fiscal Risks Report."[79] In extreme climate scenarios, the OBR states, "it would be nature, rather than human action, that ultimately brings net emissions towards zero by leading to depopulation."[80]

What was this dire prognostication based on? The OBR cites accelerated melting of the Greenland ice cap as an example of a tipping point. To put this risk in perspective, in its Sixth Assessment Report, the IPCC states its opinion that a sustained warming of 3°–5°C is projected to lead to a near-complete loss of the Greenland ice sheet "over multiple millennia," a longer time frame than any conceivable fiscal projection.[81] The words "catastrophe" and "catastrophic" appear eight times in the 49 pages of the OBR report (a mention once every six pages) and appear five times in 3,849 pages of Working Group I's contribution to the IPCC Sixth Assessment report (an average of once every 770 pages), the first mention being with respect to catastrophist climate narratives in the media.

To illustrate the effect on the public finances of what it calls unmitigated global warming, the OBR uses the most pessimistic Met Office scenario of future GHG emissions over the current century. This turns out to be the discredited RCP 8.5*** ultrahigh emissions scenario, one originally founded on mistaken reports from the late 1980s of cheap and virtually limitless coal reserves in China and Siberia, which climate scientists Roger Pielke, Jr. and Justin Ritchie have comprehensively debunked, describing the use of RCP 8.5 as a "stubborn commitment to error."[82]

The OBR's stubborn commitment to error, coupled with a simplistic assumption about a series of 11 climate shocks, ratchets up public debt to 289 percent of GDP by the end of the century, pushing net debt interest payments to about 10 percent of GDP.[83] Making up a phony fiscal horror show out of an extreme and implausible climate scenario can hardly be described as fiscal responsibility. In one of its few concessions to realism, the OBR acknowledges that the UK's 1 percent share of global emissions means that "the fiscal risks from unmitigated global warming are largely beyond the UK government's control" but fails to draw the obvious conclusions.[84]

One public service that the OBR performs is nailing a myth promoted by the IMF of huge fossil fuel subsidies and its claim that globally, fossil fuel subsidies amounted to $5.9 trillion in 2020, equivalent to 6.8 percent of global GDP.[85] The OBR reckons that fiscal receipts (i.e., tax revenues) forecast to be worth 1.6 percent of GDP in 2025–26 could be lost as a result of decarbonization by 2050.[86] By far the largest share of the loss is from fuel duties. Revenues worth about 1.2 percent of GDP in 2025–26 are halved by the mid-2030s and fall to virtually zero by 2050.[87]

To make up for these lost revenues, the OBR assumes that the government imposes a carbon tax from 2026–27, starting at £101 per tonne and rising to £187 per tonne in 2050–51. Nonetheless, fossil fuel tax revenues fall steadily as carbon dioxide emissions fall and reach 0.5 percent of GDP in 2050–51. The net effect is a reduction in tax revenues equivalent to 1.1 percent of GDP in 2050–51.[88] There is, however, no boost to the public finances from reduced public spending on fossil fuel subsidies because there aren't any meaningful ones.

5.2 HM Treasury

Hard on the heels of the OBR's consideration of climate change and fiscal risk came the Treasury's *Net Zero Review* in October 2021. The review was the outcome of the agreement between Theresa May and Philip Hammond to secure his non-opposition to legislate net zero. It turned out very differently from what Hammond had envisaged (Section 4.2 above).

Analytically, the review is a non-happening. It kicks off by saying that it is "not a cost-benefit analysis."[89] Despite this, the Treasury then asserts that

> a successful and orderly transition for the economy could realise more benefits—improved resource efficiency for businesses, lower household costs, and wider health co-benefits—than an economy based on fossil fuel consumption.[90]

*** A Representative Concentration Pathway (RCP) is a socioeconomic projection of future greenhouse gas emissions. Why a weather forecaster such as the Met Office has more expertise in such matters than the OBR is unclear but is part of the pattern of climate policy of government bodies outsourcing their judgment in order to duck accountability for coming up with their own views.

Two pages later: “The costs of global inaction significantly outweigh the costs of action.”[91] What action? Without specifying the action, the statement is meaningless.

The review notes that net zero studies tend not to compare the costs and benefits of net zero with the costs of unmitigated climate change. Rejecting an unmitigated climate change counterfactual to assess the economics of net zero, the review serves up an analytical word salad:

> the unmitigated costs would also be an unsuitable counterfactual for UK policy analysis: global action will be necessary to prevent these costs from materializing, and a disproportionately costly counterfactual could mask differences in the economic and distributional implications of decarbonization policy choices.[92]

This makes no sense. It’s tantamount to saying that the costs of decarbonization don’t matter because they’re going to be incurred anyway. Such circular justifications suggest that net zero can’t be justified on the grounds of benefits being greater than costs; if it could be, we can be sure that the finding would be trumpeted as dispositive. Here, the absence of evidence is evidence.

Instead, the review recycles the claim made in the 2006 *Stern Review* that the overall costs and risks of global warming are equivalent to losing “between 5 percent and 20 percent of global GDP each year” and, as the *Stern Review* added, “now and forever.”[93] As is frequently the case in climate, appearances deceive. Stern’s formulation was deconstructed by William Nordhaus, recipient of the 2018 Nobel Prize in economics, in a 2007 review of the *Stern Review*. Stern’s estimate of the output loss now, as in “today,” is essentially zero. Nordhaus explains that the low climate damages over the next two centuries are overwhelmed by the long-term average of the many centuries that follow. “In fact, using the *Review*’s methodology, more than half of the estimated damages ‘now and forever’ occur after the year 2800,” according to Nordhaus.[94] Mean losses in 2100 for Stern’s catastrophic and nonmarket impacts are 2.9 percent of world output and are lower than Nordhaus’s own estimate of 4.1 percent of world output.[95]

Set against this catastrophizing—like the OBR, the Treasury highlights climate tipping points such as ice-sheet collapse thousands of years into the future[96]—when the Treasury comes down to earth, it says that if shoreline management plans are not implemented “5,000 properties could be affected by coastal erosion.”[97] Using the discredited RCP 8.5 emissions scenario of 4°C warming by the end of the century, the Treasury review cites a CCC estimate of £1.2bn ($1.5bn) annual flood damage to nonresidential property—footling numbers, compared with the costs of net zero and an argument for intelligent adaptation.[98]

The Treasury does point to some negative consequences of net zero. These include reduced consumption and lower living standards, rebalancing the economy away from manufacturing to professional services, increased likelihood of carbon leakage, and higher energy costs—issues that are common to aggressive net zero policies being pursued in other countries (Box 2).

BOX 2: HM TREASURY NET ZERO REVIEW: NET ZERO POTENTIAL DOWNSIDES

Impact on living standards

- "Some green investments could also displace other, more productive, investment opportunities…. To the extent that additional investment does not stimulate additional growth, this implies a structural rebalancing away from consumption." (p. 16)
- "Although the highest income households emit around three times as much carbon as the lowest income households, they have incomes that are more than eight times greater on average." (p. 47)

Deindustrialization

- "The UK also currently has a very strong comparative advantage across a broad range of professional, financial, and engineering and design services…. The UK has a 'natural advantage' in providing services for a low carbon economy, including financing, legal and consulting expertise and software services" (p. 24). The implication is that net zero, while potentially beneficial to white-collar professionals, will accelerate deindustrialization.

Carbon leakage

- "Businesses in the jurisdictions with more ambitious emission reduction policies face higher costs, causing a drop in domestic output, and an expansion elsewhere." (p. 26)
- "Although there are many uncertainties, and the data is imperfect, the analysis above suggest that some UK sectors are at risk of carbon leakage." (p. 33)

Energy costs

- Impact on electricity bills: "Infrastructure, carbon and social costs have nearly tripled since 2010, as investment in renewables has increased." (p. 52)
- "Assessments of abatement costs in the future are highly speculative." (p. 43)

Source: HM Treasury, *Net Zero Review* (Oct. 2021)

5.3 Three shared errors

The OBR and Treasury commit three major errors: exclusive focus on market failure while ignoring the risk of government failure; ignoring the most likely global emissions scenario; and wishful thinking on the impact of decarbonization on productivity.

5.3.1 Market failure vs. government failure

Both reports are littered with references to market failure. "Multiple policy instruments will be needed to address multiple market failures," the Treasury says.[99] The OBR's definition of market failure extends to technological solutions being more uncertain to deliver higher emissions reductions targets. The implication is that state interventions can conjure up all the technological solutions needed for net zero, as if political will can overcome technological frontiers imposed by the laws of physics.[100] Other than one reference to the risk of government failure from having to design specific policy intervention for each sector in the Treasury's *Net Zero Review*, neither it nor the OBR recognizes the danger of policy capture by vested interests.[101]

This was a major theme of the Helm *Cost of Energy Review*, published four years earlier. Helm had asked BEIS to provide a list of all the main current policy interventions. It ran to several pages, Helm reported—"and is almost certainly incomplete"—administered by 17 separate bodies and organizations.[102] "Each of these interventions has been developed in an *ad hoc* way," Helm notes, "and little serious thought has been given to how they fit together, and whether they comprise a cogent approach to general taxation and correcting market failures."[103]

Although Helm is listed as a member of the Treasury's decarbonization economic advisory group, there is no reference to his review or to Helm's analysis and recommendations. In terms of informing Treasury and OBR thinking, the Helm review might as well never have been written. This is itself evidence of government failure—the refusal even to acknowledge the existence of an incoherent mishmash of inefficient decarbonization interventions, let alone correct it.

5.3.2 Skewed scenario analysis

Global warming is a global problem, indifferent to where or who emits a tonne of carbon dioxide. The OBR acknowledges this, correctly observing that the UK's small share of global emissions means that "if the world fails to bring global warming under control, we will inevitably be hit by the consequences even if the UK has successfully decarbonized."[104] The Treasury, too, emphasizes the unavoidable global aspect of climate mitigation policy. "Global action to mitigate climate change is essential to long-term UK prosperity," the first sentence of its *Net Zero Review* asserts.[105]

What happens if the UK decarbonizes but the world doesn't? The OBR discusses seven scenarios (early UK action, no UK action, delayed UK action, high and low productivity climate policy impact variants, and high and low public spending variants). Missing from the list is the scenario that has been unfolding since 1992 when the UNFCCC was signed in Rio—reductions in the West's emissions being more than offset by growth in the rest of the world's.

The same scenario bias affects the Treasury's review. It frames its net zero analysis in terms of whether to "highlight the opportunities, costs and trade-offs of playing a leading role compared to free-riding in the global transition."[106] This is an odd way of looking at free-riding and the collective action problem posed by global warming. The success of the 1987 Montreal Protocol on ozone-depleting substances largely stems from the protocol's incentives to counter free-riding on other countries' efforts. The weakness of the UNFCCC process is the absence of any such countervailing incentives, especially, as the Treasury concedes, over three-quarters of global emissions remain unpriced.[107] What has been happening is that the Global South has been free-riding on the UK's and the West's emissions reductions, a reality that the Treasury and OBR ignore.

The OBR acknowledges that the UK is "relatively insulated" from the direct physical effects of climate change over the next few decades.[108] At higher temperatures, it says that "an increasing number of catastrophic risks could be faced. Competition for scarce resources could lead to conflict and war."[109] Similarly, the Treasury says that in the UK, which is an advanced economy enjoying a temperate climate, significant climate impacts are likely to be indirect, such as damage to global supply chains, reduced output of partner trading nations, or changes in migration patterns.[110]

If reducing these risks is a rationale for UK climate action, they also constitute risks in a unilateral decarbonization scenario where the West, including Britain, decarbonizes and the rest of world doesn't. This was a scenario identified in the 2009 impact assessment on the Climate Change Act's 80 percent target, when the relevant government department concluded that the economic case for the UK continuing to act alone where global action cannot be achieved would be weak (Section 4.2 above). Moreover, decarbonization and increased exposure to weather-dependent electricity generation weaken the resilience of the British economy to weather-adverse climate shocks.

Lost in all this is any recognition of scarce resources colliding with the need to make informed judgment on economic trade-offs. Every pound spent on climate mitigation is a pound forgone on investment in climate adaptation and resiliency investment. The figures in Table 5 show Britain reducing emissions by 33.1 percent between 2008 and 2019 while the rest of the world boosted its emissions by 16.4 percent. The obvious takeaway is that the UK's mitigation "investment" is being squandered on immeasurably small climate mitigation benefits that accrue to the world at large, while 100 percent of these scarce resources could have produced meaningful adaptation outcomes at home, where 100 percent of the impact would be retained within the domestic economy.

5.3.3 Impact on productivity

Of all economic questions raised by net zero, the most important is its likely impact on productivity. The Treasury's top priority is to achieve strong and sustainable economic growth. Increasing employment and productivity is one of its three objectives.[111] In its assessment of net zero, the OBR notes that long-term productivity growth is the key determinant of fiscal sustainability because "it underpins growth in all the major tax bases, which in turn provides the resources to meet demands for public spending."[112] Notwithstanding their belief in catastrophic climate change, the duty of both bodies as providers of economic advice to ministers is to bring rigor and objectivity to the analysis of the economic consequences of net zero, particularly on economy-wide productivity.

Instead of analytical rigor, the Treasury offers a net zero sales pitch. The tone is set early on. The transition to net zero will, it says,

> create new opportunities for growth. A step change in investment and the creation of new markets can catalyse innovation and lead to productivity growth.[113]

"Innovation" appears 59 times in the *Net Zero Review* and "innovate" a further eight times. At 49 times, "opportunity" runs "innovation"—as in "opportunities for innovation"—a close second.[114] This usage highlights the Treasury's analytical error: it assumes that there is no opportunity cost to innovation. There is a reason that Silicon Valley has so many billionaires. Innovation is the most valuable input in the economic process. Its supply is not limitless. If regulatory interventions create opportunities for growth-generating innovation, decades of India's License Raj would have propelled India to the top of the economic growth league.

Moreover, imposing dense regulation risks switching the entrepreneurial function from innovation to negative-sum rent-seeking because the prospective returns from the rent-seeking are higher. This danger was highlighted by Dieter Helm in the *Cost of Energy Review*. Regulatory complexity has significant additional costs for energy, Helm wrote, because

> the greater the complexity, the greater the scope for capture by rent-seeking lobbyists and interest groups. Each intervention changes returns. Once gained, they tend to be capitalized. As a result, any moves to reform and change arrangements—for example, by phasing out particular subsidies—creates losers, and often capital losses. Understandably these are resisted, and the complexity makes it much easier to protect specific interests, while at the same time reducing the ability of households and industrial users to defend their general interests in general efficiency. It is no accident that the growth of complexity has been closely matched by a growth in lobbying (and vice versa).[115]

The Treasury states that although it is uncertain by how much additional net zero investment will boost growth, all other things being equal, "additional investment will translate into additional GDP growth."[116] Economists' ceteris paribus assumption can help illustrate key economic relationships. Here, the assumption is downright misleading. Other things aren't equal, as a comparison is being made between investment in a market-driven world and where those decisions are taken by the state. There is a world of difference between markets allocating capital, where investors seek to maximize risk-adjusted returns, and the state taking over this function to direct capital into assets, which, without government subsidies, would yield low or negative private-sector returns. The Treasury's *Net Zero Review* demonstrates alarming levels of ignorance or extreme cognitive dissonance.

The OBR is generally more circumspect. The effects of global warming and decarbonization on productivity are "uncertain," it says.[117] Based on a 2020 Our World in Data post, in turn based on unverified Lazard LCOE estimates (see Section 3 above), the OBR claims that the costs of low carbon generation have fallen so fast that they are now cheaper than fossil fuel generation.[118] On that basis, an optimistic scenario in which decarbonization boosts productivity

> is not impossible. But equally, the costs of such a major structural change over a sustained period could easily be greater than assumed—for example, if policy needs to change course unexpectedly or if a technology that has been heavily invested in proves unsuccessful.[119]

Unlike the Treasury, the OBR discusses potential downsides of early action to reach net zero, including "the possibility of investing in what proves the wrong technologies," a possibility that the analysis of offshore wind costs reviewed above accords with reality.[120] The OBR estimates that this low-productivity scenario would reduce GDP by 4.4 percent through 2050–51 and increase the ratio of debt to GDP by 11 percentage points.[121] (The OBR did not combine this scenario with the fiscal consequences of rising global emissions, which is the scenario currently unfolding.)

The Treasury's *Net Zero Review* simply presents a net cost estimate of 1–2 percent of GDP in 2050, qualifying this by saying that cost projections over the 30-year transition are "highly uncertain and will depend on the rate of innovation and technology cost reductions," implying that the outturn is likely to be lower.[122]

Institutionally, the Treasury has always been highly skeptical of cost estimates used to support public-sector infrastructure projects, as it has to fund cost overruns. Not so with net zero; its pattern of lowballing net zero cost estimates continues with its assumption of £50 per MWh (2020 prices) for low carbon generation based on AR3 CfD strike prices. "It is not unreasonable to expect lower strike prices in the future but estimating the level at which they will plateau is very difficult"—an extraordinary statement, given the upward cost pressures in the offshore wind sector that were already evident.[123]

The Treasury's £50 per MWh assumption compares with Gordon Hughes's break-even prices for offshore wind of £125–£152 per MWh derived from accounting data in his 2020 study cited above. Hughes is scathing about the overall cost estimates for net zero pushed by the Treasury:

> The projections of the costs of achieving net zero put out by government bodies and many others rely on cost estimates that are just wishful thinking. They have no basis in actual experience and a realistic appraisal of trends in costs. As a very broad brush calculation the cost of meeting the net zero target by 2050 is much more likely to be ten plus percent of annual GDP than the claimed 1–2 percent of GDP.[124]

Confirmation of the negative impact on productivity and economic growth comes from the International Energy Agency (IEA). In its *Net Zero by 2050: A Roadmap for the Global Energy Sector*, published in May 2021, the IEA net zero pathway sees the global energy sector in 2030 employing nearly 25 million more people, using $16.5tn more capital and taking an additional land area the combined size of California and Texas for wind and solar farms and the combined size of Mexico and France for bioenergy, all to produce 7 percent less energy, as total energy supply falls from 591 exajoules (EJ) in 2020 to 550 EJ in 2030.[125] More labor, capital, and land to produce less is a textbook definition of negative productivity growth, pushing up costs and shrinking the economy's productive potential. The Treasury and OBR got their economic analyses of net zero horribly and inexcusably wrong.

5.4 Policy capture

Cogent policy analysis is critical to governments' ability to resist policy capture. The Treasury is the most powerful department in Whitehall. Not only is it involved in every major public spending decision; its stewardship of economic policy gives it a privileged voice on virtually all aspects of domestic policy, as seen by Philip Hammond's intervention on net zero in the final weeks of the May premiership.

The credulity displayed by the Treasury in its net zero review and the soft-focus, feel-good treatment of the economics of net zero make for a travesty of policy analysis. Together with the OBR's net zero effort, the Treasury's *Net Zero Review* demonstrates the extent to which Britain's energy policy had been captured. Worse still, its policy establishment blinded itself to the economic consequences of net zero, selling voters a fairy tale of green growth ("net zero is the economic opportunity of the 21st century") that ignores accumulating counterevidence and defies economic logic.

5.5 Ofgem's net zero prize

A postscript to writing net zero into law is Parliament turning the notionally independent energy regulator into a governmental agency to implement net zero in a move reminiscent of the Biden administration's all-of-government approach to climate change. The Office of Gas and Electricity Markets (Ofgem) had shown itself grossly incompetent in regulating the energy supply market (discussed in Section 15 below). Commenting on this in a July 2022 report, the House of Commons BEIS committee declared itself

> unconvinced of Ofgem's ability to undertake regulatory reform in a way that effectively manages the complex trade-offs or range of business models in the market.[126]

Instead of reforming Ofgem, the Sunak government capitulated to pressure less than a year later from the climate lobby to give Ofgem a statutory duty to promote net zero. The Energy Act 2023 (Box 3) achieves this by requiring Ofgem to "assist the Secretary of State's compliance" with meeting the net zero target in the Climate Change Act.[127]

BOX 3: THE ENERGY ACT 2023

The Energy Act 2023 is the first major piece of decarbonization legislation since adoption of net zero in 2019.

In addition to amending Ofgem's statutory duties to include assisting the government with attaining its climate targets, the legislation creates a new, government-appointed Independent System Operator and Planner, taking over the Electricity System Operator function of the National Grid, and imposes on the new body a duty to carry out its functions in a way that it considers best calculated to promote the net zero objective.

The coercive nature of net zero and the need to curtail electricity consumption due to reliance on intermittent wind and solar generation can be seen from the Act's provision authorizing smart meter regulations, including conferring powers of entry, including by reasonable force; of inspection, search, and seizure; powers to require the production of information or things held at, or electronically accessible from, entered premises (s.237 (2) (c)–(f)).

The Act contains a chapter authorizing regulations of energy-smart appliances so that they respond to a "load control signal," defined as "a digital communication sent via a relevant electronic communications network to an energy smart appliance for the purpose of causing or otherwise facilitating such an adjustment" (s.234 (4)).

Appliances covered by the energy-smart regulations are refrigeration, cleaning tableware, washing or drying textiles, storing energy that was converted from electricity and is stored for purpose of its future reconversion into electricity (i.e., Battery Electric Vehicles), heating, and air conditioning or ventilation (s.235 1–2).

Source: UK Parliament, Bill 340, 2022–23 (as amended in Public Bill Committee), https://publications.parliament.uk/pa/bills/cbill/58-03/0340/220340.pdf

Ofgem's new net zero duty adds to an already-stacked deck. In the Energy Act 2010, the Labour government had twisted Ofgem's consumer protection duty by redefining the interests of "existing and future customers" to include reductions of GHG emissions, a tendentious formulation, given the extremely attenuated linkages—if any—between Britain's GHG emissions and adverse changes to Britain's temperate climate.[128] As John Constable has noted, this change was of enormous importance, as an increasingly large share of the costs imposed on consumers are the result of climate policy.[129] This was a fatal error, now reinforced by Ofgem's new net zero duty.

Ofgem welcomed the latest change, its chief executive Jonathan Brearley saying that while Ofgem's fundamental objective "will always be to protect the interests of existing and future consumers," the addition of the net zero duty "directly links consumers' interests to specific net zero targets."[130] Logic demonstrates that this is false: if meeting net zero and promoting the consumer interest are identical, then adding net zero to Ofgem's statutory duties is nugatory; it adds nothing.

Indeed, Brearley, appointed to head Ofgem in 2019, has no expertise as an economic regulator, and his entire career as a Whitehall insider shows why he will treat consumers as a green piggy bank to fund net zero. Having served in Tony Blair's strategy unit (2002–06), Brearley worked as director of the Office for Climate Change in the government department drafting the Climate Change Act, later becoming director of Electricity Markets and Network, responsible for devising the EMR program that introduced CfDs—before resigning noisily in 2013, complaining that the Treasury was frustrating his attempts at improving the investment climate for renewables, i.e., throwing more money at them.[131]

Naturally, the renewables lobby pressed for the addition of the net zero duty precisely because the net zero target conflicts with Ofgem's consumer protection objective. Even if it were inclined to withstand pressure from vested interests and climate NGOs, their ability to challenge Ofgem policies in the courts is enormously enhanced, as the addition of Ofgem's net zero duty renders its consumer protection objective an empty husk.

"The net zero mandate has overwhelming backing from every part of the energy industry, consumer campaigners and climate activists," Brearley continued. "It underlines that net zero is the best option, not only from a climate perspective, but to ensure a low-cost energy future."[132] Ofgem's net zero mandate, Brearley says, "sends a clear message [that] we must end our historic dependency on fossil fuels." Easy to say and easy to legislate. Reality is not so amenable. Vaclav Smil, a rare energy expert who has actually studied energy transitions, writes in his 2022 book *How The World Really Works:*

> [W]e are a fossil-fueled civilization whose technical and scientific advances, quality of life, and prosperity rest on the combustion of huge quantities of fossil carbon, and we cannot simply walk away from this critical determinant of our fortunes in a few decades, never mind years.[133]

6. Public attitudes

Key Points

Surveys of public opinion show broad support for net zero. Although addressing the cost-of-living crisis is more important, the public does not see a conflict between the two, reflecting the success of the climate lobby and the absence of accurate data on the real costs of climate policies in the mass media. The Ukraine war has strengthened support for renewables, as the public believes that these reduce the country's exposure to bad foreign actors like Vladimir Putin.

Not only did the British policy establishment fool themselves; they fooled the public, too. Opinion research consistently shows high levels of public support for net zero and renewable energy. Polling and focus groups conducted in autumn 2022, as the energy crisis hit hard, by Public First, a public affairs consultancy heavily invested in net zero, found that

> baseline opinion is so supportive of investment in these energy sources that arguments have little effect on levels of support. Regardless of the arguments for and against investment which we showed respondents, support for both solar and wind was over three-quarters.[134]

That finding should be qualified by respondents' admission that they "felt under-qualified to make choices between technologies without really understanding the costs and benefits of each."[135] Respondents were not presented with facts on the high and rising costs of offshore wind or on the impact of the ETS cap-and-trade and the CPS carbon tax on their bills. Instead, they were told that investment in wind farms "will bring down the cost of energy to households."[136] Unsurprisingly, Public First found that most of the respondents expect environment-friendly solutions to be lower-cost and report net agreement of 54 percent on the statement: "I would prefer the rising cost of living to be addressed without compromising the UK's plan to each net zero by 2050."[137]

A June 2023 YouGov survey for *The Sun* also found a high level of support for net zero, with 65 percent of those polled strongly supporting or tending to support net zero, which crumbles when voters are asked whether it's possible to reach net zero without increasing the cost of living; they split 37 percent each way. Even this overstates public support for net zero. When the issue is framed in terms of prioritizing net zero or keeping down the cost of living, only 20 percent support prioritizing net zero and 62 percent the cost of living, YouGov found.[138] The inference is that the community does have concerns about climate change and would like to reach net zero, but this support is conditional and comes lower down in their priorities. In a contest between the soft value of supporting for net zero and their hard interest in maintaining their standard of living, British voters overwhelmingly opt for protecting their economic interests.

Caution is needed in interpreting poll results headlining support for net zero. Environmental economists have known for many years that there is a huge discrepancy between stated and revealed preference. When respondents are asked whether they support renewable energy, climate-change mitigation, or net zero policies, there is a favorable, socially acceptable response. Who doesn't want to be on the side of the angels as the current climate zeitgeist is typically fashioned? When personal cost and consequences enter the equation, support weakens dramatically.[139] Polling foundation IPSOS makes clear:

> Public support typically falls when the possible impacts of each net zero policy on them personally are considered—both the impact on their lifestyle and the financial cost.[140]

Russia's invasion of Ukraine means that right now, the public wants security and energy self-sufficiency. They link the high cost of living to the war in Ukraine and do not want the country to be put in a position again where a foreign government or dictator can affect our economy and their wallet so immediately. Support for renewable energy is not just because it is clean and "free" but also because the wind and the sun can't be taken away by a foreign dictator; the public mistakenly seeing renewables as reliable sources of energy.

This simplistic narrative ignores the fundamental defect of renewables, for which there is no practical solution. Their intermittency requires fossil fuel backup. Moreover, powering past coal increases Britain's dependence on shipments of liquefied natural gas (LNG) to keep the grid stable and the lights on. Yet the demonization of coal has succeeded in putting the fuel source best able to guarantee security of supply beyond the pale in the minds of the British public; coal, according to Public First's research, "being so unpopular a source of energy that no argument for it performed well—even energy security."[141]

What's missing is information in the public arena on the true costs of net zero because the public has been fed a diet of misleading claims about cheap renewable energy that they are inclined to accept because the wind and the sun don't cost anything. On that basis, neither does coal, oil, or natural gas cost anything. One need only dig it out of the ground. Media reporting is overwhelmingly favorable to renewables, especially at the BBC, which remains the news organization with the highest cross-platform audience reach (76 percent) among those following the news.[142] That won't change for as long as all political parties remain committed to net zero, as it's not in their interest to alert the public to how much net zero is costing them and contributing to Britain's economic weakness.

PART III. POWERING PAST COAL

Key Points

A big thrust of British climate policy has been to eliminate coal-fired generation, which has been achieved principally through the Carbon Price Support (CPS), a unilateral carbon tax on top of the EU's Emissions Trading Scheme (ETS) (Section 7 and Fig. 3), and from 2016, natural gas became the price setter (Figs. 4 and 5). Portrayed as having no downsides, powering past coal worsened the post-Ukraine invasion energy crisis by increasing dependence on more expensive natural gas, which cannot be stockpiled as easily and as cheaply as coal.

- Without the CPS and ETS, the fuel cost of coal would have been £121.70 per MWh against the fuel plus carbon cost of natural gas of £170.36 per MWh (Table 7). A pure non-climate counterfactual would have thermally efficient power stations generating electricity at £76.86 per MWh (Section 8.1).
- As a unilateral carbon tax, the CPS created a price arbitrage that sucked in imported electricity from mainland Europe, disadvantaging domestic dispatchable generation (Section 8.2).
- Powering past coal weakens energy security and resilience. Coal is uniquely cheap and easy to store. The 1984–85 miners' strike was defeated because the Thatcher government built up coal stocks equivalent to more than five and a half months of 2019 electricity generation, compared with the newly reopened £2bn Rough gas storage facility that could power Britain for about four and a half days (Section 8.3).
- Although fracking in the US brought about a dramatic fall in the cost of natural gas, coal remains the cheapest generating fuel (Section 9 and Fig. 6). Coal-to-gas switching reflects changes in market structure and the cost of complying with Obama-era environmental regulations, which raised the capital cost of coal generation.

7. ETS and Carbon Price Support

Of all fossil fuels, coal is deemed to be the worst from an environmental standpoint. As well as carrots (subsidies for renewable generation), the government has deployed additional sticks in the form of aggressive carbon pricing with the explicit aim of forcing coal-fired generation off the grid. Before decarbonization became a major policy objective, in 2001, the EU adopted the Large Combustion Plant Directive (later rolled into the Industrial Emissions Directive), which aimed to curb emissions of acid-rain-causing sulfur dioxide and nitrogen oxides. Power stations could be retrofitted to comply with emissions limits or opt out and operate for a maximum of 20,000 hours. Although framed as anti-acid-rain measures, these directives could equally well have been adopted as anti-coal regulations.

In its first year in office, David Cameron's Coalition government consulted on a proposal for a carbon price floor. At that stage, the objective was framed as supporting the low price of carbon under the EU's ETS, in the words of the December 2010 consultation document: "The level of the carbon price and its uncertainty is one of a number of factors affecting investment in low-carbon generation."[143]

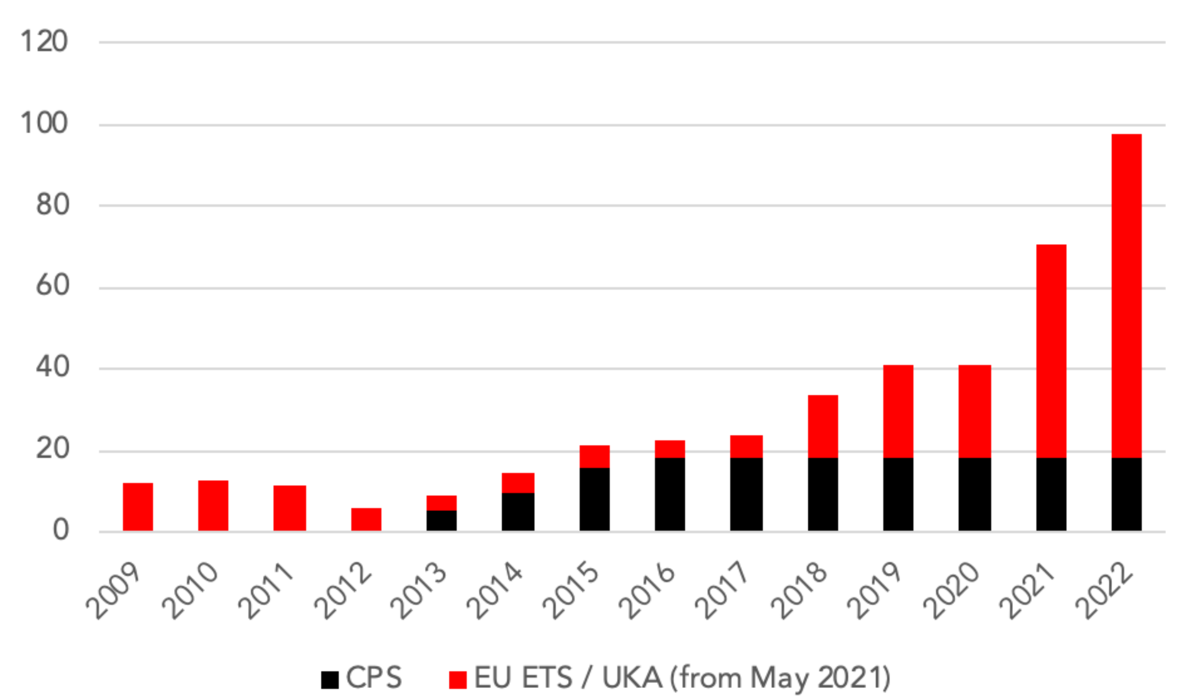
The Carbon Price Support (CPS) is not a floor but a carbon tax on top of the ETS. It was announced in the April 2013 budget at an initial rate of £4.94 per tonne of CO_2, rising to £18.08 per tonne of CO_2 in 2015 and ratcheting up to £70 per tonne of CO_2 in 2030. In the event, the rate was frozen at £18 per tonne of CO_2 and its objective switched from incentivizing investment in low/zero carbon generation to simply targeting coal. In the 2017 budget, the Treasury stated:

> The government is confident that the Total Carbon Price, currently created by the combination

> of the EU Emissions Trading System and the Carbon Price Support, is set at the right level, and will continue to target a similar total carbon price until unabated coal is no longer used. This will deliver a stable carbon price while limiting cost on business.[144]

As can be seen in Figure 4, the carbon price has been anything but stable. When the CPS was introduced in 2013, ETS Emissions Allowances were trading at £3.80 per tonne. The average price in 2018 had quadrupled, to £15.49 per tonne and in 2022 had more than quintupled again, to reach an average of £79.60 per tonne after the introduction of the UK ETS in May 2021 as a result of Brexit. From the introduction of the CPS in 2013, the sum of the ETS carbon price and the CPS rose from £8.74 per tonne of CO_2 to £97.68 per tonne in 2022—a more than 11-fold increase.

FIGURE 4: ETS AND CARBON PRICE SUPPORT (£ PER TONNE OF CO_2)



Source: House of Commons Library, "Carbon Price Floor (CPF) and the Price Support Mechanism," Jan. 8, 2018, https://researchbriefings.files.parliament.uk/documents/SN05927/SN05927.pdf; Bowei Guo, Renmin University of China; ICE via Montel, https://ember-climate.org/data/data-tools/carbon-price-viewer

Coal combustion for electricity generation emits about 60 percent more carbon dioxide than natural gas, based on like-for-like energy content (0.32 tonnes of CO_2 per MWh of energy for coal and 0.20 tonnes of CO_2 per MWh of energy for natural gas). That's the energy content before combustion. During 2009–22, the thermal efficiency of Britain gas-fired power stations fluctuated between 46 and 49 percent. Although modern ultra-supercritical coal-fired power stations achieve thermal efficiencies of up to 47.5 percent, Britain's remaining coal fleet is old, inefficient, and increasingly operated as peaking capacity, and its thermal efficiency declined from 37 percent in 2009 to 30 percent in 2022.145

The differential in thermal efficiency between coal and gas leads to coal emitting more than double the amount of carbon dioxide per MWh of electricity generated. In turn, this adds an extra £4.40 per MWh of electricity generated from coal for every £10 increase in the combined ETS and CPS (Table 6).

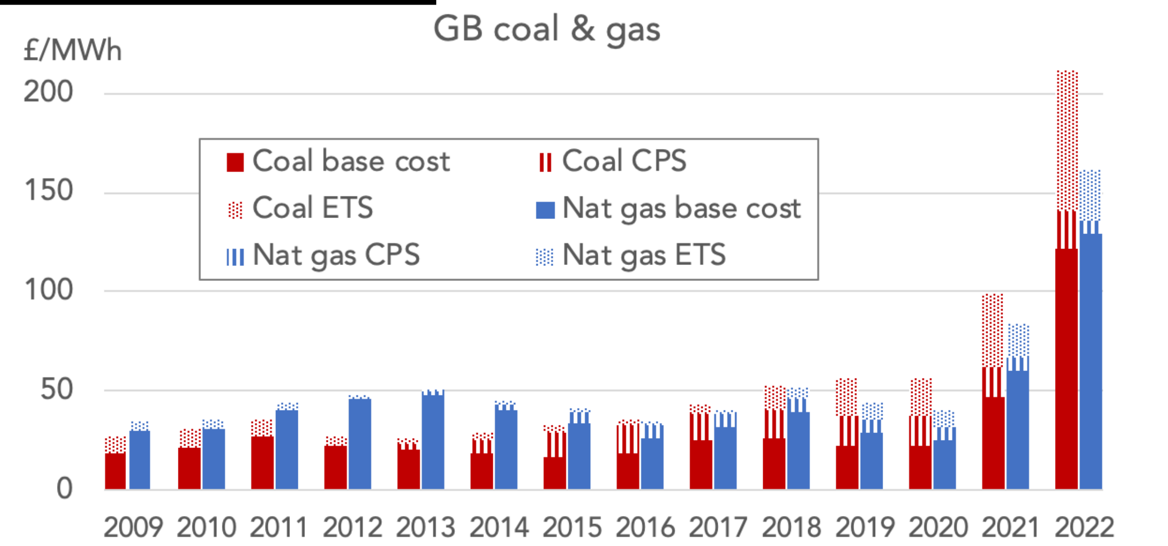
TABLE 6: ILLUSTRATIVE IMPACT OF CARBON PRICING ON NATURAL GAS AND COAL

	Natural gas	Coal	Difference
CO_2 per MWh of energy (tonnes)	0.20	0.32	+60%
Thermal efficiency	48%	37%	–23%
CO_2 per MWh of electricity (tonnes)	0.42	0.86	+105%
Cost per £10 of ETS+CPS per MWh of electricity	£4.20	£8.60	+£4.40 +105%

Coal is a cheap fuel. There has only been one year (2020) when the cost of coal to generate 1 MWh of electricity was higher than for natural gas, but the rise in the combined cost of the ETS and the CPS meant that from 2016, the relative cost of coal and natural gas switched, so that gas became the price setter in the wholesale market.

The post-pandemic recovery and then the Russian invasion of Ukraine saw a surge in the price of both coal and natural gas. There was also a large increase in the price of ETS Emission Allowances. In 10 years, the cost of carbon dioxide rose from £5.21 to £104.15 per MWh of coal-generated electricity and from £2.61 to £41.06 per MWh for gas, opening up a £55.48 per MWh carbon cost differential between coal and natural gas (Fig. 5).

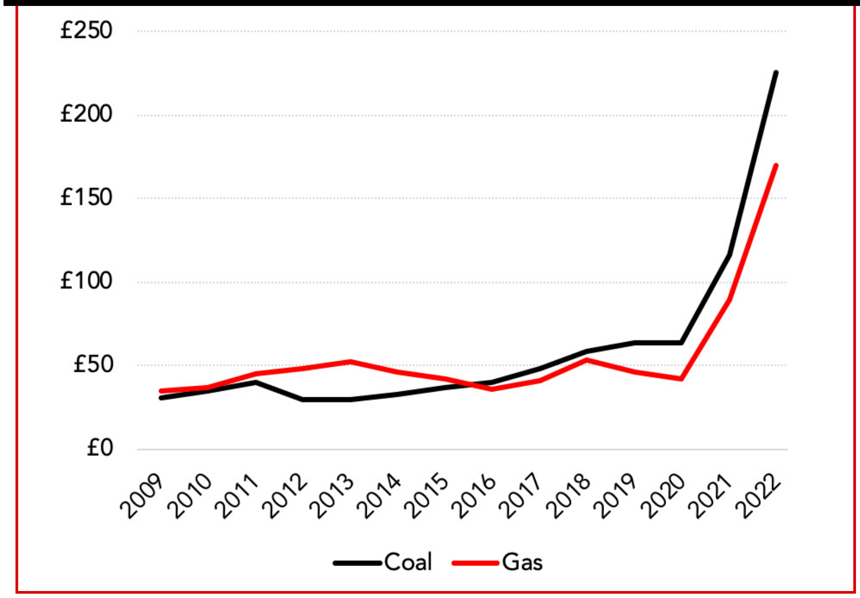
FIGURE 5: FUEL, ETS, AND CARBON SUPPORT COSTS OF COAL AND GAS (£ PER MWH)



Source: Digest of UK Energy Statistics (DUKES), table 3.2.1; Carbon Emission Factors and Calorific Values from the UK Greenhouse Gas Inventory (Ricardo Energy & Environment, 2022); House of Commons Library, "Carbon Price Floor (CPF) and the Price Support Mechanism"

The 2016 coal/gas price inflection can be seen in Figure 6, resulting in coal being forced off the grid other than in periods of peak demand.

FIGURE 6: FUEL AND CARBON COST OF COAL AND GAS (£ PER MWH)



Source: DUKES, table 3.2.1; Carbon Emission Factors and Calorific Values from the UK Greenhouse Gas Inventory (Ricardo Energy & Environment, 2022); House of Commons Library, "Carbon Price Floor (CPF) and the Price Support Mechanism"

The government set a target date of October 2024 for the complete termination of coal-fired generation. Anticipating fragile gas supplies over the 2023–24 winter, National Grid's Electricity System Operator asked Drax to bring two coal-fired power stations out of retirement, but the request was turned down, leaving a single coal plant, operated by Uniper, on standby over the winter.[146]

8. Net zero and the energy crisis

Britain's aggressive use of carbon pricing to force coal off the grid is widely seen as successfully cutting emissions at virtually no cost. The second half of this proposition cannot be sustained. Taking coal off the grid unambiguously increased costs, increased dependence on imported electricity, and worsened energy security.

8.1 Higher electricity costs

The surge in energy costs following the end of the pandemic precipitated Britain's most acute energy crisis since the 1970s. What would have happened in the absence of carbon pricing in the form of the ETS and CPS? As noted above, 2020 was an exceptional year. Because of the pandemic, the fuel cost of natural gas fell by 16.2 percent, while the price of coal rose 1.96 percent, giving natural gas a temporary cost advantage over coal before carbon costs.

Recovery from the pandemic and a deliberate squeeze in natural gas supplies from Russia saw the pre-carbon cost of natural gas in 2022 increase 81.5 percent, compared with a 59.7 percent increase for coal (Table 7). These increases restored coal's fuel cost advantage, but between 2020 and 2022, just over 40 percent of the increased cost of coal-generated electricity was caused by higher carbon prices. As a result, the addition of the ETS and CPS gave natural gas a £55.49 per MWh cost advantage over coal. Absent carbon pricing, the fuel cost of coal would have been £121.70 per MWh, compared with the fuel cost plus carbon price of £170.36 per MWh cost of natural gas–generated power, which set the wholesale price of electricity.

TABLE 7: IMPACT OF CARBON PRICING ON NATURAL GAS AND COAL, 2020–22 (£ PER MWH OF ELECTRICITY)

	2020	2022	Change	Components of cost increase
Coal				
Fuel cost	£25.21	£121.70	+£96.49	59.7%
ETS + CPS	£38.99	£104.15	+£65.16	40.3%
Total	**£64.20**	**£225.85**	**+£161.65**	
Natural gas				
Fuel cost	£24.84	£129.30	+£104.46	81.5%
ETS + CPS	£17.33	£41.06	+£23.73	18.5%
Total	**£42.17**	**£170.36**	**+£128.19**	

Source: DUKES, table 3.2.1; Carbon Emission Factors and Calorific Values from the UK Greenhouse Gas Inventory (Ricardo Energy & Environment, 2022); House of Commons Library, "Carbon Price Floor (CPF) and the Price Support Mechanism"

If energy companies had invested in clean-burning, ultra-supercritical coal-fired plant with a thermal efficiency similar to natural gas, the fuel cost of coal in 2022 would have been £76.86 per MWh, 55 percent lower than the fuel plus carbon cost of natural gas that year. Cutting carbon dioxide emissions with high carbon prices to force a coal-to-gas switch is not cost-free.

A related consideration is the high price that UK electricity ratepayers paid in 2022 to abate carbon dioxide under the ETS and CPS. Using the emissions input values from Table 6 above, the abatement cost per tonne for natural gas is £205.30 and £325.47 for coal. These values far exceed any reasonable estimates of the social cost of carbon.[147] When governments impose costs far higher than any conceivable estimate of benefits, it has the practical effect of impairing economic efficiency. Extended globally, these carbon costs—driven by the net zero timetable—imply that fossil fuel usage causes nearly £12 trillion in damages from coal and £7.6 trillion from natural gas.[148] Coal-using nations in the Global South serious about improving the well-being of their citizens would beg to differ. These are measures that are simply detached from any sense of reality or concern about human welfare, which is another way of saying that global net zero is not going to happen.

8.2 Higher imports

The CPS is a unilateral carbon tax levied on top of the EU ETS (later superseded post-Brexit by a UK ETS). A 2019 analysis by academics from University College London and Cambridge University estimates that the doubling of the CPS in 2015 created a price premium of about €10.5 per MWh. This sucked electricity into Britain from mainland Europe via two interconnectors—one from France, the other from the Netherlands—to take advantage of the carbon tax arbitrage. The report estimates that the CPS increased imports of electricity by 13.6 terawatt-hours (TWh) a year, irrespective of its carbon intensity.[149] This is significantly higher than the 6.8 TWh increase in *net* imports recorded between 2013 and 2019.[150]

In 2012, the European Commission considered options to strengthen the ETS. A CPS similar to Britain's was one of the options considered. However, it was opposed by the vast majority of stakeholders. Following the December 2015 Paris climate conference, the French government announced that it would be introducing its own floor price of €30 per tonne, but the proposal was dropped.[151] A policy can hardly be described as a success if no one else adopts it—a case of leading, but no one following.

8.3 Impaired energy security

Until Russia's invasion of Ukraine, successive British governments had taken energy security for granted. Domestic production of natural gas, mostly from the North Sea, peaked in 2000 and has since fallen by nearly 70 percent.[152] In 2017, the Rough seasonal natural gas storage facility under the North Sea was closed. Ahead of the December 2019 election, Boris Johnson's government imposed a moratorium on fracking. Five months after the Russian attack, Centrica was given a 10-year license to reopen Rough as Europe's largest long-duration energy-storage facility, with a capacity of about 30 billion cubic feet, requiring £2bn of investment.[153]

This highlights the biggest downside of the energy transition—energy storage. Net zero makes Britain far less able to manage threats to energy supply. Britain became dependent on continuous supplies of natural gas. In powering past coal, the country has lost the benefit of the most easily stored form of energy and forgotten a key lesson from the last energy crisis.

Britain's energy crisis of the 1970s was marked by a miners' strike that brought down the Heath government. Elected in 1979, the Thatcher government knew that it would face a similar challenge in the 1980s. "The overriding need in preparing for a coal strike was to increase substantially power station endurance—that is, the length of time the power stations could continue to meet the nation's needs in the event of a complete cessation of coal production in the UK," Nigel Lawson, who. as energy secretary, built up coal stocks, wrote in his memoirs.[154]

In 1983, a year before the miners' strike, stocks of coal at power stations stood at 58 million tonnes.[155] If 1 kg of coal contains 8.141 kWh of energy, then this stockpile had 472 TWh of energy.[156] In 2019, gross electricity supply (i.e., including losses and electricity consumed in electricity generation) was 345 TWh (Table 9). At 35 percent thermal efficiency, this colossal amount of energy is equivalent to over five and a half months of 2019 net electricity supply. By contrast, Rough's 30 billion cubic feet capacity and £2bn cost is equivalent to 8 TWh, or about four days of 2019 electricity supply (47.5 percent thermal efficiency). Powering past coal means denying Britain the lowest-cost, most scalable form of energy storage. In an age of increased geopolitical tensions, it represents a critical strategic vulnerability.

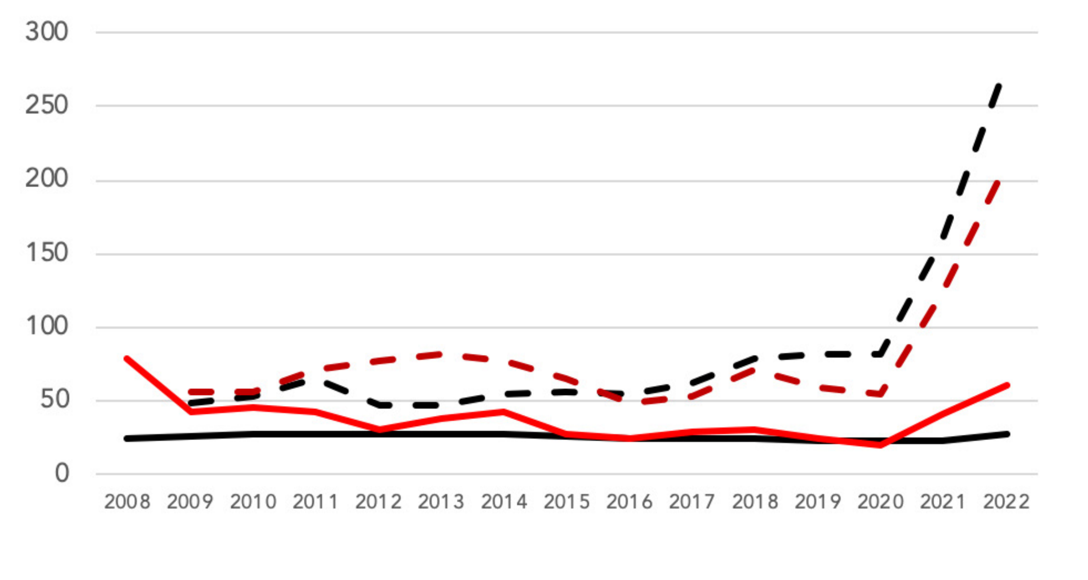
9. Coal comparison with the US

A similar switch from coal to gas generation has also been under way in the US. However, its dynamics are different. Even before carbon prices began to bite in Britain, the cost of generating electricity from coal in the US was about half that in Britain, and except for 2008, the cost of natural gas as a generating fuel has also been lower in the US than in Britain (Fig. 7).

The cost of coal in the US has been remarkably stable, averaging $25.32 per MWh of electricity between 2008 and 2021. After falling sharply in 2008, the cost of natural gas averaged $33.59 per MWh from 2009 to 2021—a 32.7 percent cost premium to coal—and its price remained volatile, compared with that of coal. There was only one year (2016) when gas was cheaper than coal (by four cents!) and two years (2012 and 2015) when the cost of natural gas was within 10 percent of the cost of coal.

In 2021, the average cost of generating electricity from natural gas doubled in the US (from $20.16 in 2020 to $41.66 per MWh of electricity in 2021) and increased by a further 45 percent in 2022 to reach $60.56 per MWh, before falling back in 2023. Despite these hefty rises, the US avoided Britain's damaging surge in energy and carbon costs that took the cost of generating electricity from gas and coal to, respectively, $210.61 and $279.20 per MWh in 2022, when the average cost of coal-generated electricity in the US was only $27.42 per MWh.

FIGURE 7: US AND GB: FUEL + CARBON COST PER MWH ELECTRICITY ($)



Note: GBP converted at an annual average exchange rate

Source: DUKES, table 3.2.1; Carbon Emission Factors and Calorific Values from the UK Greenhouse Gas Inventory (Ricardo Energy & Environment, 2022); House of Commons Library, "Carbon Price Floor (CPF) and the Price Support Mechanism"; U.S. Energy Information Administration (EIA)

Figure 7 shows that it is a myth that the switch from coal and gas in the US was driven by the cost of gas falling below that of coal, thanks to the shale revolution. Rather, the explanation must be found elsewhere. Levelized cost of electricity (LCOE) estimates provided by the US Energy Information Administration (EIA) for new power stations confirm that new ultra-supercritical coal capacity has lower levelized variable costs than combined-cycle gas plant ($23.67, compared with $27.77 per MWh) but has much higher capital costs ($52.11, compared with $9.36 per MWh for gas).[157] Much of the extra capital costs of coal—and much of the credit for their slow strangulation of coal in US power generation—are driven by the cost of pollution abatement in response to Obama-era EPA regulatory changes, such as MATS, Cross-State Air Pollution Rule, MACT, NAAQS, and the New Source Review.

More generally, market liberalization by unbundling vertically integrated upstream electricity generators and downstream suppliers and moving to a trading model limits the prospects for investment in coal generation and zero-emission nuclear. They are unfinanceable by merchant generators with no long-term off-take contracts and with little stability in regulation and market arrangements. Hence the only parts of the US where new ultra-supercritical plants have been considered in the last 20 years are in states dominated by vertically integrated utilities, primarily in the South.

9.1 Impact of fracking

Viewed in this context, the role of the shale revolution was not making natural gas significantly cheaper than coal, since the foregoing analysis shows that contention is false. Rather, the shale revolution had a twofold impact of:

- dramatically increasing the supply of domestic natural gas, providing assured access to supply as the US went from being a net importer of natural gas in 2008 to being a net exporter from 2017; and

- reducing the domestic natural gas electric power price, which declined from $9.11 per thousand cubic feet (tcf) in 2008 to $2.51 per tcf in 2020.[158]

The shale revolution was serendipitous; it didn't figure in the Obama administration's plan to get coal off the grid. Without it, US electricity costs would have moved closer to European levels. Absent fracking, America's coal-to-gas switch might not have happened because as a net importer of natural gas, the US would have had to compete with other gas-importing nations for an increasingly constrained global supply and made it dependent on major global natural gas suppliers such as Russia, Iran, and Qatar.

There are other downsides from the coal-to-gas switch. Coal is cheap and easy to store and provides resilience against unexpected eventualities, such as the February 2021 Texas energy crisis, in which more than 200 people lost their lives.

9.2 Barack Obama's fracking windfall

In response to the oil shocks of the 1970s, President Jimmy Carter pushed for an oil-to-coal switch in power generation in a quest for improved energy security—a quest that did not save Carter from being a one-term president. The irony is that in 2008, America elected a president who would have reversed the quest for energy independence. While running for office, Barack Obama spoke of putting coal producers out of business without ever articulating any realistic alternative. His first three years in the White House saw his administration doing everything it could to put fracking out of business—his EPA worked overtime to disrupt the practice in Texas, Pennsylvania, and Wyoming—before reality won.

In this way, Obama became the fortunate beneficiary of an energy production revolution that he knew nothing about when he first ran for president. It was a revolution that would enable America to become a net energy exporter, drive natural gas prices down to nearly one-fourth of previous levels, and be the brightest spot in the otherwise anemic post-2008 economy. Fracking was the unsought gift essential to Obama's 2012 reelection campaign and avoiding Carter's one-term fate.

9.3 Fracking lesson

The lesson for policymakers is that a coal-to-gas switch needs prodigious and secure supplies of natural gas. At their own initiative, cost, and risk, American frackers provided this, and America's power producers, businesses, workers, and households are the beneficiaries. The flood of foreign direct investment from around the world, particularly from EU countries, provides strong evidence that affordable energy has greatly augmented America's competitive advantage vis-à-vis its major trading partners.

By contrast, in 2012, British politicians imposed strict seismological regulations on fracking that no other activity faced. "I'm very proud that you're looking at the person who basically stopped the fracking industry in this country," said Liberal Democrat leader Sir Ed Davey, who, as energy and climate secretary, introduced the anti-fracking regulations.[159] In preventing fracking, British politicians have rendered Britain living hand-to-mouth each winter, depending on the next ship-borne delivery of LNG from Brownsville, Texas, or from Hamas-harboring Qatar.

PART IV. BRITAIN'S ELECTRICITY SECTOR

10. Higher prices and falling demand

Key Points

An underappreciated feature of Britain's energy transition is falling electricity consumption in response to higher prices.

- In the five years to 2010, electricity consumption declined by 5.3 percent and between 2010 and 2019 by 12.1 percent, with households and industry accounting for three-fourths of the decline (Table 8).
- Whereas electricity consumption in the UK fell by 15.5 percent between 2005 and 2019, US consumption rose by 4.1 percent over the same period (Table 11). If the US were to pursue similar climate policies as the UK, it would require very large price increases to choke off demand and prevent supply constraints, which otherwise would lead to grid instability and blackouts.
- The 19.8 percent fall in British electricity generation from 2005 to 2019 was greater than the 15.5 percent decline in demand, the gap being filled by a surge in imported electricity, which more than doubled and in 2020 met 7 percent of demand (Table 9). If the US emulated this, it would need to import 42 percent of Canadian electricity generation (Section 10.3).
- Whereas fracking helped contain the increase in US electricity prices, British businesses were paying 2.76 to 4.3 times more per kWh in 2022 than in 2004 (Table 10), and in 2022, their electricity was costing them 2.3 times what American businesses were paying (Fig. 7 and Table 11).

The principal focus of climate policy in Britain has been on decarbonizing power generation and subsidizing wind and solar investment. These policies began after the global surge in energy prices in the mid-2000s that saw domestic electricity prices rise by 132 percent between 2005 and 2009 and then had the effect of pushing up energy costs even higher from an already-elevated base. In this respect, the policy response was the opposite of the energy crises of the 1970s, when high prices stimulated investment that increased output and led to two decades of falling energy prices. Instead, climate policy saw Britain take the path of ever-higher energy costs.

Electricity consumption in Britain peaked in 2005, at 360.9 TWh and then started to decline due to a surge in energy prices. Within six months, the wholesale price of natural gas rose more than fivefold, from 17.31p (21.5¢) per therm in May 2005 to 95.75p (118.7¢) per therm in November 2005.[160]

As a result, there was a sharp increase in electricity prices. Between 2004 and 2009, electricity prices for domestic consumers rose by 53.6 percent after inflation.[161] Businesses faced even sharper increases. Over the same period, electricity prices rose by 132 percent, rising from 3.13p per kWh in 2005 to 7.27p per kWh in 2009.[162]

The effect of higher energy costs and then the global financial crisis saw electricity consumption decline by 19.18 TWh, equivalent to a 5.3 percent contraction, between 2005 and 2010. After 2010, the trend of reduced electricity consumption intensified. The period 2005–10 averaged a 3.8 TWh yearly fall in consumption, while 2010–19 saw an average fall of 4.1 TWh a year (i.e., larger absolute reductions off a declining base).

10.1 Sectoral trends

Consumption reductions came from the two largest energy-consuming sectors of the economy—industry and households, accounting for 67 percent of electricity demand in 2005. Between them, these two accounted for 96 percent of the 19.18 TWh fall in consumption between 2005 and 2010, consumption shrinking by 9.9 percent and 5.5 percent, respectively.[163]

In 2010–19, the largest consumption declines also came from domestic consumers and industry, with a combined 27.45 TWh decline, accounting for very nearly three-quarters (74.5 percent) of the 36.86 TWh fall in electricity consumption. Industry suffered the biggest consumption fall in the previous period; but in 2010–19, households bore the brunt, cutting their electricity usage by 15.11 TWh. Ironically, the public sector (government and public administration, in Table 8), cheerleaders for decarbonization and net zero, were laggards, cutting electricity consumption by 10.8 percent between 2008 and 2019, compared with an economy-wide reduction of 15.5 percent. This likely reflects the public sector's relative immunity from cost pressures that affect households and private-sector businesses.

TABLE 8: ELECTRICITY CONSUMPTION BY SECTOR, 2005–10 AND 2010–19 (TWH)

	2005	2010	Change, 2005–10	2019	Change, 2010–19
Energy	12.2	12.9	0.65	9.1	–3.78
Industry	116.0	104.5	–11.49	92.2	–12.34
Domestic	125.7	118.8	–6.88	103.7	–15.11
Commercial	78.9	78.3	–0.58	72.2	–6.07
Government and public administration	20.0	19.1	–0.93	17.9	–1.24
Transport and agriculture	8.1	8.1	0.04	9.8	1.67
Final consumption	360.9	341.7	–19.18	304.9	–36.86

Source: BEIS; DUKES, table 5.1

10.2 Falling domestic generation

Although consumption between 2005 and 2019 declined by 15.5 percent, domestically generated electricity contracted by 19.8 percent, the gap being filled by a 2.5-fold increase in net imports of electricity. In 2019, electricity imports amounted to 21.2 TWh, accounting for 7 percent of net electricity supply (Table 9).

TABLE 9: ELECTRICITY PRODUCTION AND CONSUMPTION, 2005–19

	2005 TWh	2019 TWh	Change, 2005–19 TWh	Percent
Production minus pumped storage	398.4	323.9	–74.50	–18.7%
Losses	–27.7	–26.4		
Electricity consumed in electricity generation	–17.9	–14.4		
Domestic supply	352.8	283.0	–69.77	–19.8%
Net imports	8.3	21.2	12.85	154.4%
Net electricity supply	**361.1**	**304.2**	**–56.92**	**–15.8%**
Statistical difference	–0.2	0.6		
Final consumption	**360.9**	**304.9**	**–56.04**	**–15.5%**

Source: BEIS; DUKES, table 5.1

The surge in imported electricity stems from decarbonization policy choices. As explained in Section 8.2 above, the British government decided to impose a unilateral carbon tax on top of the EU's ETS. This opened up a price arbitrage between domestic and EU fossil fuel power generation that sucked in electricity through the two cross-channel interconnectors.

10.3 Britain's energy divergence from the US

The surge in global energy costs in the first decade of the century was a cyclical phenomenon caused by reduced investment in response to falling oil prices. After the twin oil-price shocks of the 1970s, oil prices peaked in 1980. Far from the energy crises of the 1970s presaging a world running out of oil, high prices stimulated increased investment and output that led to falling energy prices for the next two decades. At the turn of the century, supply began to tighten and prices rose.

The mid-2000s energy-price shock hit British business hard. Between 2004 and 2009, electricity prices rose by 95.5 percent for businesses consuming small amounts of electricity and more than doubled for medium and large businesses (Table 10). The 13 years to 2022 saw similar rises, so that in 2022 the electricity prices paid by small businesses had more than tripled (3.76 times) and, for medium and large business, more than quintupled (5.34 times).

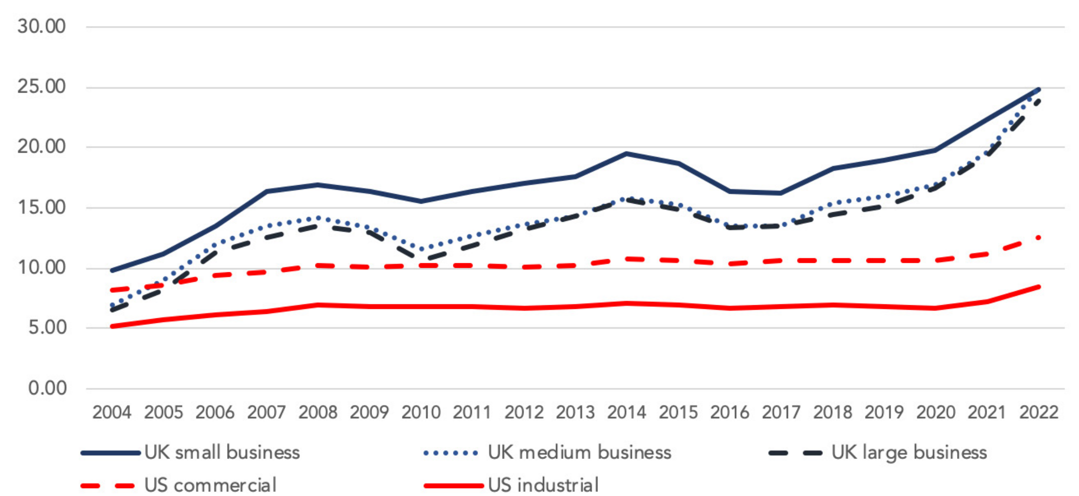
TABLE 10: UK NONDOMESTIC ELECTRICITY PRICES (PENCE PER KWH)

	2004	2009	% Change, 2004–09	2022	% Change, 2009–22	% Change, 2004–22
Small	5.34	10.44	+95.5%	20.09	+92.5%	+276%
Medium	3.82	8.54	+123.6%	20.21	+136.7%	+429%
Large	3.62	8.29	+129.4%	19.30	+132.7%	+434%

Source: DESNZ, "Energy Price: Nondomestic Prices," table 3.1.3

American businesses were also affected by the surge in energy costs in the middle of the first decade of the century, but the rises they faced were more modest. Rather than the increases of 276–434 percent for British businesses (2004–22), average electricity rates for American commercial and industrial businesses rose by 53.3 percent and 61.0 percent, respectively.[164] Unlike UK electricity prices, which peaked in 2009 and briefly fell back before continuing their rise in 2010, US business electricity rates peaked in 2008 and remained broadly flat through 2020, after which they rose (Fig. 8).

FIGURE 8: COMPARISON OF US AND UK NONDOMESTIC ELECTRICITY PRICES AT AVERAGE ANNUAL EXCHANGE RATES (US CENTS PER KWH)



Source: DESNZ, "Energy Price: Nondomestic Prices," table 3.1.3; ONS, "Average Sterling Exchange Rate: Dollar," https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/timeseries/auss/mret; EIA, "Average Retail Price of Electricity"

Even allowing for the one-third fall in the value of the pound against the dollar since 2004, British businesses in 2022 were being charged 2.3 times more for electricity than their American competitors—23.86¢ to 24.98¢ per kWh, compared with 8.45¢ per kWh for American industrial businesses and 12.55¢ per kWh for commercial businesses. (Of the two dips in UK electricity rates in Fig. 8, the second is purely down to a fall in the value of the pound against the dollar.)

Focusing on 2009–22, Table 11 shows that despite the sharp post-pandemic rise in US business electricity prices, they remained a small fraction of what British businesses were paying, at about one-half to one-third of electricity prices in Britain.

TABLE 11: BUSINESS ELECTRICITY PRICES, 2009–22

	Increase, 2009–22	Price per kWh in 2022 (US cents)
UK business		
Small	+92.5%	24.84
Medium	+136.7%	24.98
Large	+132.7%	23.86
US		
Commercial	+23.5%	12.55
Industrial	+23.7%	8.45

Source: DESNZ, "Energy Price: Nondomestic prices," table 3.1.3; EIA, "Average Retail Price of Electricity"

What accounts for this divergence? For the US, 2005 marked the end of declining natural gas output and the start of the shale revolution, and—not coincidentally—2005 was also the year when total US domestic primary energy production as a percentage of total consumption reached its historical low point and started to increase.[165] The response of increased investment and output to high energy prices was the same market mechanism that enabled the global economy to overcome the 1970s oil-price shocks. Between 2001 and 2005, US natural gas output had fallen by 8.0 percent. By 2009, natural gas output had increased by 14.3 percent from its trough, reaching its highest level since 1974. In the next 10 years, US natural gas output surged a staggering 64.4 percent, to 33,899 billion cubic feet (bcf), 56.0 percent higher than its previous peak of 21,731 bcf in 1973.[166]

The US–UK energy divergence is also manifested in electricity consumption and generation. Whereas UK domestic supply contracted by one-fifth between 2005 and 2019, US domestic supply was flat. Rather than falling, final consumption rose by 4.1 percent (Table 12). In part, the different trajectories are accounted for by differences in economic growth. Over the period, the US economy opened up a 5-percentage-point growth gap over the UK economy: the US economy expanding by 27.8 percent and the UK's by 22.1 percent.[167] The US is also a much more electricity-intensive economy. In 2019, the US consumed 171.2 MWh, to generate $1 billion of GDP; the British consumed only 109.6 MWh, to generate $1 billion of GDP—64 percent of the electricity intensity of the US.[168]

Although net imports of electricity in the US rose by 14.2 TWh (compared with a 12.9 TWh rise in the UK's net imports of electricity), the sheer scale of the US economy makes it impossible for the US to replicate what Britain did. If in 2019, the US had imported the same proportion of its electricity consumption as Britain, it would have been the equivalent of 42 percent of Canadian electricity generation.[169] America cannot outsource its supply power generation, as Britain and California have done.

TABLE 12: UK AND US ELECTRICITY PRODUCTION, CONSUMPTION, AND NET IMPORTS, 2005–19 (TWH)

	2005	2019	Change, 2005–19
Domestic generation			
UK	352.8	282.0	–19.8%
US	3,786.2	3,815.4	+0.8%
Net imports			
UK	8.3	21.2	+154.4%
US	24.8	39.0	+57.3%
Final consumption			
UK	360.9	304.9	–15.5%
US	3661.0	3,811.2	+4.1%

Source: BEIS; DUKES, table 5.1; EIA, May 2023, Monthly Energy Review, table 7.1

11. Britain's deteriorating power generation capacity

Key Points

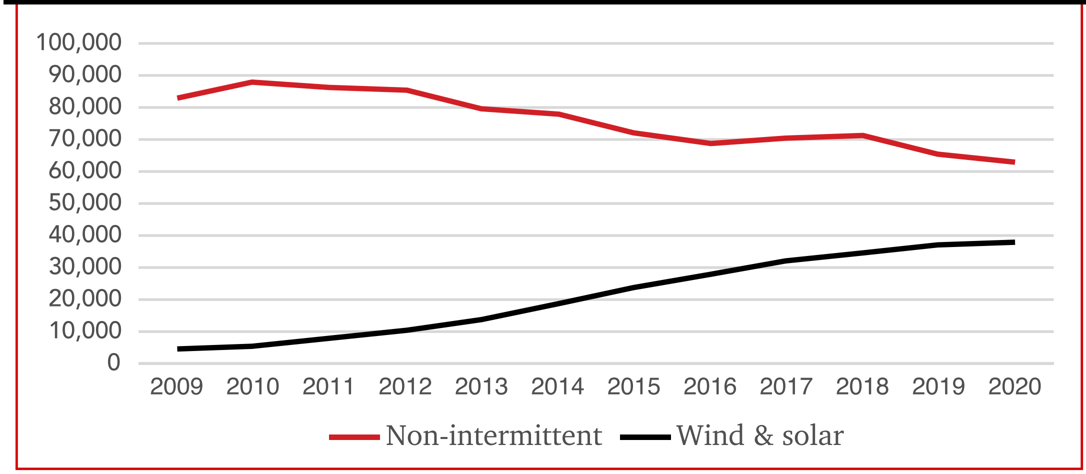
Rising electricity prices and falling demand have been essential to keeping Britain's lights on, as baseload and dispatchable generating capacity (principally nuclear, coal, and gas) peaked in 2010 and, by 2020, had declined by 25.1 GW (28.5 percent).

- The retirement of 18.3 GW of coal-fired capacity accounted for 73 percent of the 25.1 GW reduction in such capacity.
- The government originally envisaged that investment in up to 26 GW of new gas-fired capacity would replace coal. This new capacity failed to materialize. Instead, gas-fired capacity shrank by 783 MW.
- Over the same period, wind and solar capacity increased by 33.5 GW. As a result, the ratio of non-intermittent to intermittent capacity fell from 18.6 GW of non-intermittent capacity in 2009 to 1 GW of wind and solar to 1.7 GW of non-intermittent for every 1 GW of wind and solar in 2020.

Turning to the evolution in Britain's generating mix since 2009, it becomes clear why falling demand has been an important factor in helping maintain the resilience of Britain's electrical grid. Although generating capacity rose from 87.4 GW in 2009 to 100.9 GW in 2020, the generating mix has undergone a profound change. Non-intermittent capacity—principally coal, natural gas, and, to a lesser extent, nuclear—peaked in 2010 at 88.0 GW and subsequently fell by 25.1 GW to 63.0 GW in 2020. In 10 years, Britain lost 28.5 percent of its non-intermittent capacity.

The year 2012 is another milestone. For the first time, wind and solar accounted for more than 10 percent of total generating capacity. As shown in Figure 9, nameplate wind and solar capacity rose from 4.5 GW in 2009 to 37.9 GW in 2020, 2014 and 2015 being the peak deployment years, when nearly 10,000 MW of wind and solar capacity was added. This has transformed the UK grid. In 2009, there were 18.6 GW of non-intermittent capacity for every 1 GW of wind and solar capacity. In 2020, this had fallen to 1.7 GW of non-intermittent capacity for every 1 GW of wind and solar.

FIGURE 9: NON-INTERMITTENT AND INTERMITTENT GENERATING CAPACITY (MW), 2009–20



Source: BEIS; DUKES, table 5.7

The retirement of coal-fired power stations accounts for 18,300 MW of the 22,131 MW net decline in non-intermittent capacity between 2012 and 2020, leaving only 5,361 MW of coal-fired capacity operating at the end of the period. However, all other types of non-intermittent generating capacity also saw declines, with the exception of bioenergy and waste, which increased by 5,071 MW.

This last category includes the 3,906 MW Drax power station. Formerly Europe's largest coal-fired power station, Drax has been converted to burn wood pellets, mostly sourced from North America. Wood pellets emit more carbon dioxide than coal. Thanks to carbon accounting arbitrage, they are deemed zero-emission and in 2020 received £832m ($1,027m) in renewable energy subsidies and price supports.[170] Although few believe in the non-CO_2-emitting wood pellets carbon-accounting theory, Drax in 2020 represented 6.2 percent of dispatchable capacity, a share that will increase over the next few years as more baseload and dispatchable capacity comes off the grid.

It wasn't meant to be like this. The government's 2012 *Gas Generation Strategy* command paper published by the Department of Energy and Climate Change (DECC) stated that

> we are likely to need significant investment in new gas plant. Modelling by DECC suggests that up to 26 GW of new gas plant could be required by 2030 (in part to replace older coal, gas and nuclear plant as it retires from the system). It also indicates that, in 2030, we could need more overall gas capacity than we have today, although operating at lower load factors.[171]

In an interview with *The Guardian* before its publication, Ed Davey, the energy and climate-change secretary, indicated that 20 new gas-fired plants would be needed between 2012 and 2030. "I strongly support more gas, just as I strongly support more renewable energy. We need a big expansion of renewable energy and of gas if we are to tackle our climate change challenges," Davey told the paper.[172]

In fact, gas-fired generating capacity peaked in 2012 at 37 GW and, by the end of 2020, had fallen by 2.25 GW to 34.8 GW, constituting 55 percent of Britain's remaining non-intermittent generating capacity. In October 2021, during the run-up to the Glasgow climate conference, the government announced a new target of fully decarbonizing the electricity system by 2035, the government declaring that "home-grown, green technologies such as offshore wind and nuclear energy will support the UK to transition away from reliance on fossil fuels."[173] This effectively sounded the death knell for any further investment in unabated gas-fired capacity.

12. More wind and solar, less energy

Key Points

The large increase in wind and solar capacity caused a deterioration in the capital efficiency of Britain's generating mix.

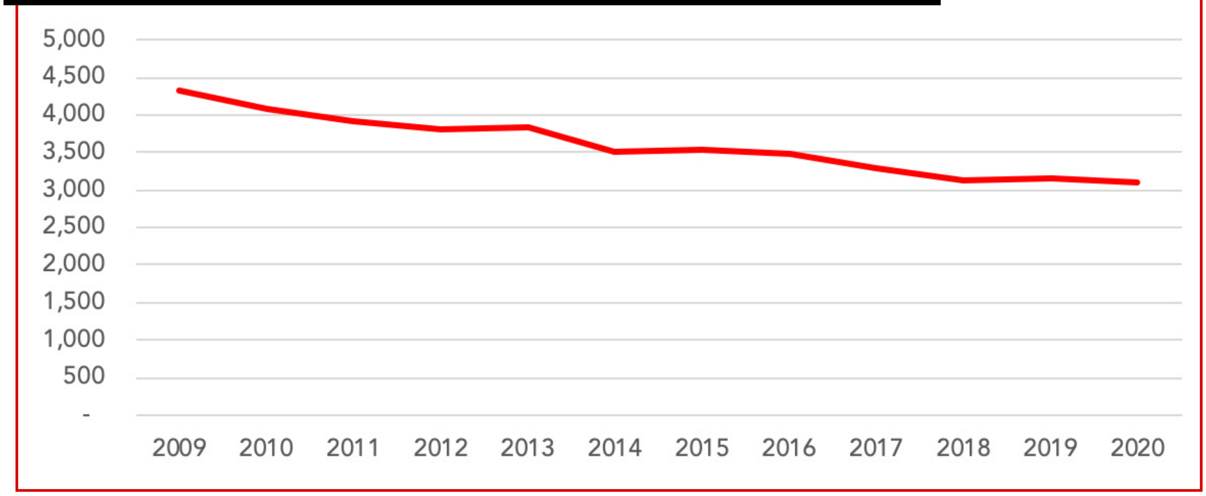
- Between 2009 and 2020, there was a 28.3 percent decline in output per unit of generating capacity.
- The capital inefficiency of having a high proportion of renewables is a major factor that explains why having more renewables on the grid means higher electricity costs.
- This accords with net zero modeling by the IEA that estimates that the share of capital recovery costs rise from 60 percent in 2020 to about 80 percent in 2050.

Between 2009 and 2020, the switch to renewables saw 19.4 GW of dispatchable capacity replaced by wind and solar with a nameplate capacity of 33.5 GW, resulting in a 13.6 GW increase in notional capacity. Here we see how intermittency embeds capital inefficiency in the grid:

- In 2009, 87.3 GW of generating capacity, comprising only 5.1 percent of wind and solar, produced 376.8 TWh of electricity.
- In 2020, 100.9 GW of generating capacity, with wind and solar accounting for 37.6 percent of nameplate capacity, produced 312.3 TWh of electricity.[174]

Thus a 15.5 percent *increase* in nameplate generating capacity produced 21.6 percent *less* electricity. In 2009, 1 MW of capacity produced 4,312 MWh of electricity. In 2020, 1 MW of capacity generated 3,094 MWh, a decline of 28.3 percent (Fig. 10).

FIGURE 10: OUTPUT PER MW OF GENERATING CAPACITY (MWH)



Source: BEIS; DUKES, tables 5.1 and 5.7

Producing less with more is the essential fact of the energy transition. In its *Net Zero by 2050 Roadmap for the Global Energy Sector* (May 2021), the IEA warns that the electricity supply sector becomes much more capital-intensive. It predicts that globally, the share of capital in total costs rises from less than 60 percent in 2020 to about 80 percent in 2050. "This is largely due to a massive increase in renewable energy and the corresponding need for more network capacity and sources of flexibility, including battery storage," the IEA says.[175] The much shorter operating lives of wind and solar further increase the capital intensity (i.e., capital inefficiency) of the energy transition.

The period of intensive deployment of wind and solar in Britain coincided with a unique period of ultralow interest rates. In March 2009, the Bank of England cut its official bank rate below 1 percent for the first time, where it stayed until May 2022. The only comparable period of extended low interest rates was in the 1940s (October 1939–November 1951), when the Bank of England pegged interest rates at 2 percent for 12 years. The previous occasion when interest rates had been 2 percent was for four months in 1897. Even partial normalization of interest rates would have a large adverse impact on the costs and economics of renewables and the energy transition.

Assertions about the falling costs of renewables have been made because of two erroneous assumptions: first, the cost of capital will continue to fall, which was impossible and would inevitably reverse when borrowing rates increased; and second, a drastic underestimation of ongoing operating costs and their evolution over time. In essence, wind and solar substitute recurring fuel costs with much higher up-front levels of capital assets. Viewed purely in terms of their financial characteristics, renewables are like a bond. Their value and their financial viability are inversely related to the level of interest rates.

Thus, the private-sector investment case for renewables depends on two factors: lavish government subsidies but also the persistence of ultralow interest rates. The climate lobby has been highly successful in ensuring that renewable subsidies remain in place and, in the case of the Inflation Reduction Act, are massively extended. But keeping interest rates to near zero is beyond their reach. Past investments in renewable generation were underpinned by a period of extreme monetary policies that led to a boom in asset prices that was bound to come to an unpleasant end.

PART V. BIG SIX SEGMENTAL ANALYSIS

Key Points

At the start of the 2010s, Britain's energy market was dominated by the Big Six energy companies which were required to file segmental financial and operating data. These filings yield insights into the underlying economics of different generating technologies, the effect of climate policies on their costs and profitability, and the consequential impacts on retail electricity prices and household bills.

- Except for one year, the average revenue (i.e., price) for the Big Six's renewable output was over £100 per MWh and peaked at £129 in 2018, while thermal and nuclear earned about £60 per MWh (Fig. 10).
- Profitability of each generating segment reflects these price differentials. In 2017, renewables EBIT per MWh exceeded the prices obtained for thermal- and nuclear-generated power (Section 14.1 and Fig. 11).
- Thermal generators, especially coal, were hit by higher environmental levies, which in 2014 saw the Big Six take large write-downs on their thermal assets when the segment recorded a £1.6bn EBIT loss (Table 13).
- The Capacity Market introduced to mitigate intermittency of wind and solar in 2020 saw Uniper, an ex–Big Six thermal generator, receive an average of £224 per MWh from its written-down power stations. Such costs should be allocated to intermittent generators.
- Prices and profitability of nuclear also declined, reflecting the age and inefficiency of Britain's nuclear fleet. Nuclear's 2020 EBIT of £98.8m was 92 percent lower than in 2013 (Section 14.3).
- Although fuel input costs for thermal generators were flat from 2009 to 2020, average price paid by households rose 67 percent, driven by increases in environmental levies, which accounted for three-fourths of the price rise between 2013 and 2020 (Section 15.1 and Table 14).
- Price increases, not energy efficiency, drove reduced household consumption. Between 2014 and 2020, average residential electricity prices charged by the Big Six rose 20.3 percent; average consumption fell 8.1 percent, and average bills rose 15.6 percent (Table 15).
- American households are paying less for their electricity because the US has less aggressive climate policies. In 2009, Americans were paying an average retail price 2.24¢ per kWh less than British households. Although the average retail electricity price rose in the US by 14.3 percent, to 13.15¢ per kWh in 2020, British households were paying 9.85¢ per kWh more (+74.7 percent) for electricity (Fig. 13).

13. Introducing the Big Six

At the start of the 2010s, the British energy sector was characterized by high market shares of six vertically integrated energy companies (the Big Six) that generated electricity and sold electricity and natural gas to households and businesses.

By the end of the decade, the Big Six had ceased to exist. The upstream generating side had been transformed by the entrance of infrastructure funds and other investors in wind and solar and exits from coal generation, and the downstream retail supply segment was disrupted by a large number of poorly capitalized entrants. Because the supply business requires balance-sheet strength to sustain buying in advance for customers who can exit at any time, a sharp rise in wholesale energy costs in 2021 saw a slew of supplier failures, landing customers with a bill of £2.7bn ($3.3bn).[176]

From 2009, the energy regulator Ofgem required the Big Six to file segmental financial and operating data.[177] These filings provide insight into how a market subject to rapid deployment of zero-marginal cost, intermittent capacity, and increasingly stringent climate policies affects the profitability of different generating technologies.

13.1 Setting the scene

Before diving into the analysis, three points set the scene at the start of the period:

- By the 2010s, Britain's nuclear power stations were aging, inefficient, and increasingly costly to maintain and operate. In contrast to France and its adoption of the American-developed pressurized water reactor (PWR) technology in the mid-1970s, the second phase of Britain's nuclear power program began a decade earlier and adopted less successful indigenous technology, apart from the last nuclear power station (Sizewell B), which uses a similar technology as the French.
- Britain's dash-for-gas had already happened. Electricity privatization in 1990 had created a generating duopoly. In order to erode the duopoly's market power, the first electricity regulator, Stephen Littlechild, liberalized rules on cost pass-through on power purchase contracts, setting off an investment boom in gas-fired plant. Within a decade, gas went from zero to about a one-third share of electricity generation output.
- As noted previously, EU environmental directives aimed at curbing acid rain (the Large Combustion Plant Directive and then the Industrial Emissions Directive) effectively sunsetted Britain's coal-fired power stations.

Two climate policies implemented in 2013 had a major impact on the evolution of the sector:

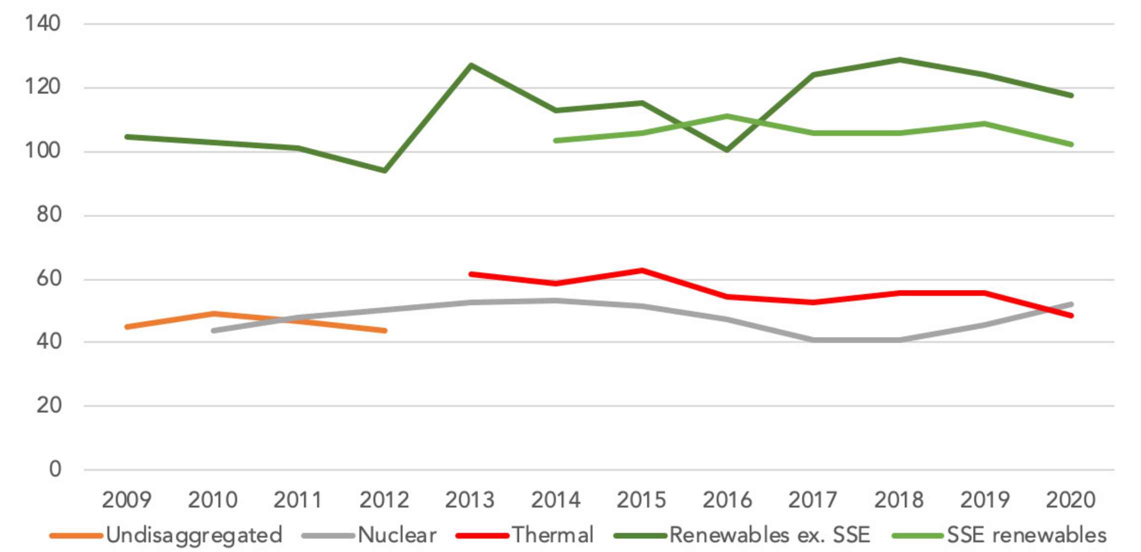
- Electricity Market Reform (EMR), under David Cameron's Coalition government, saw the state effectively become sole buyer of new generating capacity funded by electricity consumers via feed-in tariffs set out in CfDs. Whereas the previous system of Renewable Obligation Certificates (ROCs) left price risk with wind and solar investors, CfDs transferred market-price risk from investors to customers. EMR also created a government-run Capacity Market to procure standby availability to cover for renewables' intermittency;
- The EU's cap-and-trade ETS was conceived as the bloc's principal decarbonization policy instrument, but over-allocation of carbon credits saw the price of emissions allowances drop to about €5 ($5.36) per tonne of CO2. From April 2013, the British government added a £9 ($11) tax on top of the ETS, rising to £18 ($22) per tonne from 2015, shifting the relative prices of gas and coal.

14. Prices and profitability

Big Six segmental reporting provides consistent financial and operating data on nuclear, thermal (coal and gas-fired), and renewables from 2013. For the first three years, segmental reporting was less defined, hence the undisaggregated line for 2009–12 in Figure 11. A further anomaly is that SSE, the largest renewable player among the Big Six, reports 100 percent of the output from its renewable joint ventures (JVs) but only its 50 percent share of turnover and profits. This means that SSE prices and profit per MWh are understated. For this reason, Figures 11 and 12 show SSE separately, and average revenue (i.e., price) and profit per MWh are therefore higher than indicated below.

These qualifications do not alter the picture of intermittent renewables receiving about twice the average revenue per MWh as nuclear- and thermal-generated electricity for lower-quality, intermittent output. To put that in numbers, the average effective price per MWh for Big Six renewables (excluding SSE) in 2009–20 was £112.81; for nuclear, it was £47.84 (2010–20) and £56.22 per MWh for thermal (2013–20), implying that renewables enjoyed a 135 percent premium over nuclear and 100 percent premium over thermal generators for its less dependable, demand-unresponsive, and therefore less valuable, output.

FIGURE 11: BIG SIX AVERAGE PRICE PER MWH (£)



Source: Company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated), https://www.ofgem.gov.uk/sites/default/files/docs/2021/03/energy_companies_individual_consolidated_segmental_statements_css_2019-2020.pdf

14.1 Wind and solar

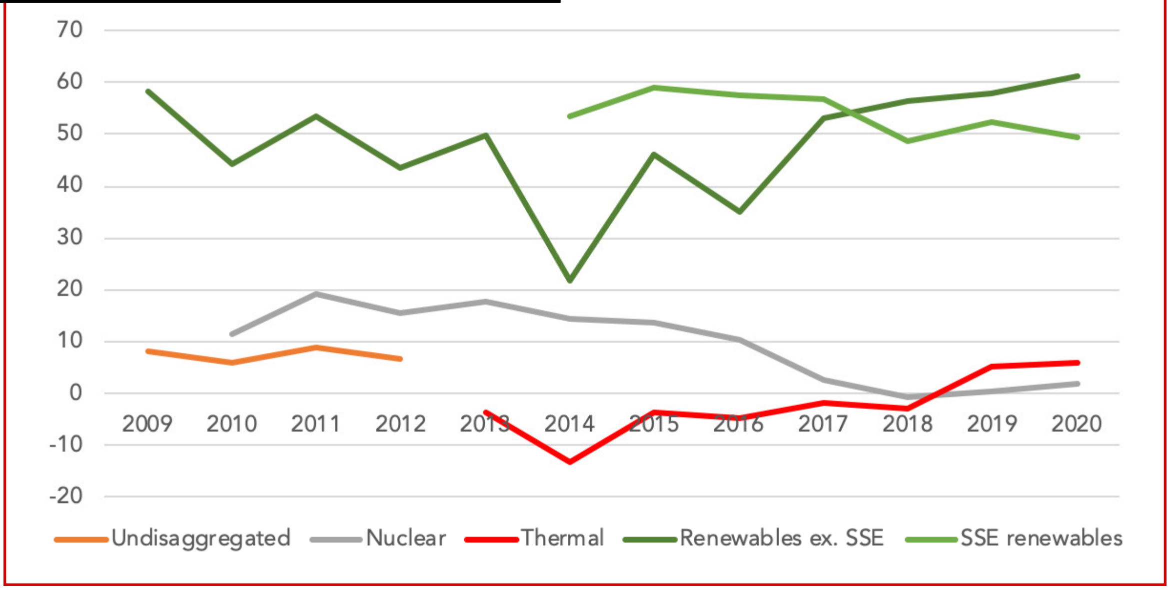
Most of the Big Six's renewable portfolio was developed prior to EMR, which established CfDs as the principal renewable energy subsidy mechanism for new projects after that date. Income from renewables comprises the wholesale price of the electricity that they sell plus income from the sale of ROCs to electricity suppliers that are forced to buy ROCs under the Renewables Obligation scheme. By comparison with the average revenue £112.81 per MWh for the Big Six renewables, the unweighted average strike price of all CfD projects to May 2023 is £127.52 (in 2012 prices) per MWh.[178]

Not only do renewables get higher prices for their output; their intermittency incurs higher system costs. Creation of the Capacity Market was the second principal feature of EMR and constitutes a further cost of renewables and the energy transition. The requirement to have large amounts of capacity on standby isn't cheap. In 2016, German-owned E.ON, one of the Big Six, transferred its thermal assets to Uniper, which was then spun out as a separate quoted company. All Uniper's UK power stations, comprising nearly 6 GW of capacity, have participated in the capacity market. For the 2020–21 delivery year, Uniper was awarded a clearing price of £22,500 per MW of available capacity.[179] In 2020, Uniper had £2,455m (2019: £3,356m) of revenues and generated 10.9 TWh (2019: 13.92 TWh) of electricity, implying an average price of £224.31 per MWh (2019: £241.09 per MWh).[180]

This expensive electricity, procured in a competitive auction, forms part of the additional system costs of wind and solar that are typically left unaccounted for in cost comparisons between dispatchable and wind and solar generation. Prior to the energy transition, thermal generators supplied capacity availability for free, as well as other services necessary to maintain grid stability, such as spinning inertia to keep electrical frequency within tight limits.

High prices obtained by wind and solar are reflected in astonishingly high profits (Fig. 12). In 2017, the earnings before interest and tax (EBIT) for renewables of £54.93 per MWh exceeded that of the £52.47 per MWh average price obtained for thermal-generated electricity and £40.98 per MWh for nuclear. The implied EBIT for SSE's renewable portfolio of £56.97 per MWh was even higher, despite reporting 100 percent of renewables output from its JVs but its 50 percent share of revenues, therefore understating revenue and EBIT per MWh. To reiterate, in many years, the profit per MWh flowing to renewables generators is *higher* than average revenue per MWh earned by conventional generators.

FIGURE 12: BIG SIX EBIT PER MWH (£)



Source: Company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated), https://www.ofgem.gov.uk/sites/default/files/docs/2021/03/energy_companies_individual_consolidated_segmental_statements_css_2019-2020.pdf

14.2 Gas- and coal-fired power stations

From 2013, the Big Six thermal generators became loss-making as free carbon allowances under the ETS were used up and the concurrent Carbon Price Support that came into effect in April 2013 (discussed further in Section 7 above). Revenues from thermal generation rose by £459.3m in 2014 on the back of a 10.4 percent increase in output, and operating costs before environmental costs (principally in respect of carbon) rose by only £80.6m, leading to a decline in opex per MWh from £54.96 per MWh in 2013 to £50.44 per MWh in 2014. However, the first hit came from a tripling of environmental costs, rising from £334.6m to £1,016.4m in 2014 (£3.06 per MWh in 2013 to £8.41 per MWh in 2014), reducing earnings before interest, tax, depreciation, and amortization (EBITDA) by £303.1m.

A related hit comes from a near-doubling in depreciation and amortization, which rose from £935.7m in 2013 to £1,833.1m a year later (Table 13). In 2014, E.ON took a £1,121m write-down in the value of its thermal assets that were later transferred to Uniper and spun out.[181] These write-downs saw the Big Six thermal generators record a £1,603.3m loss before interest and taxes in 2014, up from a £402.8m loss in the previous year.

TABLE 13: BIG SIX THERMAL GENERATION FINANCIALS FOR 2013 AND 2014 (£M)

	2013	2014	Change
Revenue	6,880.3	7,339.6	+459.3
Opex before environmental charges	-6,012.8	–6,093.4	–80.6
Environmental charges	–334.6	-1,1016.4	–681.8
EBITDA	532.9	229.8	–303.1
Depreciation and amortization	–935.7	–1,833.1	–897.4
EBIT	–402.8	–1,603.3	–1,200.5

Source: Company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated), https://www.ofgem.gov.uk/sites/default/files/docs/2021/03/energy_companies_individual_consolidated_segmental_statements_css_2019-2020.pdf

Although the profitability of thermal generation subsequently recovered, chiefly through participation in the Capacity Market, it essentially became a cash business operated with written-down assets. That written-down thermal assets generate cash but don't repay their capital costs shows that the activity is uninvestable. Once these assets are retired, the activity comes to an end.

The non-replacement of thermal generating assets constitutes the biggest failure of EMR and Britain's energy policy in general. Media attention since Putin's invasion of Ukraine has focused on the cost and availability of natural gas. However, more fundamental is not having sufficient gas-fired generating capacity to generate electricity from whatever gas is available. It's not much use having natural gas if there's insufficient gas-fired capacity to keep the lights on. At this point, new gas is uninvestable. Policy-makers have no answer to this; indeed, politicians appear to be oblivious to the fact that the continuous fall in non-intermittent generating capacity is a problem at all.

New gas plants (like new coal plants) have far higher thermal efficiency levels than ones built in the 1990s and early 2000s. By being run at load factors of only 40–50 percent, lots of fuel is wasted ramping them up and down, lowering their thermal efficiency. As a consequence, their emissions are much higher than they would be if run at maximum efficiency—an overlooked factor that means that renewables can result in more carbon dioxide emissions.

14.3 Nuclear

The profitability of nuclear has also declined since 2013, but for different reasons. Britain had been a pioneer of civil nuclear power and paid a huge penalty for its attempt to win the nuclear race by developing indigenous advanced gas-cooled reactor (AGR) technology, rather than buying in proven American technology, as France was doing in the 1970s. It was only in 1980. with planning for the Sizewell B nuclear project, that the British state conceded defeat and switched to Westinghouse's PWR design.

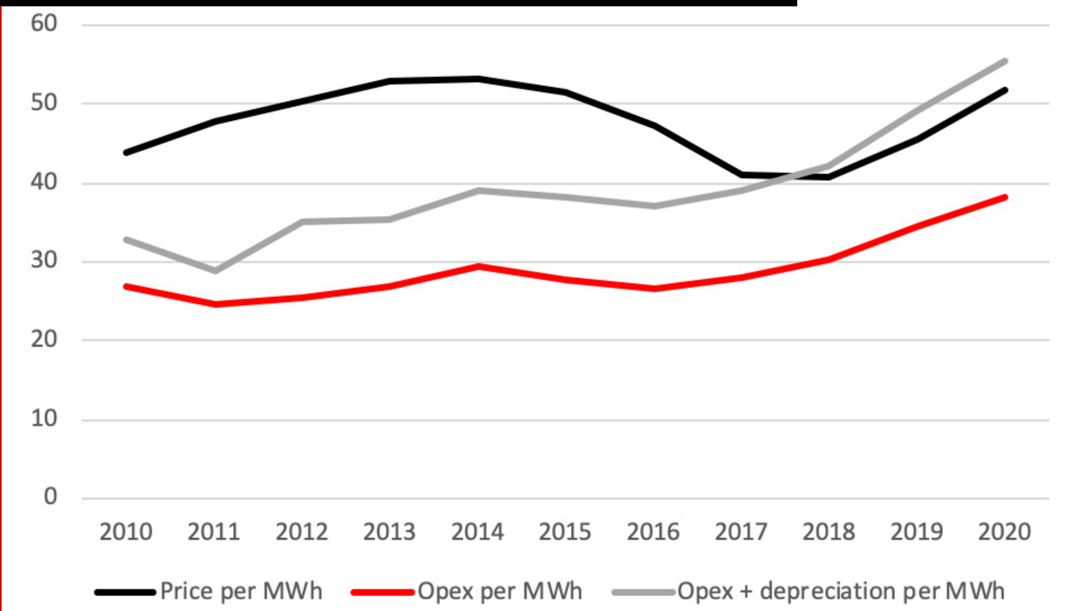
Britain's civil nuclear program, together with the Concorde project, was the subject of a 1976 lecture by economist David Henderson, titled "Two British Errors."[182] In a subsequent radio talk, Henderson went on to suggest that they might come to be seen as "two of the three worst civil investment projects in the history of mankind."[183] This is not a criticism of nuclear power as such. France and Sweden developed successful nuclear power programs. Rather, it is a timely warning against falling into the trap of energy-policy jingoism in which the risk-adjusted upside is minuscule, compared with the possible—and likely—downside. Once the Union Flag is plastered over a policy, it becomes almost impervious to error correction, as is the case today with Britain's ambition to win the race to net zero.

Instead of being the first of 10 PWRs, Sizewell B was the last nuclear power station to be built in Britain for two decades, until construction started on Hinkley Point C in 2018. Electricity privatization had left Britain's nuclear power stations orphaned assets—initially retained in the public sector, privatized, then taken back into state ownership—until acquired by France's EDF in 2009, which sold a 20 percent stake to Centrica.

That challenging legacy is reflected in fluctuating output and deteriorating financial performance. Nuclear power capacity peaked in 1999. The subsequent 15 years saw retirement of all the first-generation Magnox nuclear power stations. The second-generation AGR power stations are now approaching retirement and operating significantly below their design capacity. Even Sizewell B has experienced maintenance issues, and in 2020, National Grid requested the plant halve its output, in order to protect the grid in the event of an unplanned outage when demand was suppressed because of Covid restrictions.[184]

The price obtained by nuclear appears not to have benefited materially from the introduction of the Carbon Price Support in 2013. From 2014 to 2018, the average price obtained for nuclear output fell by £12.55 per MWh, a decline of 23.6 percent. However, from 2016, operating costs per MWh began increasing and by 2018 had risen by £2.60 per MWh before depreciation and £5.22 per MWh including depreciation, resulting in a £37.8m loss at the EBIT level (Fig. 13). Although firmer prices eliminated losses, 2020 EBIT of £98.8m represents a 92 percent decline from 2013 EBIT of £1,267.0m.****

FIGURE 13: NUCLEAR—PRICE AND OPEX PER MWH (£)



Source: Company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated)

15. Big Six supply (retail) segment

In addition to generating electricity, the Big Six sold electricity and gas to residential and business customers—what Ofgem rather confusingly calls their "supply segment." In 2009, the Big Six dominated the energy supply market, with a 90+ percent share of residential customers.

In order to reduce Big Six market share, the energy regulator Ofgem implemented a series of disastrous measures to encourage entry. In a scathing July 2022 report, the House of Commons BEIS Committee noted that Ofgem did not require license applicants to submit information on their business models,

**** In addition to revenue from sale of electricity, nuclear earned £79.8m and £230.0m of "other revenue" in 2018 and 2019, respectively, enabling the segment to be profitable in both years at the EBIT level.

working capital arrangements, or financial viability.[185] The lack of ongoing requirements allowed thinly capitalized companies to use customer prepayments to finance their growth and operate with no or inadequate hedging against future price rises. Many of them duly collapsed when prices rose. “Ofgem has proved incompetent as the regulatory authority of this complex market, thereby costing taxpayers billions of pounds,” the BEIS committee concluded. “The scale of failure and the cost exposure to taxpayers is only comparable to the financial crash of 2008.”[186]

As a result of Ofgem’s botched market-entry measures, the number of energy suppliers rocketed from just 12 in 2010 to 70 in 2018. In 2014, the Big Six served 25.2m residential customers. By 2020, two of the Big Six (RWE and SSE) had exited the domestic supply segment, and the remaining four had retained just 16.1m residential customers between them.

15.1 Household electricity consumption, prices, and bills

Analysis of aggregated Big Six electricity supply data reveals a strong upward trend in retail prices and decreases in household electricity consumption, mapping the decline noted in Table 8 above. Lower demand did not offset higher prices, leading to a rise in average household electricity bills. In 2008, households on Big Six tariffs paid an average of 10.71p per kWh. Although input fuel costs were more or less flat through 2020—fluctuating between 5.31p per kWh in 2017 and a high of 6.43p per kWh in 2019—average electricity prices kept rising, hitting 13.76p per kWh in 2013 and reaching 17.92p in 2020, making for an increase of 67 percent between 2009 and 2020.

Of the 2.99p per kWh increase in the cost of electricity between 2009 and 2013, 2.09p is accounted for by increases in the sum of environmental levies (mostly subsidies for renewable energy), social obligations (to subsidize poorer households), and network infrastructure charges. Thus, 70 percent of the increased cost of electricity came from environmental levies, social obligations (Table 14, Row A), and network charges (B).

From 2013, Big Six segmental filings have separate lines for environmental and social obligations and network charges. Of the 4.00p per kWh rise in the cost of electricity between 2013 and 2020, 3.00p came from government-imposed environmental levies and social obligations.

TABLE 14: BIG SIX AVERAGE RESIDENTIAL ELECTRICITY PRICES (PENCE PER KWH)

		2009	2013	Change, 2009–13	2020	Change, 2013–20
Retail price		10.71	13.76	+3.05	17.92	+4.16
Fuel costs		6.00	6.15	+0.15	5.55	–0.60
	A. Environmental levies and social obligations		1.83		4.83	+3.00
	B. Grid and distribution costs		3.43		4.43	+1.00
A + B		3.17	5.26	+2.09		
Indirect costs (sales, marketing, billing, etc.)		1.19	1.80	+0.61	2.80	+1.00
Supplier profit (EBITDA)		0.44	0.58	+0.14	0.04	–0.40
Total costs + profit		10.80	13.79	+2.99	17.65	+4.00

Note: Columns do not reconcile due to rounding and omission of other income and other costs.

Source: Company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated)

From 2014, segmental filings include customer numbers. This provides a fuller picture of the relationship between price, demand, and average customer bills. Between 2014 and 2020, residential electricity prices rose 20.3 percent; average consumption per household fell 8.1 percent, and average household electricity bills rose 15.6 percent. The year 2020 was, of course, a Covid year marked by lockdowns and extensive working from home, which saw fuel costs ease and residential consumption tick up by 6.6 percent. In the four years to 2019, electricity prices rose 25.3 percent—an average rate of 5.9 percent a year—and consumption fell 13.8 percent.

TABLE 15: BIG SIX AVERAGE RESIDENTIAL ELECTRICITY PRICES, CONSUMPTION, AND ANNUAL CUSTOMER BILLS, 2014–20

	2014	2015	2016	2017	2018	2019	2020
Average selling price per kWh (p)	14.30	14.17	14.05	14.96	16.28	17.98	17.92
Average electricity consumption per customer (kWh)	3,800	3,753	3,729	3,647	3,554	3,277	3,493
Average bill per customer (£)	545.13	535.06	527.94	549.85	582.58	592.51	630.26

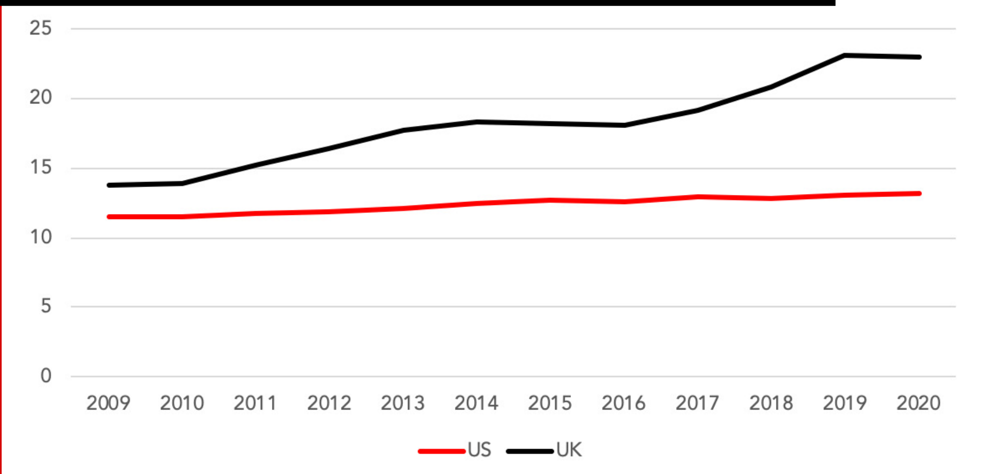
Source: Company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated)

The CCC claims that lower household electricity demand is "due to improvements in energy efficiency of lighting and appliances."[187] A simpler explanation: price. The downward slope of the demand curve and higher prices mean less quantity demanded. Predictably, the CCC does not mention higher electricity prices as a factor reducing demand. Neither does it mention the Jevons Paradox, which says that increased efficiency of resource consumption leads to more of that resource being consumed due to its lower effective price.

15.2 US vs. GB residential electricity rates

Comparison with US residential electricity rates reveals how much more Britons are paying for their supposedly climate-friendly electricity. Whereas British residential electricity rates rose by 67.3 percent between 2009 and 2020, average US residential rates rose 14.3 percent, from 11.51¢ per kWh in 2009 to 13.15¢ per kWh in 2020. In 2009, Britons were paying 2.24¢ per kWh (19.4 percent) more for electricity in 2009 than American households. In 2020, the gap had widened to 9.85¢ per kWh—74.9 percent more than average US residential prices (Fig. 14).

FIGURE 14: US AND UK RESIDENTIAL ELECTRICITY PRICE (CENTS PER KWH AT CONSTANT 2020 EXCHANGE RATES)



Note: GBP translated at 2020 average rate of $1.2837

Source: EIA Annual, table 2.7, "Average Price of Electricity to Ultimate Customers"; company filings accessed via Ofgem, "Energy Companies Consolidated Segmental Statements" (undated)

PART VI. CONCLUSION AND RECOMMENDATIONS

Key Points

The case for net zero rests on two falsehoods: the low and falling costs of renewable energy; and that net zero is good for economic growth. It will take time for these to be exposed for what they are and for net zero to be recognized as the greatest error of our age. This report makes two recommendations to help bring forward that time:

- De-legislate net zero. Writing net zero into law elevates decarbonization above all other policy objectives and transfers power from the government to NGOs and the courts to second-guess government decision-making across potentially ever-expanding policy domains (Section 17).
- Open the books! The climate lobby made false claims about the low and falling cost of renewable energy in the absence of widely available audited financial and operating data. The cure is transparency: all energy projects benefiting from public subsidy in any form should file annual audited financial and operating data and should be made subject to the provisions of the Freedom of Information Act (Section 18).

16. Net zero: An antigrowth strategy

Net zero was adopted on the basis that renewable energy costs had fallen sharply and subsequently justified as a growth elixir for Britain's moribund economy. This report shows that both contentions are false. Energy costs had already risen in the years preceding the financial crisis in 2008. Instead of letting markets respond to high energy prices by stimulating investment and increasing output, as had happened in the 1980s, climate policies pushed the market out of the way and pushed energy costs even higher. The result can be seen in the widening divergence between electricity prices in Britain and the US.

The costs of climate policy are not limited to funding renewable subsidies that successive governments imposed on electricity consumers, especially as decarbonization policies are widened to include transportation, home heating, and energy-intensive manufacturing such as steelmaking—to be done less efficiently with high-cost electricity. The higher costs of generating electricity from a grid with a high proportion of renewable capacity reflects a basic economic fact: more inputs are needed to produce less output. The outcome is structurally higher energy prices, with adverse knock-on effects sapping the supply side of the economy.

Productivity growth propels long-term economic growth. Net zero throws this into reverse. It is an antigrowth strategy because it consumes more resources to produce less. Beyond its direct and negative impact on living standards, net zero will have an increasingly debilitating macroeconomic effect on the sustainability of public spending and of public and private debt. It shrinks the economy's growth potential, which implies higher interest rates to bring inflation back to target. Net zero presents a cocktail of higher energy costs, higher inflation, higher interest rates, higher taxes, squeezed family budgets, less opportunity, and prolonged public-sector austerity.

16.1 Net zero and Brexit

Eight years after Parliament passed the Climate Change Act, the British people voted to leave the EU. Although it would have been possible to be outside the EU and, like Norway, be part of the European Economic Area and have privileged access to the Single Market, the Brexit adopted by Boris Johnson after becoming prime minister in July 2019 foreclosed this option. Leaving the EU's Single Market constituted another negative supply-side shock.

For Brexit to be perceived a success required a strong, growing economy. Rather than recognize the primacy of recharging the supply side of the British economy to alleviate a decade of stagnating living standards, Britain's political class took the fateful decision of upping its decarbonization target from 80 percent to 100 percent.

A peculiarity of Britain's Brexit divide is that pro-Brexit politicians and commentators took the position that the EU's Single Market conferred little economic benefit and that leaving it would be pain-free. Their opponents argued that leaving the Single Market would damage supply-side performance, much of which is likely to be transitory. Yet they say nothing about the far-reaching, pervasive, and long-duration impact of net zero on economic growth.

In inflicting a negative supply shock, net zero was the opposite of what was needed to overcome the Brexit hit and lift the British economy out of its more than decade-long torpor. It is not only the economy. We live in a world of intensifying geopolitical rivalry. Sooner rather than later, a choice will have to be made between prioritizing net zero above all else and national security.

17. Recommendation #1—De-legislate net zero

The means to achieve a policy objective often requires fresh legislation. Writing a policy objective into law is different. The Climate Change Act elevated achieving one particular objective over all others, however critical they might be to national well-being and security. It denies elected politicians the unique function that only they can fulfill: making trade-offs between competing policy objectives. It weakens democratic accountability, as it turns elected politicians into mere executors of policies designed to meet climate targets, with other policy objectives subordinated to meeting that goal. Once in law, a climate target is to be prosecuted however much it costs and whatever must be sacrificed to meet it. It is the antithesis of democratic governance. And that is the point. The purpose of putting decarbonization targets into law is to place climate policy beyond politics.

A consistent message from public opinion surveys is that although there is majority support for net zero, it is not their top priority. The YouGov/*Sun* June 2023 survey asked respondents the three most important priorities for their family. Reducing bills / tackling inflation came at the top (60 percent); reaching net zero was ranked eighth (12 percent). Here, it is less a trade-off between objectives than a conflict between them, as decarbonization means higher energy costs. Although surveys of public opinion show support for net zero, they are a fallible guide when voters face hard trade-offs and a structurally weakened economy that net zero entails.

Furthermore, a legislated target transfers political power over huge and unbounded policy domains to the climate lobby and NGOs and to the courts, which can decide whether a particular policy decision might conflict with the government's legal duty to meet the 2050 decarbonization target. The Climate Change Act does not put into place the policies required to meet it; it promotes policy incoherence by transferring power to the courts, mechanically breaking down coherent governance, and ultimately undermining trust in the political system. For this reason, it is inherently antidemocratic.

- A future British government should amend the Climate Change Act to remove the statutory duty on the government to ensure that the UK's net greenhouse gas emissions fall by a prescribed amount (currently 100 percent) by a particular year (currently 2050). The justification for de-legislating net zero is to restore the government's ability to meet the people's priorities, and not subordinate their priorities to one overriding objective defined in the Climate Change Act. The case should be framed in terms of restoring democratic control, which also happened to be the case made for Brexit.
- Doing this would not require jettisoning net zero as a policy objective. It would mean that voters could judge progress on meeting that objective as part of the overall balance and mix of that government's record when it comes to fighting a subsequent election.

18. Recommendation #2—Open the books!

In advocating that Britain adopt net zero, the Committee on Climate Change made false, unverified claims that its costs would be within the envelope of the previous 80 percent decarbonization target. It could get away with making false claims about the falling cost of wind power because of the opaqueness of wind cost and performance data. Subsequent appraisals by the OBR and the Treasury on the fiscal and macroeconomic consequences of net zero were also based on false assumptions about the low and falling costs of renewable energy.

Whatever one's views on the net zero target, it cannot be right that a policy decision of such magnitude and consequence be taken on the basis of tainted data furnished by parties with strong vested interests and hard inferences drawn from CfD strike prices on alleged cost discovery from an allocation mechanism that has moral hazard hardwired into its design. In Britain, it fell to a handful of independent researchers, Gordon Hughes preeminent among them, to collect financial data by trawling through Special Purpose Vehicle company filings to assemble the data that demonstrate that these cost assumptions are false and that the rosy scenario of falling renewable energy costs is a green mirage.

It is a sound principle of good governance that public financial support should go hand in hand with public transparency. Virtually all renewable energy projects benefit from public support in one form or another: in Britain, as in the EU, mostly funded through consumer levies; in the US, funded through federal and state spending masquerading as tax credits and state-legislated portfolio-generating standards. Much of the data in this report have been drawn from the Big Six consolidated segmental statements required by Ofgem. These mandated disclosures came about because of concerns about lack of competition in the electricity market.

The public interest case for full transparency with renewable energy is much stronger. Policymakers are making capital-allocation decisions between generating technologies, which the public is being forced to fund via their bills or through their taxes. Full disclosure is needed so that politicians, opinion-formers, and the public have dependable data on the true costs of wind and solar. Such a requirement will be strongly resisted by the climate lobby, as it doesn't want the public to see the true costs of renewable energy and its atrocious value for the money.

Additionally, any company receiving CfD, ROC, Capacity Market, or similar payments, together with anyone acting on their behalf (investors, consultants and advisors, and trade organizations) plus National Grid should be subject to the provisions of the Freedom of Information Act with no exclusions on the grounds of commercial confidentiality or difficulty of extracting information. When government policy has been totally captured by vested interests, the public needs to see the web of vested interest influence and follow the money. As US Supreme Court Justice Lewis Brandeis said over 100 years ago, sunlight is said to be the best of disinfectants.

- All generating capacity benefiting from public subsidies (guaranteed price supports, portfolio standards, tax credits) should file audited annual returns from project inception containing financial and operating data in a standardized format that includes associated grid extension and reinforcement costs.
- Similarly, these companies and those acting on their behalf, together with National grid, should be subject to the provisions of the Freedom of Information Act.

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