The true affordability of net zero

Kathryn Porter

Watt-Logic

www.watt-logic.com | kathryn.porter@watt-logic.com | +44 7958 775 745

ABSTRACT

Policymakers insist that renewables are cheap and that the only way to lower energy costs is to move away from the use of gas and embrace the use of renewable generation. But in Great Britain, the only renewables that can be deployed at scale are wind and solar whose output depends on the notoriously unreliable and unpredictable weather. To ensure the lights stay on it is necessary to maintain an equivalent amount of dispatchable generation, batteries and interconnectors. But batteries are small and run out quickly and interconnectors rely on the goodwill of neighbouring countries. Both can be expensive, particularly if the connected countries also rely on wind and solar power.

Renewables also have low energy density meaning that more grid infrastructure is needed to connect them. And most of all, despite subsidies starting in 1990, renewables STILL require subsidies in order to be built, and these subsidies are increasing rather than falling.

The result is that the UK has the highest industrial electricity prices in the world and the fourth highest domestic electricity prices, with many of the costs paid by consumers resulting from policy choices designed to support renewable generation and the drive to net zero carbon dioxide emissions by 2050. This report will explore these costs in detail and demonstrate that the promises of policymakers about cheap green energy are unlikely ever to be fulfilled.

About Watt-Logic

Watt-Logic is an independent energy consultancy founded by Kathryn Porter. Watt-Logic was established in 2016, initially as a blog which grew into a consulting business that now works with clients around the world on projects across the energy supply chain. Projects include assisting clients on negotiating commercial contracts and gas and electricity trading arrangements; assisting businesses in evaluating new investments in solar generation, behind-the-meter storage and energy-from-waste; advising on various regulatory matters such as the impact of changing market price formation, and acting as an expert witness in energy-related disputes.

Watt-Logic's founder, Kathryn Porter has extensive experience of physical and financial electricity, gas and oil markets, as well as significant experience in financial services across risk management/hedging and debt and equity financing in both public and private markets.

Watt-Logic is entirely self-funding and receives no external capital from any sources. It is therefore independent of any other business, individual or special interest group. The views contained within this report are solely those of the author.

Contents

Executive Summary

The UK has the highest industrial and fourth highest domestic electricity prices the developed world...

Energy Secretary, Ed Miliband claims that renewables are cheap and will lead to lower bills. This sounds great, but unfortunately is not true. The only renewables that are viable at scale in the UK are wind and solar, which are intermittent – that is they do not work all the time. Wind turbines do not generate when it's not windy and solar generates nothing at night. This includes the peak demand periods which occur at dinner time in the winter which is after sunset. The average load factor of wind is just 35% which means that on average only 35% of the possible amount of electricity that could be generated actually is. One can think of this, although it's an imperfect analogy, as wind only working "35% of the time".

...Yet its gas prices are only the 15th highest...

> "It is a sad fact that the UK's industry electricity prices are amongst the highest in developed economies – higher than in the EU and around four times the prices in the US. The result is that UK energy-intensive industries are uncompetitive,"
>
> -Professor Sir Dieter Helm

...Gas prices do not explain why British businesses and households face such high electricity costs

Had Britain continued with its legacy gas-based power system consumers would have been almost £220 billion better off (2025 money) since 2006, even taking into account the impact of the gas crisis

It is therefore not surprising that not only have business and household electricity prices consistently increased faster than underlying wholesale prices, but they are the highest and fourth highest in the world respectively. According to international energy price statistics published[1] by the UK Government, as of June 2024 (the last month included in the dataset), large British firms were paying 27.91 pence per kilowatt hour (p /kWh) for electricity while those in the EU paid just 10.80 p /kWh. But this was not always the case. Back in July 2011 there was almost no difference between the price paid by industrial consumers in the UK versus those in the 7.48 p /kWh compared with 7.04 p /kWh.

High electricity prices are leading to high levels of de-industrialisation...

Miliband likes to blame this on "high international gas prices" and "dictators" (the biggest exporter of gas to the UK is Norway: the idea that Norwegians are dictators can only be described as a niche view!). Yet by definition, all countries that are net importers of gas will pay the same international gas prices, and many other countries rely on gas, as the UK does, for electricity generation. So neither dictators nor gas prices explain why UK electricity prices are so high compared with other countries. In fact, other data[2] published by the UK Government (sourced from the International Energy Agency) show that UK gas prices were the 15th highest of the 24 countries analysed.

...without reducing global emissions as manufacturing is offshored to countries with dirtier energy and shipping emissions are incurred bringing goods to the UK

This is not a trivial point. High domestic electricity prices create hardship and increase energy poverty, while high industrial prices make UK manufacturing uncompetitive and lead to de-industrialisation. In recent months, major job losses and /or business reductions have been announced at BP, the Grangemouth refinery, the Port Talbot steelworks, Vauxhall's Luton car plant, and the Yara ammonia plant in Hull. At the end of 2024 the last remaining Hotpoint manufacturing site in the UK ceased operations, while AstraZeneca cancelled a planned expansion of its vaccine production plant in Liverpool.

1 https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices
2 https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices

The UK's high electricity prices are a deliberate policy choice

The UK's high electricity prices are a deliberate policy choice. This report will set out all of the additional costs applied to bills as a result of net zero policies which in 2023-24 amounted to over £17 billion, and are projected to increase to over £20 billion per year in 2029-30.

Some countries recover a portion of the costs of decarbonisation through taxation rather than adding them to bills, reducing the burden on energy consumers, but this hides rather than removes transition costs.

Other countries have fewer costs and levies – the UK chooses to not only subsidise renewables but also impose other levies and taxes which are designed to encourage a move away from carbon intensive energy. Unfortunately this is often impractical, meaning that households and businesses effectively pay additional taxes on their energy without being able to receive any associated benefits. These are clear policy choices, in part driven by the Government's determination to "lead the world" on climate.

Windfarms are knowingly built behind grid constraints meaning their electricity cannot always be used...

In the meantime, the UK wastes large amounts of money through a failure to properly manage net zero investment. Windfarms have been deliberately built behind grid constraints in the knowledge that the electricity they produce cannot all be used. In 2024 the Seagreen windfarm which opened in October 2023 was constrained off (ie paid not to export its electricity to the grid) twice as often as it actually sold its electricity to the grid. When this happens, consumers must pay a gas power station to generate the electricity they actually use, and pay windfarms not to generate the same amount of electricity. Consumers pay twice because investments in the power grid have failed to keep pace with the construction of subsidised windfarms.

...the Seagreen windfarm which opened in October 2023 had curtailment volumes double the amount it generated during 2024

> "We currently pay around £1 billion per annum to curtail renewable energy generation when the grid cannot handle the power. This eye-watering amount of money is simply passed on to consumers, who end up paying for both the curtailed renewable energy and the gas that replaces it,"
>
> - Chris Glover, director of total utilities management at Buro Happold

Nor is there any sign of relief. Despite the Government's claims that a move to renewables will result in cost savings, the Climate Change Committee in its recently published 7th Carbon Budget says that savings from net zero are only expected during the 7th budget period which runs from 2038 to 2043. The cost assumptions contained within this report are unrealistically optimistic, anticipating reductions in the costs of windfarms that are not substantiated by the evidence. The chances or realising such savings in the 2040s or at any time, are remote.

Net zero policies make energy more expensive for end users, and will continue to do so indefinitely.

The true costs of the energy transition

Increased use of renewables may lower wholesale electricity prices...

...but consumers do not only pay the wholesale price: they pay the retail price...

...which contains other elements, many of which increase in the presence of renewables

It is frequently stated by policymakers and green lobbyists that renewables are "cheap" and indeed, cheaper than the alternatives provided primarily by gas. The high gas prices of 2022 are cited as being a particular problem with the use of gas, despite the very low gas prices that endured in the first twenty years of this century.

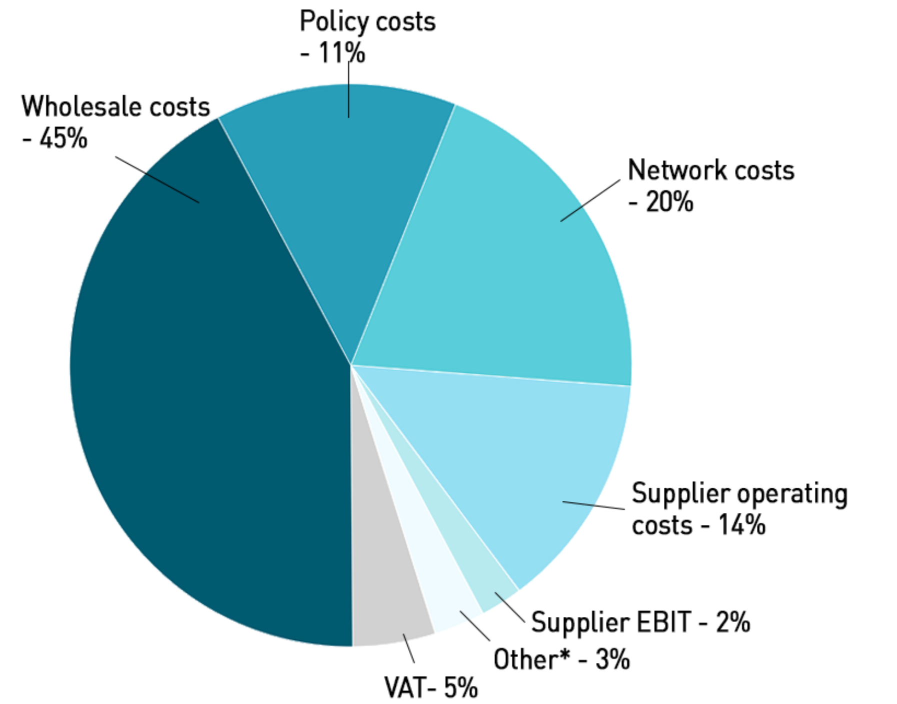
Increased use of renewables may well result in lower wholesale prices of electricity, but unfortunately, end users do not only pay the wholesale price – they pay the retail price, which contains several other elements, many of which increase in the presence of renewable generation (and others which do not such as VAT, supplier operating costs and supplier profits).

For example, the most recent price cap for a typical dual fuel (gas plus electricity) bill for a direct debit consumer, for the period April to June 2025 is broken down as shown in the chart.

The wholesale price of electricity is based on so-called "marginal pricing" ie the market clears at the cost of the last unit of generation that must be used in order to meet demand. This is typically a gas-fired power station, which leads to the claim that electricity costs are "based on" gas costs.

This is only partly true: the costs of gas power stations obviously include the gas fuel cost, but they also include carbon costs. Analysis of gas and electricity futures data from 2014 shows that wholesale gas prices explain about 93% of wholesale electricity prices, meaning there is a high linkage between them.

Default price tariff, dual fuel, direct debit, April – June 2025



*Other includes the Adjustment and Levelisation allowances and Headroom

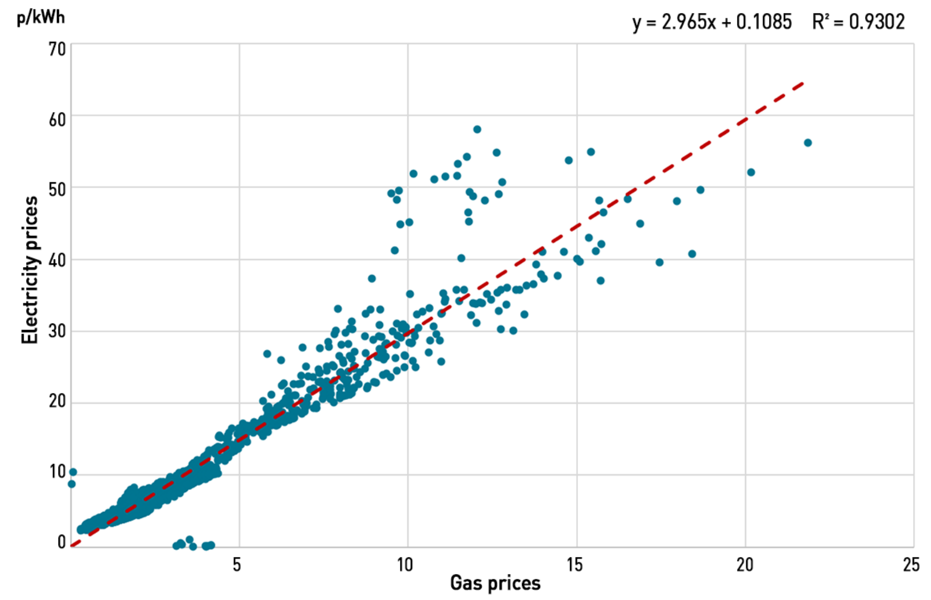
Source: Ofgem[3]

Wholesale electricity prices (excluding the CfD and Capacity Market) are just 42% of electricity bills...

...gas prices determine less than 40% of electricity bills ie gas prices do not "drive" the price homes and businesses pay for electricity

3 https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/energy-price-cap-default-tariff-policy/energy-price-cap-default-tariff-levels

Wholesale gas vs electricity prices in the UK, 2014 - 2024



Source: Watt-Logic using Trading Economics data

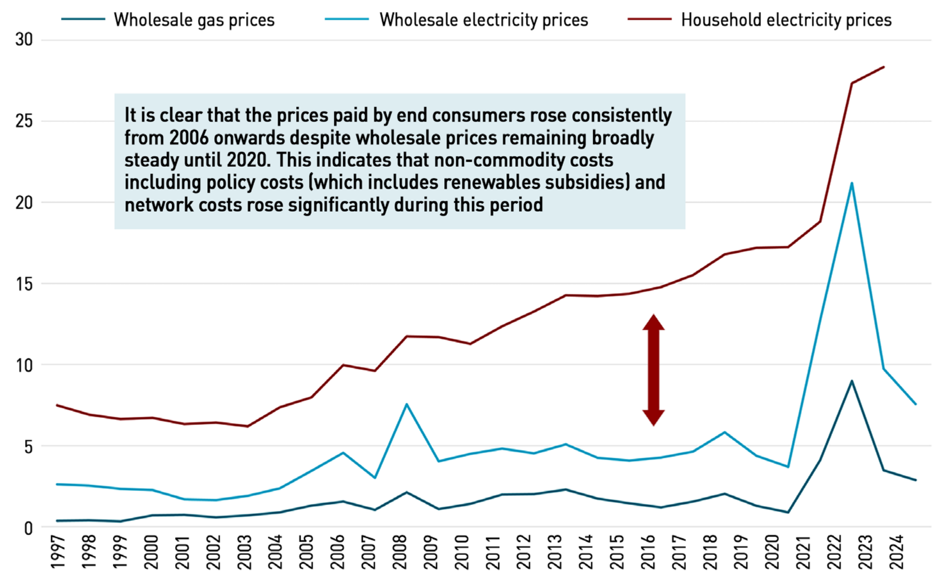
While wholesale gas prices explain a large portion of wholesale electricity prices, it is a different story when it comes to the amounts paid by homes and businesses (known as the retail price). The following chart shows wholesale gas and electricity prices and retail electricity prices in current money terms (ie the money of the day for each year), from 1994 to 2024 (household spend data for 2024 are not yet available).

From 2006 retail electricity prices began to diverge from wholesale prices...

...wholesale gas and electricity prices were broadly stable until 2021...

...yet retail electricity prices experienced consistent increases

Wholesale gas and electricity prices vs retail electricity prices in the UK, 1997 – 2024 (p /kWh, money of the day)



Note on data

The household prices use the Office for National Statistics, Table 2.6.1 Total household expenditure on energy, United Kingdom and Energy consumption in the UK 2024: consumption data tables are from the Office for National Statistics, Energy Consumption in the UK (ECUK): Final Energy Consumption Tables.

The wholesale gas prices are a simple annual average of daily ICE futures closing prices for each contract from Trading Economics.

It was more difficult to obtain consistent wholesale electricity price data covering the whole period. The data used come from a variety of sources, which used different averaging conventions.

1997-2001 were from the Ofgem report "The review of the first year of NETA", July 2002.

2022-2010 were from evidence presented by Centrica plc to the House of Commons and can be found here:

https://publications.parliament.uk/pa/cm201012/cmselect/cmenergy/670/10120703.htm

Data from 2010 onwards are averaged from Ofgem's monthly wholesale market indicators available.

All inflation adjustments are made using the Bank of England inflation calculator

It should also be noted that the electricity market underwent a major structural change in 2001 from the first iteration of price formation following privatisation - the electricity pool of England and Wales - to the current market structure known as "NETA", the New Electricity Trading Arrangements. This resulted in cost reductions for consumers as NETA was considered to be a more efficient means of price formation.

Source: Office for National Statistics, Trading Economics, Ofgem, Centrica, Bank of England, Watt-Logic

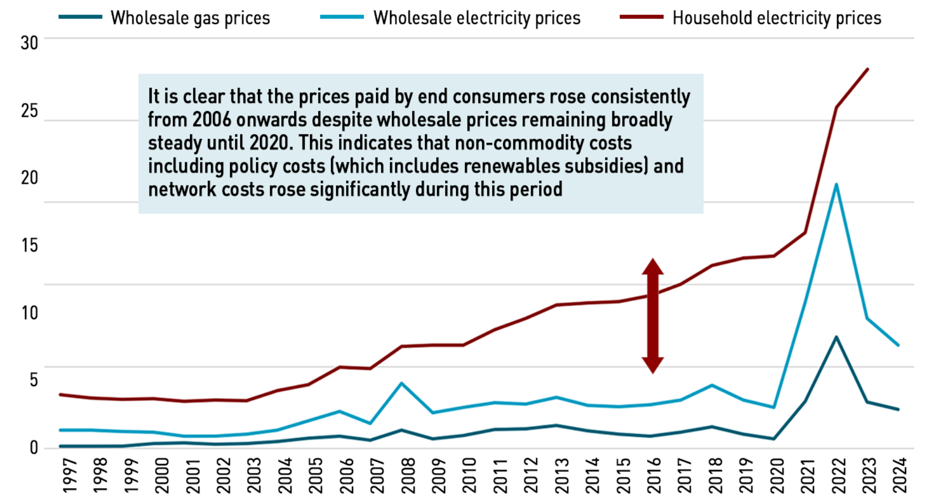
Had the margin of the retail price over the wholesale price been maintained after 2006, ie the costs of the energy transition not been added to bills, households would have saved £130 billion in 2006 money (£218 billion in today's money)

De-carbonisation policies have cost households almost £220 billion (£2025) since 2006

This compares with an estimated cost of £75 billion of the gas crisis

Here are the equivalent data presented in 2006 money:

Wholesale gas and electricity prices vs retail electricity prices in the UK, 1997 – 2024 (p /kWh, 2006 money)



Source: Office for National Statistics, Trading Economics, Ofgem, Centrica, Bank of England, Watt-Logic

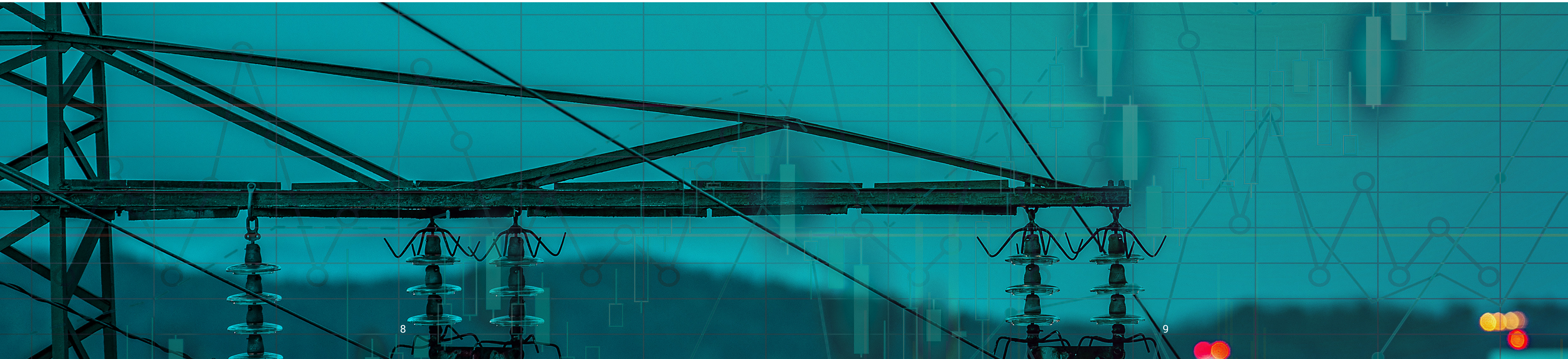
It can clearly be seen that from 2006 retail electricity prices begin to diverge from wholesale prices – while wholesale gas and electricity prices are broadly stable until 2021, yet retail electricity prices experience consistent increases.

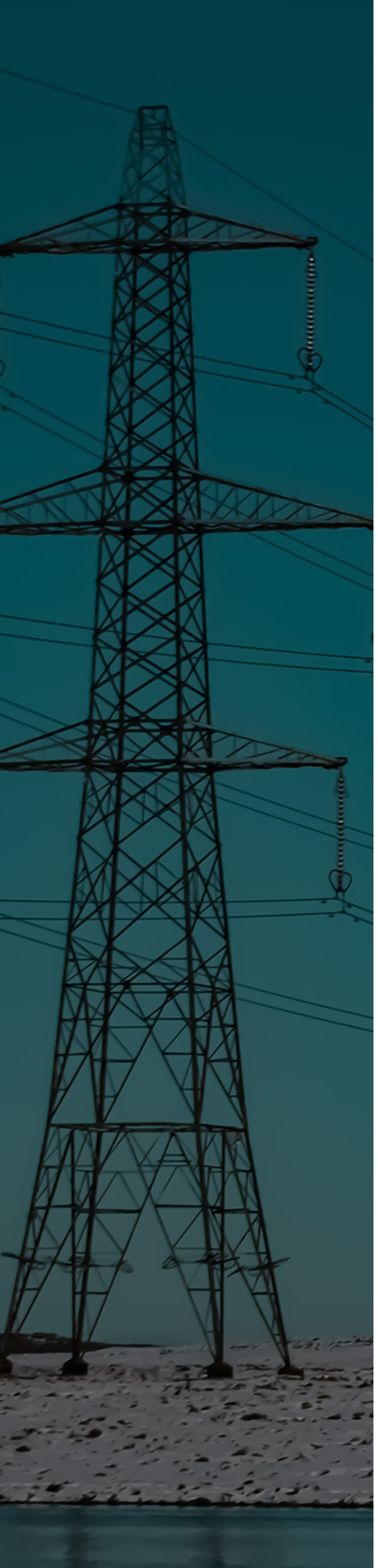
Prior to 2006, the margin between retail and wholesale electricity prices was broadly stable at 3.88 – 4.79 p/kWh with an average of 4.23 p/kWh (2006 money). Had this margin been maintained in the subsequent years ie the costs of the energy transition not been added to bills, households would have saved £130 billion in 2006 money (£218 billion in today's money). In contrast, some estimates[4] suggest that the UK spent an additional £75 billion as a result of the 2021-23 gas crisis.

So despite what people say about high gas prices being responsible for high electricity prices, this was only true for late 2021-23 – for most of the past 25 years, something other than gas prices has been driving electricity prices higher.

Policymakers are also fond of blaming "high international gas prices" on

4 https://eciu.net/analysis/reports/2024/the-cost-of-gas-in-2-5years-of-the-gas-crisis#:~:text=UK%20will%20have%20spent%20around%20%C2%A3105bn%20buying,to%20before%20the%20gas%20crisis%20and%20pandemic.

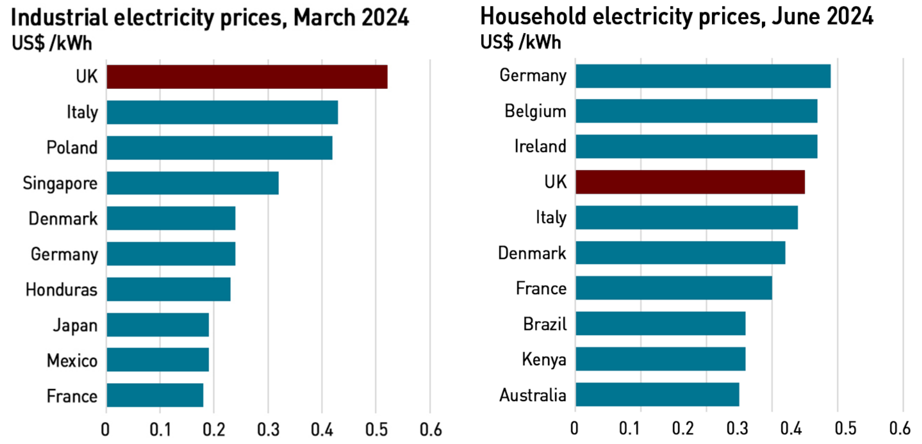




the UK's high energy costs. However, this claim also does not survive closer scrutiny. Firstly, there is no single "international gas price" – there is not even a single British gas price! However, what policymakers mean by this expression is that, as net gas importers, we must pay whatever prices are demanded by the international gas markets.

But this is true for all net gas importers, many of whom, like the UK, use gas as the fuel in their marginal electricity generating plant. So while "international gas prices" may explain periods of higher energy prices in the UK, they do not explain why the UK has relatively expensive energy compared with other countries. This additional expense undermines the UK's international competitiveness and is driving de-industrialisation.

Industrial and household electricity prices



Source: Statista[5,6]

Additional costs imposed by the energy transition

There are multiple additional costs associated with the energy transition.

Renewables subsidies

First of all, the construction of renewables, and in particular wind, requires subsidies. In fact, the UK has been subsidising renewables since 1990 with the Non-Fossil Fuel Obligation. This was replaced in 2002 by the Renewables Obligation which was itself replaced in 2017 by the Contracts for Difference but whose last contracts won't expire until 2037. From 2010, small scale renewables were supported by the Feed-in Tariff which closed to new schemes in 2019, but won't fully expire until the last contracts end in 2039.

Subsidies were initially sold as a means of priming the pump for immature technologies. After 35 years, these technologies should now be mature – and indeed they are – so there is clearly another reason they continue to require subsidies. The reason is that wind in particular is not economically viable even though most of its costs are socialised and not borne by the generators themselves.

These subsidies are not included in the wholesale price of electricity traded in the market, but are added directly to electricity bills (with the CfD going into the wholesale category and the RO and FiT going into policy costs under the price cap methodology). According to the Office for Budget Responsibility, the UK spent £9.9 billion on environmental levies in 2023-24[7]:

5 https://www.statista.com/statistics/1369634/business-electricityprice-worldwide-in-selected-countries/

6 https://www.statista.com/statistics/263492/electricity-prices-in-selected-countries/

7 https://obr.uk/download/october-2024-economic-and-fiscal-outlook-detailed-forecast-tables-receipts/?tmstv=1740356990

The UK has been subsidising renewables since 1990...

...and is now spending over £17 billion per year on environmental levies, subsidies, carbon taxes and other energy taxes

By 2030 Brits will be spending more than £20 billion per year on environmental levies, subsidies, carbon taxes and other energy taxes

Environmental levies

3.8 Environmental levies

	£ billion						
	Outturn	Forecast					
	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Renewables obligation	7.6	7.8	8.2	8.5	6.9	7.0	7.0
Contracts for difference	1.8	2.3	1.4	2.2	2.9	2.6	2.9
Capacity market[1]	0.0	1.3	1.8	3.2	4.0	4.0	4.0
Green gas levy[1]	0.0	0.0	0.1	0.1	0.2	0.2	0.2
Warm Home Discount	0.4	0.6	0.6	0.6	0.6	0.6	0.6
Environmental levies	**9.9**	**11.9**	**12.1**	**14.7**	**14.6**	**14.5**	**14.8**
Memo: Expenditure on renewable heat incentive (RHI)	1.2	1.2	1.3	1.3	1.3	1.3	1.3

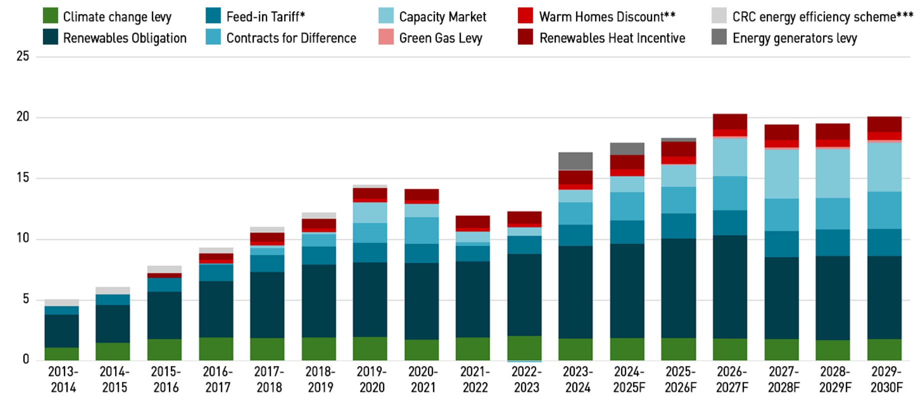
Note: The 'Environmental levies' line above is consistent with the 'Environmental levies' line in Table A.5 of the March 2025 *Economic and fiscal outlook*.

[1] The ONS have yet to include capacity market auctions or green gas levy in their outturn numbers. If they were included, they would have been £1.0 billion and £0.02 billion in 2023-24 respectively.

Source: Office for Budget Responsibility

The environmental levies listed above exclude the Feed-in Tariff which subsidises small-scale renewables, the Climate Change Levy and the Energy Generators Levy[8], all of which are ultimately paid for by consumers. A more complete assessment of these levies indicates that in fact in 2023-24 the total cost was £17.2 billion:

Environmental levies (£ billions)



* Feed-in Tariff data are from Ofgem except for 2016/17 and 2017-18 which were from the OBR. The scheme closed in April 2019 to new projects. Contracts were typically for 20 years so payments will continue until 2039. Forecasts for 2024/25 and 2025/26 are from Drax. After that an RPI increase is applied

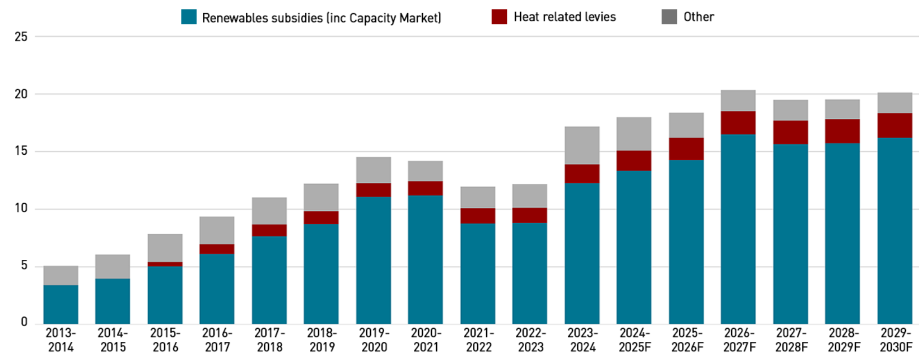
** The OBR did not provide data for the WHD between 2018-19 and 2022-23 so these are estimates

*** The Carbon Reduction Commitment (CRC) Energy Efficiency Scheme was a UK government program that ran from 2010 to 2019. The scheme was designed to reduce carbon emissions from large public and private sector organisations. The scheme was withdrawn in April 2023

Source: Office for Budget Responsibility, Ofgem, Watt-Logic

These levies can be simplified into three main categories: renewables enablers (subsidies and the Capacity Market), heat-related levies (the Renewables Heat Incentive, Green Gas Levy and Warm Homes Discount) and everything else (the CRC Energy Efficiency Scheme and the Energy Generators Levy which was a windfall tax on generators which benefitted from high electricity prices during the gas crisis but that did not incur gas-related fuel costs).

Environmental levies (£ billions)



Source: Office for Budget Responsibility, Ofgem, Watt-Logic

8 The Energy Generators Levy is a windfall tax paid by nuclear generators and is likely to be passed on to consumers, not least because of the need to invest to maintain and secure life extensions for the aging Advanced Gas Cooled reactors which form the bulk of the existing nuclear fleet.

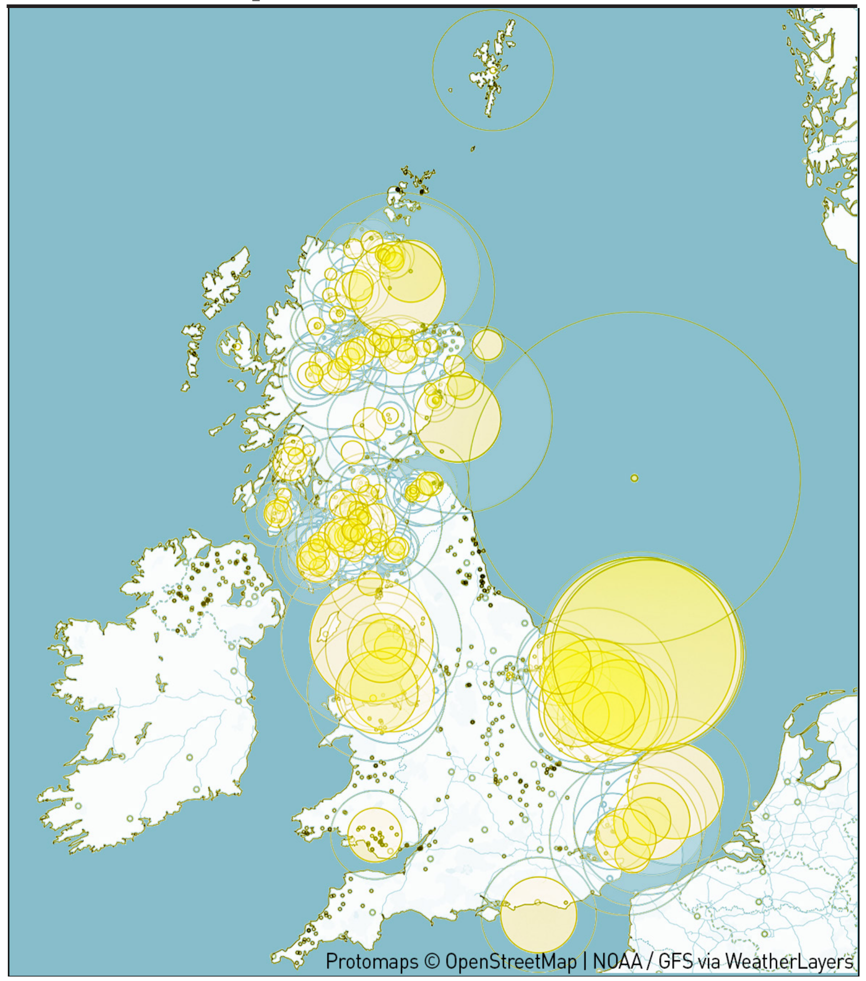
The reduction in subsidies in 2021-22 and 2022-23 was largely due to the Contracts for Difference scheme which saw a significant reduction in payments and even some payments back from generators as market prices, driven by the gas crisis, exceeded the strike prices. Despite this, overall levies still exceeded £12 billion!

According to the OBR, environmental levies are set to rise from the current £17 billion per year to over £20 billion in 2030, and its forecast may well be an under-estimate when higher CfD strike prices and new levies such as the proposed Carbon Capture & Storage levy are added.

Additional network costs resulting from location

Windfarms tend to be built in places that have not historically hosted large amounts of generation, so the wider grid infrastructure is often insufficient to transmit all of the electricity they generate to end users. This means that significant additional infrastructure is needed to connect windfarms compared with other forms of new generation.

GB renewables map

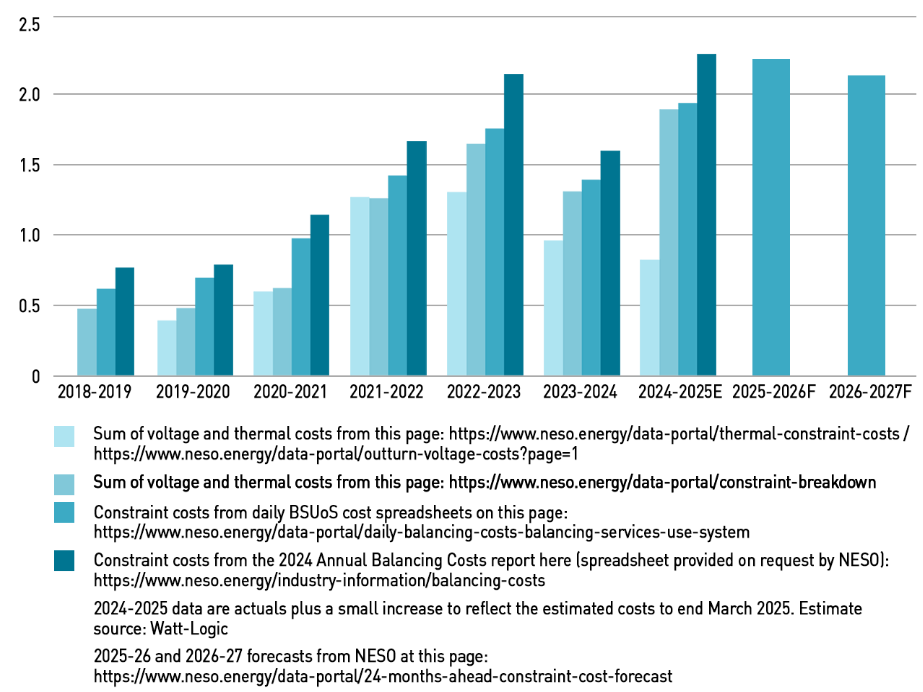


Source: Robin Hawkes

However, the construction of this grid infrastructure has failed to keep pace with need, resulting in grid congestion and constraints. Constraints mean generation on one side of a grid bottleneck has to be turned down and other generation downstream of the bottleneck turned up, in order to serve consumers. Because renewables subsidies are only paid when a generator is running, being constrained or curtailed off would mean the loss of subsidy payments, so the generator receives a compensating payment known as a "constraint or curtailment payment".

In this case, the consumer pays the downstream generator – typically a gas power station – for producing the electricity it actually uses, plus a constraint payment to the windfarm whose electricity was not used. These constraint fees amount to £ billions per year and are added directly to consumer bills.

Constraint costs (£ billions)



Source: NESO Portal voltage[9] and thermal constraint costs[10], constraint breakdown spreadsheets[11], Daily BSUoS cost data[12], 2024 Annual Balancing Report[13] and constraint forecast data[14], Watt-Logic for FY 2024-25 estimate

Unfortunately NESO data on constraints are difficult to interpret. I found four different datasets described as "constraint costs" on the NESO Portal, none of which was consistent with any other. According to NESO some of the differences may be due to settlement timing differences – final electricity settlement prices can take up to 28 months[15] after the delivery of the electricity to determine, so data can be subject to revisions. Another source of difference could be the inclusion of ancillary services such as the Obligatory Reactive Power Service in some of the data. This is included in the 2024 Balancing Costs report for example but may not be included in some of the other datasets. The constraint costs in the BSUoS spreadsheets apparently include the costs of "reducing largest loss cost" and "increasing system inertia cost" as well as thermal and voltage constraints.

In any case, all datasets indicate that £ billions are being spent on curtailing windfarms and these costs have risen significantly in recent years, and are projected to continue to rise. It appears likely that actual curtailment costs have increased from around £0.5 billion in 2018-19 to £1.9 billion in 2024-25 ie a fourfold increase in the past seven years. In its Clean Power 2030 report, NESO expects constraint costs in 2030 to be £2.8 – 3.7 billion depending on the scenario, and curtailment volumes in 2030 to be 2 TWh in the counterfactual case, rising to 18 TWh and 22 TWh in its clean power 2030 compliant cases.

Current curtailment volumes are as difficult to find on the NESO portal as constraint costs. The Constraint Breakdown Costs and Volume spreadsheet indicates that in 2024-25 (to 13 March) the total volume across all categories was 16,551,939 but no units are quoted. The Future Energy Scenarios[16] ("FES") for 2024 suggest that in 2025 annual curtailment will be

9 https://www.neso.energy/data-portal/outturn-voltage-costs?page=1
10 https://www.neso.energy/data-portal/thermal-constraint-costs
11 https://www.neso.energy/data-portal/constraint-breakdown
12 https://www.neso.energy/data-portal/daily-balancing-costs-balancing-services-use-system
13 https://www.neso.energy/industry-information/balancing-costs
14 https://www.neso.energy/data-portal/24-months-ahead-constraint-cost-forecast
15 https://bscdocs.elexon.co.uk/guidance-notes/the-electricity-trading-arrangements-a-beginners-guide
16 https://www.neso.energy/publications/future-energy-scenarios-fes/fes-documents

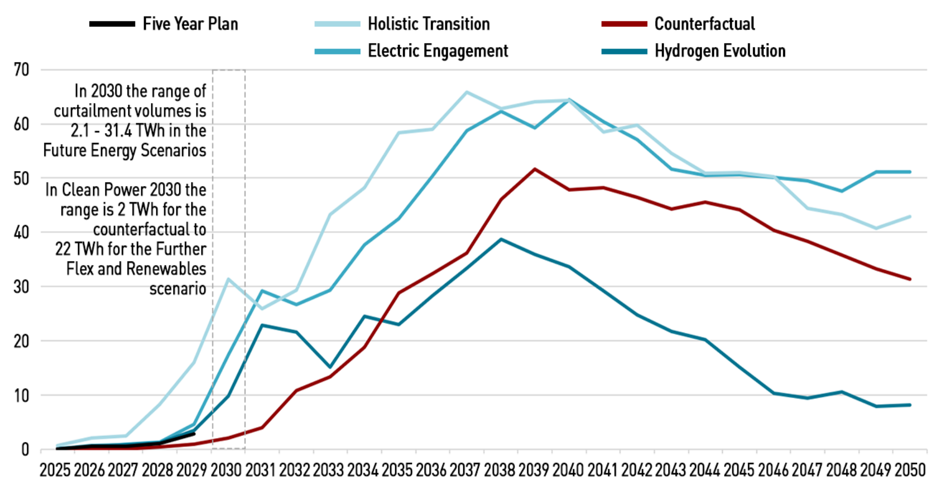

0.1 TWh, rising to 2.9 TWh in 2029 under the Five Year Plan. However the counterfactual scenario in the FES for 2029 is 0.9 TWh rising to 2.1 TWh in 2030 which is not consistent with the counterfactual in the Clean Power 2030 report.

Windfarms are being knowingly built behind grid constraints leading to £ billions in curtailment costs every year

The CP2030 compliant scenarios are different to the FES scenarios. NESO did not break out curtailment forecasts in its CP2030 report or accompanying annexes and workbooks. The chart below shows the projections set out in the FES, which suggest that unless hydrogen is deployed to use excess renewable generation, volumes of renewable generation curtailed will be 40-50 TWh in 2050, and in all scenarios they will be many times higher than they are today.

This trend is expected to grow significantly: in all future grid scenarios as the volumes curtailed will be many times higher in 2030 than they are today

Constraint volumes (TWh)



Source: NESO Future Energy Scenarios, 2024

It is deeply unsatisfactory that NESO publishes such conflicting data on constraints and curtailment. It should be clear what is included in each dataset it produces, and where it is not clear, comprehensive explanations should be provided on request. The available data are all presented in this report because there is insufficient information to determine which data are the most appropriate, and to demonstrate that, however they are presented, they all show constraints and curtailment are a growing problem that is adding £ billions to bills, and that these volumes and their associated costs will grow in the coming years[17].

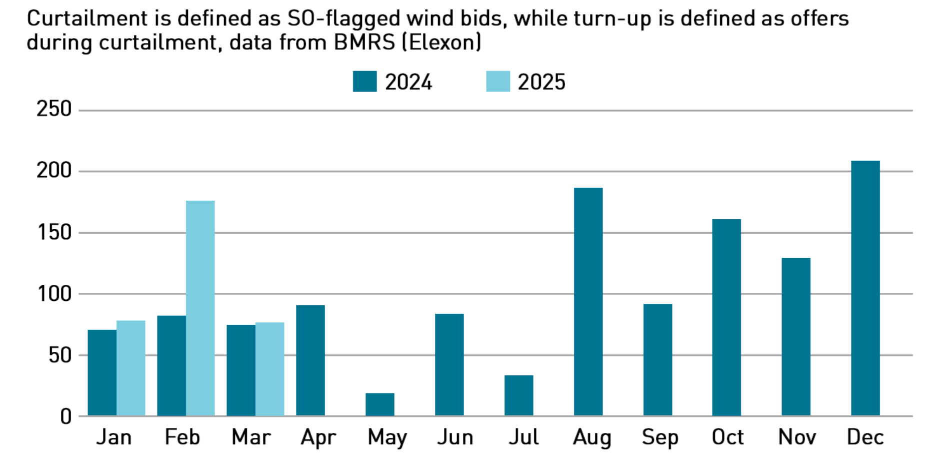
17 NESO responded to my queries relating to these different versions of the constraint data by saying that some include ancillary services and others do not, and some are adjusted for changes following later settlement runs and others are not

£1.2 billion was spent on curtailing windfarms in 2024...

Certain analysts such as Robin Hawkes[18] have also attempted to show the levels of renewables curtailment and curtailment costs. His data are taken from the Balancing Mechanism where Bid Offer Acceptances are flagged if they relate to constraints. He considers both curtailment, where generation is reduced and turn-up where it is increased after being curtailed. His analysis suggests that in 2024 these actions cost £1.23 billion and that so far in 2025 NESO has spent £329 million, with each month of 2025 being more expensive than its equivalent in 2024 so far.

...so far in 2025 costs are higher than in the same period last year

Curtailment and turn-up costs (£ millions)



Source: Robin Hawkes

Connecting new windfarms has been prioritised above building enough power lines to transmit their electricity to consumers...

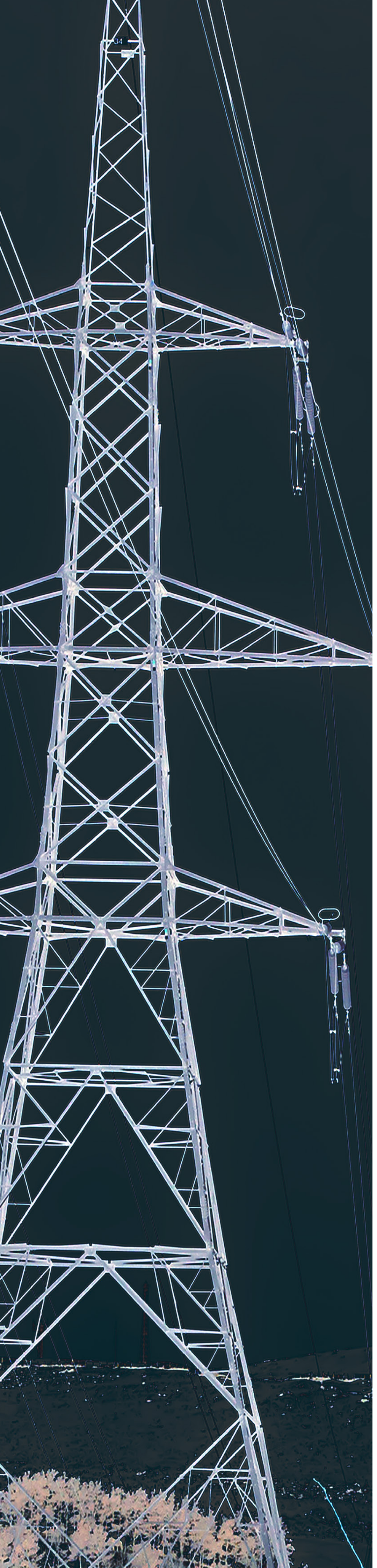
...it has also been prioritised above replacing aging legacy grid infrastructure....

Another consequence of the network costs associated with connecting renewables is that, in a world where electricity is increasingly unaffordable, the construction of new grid has been prioritised over upgrading existing grid infrastructure. Grid length has almost doubled over the past 30 years, growing at a rate of about 1 million km per year, primarily driven by expansion of distribution networks which account for about 93% of the total length. In 2021, there were almost 80 million km of overhead power lines and underground cables worldwide, which equates to about one hundred trips to the moon and back.

....the recent substation fire which caused a blackout at Heathrow airport involved transformers built in the 1960s

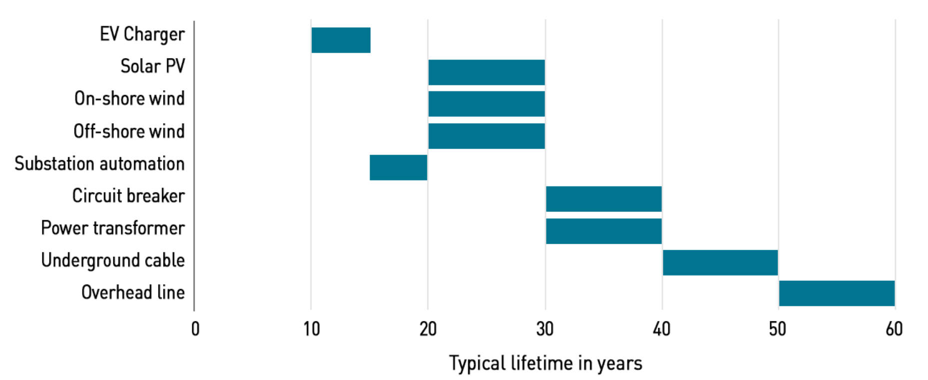
Some 15 million km of distribution lines have been constructed in the past decade, with emerging markets and developing nations accounting for almost 12.5 million km. India alone contributed more than 3.5 million km, while China added nearly 2.2 million km and Brazil added 1.7 million km. Advanced economies experienced a modest rise of around 9% over the past

18 https://renewables-map.robinhawkes.com/curtailment



ten years. The US added around 925 000 km of new distribution lines, and EU countries added around 715 000 km.

Typical design lifetimes for high voltage equipment, renewables and electric car charging



Source: International Energy Agency[19]

Grids, particularly in the developed world, are aging, posing safety and reliability risks as well as a requirement for additional investment. Only around 23% of grid infrastructure in advanced economies is under 10 years old, and more than half is over 20 years old. Countries such as Japan, the US and those in Europe, have a high proportion of their grids dating back over 20 years.

Transformers, circuit breakers and other switchgear in substations typically have a design life of 30 to 40 years. Underground and subsea cables are generally designed for 40 years, although newer versions may be expected to last for 50 years, while overhead transmission lines can go for up to 60 years before requiring a major overhaul. However, expensive items such as transformers are often kept in use past their expected lifetime, due to their high cost of replacement.

The recent transformer fire[20] which caused a blackout for 60,000 homes and businesses including Heathrow Airport indicates the problems with aging grid infrastructure – the economic cost of the airport closure is considered likely to be in the region of £60 – 70 million. The transformers appeared from footage of the fire to be old, 1960s units and the substation had no blast walls separating them, meaning that not only was the transformer which caught fire destroyed, but the adjacent one was also damaged.

The substation had been operating in recent years at 106% of capacity, with problems of grid overloading in the area well known to the authorities. It seems likely that as a consequence of this incident there will be a greater focus on maintenance and replacement of aging legacy grid infrastructure, and, unless the construction of new grid for renewables is slowed, this will put further pressure on bills.

Additional network costs resulting from low energy density

Renewables have low energy density – less energy is produced per unit area of land than with conventional generation – so renewables require many more wires and associated grid infrastructure to connect them to the grid. A gas power station requires a single connection but a windfarm requires that every single individual turbine is connected. A decent sized gas turbine might be 800 MW in size – an 800 MW windfarm would require over 60 turbines to be connected.

And since windfarms have a capacity factor of only about a third, three times as many turbines would be needed to produce the equivalent annual generation as the gas plant, ie 180 turbines, or two orders of magnitude more grid wires than for conventional generation. The costs of all of these

19 https://iea.blob.core.windows.net/assets/70f2de45-6d84-4e07-bfd0-93833e205c81/ElectricityGridsand-SecureEnergyTransitions.pdf

20 https://watt-logic.com/2025/03/24/heathrow-airport-blackout/

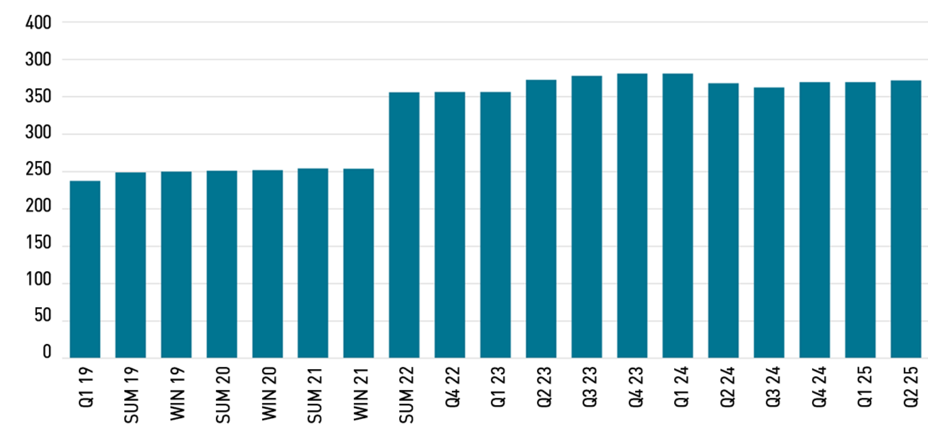
additional wires are also added directly to bills.

Network operators have been encouraged to connect renewables even if the grid cannot cope with them under 'Connect & Manage', increasing grid congestion...

An indication of the extent to which network costs have increased can be found in the regulated tariff for households (the price cap). A dual-fuel household with typical consumption (based on current consumption levels), paying by direct debit, would have spent £238 (annualised) on network costs in Q1 2019 when the price cap began, but will pay £372 (annualised) in Q2 2025, an increase of 57%.

...the low energy density of wind in particular means that two orders of magnitude more wires are needed to connect it than for gas generation...

Network cost component in the default tariff (price cap)
(£ /year for a typical dual fuel customer paying by direct debit, adjusted for volume and levelisation*)



...at the same time, cost concerns have restricted funds available for upgrading aging legacy infrastructure

* the typical consumption volumes have changed several times since the inception of the price cap, so this calculation assumes the volumes are consistent and in line with the current level

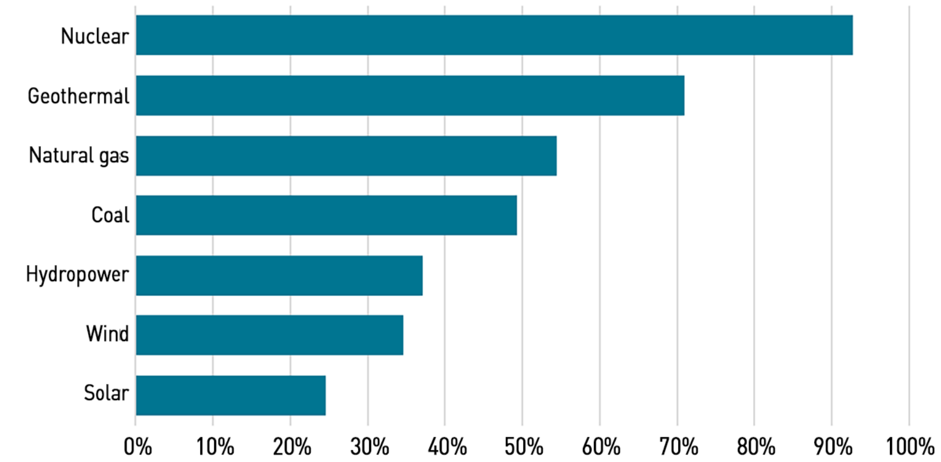
Source: Ofgem

Costs of intermittency: backup generation and alternative sources of supply

Weather-based sources of generation have low capacity factors – that is they generate relatively low amounts of electricity relative to their nameplate capacity compared with conventional generation. Data from the US Energy Information Administration[21] illustrate this point:

The biggest problem with weather-based renewables is the weather!

Capacity factors for electricity generation in the US



Weather is hard to predict. Solar power varies hugely from summer to winter when there is zero contribution during peak demand periods

Wind can vary from effectively zero to about half of the nameplate capacity...

...but high winds create 'shut-off' risk: once wind speeds exceed around 55 mph, turbines will abruptly turn off to prevent damage...

Source: US Energy Information Administration

The capacity factors for wind power in the UK are similar[22] but those for solar are worse[23] – of the order of 10% compared with 25% in the US. A 2020

...leaving a major challenge for grid operators to manage

21 https://www.energy.gov/ne/articles/what-generation-capacity

22 https://watt-logic.com/2024/12/09/renewables-and-interconnectors/

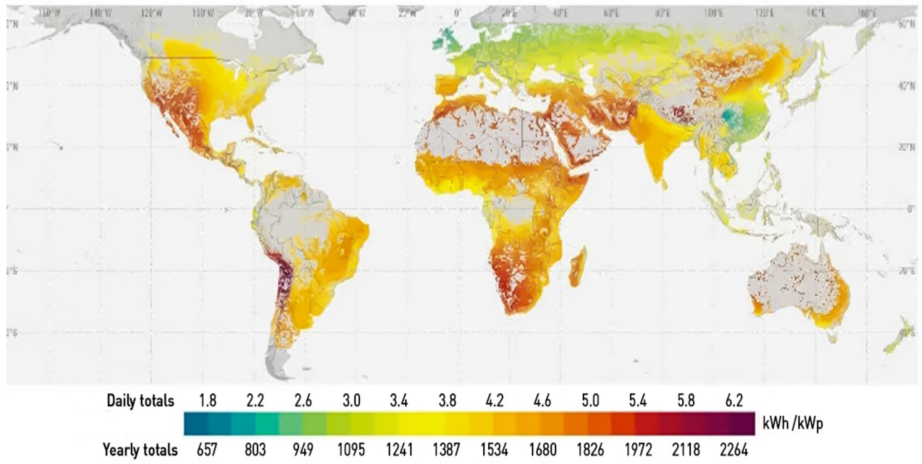
23 https://assets.publishing.service.gov.uk/media/63a2dcc5e90e07586e7642bd/

report by the World Bank[24] rated the UK as the second worst country in the world for solar generation, behind Ireland. This makes the pursuit of solar power in the UK less cost effective, particularly when prime agricultural land is lost to solar schemes.

The UK is the second worst place in the world to build solar power, after Ireland...

...yet the Government is pressing ahead with new projects including on prime agricultural land

Solar photovoltaic power potential by country



Source: World Bank Group

Because it's not always windy or sunny we need to invest in alternative forms of generation or storage, effectively paying twice for the same capacity...

...this adds significant cost to bills

Because sometimes it is not windy or sunny, alternative forms of generation, batteries or demand side response must be held in reserve to contribute at times of low renewables output. These sources of additional supply or demand reduction are paid for through the Capacity Market, with the associated costs being added directly to consumer bills. Because the main participants in the Capacity Market are gas-fired power stations, some commentators claim they are a "fossil fuel subsidy".

This is an incorrect characterisation – the Capacity Market was designed to ensure that these gas power stations did not close if their lower running hours as a result of the deployment of renewables made them uneconomic to maintain. Preventing this plant from closing is essential as it is required on days when it is not windy or sunny.

Therefore the Capacity Market is the mechanism through which the backup for renewables is secured, and therefore it is a cost of renewables, and not a subsidy for fossil fuels. Prior to the introduction of intermittent renewables, there was no requirement for a Capacity Market, and so these costs did not exist in the conventional British electricity system.

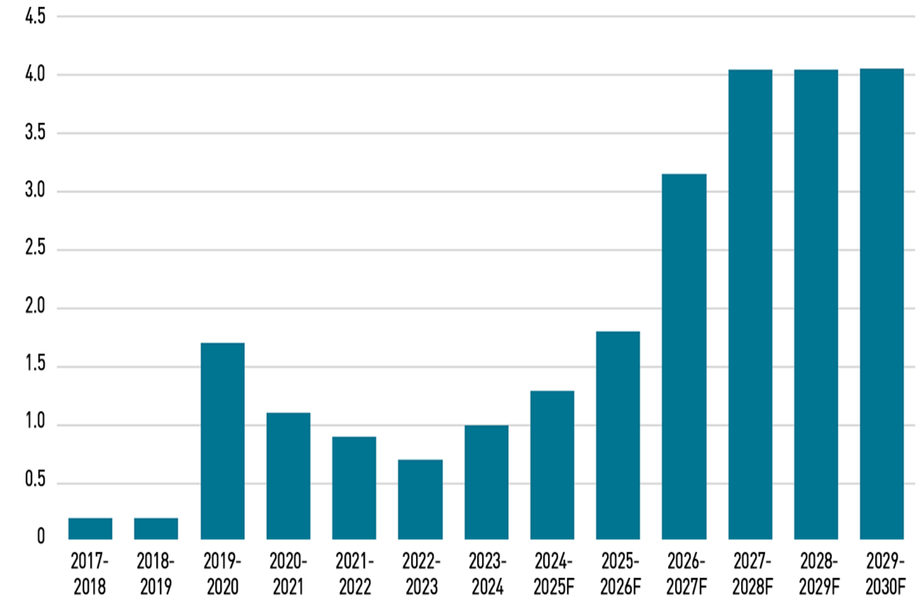
The Capacity Market was introduced to ensure that conventional generators, particularly gas plant, were able to earn enough money despite lower running hours as renewable generation increased...

Capacity Market costs in Britain were introduced as part of the Electricity Market Reform[25] implemented to promote decarbonisation, and are wholly attributable to the deployment of intermittent renewables. OBR data indicate that in 2023-24 the Capacity Market added £1 billion to bills and that this is projected to increase to over £4 billion by the end of the decade.

...this is a cost of backing up renewables and is not, as some claim, a fossil fuel subsidy. Without it the lights would go out...

...the cost of this backup is set to increase rapidly in the coming years. The OBR's forecasts are likely to be an under-estimate as much of the existing gas fleet is near end of life - bigger payments would be needed to attract new plant to replace any that closes

Capacity market costs (£ billions)



Source: Office for Budget Responsibility

Feed-in_Tariff_load_factor_analysis_2021-22.pdf

24 https://documents.worldbank.org/en/publication/documents-reports/documentdetail/466331592817725242/global-photovoltaic-power-potential-by-country

25 https://assets.publishing.service.gov.uk/media/5a74990ee5274a44083b7f62/7090-electricity-market-reform-policy-overview-.pdf

Electrical equipment is very sensitive to a measure called 'grid frequency' which is the frequency with which alternating current alternates...

...to keep grid frequency in stable bounds, supply and demand must to be finely balanced in real time, moment to moment, all day, every day...

...this is difficult to do in the presence of wind and solar generation when each gust of wind or cloud can effect the supply of electricity to the grid...

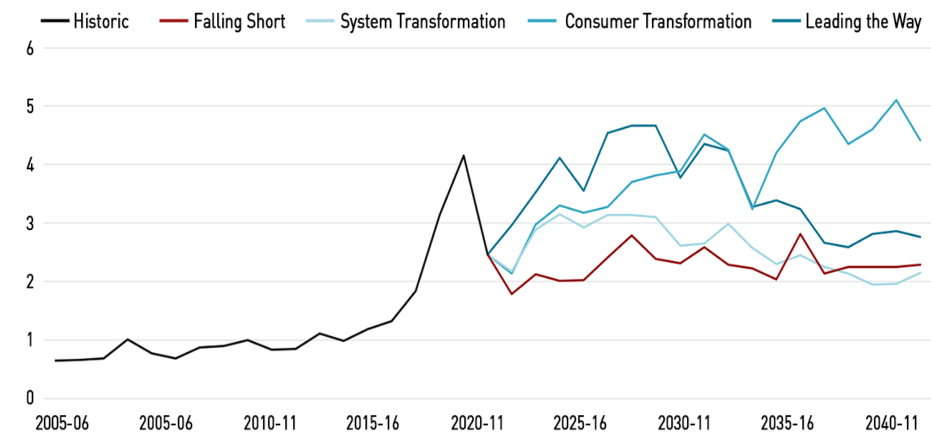
...as renewable generation increases, the cost of maintaining this balance increases

Costs of intermittency: real time balancing

Finally, because wind and sun are highly variable in real time, the cost of balancing the grid, that is maintaining a balance at all times between generation and demand, has become harder and more expensive.

These balancing costs have risen from £642 million in 2005-06 to £2,459 million in 2023-24 (after falling from a high of £4,150 million in 2022-23 as a result of high gas and electricity prices in the aftermath of the invasion of Ukraine). This is an increase of more than 380% - additional costs which are added directly to consumer bills.

Balancing costs (£ billions)



Source: NESO[26,27], Ofgem (2014-15 - 2017-18)[28], National Audit Office (2005-06 - 2013-14)[29]

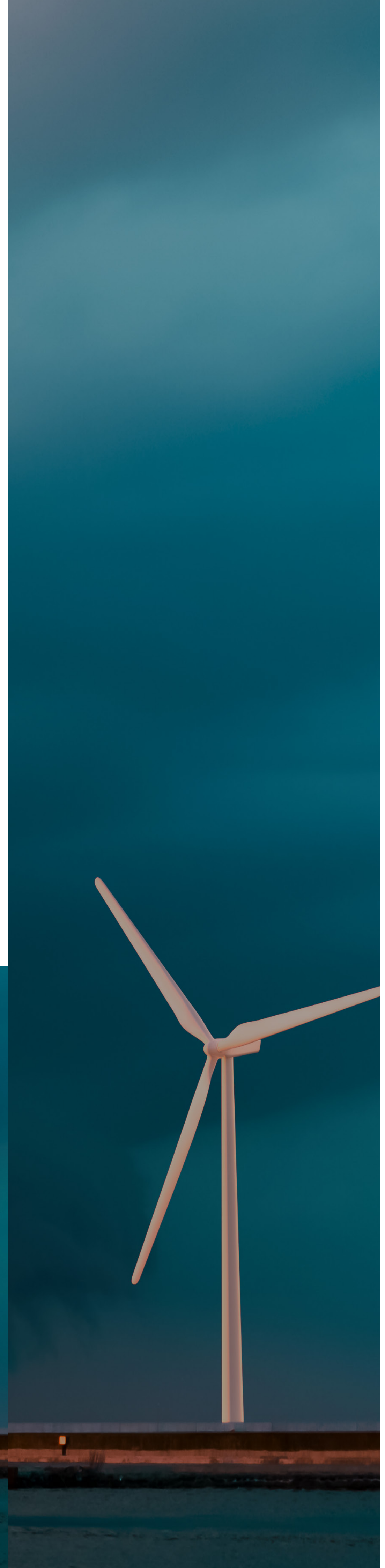
All of these costs which are added to bills are absent from the wholesale price of electricity, but appear in end user bills. They mean that although wholesale prices may fall in a renewables-based grid, the reduction is offset by higher network and policy costs. End user bills rise in electricity grids with higher amounts of intermittent renewables.

26 Historic data from 2018-2019 to 2023-24 were provided by NESO on request

27 Balancing cost projections: https://www.neso.energy/industry-information/balancing-costs

28 https://www.ofgem.gov.uk/publications/state-energy-market-2018

29 https://www.nao.org.uk/wp-content/uploads/2014/05/Electricity-Balancing-Services.pdf



Will the costs of renewables fall?

In its 7th Carbon Budget[30], the Climate Change Committee ("CCC") sets out its expectations that the costs of offshore wind will fall dramatically over the coming decades. It also expects load factors to significantly exceed what has been achieved to date.

7th Carbon Budget Balanced Pathway projections

		Technology cost			
Sector	Technology	2025	2040	2050	% reduction 2025 to 2050
Electricity supply (£ /kW)	Onshore wind	1,410	1,260	1,200	15%
	Offshore wind	1,840	1,300	1,120	39%
	Solar PV	560	310	280	50%
	Nuclear	12,920	10,330	10,330	20%
	Gas CCS	1,790	1,560	1,560	13%
Surface transport (£)	Medium electric car	23,160	18,580	18,050	22%
	Electric van	29,490	24,700	23,930	19%
	Electric small rigid HGV	119.560	81,270	78,610	34%
Residential buildings (£)	Air source heat pump	10.900	8,860	7,520	31%
	Ground source heat pump	11,200	8,790	7,340	34%
	Heat network	12,120	9,110	7,430	39%

Notes: Electricity supply technology costs are presented here in terms of £ per unit of capacity, not £ per unit of energy generation, so will differ from technology costs presented in the electricity supply sector.

Heat pump costs consist of a fixed cost component for labour and materials (including the heat pump itself), and a variable cost component which increases these costs depending on system size. The CCC uses an average system size of 12 kW.

These do not include ancillary costs such as hot water tank or radiator upgrades. The heat network cost includes the cost of connecting a 12 kW household to a heat network and the household heat interface unit.

Source: Climate Change Committee

These projections look wildly optimistic. For example, heat pumps are a mature technology – there is little basis for expecting their costs to fall[31].

The CCC assumes offshore wind costs of £51 /MWh in 2025, falling to £31 / MWh in 2050 and solar PV costs of £46 /MWh in 2025, falling to £27 /MWh in 2050. These figures for 2030 onwards are lower even than the Government's 2023 Electricity Generation Cost Report[32] which was itself considered to be highly optimistic as it assumed the costs of renewables would continue to fall despite rising supply chain costs and inflation.

This is a problem because these assumptions underpin the legally binding emissions reductions targets to which the UK is committed. It is compliance with these targets which is currently the subject of legal challenge in respect of the Rosebank and Jackdaw oil and gas fields with a Scottish court ruling their consents were unlawful due to a failure to properly account for their emissions.

30 https://www.theccc.org.uk/publication/the-seventh-carbon-budget/

31 https://watt-logic.com/2024/10/04/heat-pumps-report/

32 https://www.gov.uk/government/publications/electricity-generation-costs-2023

The CCC could have looked at CfD auction trends since the 2023 Electricity Generation Cost Report which show a reversal in the previous trend of falling strike prices:

7th Carbon Budget Balanced Pathway projections

		2025	2030	2035	2040	2050
Emissions	Emissions in year ($MtCO_{2e}$)[1]	32.5	9.8	5.6	4.6	1.0
	Change in emissions since 1990	-84%	-95%	-97%	-98%	-100%
	Change in emissions since 2023	-14%	-74%	-85%	-88%	-97%
	Share of total UK emissions	8%	3%	3%	4%	
Key drivers – quantity variables	Gross annual electricity demand (TWh)	279	333	444	562	692
	Offshore wind capacity (GW)	17	46	70	88	125
	Onshore wind capacity (GW)	16	26	29	32	37
	Solar PV capacity (GW)	20	38	70	82	106
	Low carbon dispatchable capacity (GW)[2]	0	3	8	15	38
	Battery storage capacity (GW /GWh)	7 /10	17 /28	21 /54	26 /82	35 /139
	Medium-duration storage capacity (excl hydrogen storage) (GW /GWh)[3]	3 /24	4 /174	6 /312	7 /419	7 /433
	Unabated gas share of generation[4]	29 ±3	7 ±2	3 ±1	2 ±1	0
Key drivers – price variables	Offshore wind levelised cost (£/MWh)	51	38	38	35	31
	Solar PV levelised cost (£ /MWh)	46	34	30	29	27
	Low carbon dispatchable levelised cost (£ /MWh)[5]		163-218	147-188	161-191	165-194

Notes: The CCC blanked out the share of total UK emissions in 2050 because total UK emissions have reached Net Zero at this point. All costs are in 2023 prices.

1. Emissions and the share of generation from unabated gas are based on an average weather year. Emissions associated with energy from waste are accounted for in the waste sector. Emissions associated with combined heat and power are accounted for in the industry and fuel supply sectors.
2. Low-carbon dispatchable capacity refers to generation from hydrogen and gas with carbon capture and storage.
3. Storable fuels provide a significant proportion of medium- and long-term storage needs. Hydrogen storage capacities are presented in Section 7.7 of the 7th Carbon Budget.
4. The unabated gas share of generation reflects the impact of uncertainty due to weather variation.
5. The price variable for low-carbon dispatchable capacity is highly dependent on fuel costs, carbon costs, and load factors - values in this table present the range of costs across gas with carbon capture and storage and hydrogen generation technologies, reflecting uncertainty in their relative long-run costs, and assume a constant load factor of 20% for illustrative purposes.

Source: Climate Change Committee

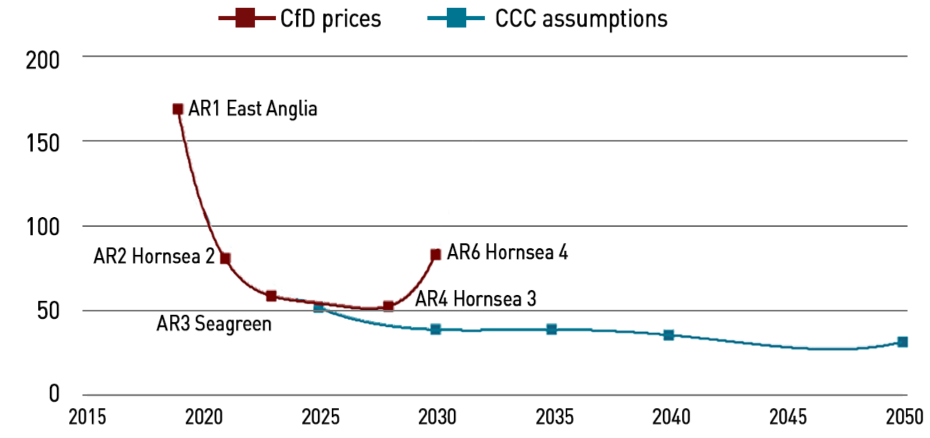
Historic auction prices also give a mis-leading account of true costs due to the effects of the "Permitted Reduction Mechanism". Under these rules, projects are allowed to withdraw up to 25% of their original capacity and rebid that capacity in a future CfD round.

In AR6, several projects that had won contracts in AR4 took advantage of this mechanism, withdrawing a portion of their capacity and re-bidding it, including Ørsted's Hornsea 3 project, which had won a CfD in AR4 at £37.35 /MWh (2012 money) and rebid a portion of its capacity in AR6 securing a higher strike price of £54.23 /MWh.

Other projects that rebid and secured contracts in AR6 include East Anglia 3, Inch Cape A & B, and Moray West, in fact all of the offshore wind projects with contracts under AR4 rebid in AR6[33] apart from the defaulting Norfolk Boreas.

33 https://www.4coffshore.com/news/%C3%B8rsted-ignites-rebidding-frenzy-in-allocation-round-6-nid29526.html

Offshore wind costs, 7th Carbon Budget vs CfD prices (£ /MWh, 2025 money)



Source: DESNZ, CCC, Bank of England Inflation Calculator

Comparing with the actual costs of windfarms

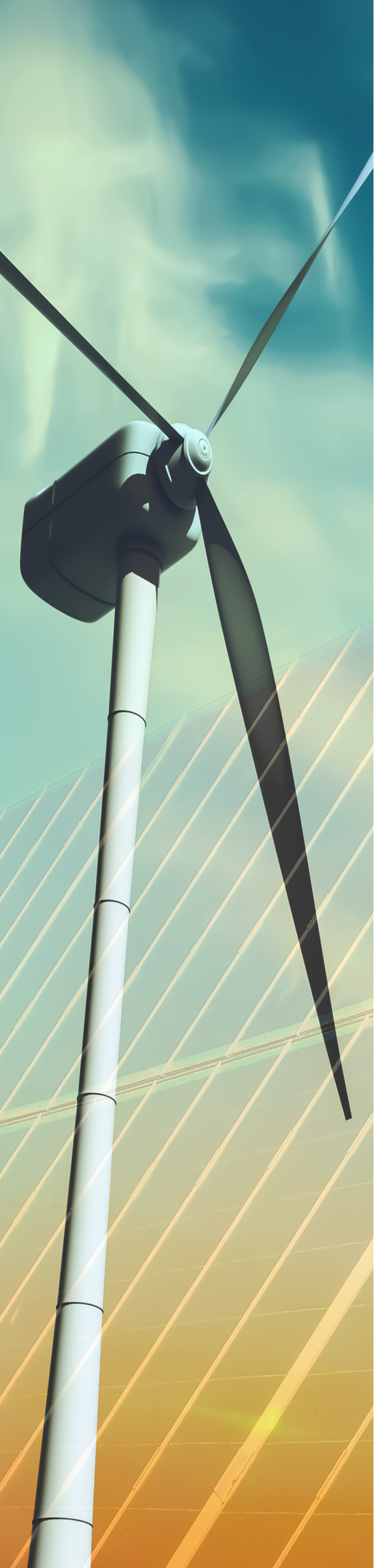
It is pretty clear that the CCC's assumptions rely on a reversal of recent cost increases, something the current consultation on CfD terms makes even more unlikely. The CCC also assumes there will be huge capacity increases for renewable generation. This risks increasing price cannibalisation as wholesale prices spend more time at or below zero. The CCC does not address this risk in its report, and while many projections assume the use of "surplus" renewable generation will be used to produce hydrogen, presumably preventing extended periods of negative wholesale pricing, the CCC says it sees hydrogen as having only a small role in 2040. In any case, arguments that the use of hydrogen will be cost effective for consumers are weak: electrolysers will be expensive to build and there are transportation and storage challenges associated with hydrogen – if the electrolyser is located close to the windfarms there will be difficulties in transporting the hydrogen to consumers, but if they are located close to demand there may be difficulties in transporting the electricity to supply them given grid constraints.

To illustrate further the low likelihood of the CCC's renewables cost projections being realised it is interesting to consider evidence from actual projects. Back in 2020, Professor Gordon Hughes of the University of Edinburgh and Senior Fellow at the National Centre for Energy Analytics, a Washington DC-based think-tank published a paper[34] in which he analysed the capital expenditure ("capex") and operating expenditure ("opex") of windfarms larger than 10 MW built in the UK since 2002.

Most wind projects are individually incorporated as special purpose vehicles ("SPVs") whose accounts are lodged with Companies House and available for public inspection. SPVs rarely employ staff, so it is straightforward to determine actual operating costs. I replicated part of his work and can confirm his conclusions, which were that:

- The actual costs of onshore and offshore wind generation had not fallen significantly over the previous two decades and he saw little prospect that they would fall significantly in the next five or even ten years;
- While some of the component costs had declined, overall costs had not. The weighted return for investors and lenders had fallen sharply, especially for offshore wind, due to a reduction in perceived risk. In addition, the average output per MW of new capacity may have increased, particularly for offshore turbines, however, those gains were offset by higher operating and maintenance costs;
- The capital costs per MW of capacity to build new wind farms in-

34 https://www.ref.org.uk/ref-blog/365-wind-power-economics-rhetoric-and-reality



creased substantially from 2002 to about 2015 and then, at best, remained constant until 2020; and

- The classic period for early cost reductions was over by 2010. While offshore wind was in itself an immature technology, it was based on two significantly more mature technologies: onshore wind and oil and gas infrastructure, limiting the potential for learning curve benefits.

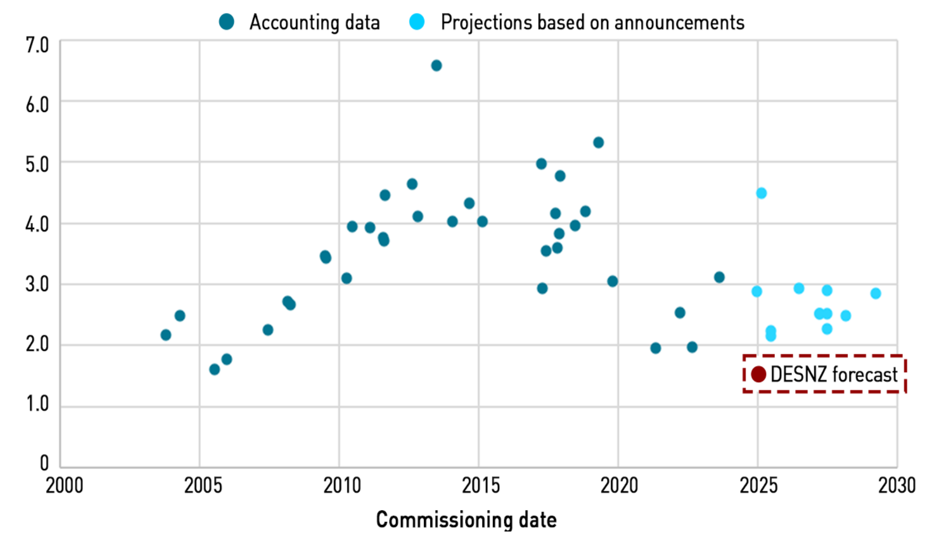
Hughes compared actual capital costs with costs reported in public announcements before or during construction – both adjusted for inflation (to 2018 prices). He found that on average, actual costs were 18% higher than reported costs and in a third of cases the cost overrun was at least 30%.

Reported capital costs were clearly affected by an "optimism bias", but even so, there was a large increase in the reported capital cost per MW of capacity for offshore wind farms over the 20-year period, with the main change being between projects completed up to 2009 and those completed in 2015-2018. Part of the increase can be attributed to a move to deeper waters, but reported costs have increased even when adjustments are made for sea depth and other factors.

Andrew Montford, Director of Net Zero Watch, has updated Hughes' analysis, adding in more recent projects as well as projections of the costs of new projects based on cost announcements made by the developers. He found that capex costs of UK offshore windfarms increased steadily through to 2013. From 2013 – 2020 average costs in 2025 terms remained roughly flat, with some projects coming in with higher costs and some with lower costs.

The early 2020s have seen costs flattening at the lower end of the previous trend, with future projects projected to continue at this level, significantly above the DESNZ projections and with no further reductions. DESNZ expects windfarms commissioning this year to cost £1.5 million /MW, but evidence from real projects suggests costs are more likely to be £2.16 - £2.89 million /MW, ie 26-44% higher than the DESNZ forecast.

Capex of UK offshore windfarms (£ /MW, 2025 money)



Source: Andrew Montford

In terms of operating costs, Hughes' analysis showed strong empirical evidence of a powerful rising trend in opex per MW to 2020, with two factors driving the trend:

- As wind farms age, the average cost of operating and maintaining turbines tends to increase because equipment failures and breakdowns become more frequent. The average increase in operating costs with age is 2.8% per year in real terms for onshore wind and at least 5.0% per year for offshore wind (or 5.9% where operating costs included separate transmission charges); and

Windfarm capex costs rose over 2000 to 2013, driven by a trend to build in deeper water and with larger turbines...

...prices began to fall until the 2020s when they stabilised...

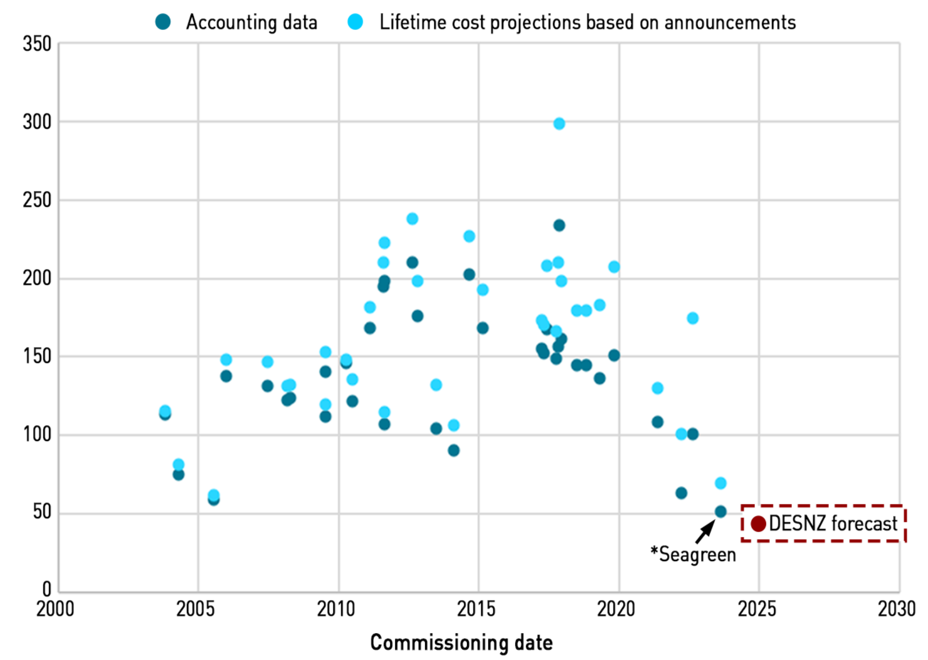
...there is no evidence of capex costs reducing beyond this point, yet DESNZ and the CCC assume they will continue to fall

There is a stronger trend of falling opex costs in the 2020s, but evidence of them falling further, as expected by DESNZ and the CCC, is not evident in either accounting data or the public annoucements by operators

Most turbines are decommissioned before they reach the end of their physical lives

- The average cost of operating and maintaining new wind farms in their first or second full year of operation also increased rapidly over time: on average 4.4% per year for onshore wind, and 5.5% per year for offshore wind, together with substantial additional costs for working at depths of either 10–30 metres or greater than 30 metres. After allowing for the combination of the underlying increase in costs plus greater depth and changes in the regime for offshore transmission, the initial operating cost per MW of capacity for a typical offshore project quadrupled between 2008 and 2018.

Opex of UK offshore windfarms (£'000 /MW/year, 2025 money)



* Seagreen opened in October 2023 so the opex in its accounts to 31 March 2024 have been annualised

Source: Andrew Montford[35]

Subsequent analysis by Andrew Montford indicates that newer windfarms are seeing a reduction in operating costs with Moray East (commissioned in 2022) and Seagreen (commissioned in 2023) both at the lower end of the cost scale, but both are above the DESNZ forecast for windfarms commissioning in 2025.

While most wind turbines have a physical life of 25-30 years almost all are decommissioned before they reach 25 years and many before 20 years, meaning their initial capital costs must be recovered over a shorter period and therefore the capital charge is correspondingly higher.

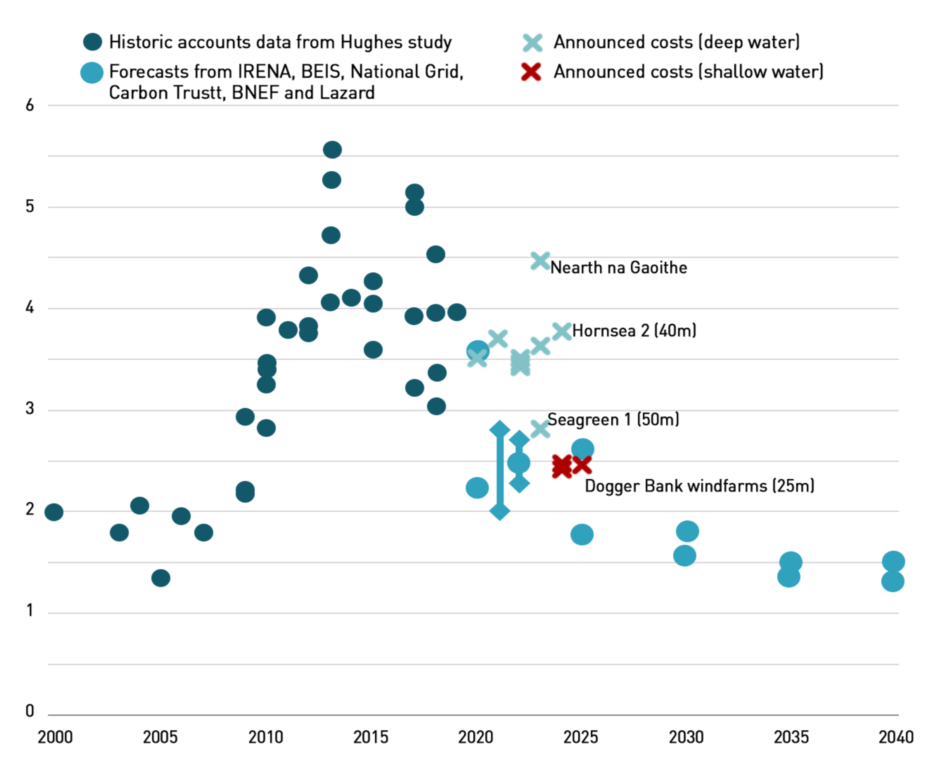
Despite the evidence from the audited accounts of actual wind farms, policy-makers persist in their belief that the costs of wind generation are (and have been) falling. While there is some evidence that opex costs are beginning to fall, reductions in capex, where present are significantly lower than many forecasts suggest. In his 2021 report for the GWPF[36], Andrew Montford compared the historic capex data from Hughes' analysis with forecasts by a number of such analysts. He then compared them with announced costs for new projects as shown below:

35 I considered whether to adjust Montford's opex analysis to account for the possible impact of curtailment. Seagreen was curtailed twice as much as it ran during 2024, which could have a material impact on opex. After speaking with industry experts I concluded that no adjustments should be made. Seagreen and the other more recent projects use turbines with direct drive rather than a gearbox. When these turbines are curtailed, they generate electricity as usual, discharging it to ground if it cannot be used on the grid. Therefore there is no change to the operating mode or operating costs. Older turbines with gear boxes would physically stop generating meaning curtailment would reduce their operating costs, possibly by 5-15%. However, since the purpose of this analysis is to consider whether the DESNZ and CCC forecasts are realistic, any adjustment for curtailment would be largely irrelevant in that it would only affect older machines which are not a major driver of the DESNZ / CCC projections.

36 https://www.thegwpf.org/publications/cheap-offshore-wind-power-claims-are-false-data-reveals/

The data show the main driver of capital costs over 2000 - 2010 was building in deeper waters

Windfarm capital costs



Source: Global Warming Policy Foundation

The data indicate that depth appears to be the main driver of capital costs. It became more expensive to build offshore windfarms between 2000 and 2010, although not all of this increase can be attributed to the move to deeper waters.

Since then, costs remained in the range £3–5 million/MW, with little evidence of a sustained fall (Seagreen, which opened in October 2023 had a capital cost of £3.04 /MW). In terms of predictions, BNEF, Lazard and Carbon Trust all predicted that capital costs for a windfarm completing financing in 2019 (and therefore starting operations in 2021 or 2022) would be around £2.3–2.7 million/MW. BEIS predicted that costs would fall to little more than £1 million/MW within ten years, with National Grid being similarly optimistic. Despite this, the costs announced by developers (bearing in mind Hughes' findings that announcements tend to understate actual costs) showed an expectation among developers that capital costs in deep waters would remain largely unchanged, at least until 2024–25.

Subsidy prices and windfarm cost trends

For many years, ministers told us that subsidies would fall away to zero, and indeed, up to and including the 4th Allocation Round for the CfD, ("AR4"), they did reduce year-on-year. This narrative was spectacularly dismantled in the 5th Allocation Round ("AR5") when there were no bids at all of offshore wind projects[37] and strike prices rose (and rose again in AR6):

Subsidy prices fell in each auction up to and including AR4...

...but AR5 was largely a failure and AR6 prices were significantly higher as supply chain inflation and more cost reflective pricing took effect

Contracts for Difference strike prices (2025 money)

	AR4	AR5	AR6
Solar PV	64.85	66.27	70.60
Onshore wind	59.88	73.73	71.77
Offshore wind	52.66		83.01

Source: Department for Energy Security and Net Zero[38,39,40], Bank of England Inflation Calculator

In AR4, 28 projects secured contracts amounting to 7.1 GW of capacity. Of these eight have been terminated (1.7 GW) including Norfolk Boreas which defaulted on its contracts, four are yet to meet their Milestone Delivery Date (0.3 GW) including the 200 MW Stornoway Wind Farm.

The Milestone Delivery Date ("MDD") is the deadline by which generators awarded a CfD must demonstrate delivery progress, by providing evidence either of (i) spend of 10% of total pre-commissioning costs, or (ii) project commitments. The Government extended the MDD for all technologies from 12 months to 18 months in AR4[41]. The remaining 16 projects (5.1 GW) have progressed to the "pre-start" phase, which means certain milestones still need to be met before commissioning can begin. This includes the 2.1 GW Hornsea 3 project which took its Final Investment Decision in December 2023.

37 https://watt-logic.com/2023/09/26/cfd-ar5-auction-failure

38 https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-4-results/contracts-for-difference-cfd-allocation-round-4-results-accessible-webpage

39 https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-6-results/contracts-for-difference-cfd-allocation-round-6-results-accessible-webpage

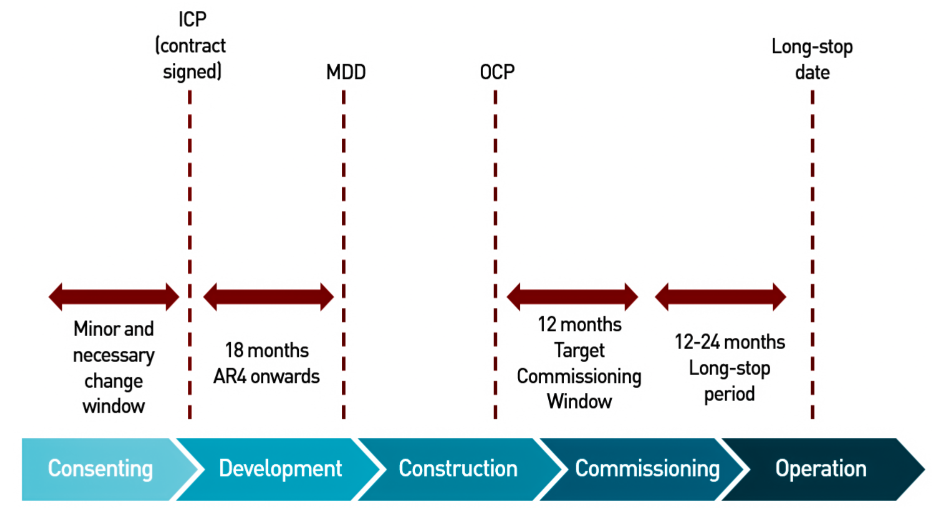
40 https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-5-results/contracts-for-difference-cfd-allocation-round-5-results-accessible-webpage

41 https://assets.publishing.service.gov.uk/media/65f1b014ff11701fff615a2f/amendments-to-cfd-contract-ar6-government-response.pdf

Following the lows of AR4, the 5th auction round did not attract any bids for offshore wind and was regarded as a failure. Similar autions elsewhere in the developed world also failed. There was just one bid in a Gulf of Mexico auction, and contracts awarded in New York were cancelled after developers asked for more money. Germany, Denmark and the Netherlands have also seen offshore wind auctions fail to attract the expected interest.

Subsidy prices were at their lowest in the 4th Allocation Round, but these prices were not cost-reflective and not repeatable. The Norfolk Boreas project (about a fifth of the offshore wind contracts awarded) was cancelled, with the remaining developers reportedly seeking tax breaks and other enhanced economics before committing to their projects. Ultimately they all rebid the maximum 25% of their capacity into AR6 which cleared at a much higher price (and above current wholesale electricity prices).

Contracts for Difference milestones



The Initial Conditions Precedent (ICPs) are the first milestone and must be delivered within 10 Business Days of contract signature

The Milestone Delivery Date (MDD) aims to ensure generators evidence significant project commitments and to give confidence that generating capacity will be delivered. It allows the LCCC to terminate the CfD Contracts of projects that have not sufficiently progressed. It is typically 18 months from contract signature

The Operational Conditions Precedent (OCP) ensure certain criteria are met before a generator can issue a Start Date Notice to inform the LCCC of commencement of operations (to start receiving payments under the CfD). The OCP include evidence of metering, grid connection, commissioned generating capacity and settlement arrangements

The OCP must be met before the Long-Stop date, which is 12-24 months after the end of a project's Target Commissioning Window

Source: Low Carbon Contracts Company[42]

In AR5, 25 projects secured contracts amounting to 3.6 GW of capacity. 2.7 GW of these are in the pre-MDD phase and the remainder in the pre-start phase. The following year saw 9.6 GW of capacity being procured as prices increased significantly from previous rounds. All but five projects are currently in the pre-MDD phase.

AR5 attracted no bids at all from offshore wind projects. At the same time there were failed wind tenders in Germany, the Netherlands and the US[43]. More recently there was a major tender failure in Denmark, where its largest ever wind tender failed to attract a single bid[44].

> "There is a common misconception that bid prices in the UK Government Contracts for Difference (CfD) auction are indicative of offshore wind costs, but this is wrong. Rather, winning bids reflect the minimum price offshore wind developers are willing to receive for a 15-year contract period to gain access to the grid, on the expectation of higher revenues in the future. However, recent weakening of UK Government climate policy ambition has lowered future expectations for carbon prices and, therefore, future power prices,"
>
> - Paul Butterworth, CRU International

Hughes postulated that three factors may explain the CfD price reductions to AR4:

- the dominance of large, often state-controlled companies in the offshore wind sector that can deploy large cash flows from existing businesses, and which are under little pressure to return cash to either customers or shareholders;
- the operators may expect to be able to sell a large portion of their shares in the projects to over-optimistic investors while projects also rely heavily on debt provided by equally naïve lenders; and
- operators / financial investors may expect to be bailed out, since once the financial consequences of the underlying economics become undeniable there will be pressure to pass the full costs of these projects to either electricity consumers or taxpayers.

However it is equally likely that operators and investors were simply happy to buy into the falling costs narrative as long as deals could be done and CfD contracts secured, particularly since the day of reckoning when subsidies expire was some 20 years away (the construction period plus the 15-year contract duration) at which point the individuals concerned would almost certainly have moved on leaving it to be someone else's problem. Of course, after AR4 there were also attempts made by developers to secure enhanced economics through tax breaks, as well as re-bidding into AR6.

Worryingly there are signs that the next subsidy round, AR7 will be significantly more expensive than its predecessors. Last year, analysis[45] by global commodities consultancy CRU International suggested that increased cost pressures and lower future power price expectations mean CfD prices would need to be £65–70 /MWh (real 2012, or £92-99 /MWh in 2025 money) for project viability. And that "further out, bid prices will need to be higher still to account for higher Crown Estate leasing costs".

CRU's analysis suggests that the business cases for UK offshore wind projects is predicated on receiving higher revenues in the future, after the 15-year CfD period expires, when power prices are expected to be higher, as a result of high carbon prices. This is not dis-similar to Hughes' belief that developers may expect further government support at this time should power prices not be high enough to support them on a merchant basis.

An expectation of higher prices is interesting since one of the main "benefits" of renewables according to policymakers is that they will reduce costs to consumers, so the idea that they are only viable if costs are higher rather undermines these claims. CRU argued that three factors undermine the windfarm business case.

Firstly, many argued that the failure of AR5 was due to the rising cost of raw materials, but CRU demonstrated that these costs peaked at the time of AR4 and therefore by AR5 were declining. However, general supply chain inflation, over and above material costs, has increased build costs (some estimates suggest by as much as 40%), as have higher financing costs, and these increases do imply higher required revenues will be needed to maintain returns. Secondly, Crown Estate, which leases seabed rights, has changed its leasing mechanism adding up to ~£40 /MWh to the cost of offshore wind.

Thirdly, and most importantly in CRU's view with respect to AR5, expectations for higher carbon prices in the UK diminished following government actions to increase availability of emission allowances which saw the UK carbon price fall by 60% relative to the EU price, or ~£50 /tCO_2. At the time of CRU's report there was an expectation of lower carbon prices. In fact, UK carbon prices rose sharply in late January 2025 after the Prime Minister announced an intention to re-connect the UK carbon market with the higher-priced European market.

The UK market has consistently traded below its European equivalent as de-industrialisation has resulted in a surplus of allowances. Artificially increasing carbon pricing is clearly price negative for consumers. Currently,

42 https://lcc-web-production-eu-west-2-files20230703161747904200000001.s3.amazonaws.com/documents/Contracts_for_Difference_-_Generator_Guide_Feb_2019.pdf

43 https://watt-logic.com/2023/10/10/off-shore-wind-targets-at-risk/

44 https://windeurope.org/newsroom/press-releases/no-offshore-bids-in-denmark-disappointing-but-sadly-not-surprising/

45 https://www.crugroup.com/en/communities/thought-leadership/2024/navigating-the-future-ensuring-stability-for-uk-offshore-wind-through-high-carbon-prices#

Experts have suggested that developers bid aggressively into AR4 in the expectation of higher income after the subsidy period ends...

UK carbon allowances are trading at £46 /t vs £59 /t for EU carbon allowances, and compared with £35 /t in January before the announcement. Harmonisation would increase end user bills by around £120 million per year based on current UK and EU carbon prices and exchange rates.

CRU concluded that AR6 would need to have a price of at least £65 /MWh in 2012 terms in order to attract offshore wind bids. In the end, the auction cleared at £53 /MWh, but the headwinds for AR7 are arguably stronger. While the carbon price expectations may have "improved" from the perspective of windfarm developers since AR7, several other factors are driving in the opposite direction. The Government has increased business and employment taxes significantly and together with the new Worker Rights Bills these are expected to have an adverse impact[46], raising costs as developers seek to protect returns. Financing costs are also likely to increase further as a result of the effects of the 2024 Autumn Budget.

...this could be either from further subsidies, or from higher electricity prices...

> "To put bid prices into context, the £37 / MWh winning bid prices in AR4 are real 2012 prices, equating to ~£50 /MWh (real 2023). This compares with the underlying LCOE [levelised cost] of offshore wind at the time of AR4 of ~£82 /MWh (real 2023), including a transmission charge to shore. Assuming a 30-year project lifetime, power prices would need to lift to ~£160 /MWh (real 2023) from year 16, for a project to be viable,"
>
> - Paul Butterworth, CRU International

...higher electricity prices would be bad news for consumers sold a promise that renewables would result in lower energy costs...

...the Government is now consulting on longer contracts: 20 rather than 15 years...

The expectation of higher prices is reflected in a consultation[47] launched by the UK Government into changes it wants to make to the CfD auction process in AR7. The timing of this consultation is odd – it ran until 21 March and the auction will not open until Summer 2025. However, for AR6, the Administrative Strike Prices were published in the November preceding the auction, and the Budget Notice was published in early March 2024 with the auction process beginning later that same month. This new consultation pushes back the entire process, from publication of the Administrative Strike Prices through to the auction itself.

...This suggests an expectation of higher prices and a need to spread payments over a longer period to preserve the optics of value

The subject matter of the consultation covers various proposed reforms to the operation of the CfDs. Arguably the most significant proposal is a change in contract term from 15 to 20 years – which would materially cover the lifespan of a windfarm (typically 20-25 years). This would mean projects would receive subsidies for a longer period, and is likely being proposed as a means of reducing the headline strike price figures by spreading payments over a longer period. This very much suggests that the Government has received feedback from the industry that much higher payments will be needed to meet the targets set out in the Clean Power 2030 Plan.

46 https://www.ft.com/content/a6d57180-7a20-4c3d-b80e-808518423968

47 https://www.gov.uk/government/consultations/further-reforms-to-the-contracts-for-difference-scheme-for-allocation-round-7

The rush to build more renewables may be counter-productive: on days where wind and solar output are high, wholesale electricity prices can become negative...

Unfortunately when wind capacity increases, the risk of price cannibalisation increases in that the frequency with which the market reference price becomes negative will increase the more wind is installed. Projects without a CfD contract, would have to accept a very low or negative price for a large portion of their output (ie pay people to take the electricity away).

Projects with a CfD receive no subsidy payments if market prices fall below zero for more than an hour. Developers will become increasingly nervous about losing income in periods of high wind as the installed base increases. Of course in periods of no wind they also lose income since the CfD is only payable when a windfarm is actually generating. Similar arguments apply to solar – on a windy summer's day high levels of renewable generation will increase the frequency with which wholesale market prices become negative. But on cold winter's days, solar output is minimal even if it is sunny, due to the low angle of the sun and short daylight hours.

...windfarms do not receive any subsidy payments if prices are negative for more than one hour. As the number of windfarms increases, there will be more occasions when prices become negative, reducing windfarm income...

The Government is also proposing changes to the way the budget for the CfD is set: instead of being determined before the auction begins, the Budget Notice would not be published until after sealed bids had been received. The Government says this would allow auction budgets for fixed offshore wind "to be set to maximise capacity" and could "enable the Government to procure more fixed-bottom offshore wind, subject to value for money considerations, to deliver clean power by 2030." This sounds as if the Government intends to prioritise volume over cost, which would likely result in higher costs being passed on to consumers.

...developers are likely to seek higher strike prices to compensate for this risk...

Another significant proposal is to allow fixed offshore wind projects to bid for CfD contracts before receiving planning permission. Expanding eligibility in this way suggests that the Government is concerned about the availability of potential projects to meet its Clean Power 2030 ambitions.

...beyond a certain point, renewables cannibalise each other's income ultimately making them all uneconomic

Finally, AR7 is also intended to include the Clean Industry Bonus ("CIB"). Formerly known as Sustainable Industry Rewards ("SIRs") that were first introduced as Non-Price Factors ("NPFs"), these measures were introduced "to support good jobs and low-carbon manufacturing factories" - in other words, to deliver on the promised "green jobs" that policymakers claim will accompany the energy transition. Although why factories should need additional support to produce the components needed for all the "cheap" renewable energy that will result is a question few are asking. The details of the scheme are complex, but according to energy analyst David Turver[48], developers will receive up to £27 million spread over four years for each gigawatt of capacity if they meet certain standards and invest enough in manufacturing facilities in certain areas of the country. CIB payments will be managed through CfD payments and will be an extra payment to developers on top of the CfD subsidy.

In any case, the trend for falling prices was not sustainable, and it seems highly likely that AR7 and subsequent CfD auctions for the rest of this decade will also see higher prices than AR4 given supply chain inflation and the large volumes of capacity the Government intends to procure.

48 https://davidturver.substack.com/p/ar7-changes-show-net-zero-is-not-working

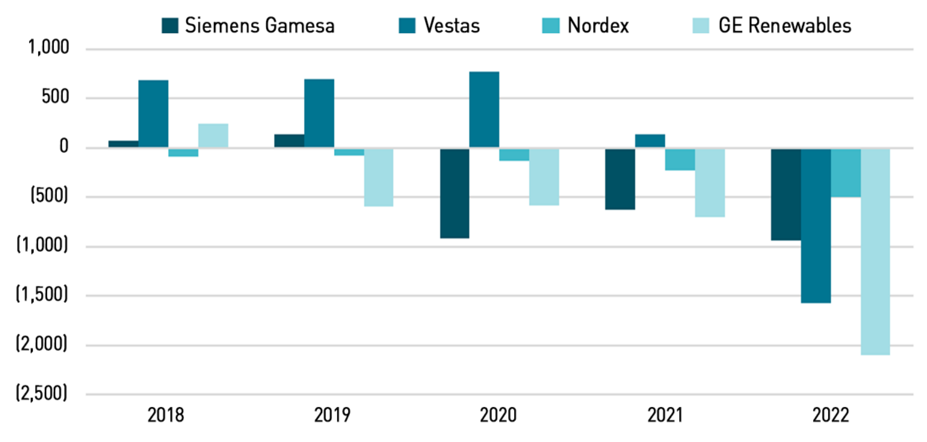
At the same time that falling subsidy levels were celebrated, turbine manufacturers were suffering major financial losses...

...these losses pre-dated both covid and the invasion of Ukraine

Supply chain losses undermine the link to CfD prices and actual windfarm costs

A final point to note is that during the period that CfD strike prices were falling, turbine manufacturers began to lose large amounts of money. While this has sometimes been attributed to covid and the gas crisis, the losses actually began to appear in 2018, before the start of either.

Net profits of major wind turbine manufacturers (€ millions)



Source: Company data, Watt-Logic

Back in 2022, market participants observed[49] that the trend of turbine manufacturers selling at a loss would (self-evidently) threaten renewable generation targets, and indeed this was borne out in the various failed tenders subsequently.

> "The state of the supply chain is ultimately unhealthy right now. It is unhealthy because we have an inflationary market that is beyond what anybody anticipated even last year. Steel is going up three times...

49 https://www.rechargenews.com/wind/were-all-in-trouble-wind-turbine-makers-selling-at-a-loss-and-in-a-self-destructive-loop-bosses-admit/2-1-1197217?zephr_sso_ott=QzoaTV

OEM losses inevitably impact windfarm developers - manufacturing capacity is cut and prices raised

> "It is really ridiculous to think how we can sustain a supply chain in a growing industry with these kind of pressures...Right now, different suppliers within the industry are reducing their footprint, they are reducing jobs in Europe. If the government thinks that on a dime, this supply chain is going to be able to turn around and meet two to three times the demand, it is not reasonable,"
>
> – Sheri Hickok, Chief Executive for onshore wind, GE Renewable Energy

Some of the OEM losses were down to warranty issues as turbines did not perform as expected requiring the manufacturers to compensate windfarm developers and rectify problems.

In June 2023, Siemens warned[50] that components in wind turbines made by its subsidiary Siemens Gamesa were wearing out faster than expected. The problem apparently involved critical parts such as bearings and blades, and affected both newly installed and older turbines in up to 15% – 30% of the installed onshore fleet. The 4.X and 5.X onshore platforms were particularly affected.

Management believed the cost of remediation could exceed €1.6 billion[51], effectively wiping out more than a third of the profit the company expected to make performing maintenance on wind turbines it already installed, with the bulk of these costs being incurred in 2024 and 2025. Siemens also found problems in its offshore turbines, which were failing to meet productivity targets due to rising material costs and manufacturing delays. Privately this was attributed to the pressure for ever larger turbines which are harder to get right.

50 https://www.wsj.com/articles/clean-energys-latest-problem-is-creaky-wind-turbines-9c865aa0

51 https://www.rigzone.com/news/siemens_posts_3b_net_loss_on_wind_turbine_quality_issues-08-aug-2023-173585-article/

Turbine size has grown steadily over the years but recently this trend has created reliability problems...

"We are quite used to wind turbines with capacities of 8 MW or 9 MW, but now we're seeing newer models reaching 14 MW to 18 MW. A project in Australia is even planning to use 20 MW turbines.

"Inevitably, with the increase in size comes a corresponding increase in risk. Although turbines are engineered to work within certain conditions, there is a lack of real-world data on both performance and the long-term impacts on these larger turbines and their associated infrastructure, especially cables and their maintenance requirements,"

– Dr Wei Zhang, senior risk consultant, natural resources construction at Allianz Commercial

...some OEMs are resisting requests from developers for further increases due to resolving the cost of warranty issues...

Wind turbines and their blades have rapidly been increasing. The largest turbines are in China (16 MW) but outside China, the largest as of June 2023 were the 15 MW Vestas units at the He Dreiht and Baltic Power projects in Germany and Poland respectively. These units were prototypes but have since been ordered for other projects suggesting they will become the largest European turbines in operation in the next few years. The largest turbines currently in operation are the 13 MW GE turbines at Dogger Bank in the UK.

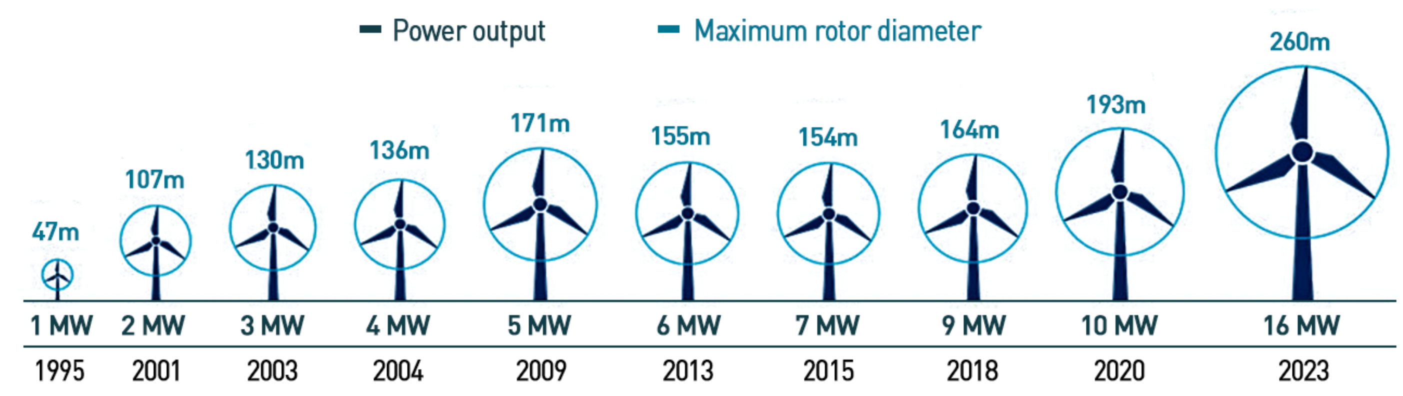
...they are also tightening up the terms of furture warranties

"Physics inherently punishes larger turbines. Larger blades will inherently deflect more, which means they need stiffer spar caps, shear webs and more expensive materials. They will also weigh more which pushes more stress and strain through the blade, root and nacelle during each rotation,"

– Rob West, analyst at consultancy Thunder Said Energy

Behavioural software has been used to enable larger turbines to be used without a corresponding increase in expensive steel and concrete by allowing them to engage automatic protection measures under different weather conditions.

Wind turbine growth



Source: Allianz, DNV GL, Clarksons, Offshorewind.biz

But the bigger turbines become, the more susceptible they are to faults[52]. Larger sizes combined with pressure for speedy delivery, created the conditions for breakages. Insiders now suggest that the growth in capacity per turbine has now peaked, at least for the time being, in European projects.

Turbine manufacturers are for the most part repairing their finances and returning to profitability (although problems remain at Siemens), but they have achieved this in part by pushing the financial challenges down the supply chain to project developers, who have started to see losses of their own.

Most notably, wind project developer Ørsted posted a loss of about £2.2 billion in 2023 and wrote off £3.3 billion from its windfarm business[53]. Vestas has imposed significant price increases[54], selling turbines at an average price of €1.21 million /MW in the second quarter of 2024 – up both from €1.04 million /MW in the same period in 2023, and from €970,000 /MW in the first quarter of 2024. Against this backdrop it is unsurprising that developers are seeking higher levels of subsidies.

52 https://www.reuters.com/sustainability/climate-energy/wind-power-industry-drifts-off-course-2023-09-28/

53 https://www.telegraph.co.uk/business/2024/02/07/wind-farm-orsted-cuts-jobs-scales-back-offshore-projects/

54 https://www.windpowermonthly.com/article/1885212/vestas-higher-wind-turbine-prices-prompt-significant-earnings-growth-%E2%80%93-sydbank-analyst

Wider costs of the energy transition

Over the past few years, several sources have estimated the costs of achieving Net Zero for the UK, Europe, OECD countries and the world. Global consultancy McKinsey estimated the global cost of reaching net zero by 2050 would be US$ 275 trillion, or 7.5% of GDP[55]. It noted that the required spending would be front-loaded, rising from about 6.8% of GDP in 2022, to about 9% of GDP between 2026 and 2030 before falling.

> In dollar terms, the increase in annual spending was estimated at US$ 3.5 trillion per year, or 60% more than was being spent in 2021.The increase would be approximately equivalent, in 2020, to half of global corporate profits, one-quarter of total tax revenue, 15% of gross fixed capital formation, and 7% of household spending. In other words, huge.
>
> \- McKinsey Sustainability

Gordon Hughes believes the investment required for the UK to reach net zero will be equivalent to a minimum of 5% of GDP for the next 25 years, but there is a high probability of this being close to 10% of GDP once the cost of inflation and overruns are taken into account[56].

Focusing on the UK, the Clean Power 2030 Plan aims to reach something close to net zero in the power sector by 2030 (gas generation would only contribute to 5% of average annual electricity demand). Allowing for supply constraints it typically takes four to five years to design, finance and build a major wind farm or solar plant.

Hughes estimates that the 100 GW of new solar and wind capacity that would need to be built in the next five years would cost almost £400 billion, plus an additional £150 billion to upgrade transmission and distribution networks. Network upgrades would be even more challenging given the lead times[57] for some transformers are now four years, meaning planning consent would need to be secured within a year to even get some of this equipment on site for installation by 2030, never mind having it connected up.

But there are significant other claims on that funding. Labour has promised to build 1.5 million new homes over 5 years[58], which is likely to mean at least 350,000 to 400,000 new houses per year in the later years, an increase of over 200,000 on the current rate of building

With 10-14% higher building costs to meet net zero standards[59], annual investment in housing would need to increase by around 3% of GDP to meet this target (based on a £250,000 average cost of a new net-zero compliant home[60]).

The UK has cut public investment in and maintenance of social infrastructure such as health and social care, education, courts, police, prisons to the point where services are collapsing. The UK's productivity growth has been poor, and has turned negative in recent years[61], exacerbated by under-investment in economic infrastructure such as transport, and business assets.

55 https://www.mckinsey.com/capabilities/sustainability/our-insights/the-economic-transformation-what-would-change-in-the-net-zero-transition

56 https://cloudwisdom.substack.com/p/can-the-uk-afford-net-zero

57 https://www.woodmac.com/news/opinion/supply-shortages-and-an-inflexible-market-give-rise-to-high-power-transformer-lead-times/

58 https://www.insidehousing.co.uk/news/labour-on-course-to-miss-housing-target-by-up-to-475000-homes-without-more-grant-88880

59 https://www.savills.com/research_articles/255800/348619-0

60 https://www.insidehousing.co.uk/news/average-cost-of-building-a-home-to-hit-250000-with-new-building-safety-and-green-requirements-88723

61 https://commonslibrary.parliament.uk/research-briefings/sn02791/

Experts say that net zero is likely unaffordable but policymakers persist in a triumph of hope over expectation

> "The UK cannot reasonably afford the costs of Net Zero over the next 5 or 25 years. Sadly, policymakers are likely to continue digging themselves into an ever deeper hold for some time before that realisation sinks in. All too often, policy changes are only possible after some exceedingly painful collision between blind hope or ignorance and reality,"
>
> - Gordon Hughes: Can the UK afford Net Zero?

The costs of net zero policies are acting as a brake on economic growth, harming investment and productivity

The Office for Budget Responsibility ("OBR")[62] estimates that raising public sector productivity by 5% to pre-pandemic levels would be the equivalent of around £20 billion extra in funding or 0.75% of GDP. The OBR also estimates[63] that a sustained 1% of GDP increase in public investment could increase economic output by just under 0.5% after five years and around 2.5% in the long run (50 years).

Together these figures imply that the UK's gross investment should increase from 13%[64] to 20% of GDP just to get back to the position 20 years ago, with very limited provision for meeting the costs of Net Zero. Hughes points out that a large part of recent economic growth has been due to population growth. Over the past 15 years, average growth in real GDP per person has been 0.7% per year. In the 15 years before that, the average was 2.2% per year.

HIgh energy costs in particular are driving de-industrialistion

To raise the share of tangible investment in GDP to 20% through growth over five years it would be necessary to raise GDP growth per head to 2% per year, and to keep private and government consumption per head constant in real terms for five years. Assuming the share of GDP allocated to government consumption (and thus public employment) were to remain constant, private consumption as a share of GDP would have to fall by 15% to provide the resources required to increase investment in housing, infrastructure and business assets.

62 https://obr.uk/docs/dlm_uploads/E03004355_November-Economic-and-Fiscal-Outlook_Web-Accessible.pdf

63 https://obr.uk/public-investment-and-potential-output/

64 https://www.ons.gov.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountsthebluebook/2023/supplementarytables

The impact of these high costs can be seen in UK industrial and domestic energy demand data. Despite long-term population growth, industrial demand has fallen consistently since 1970, and domestic demand grew until around 2005 but has since declined.

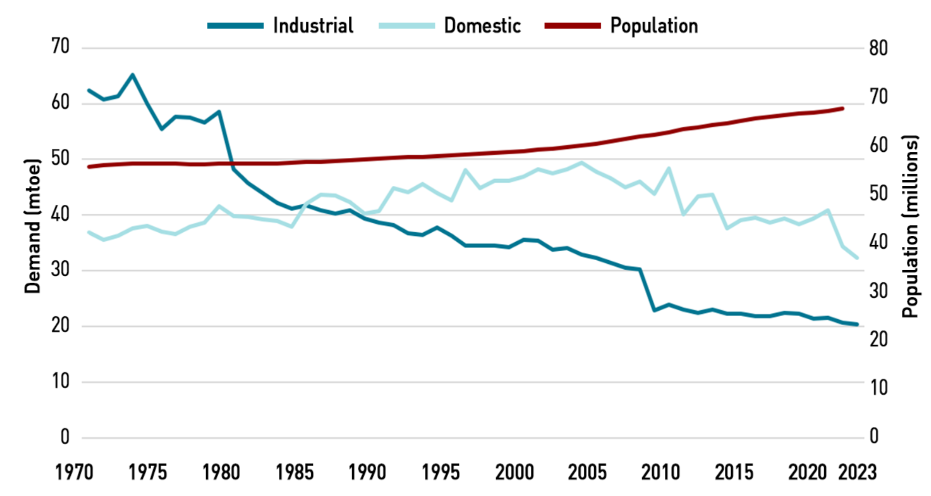
Interestingly, demand grew faster than population during the 1980s and 1990 despite schemes to improve insulation to reduce heat losses in homes, but the more recent falls are more likely driven by concerns over the cost of living. The reasons for the reduction between 2014 and 2016 are not well understood[65].

UK industrial output is falling in both absolute terms and on a per capita basis...

The move to LED lighting is likely to have made some impact, as well as the improved efficiency of white goods and other household appliances. However, electricity demand for home electronics and computers was up 17% and 45% respectively between 2004 and 2012. More significant from an overall domestic energy consumption standpoint is likely to be the increasing switch to more efficient condensing boilers during this period.

...energy intensive industries are particularly affected with high energy costs making them uncompetitive versus international peers...

Industrial and household energy demand compared with population trends



...Factories are closing with production moving to countries such as China and India where energy is cheaper but dirtier...

Source: UK Government data[66], Office for National Statistics[67]

...as a result, global emissions increase

Industrial output in the UK has declined significantly in the past decade,

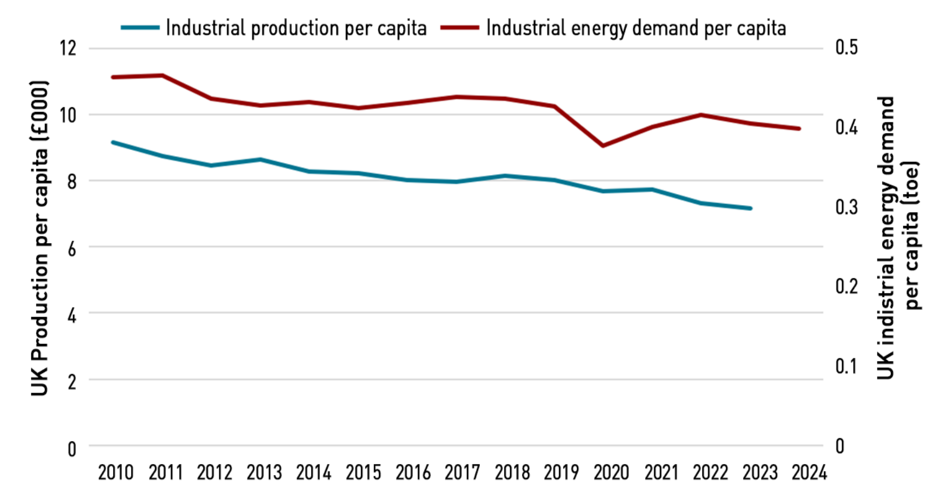
65 https://www.carbonbrief.org/a-detailed-look-at-why-uk-homes-are-using-less-energy/

66 https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2024

67 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforuk englandandwalesscotlandandnorthernireland

falling 14% on a per capita basis. There has been a corresponding decline in industrial energy demand reflecting the impact of de-industrialisation.

De-industrialisation: declining UK industrial production and energy demand



Source: Office for National Statistics UK Index of Production time series[68], Office for National Statistics population data[69] and estimates[70], DESNZ Energy Consumption in the UK (ECUK): Final Energy Consumption Tables[71]

This trend is likely to have continued and even accelerated with further factory closures announced in 2025, including British Steel's Scunthorpe Plant (2,700 jobs at risk), Cereal Partners UK & Ireland (CPUK&I) Bromborough Factory (314 jobs at risk), INEOS Synthetic Ethanol Plant at Grangemouth (c400 jobs), Hotpoint Manufacturing Site, Yate (142 jobs lost), Vauxhall's Luton van-making plant (c1,100 jobs at risk), the MMC labelling factory in Wales (180 jobs), the Ledbury cheese factory (100 jobs), Switch UK's electric bus factory in Yorkshire (200 jobs), Albéa's Colchester factory which produces tubes for toothpaste, pharmaceuticals, food and cosmetics (160 jobs), and Saputo's UK dairy facility in Yorkshire (80 jobs).

This amounts to almost 5,400 jobs with a further 6,850 jobs at risk at the Nissan factory in Sunderland (6,000 jobs at risk) and Dow's silicone plant in Wales (850 jobs) whose futures are both uncertain.

The most recent Index of Production data[72] from January 2025 published by the Office for National Statistics show that monthly production output was estimated to have fallen by 0.9% in January 2025, more than reversing the rise of 0.5% in December 2024 which followed a fall in November 2024 (down 0.5%).

The fall in monthly output in January 2025 resulted from decreases in manufacturing (down 1.1%) and mining and quarrying (down 3.3%). These reductions were partially offset by increases in water supply and sewerage (up 2.6%) and electricity and gas (up 0.5%). Monthly production output in January 2025 was at its lowest level since May 2020.

A report[73] published in March 2025 by UK Steel described UK industrial electricity prices as "a barrier to growth, competitiveness, and profitability". The report points out that steel is integral to the Government's ambitions, with renewable energy infrastructure, increased housebuilding and defence projects all relying on steel. However the UK steel industry has been "crippled" by high industrial electricity prices, which threaten the industry's competitiveness, profitability, and ability to invest in future growth.

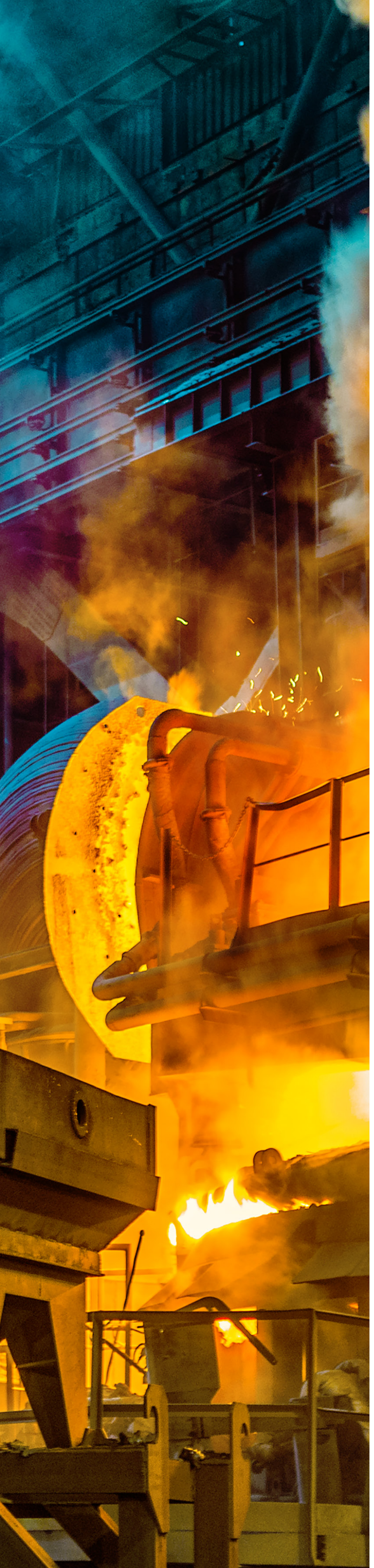
> "The British steel industry is at a severe competitive disadvantage due to long-term high electricity costs. The UK is an outlier as European competitors benefit from government wholesale price mechanisms that shield them from high power price. As part of the Steel Strategy, uncompetitive electricity prices must be addressed to ensure the steel industry can thrive, secure thousands of jobs, and safeguard national steel production as geopolitical turbulence increases.
>
> We cannot have electricity prices tying one hand behind our back any longer. To attract investment, compete internationally, decarbonise and protect jobs, the sector needs a practical, market-driven solution that ensures the UK remains a viable place for steel production. A successful Steel Strategy can deliver this, from as early as next year,"
>
> - Frank Aaskov, Director, Energy and Climate Change Policy at UK Steel

The previous Government implemented the British Industrial Supercharger to bring prices closer to those faced by competitors in France and Germany. Yet calculations in the report show that UK steel producers pay up to £22 /MWh more for electricity than their French and German competitors. UK steel producers typically pay an average electricity price of £66 /MWh in 2024/25, compared to an estimated £50 /MWh in Germany and £43 / MWh in France. This means UK steelmakers pay up to 50% more than their main competitors.

Similarly, global chemical producer Ineos warns[74] that the European chemical industry is becoming extinct as government policies "have resulted in enormously high energy prices and crippling carbon tax bills". The company said that the gas costs at its Cologne plant are €100 million higher than its US equivalent, while its electricity bill is €40 million higher than in the US.

The carbon tax bill is rising towards "a shocking" €100 million, putting the industry in a fight for survival. Ineos believes that government policies will result in the closure of all petrochemicals in Europe, saying that all its major competitors are planning to withdraw from Europe. This will mean that Europe will import all its raw materials from the USA and China.

> "Competitively priced energy is key to growth in an advanced economy. This has been proven many times in the last two centuries. But UK Government tax policy on energy is squeezing the life out of our abundant energy reserves in the North Sea...
>
> "The result of this strategy is that we import most of our energy from abroad. It is expensive. It leaves the UK strategically vulnerable as Europe discovered from its dependance on Russian supplies. It removes North Sea jobs



68 https://www.ons.gov.uk/economy/economicoutputandproductivity/output/datasets/indexofproduction

69 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2022

70 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2021basedinterim

71 https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2024

72 https://www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/indexofproduction/january2025

73 https://www.uksteel.org/electricity-prices

74 https://www.ineos.com/news/ineos-group/open-letter-from-jim-ratcliffe/

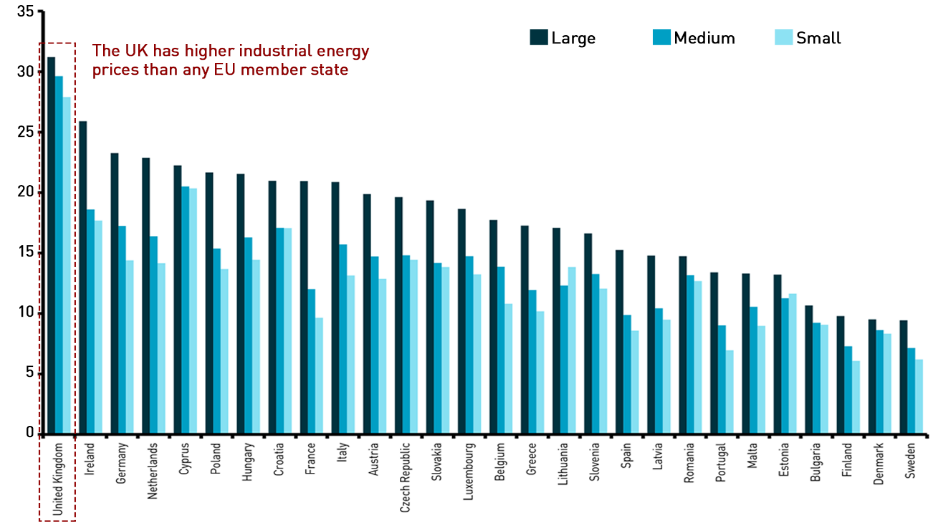
from the UK economy. And it hinders growth in manufacturing…

"Reduced UK production will result in increased imports, with less security of supply.

"The UK came perilously close to energy blackouts during this January's cold snap, when the wind stopped blowing. With one week of gas storage and strained electricity supply, the National Grid was forced to issue emergency market notices. These warnings, and the threat of energy blackouts, will only become more frequent and more serious as domestic gas production falls and critical infrastructure is prematurely decommissioned,"

- Sir Jim Ratcliffe, CEO Ineos[75]

Average industrial electricity prices in the EU27 plus UK including taxes / subsidies (p /kWh)

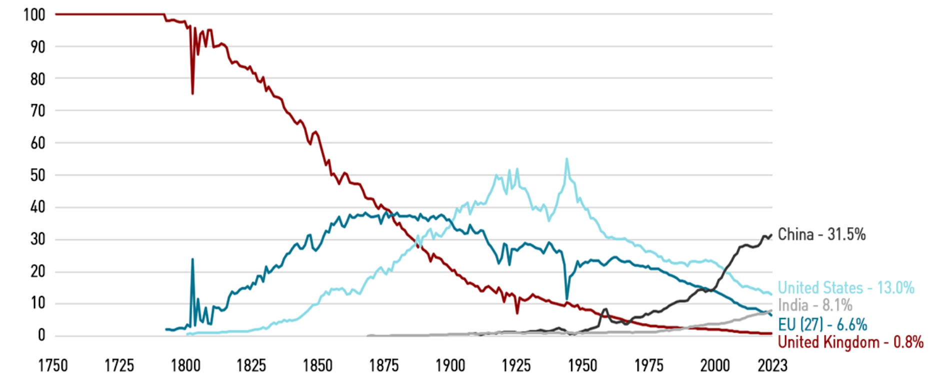


Source: DESNZ Energy Prices International Comparisons (using Eurostat data)[76]

High electricity prices have far-reaching consequences for the economy, affecting manufacturing, employment, investment, and competitiveness, and contributing directly to de-industrialisation and broader economic stagnation. High electricity prices lead to increases in the cost of goods, shrinking profit margins and potential reductions in output. This results in reduced productivity and increased inflationary pressures. High electricity prices also deter new capital investment in UK manufacturing as companies prefer to expand in regions with lower operational costs and a more stable /less punitive energy policy.

Factory closures lead to declining industrial capacity, a loss of skilled jobs, community decline, and falling regional tax bases. They also worsen the UK's balance of trade, as domestic production is replaced with imports – this is clearly seen in the vital steel industry where UK steel exports have declined while imports from low-cost producers in China, Turkey, and India have increased. A worse balance of trade increases the UK's exposure to currency and interest rate shocks and reduces economic resilience. A persistent trade deficit can weaken the pound, increasing the cost of imported goods, including the cost of imported energy. This feeds inflation and further increases industrial energy costs creating a negative feedback loop.

Share of global CO_2 emissions (from fossil fuels and industry - land-use change not included)



Source: Our World in Data

By allowing its energy prices to remain above those in other countries, the UK risks hollowing out the core industries that are vital for economic sovereignty, and, ironically, the energy transition itself. What is even more ironic is that none of this helps to address climate change. The UK is responsible for just 0.8%[77] of global carbon dioxide emissions. But the net zero targets are based on territorial production emissions – off-shoring manufacturing results in progress towards the target, but typically production moves to countries such as China and India whose energy is more carbon intensive, and then the goods are shipped to the UK incurring emissions from shipping. When this applies to bulk items such as steel, shipping emissions are higher due to the high volume and weight of the goods.

75 https://www.ineos.com/news/ineos-group/150-billion-value-to-the-uk-economy-from-the-north-sea-is-at-risk.-ineos-calls-for-urgent-reform-of-uk-energy-tax/

76 https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices

77 https://ourworldindata.org/co2-emissions

Conclusions

The public has been fed false narratives that renewables are cheap - they are not

The public has been seduced by narratives that renewables are cheap, believing them because the wind and the sun are "free", and ignoring the fact that the machines necessary to convert their energy to electricity are very far from being free, and for the most part are actually very expensive. That renewables are not cheap should be clear, based both on the evidence that after 35 years of subsidies, we are yet to see any benefits through lower bills. Indeed, the evidence suggests that consumers would have been almost £220 billion better off financially (in 2025 money) had the energy transition not been attempted.

If they were genuinely cheap it would not be necessary to create taxes such as the Climate Change Levy to encourage businesses to use them - they would make that choice for themselves

The UK's progress in reducing emissions in its power sector was largely achieved coincidentally as a result of declining coal production at a time when North Sea gas began to be exploited. Even the Climate Change Committee recognises that financial savings may not materialise until the 7th Carbon Budget period which runs from 2038 to 2040 – half a century after we first started to subsidise renewable generation!

If they were cheap we would not need to subsidise them - people would be flocking to buy them

> "In our Balanced Pathway, the UK should start saving compared to a high-carbon economy during the Seventh Carbon Budget period [2038 – 2042],"
>
> - Climate Change Committee, 7th Carbon Budget

Not only are renewables not cheap, they impose a large number of hidden costs on the energy system...

The UK's international competitiveness is being harmed by its comparatively high electricity prices. Despite the mantras of policymakers about "high international gas prices", the UK's high electricity costs are a result of policy choices: the UK has the highest industrial electricity prices in the developed world and the fourth highest domestic electricity prices, but only the 15th highest gas prices. In a world where all gas importing countries must pay "international gas prices" and many of these countries use gas as the marginal fuel for power generation, gas prices alone cannot explain why UK electricity prices are as high as they are.

...these costs are socialised through bills. The renewable generators who create these costs do not have to pay towards meeting them - consumers pay them all

In fact the reason for this is the choices made by successive governments, which have added £ billions in costs to bills. Some countries seek to recover similar costs through taxation, while other countries have simply not created many of the additional levies which apply in the `UK.

The result has been some reduction in UK emissions beyond that achieved incidentally through the switch away from coal to gas in the power sector, but not a reduction in global emissions, since manufacturing has simply moved to countries with cheaper (and dirtier) energy, with additional emissions being incurred through the transportation of goods to the UK, often from places as far away as China.

High energy prices are harming the UK economy, driving de-industrialisation...

The UK increasingly imports heavy bulk items such as steel, which incur considerable transportation emissions – ideally such items should be produced as locally as possible. But the UK's comparatively high energy prices make this uneconomic. And since the UK accounts for just 0.8% of global carbon dioxide emissions, little is gained from the economic self-harm these punitive energy policies are creating.

...as well as harming households, driving fuel poverty

The Government has said recently that it wants to prioritise economic growth and is supporting carbon intensive projects such as airport expansions. This objective is unlikely to succeed, in part because such projects will likely be the subject of legal challenge under the Climate Change Act which imposes legally binding carbon dioxide emissions targets, but also because the UK's high energy costs will make some of these projects unattractive, or more expensive than they would have been if more of the supply chain needs could be met locally. The truth is that strong economic growth will be difficult to achieve while the UK has the highest industrial electricity prices in the developed world while households struggle with some of the highest domestic prices. These high, and largely voluntary costs, represent a significant drag on the economy and are creating real hardship for the public.

Labour promised £300 savings on energy bills and Keir Starmer promised to ban increases in energy costs, yet since the General Election, bills have gone up by almost £300

It's time policymakers were more honest about the costs of the energy transition, and in particular quantified the costs of the "climate emergency" they are seeking to prevent. A cost-benefit analysis of climate change mitigation against climate change prevention should be undertaken, and the results clearly communicated to voters. It may be that the public would accept higher energy prices to prevent climate change, but this choice needs to be clearly presented, and not imposed in secret. Policymakers need to set aside dishonest narratives about renewables being "cheap" when it's becoming increasingly clear that generations of voters will not see any financial benefits from the energy transition, and that "international gas prices" are not responsible for the UK's high energy costs when so many costs are a result of policy choices and not external factors.

High energy prices in the UK are a deliberate policy choice...

...they are not the result of high gas prices...

...they are the result of high carbon taxes and environmental levies and subsidies

This report has focused on the costs of the energy transition within the power sector, but the pursuit of net zero will impose costs in other areas as well. Electric cars are more expensive to buy than conventional cars, and are more expensive to run unless they can be charged at home. Heat pumps are more expensive to buy than gas boilers, and while subsidies currently equalise the capital cost, most households would need to upgrade insulation and install new radiators and pipes to ensure that the low grade heat produced by heat pumps is able to deliver required comfort levels. And with so many policy costs added to electricity bills, heat pumps are more expensive to run than gas boilers in most cases. These economic realities are reflected in the relatively low uptake of both electric cars and heat pumps.

Energy prices could be cut today by scrapping some of these levies and recovering the rest through taxation rather than adding them to bills

It seems impossible that net zero targets can be met without significant sacrifices by the public. Sooner or later the public will understand the full extent of the requirement, and it is by no means clear that it will be willing to go along with it. Voters in both the US and Europe have begun to turn away from the net zero project – voters in the UK may well do the same. They should be provided with the full information on which to make their choices: continuing to gaslight the public about the costs of net zero is un-

Appendix - Clean Power 2030 Plan

The UK Government wants to have "clean power" by 2030...

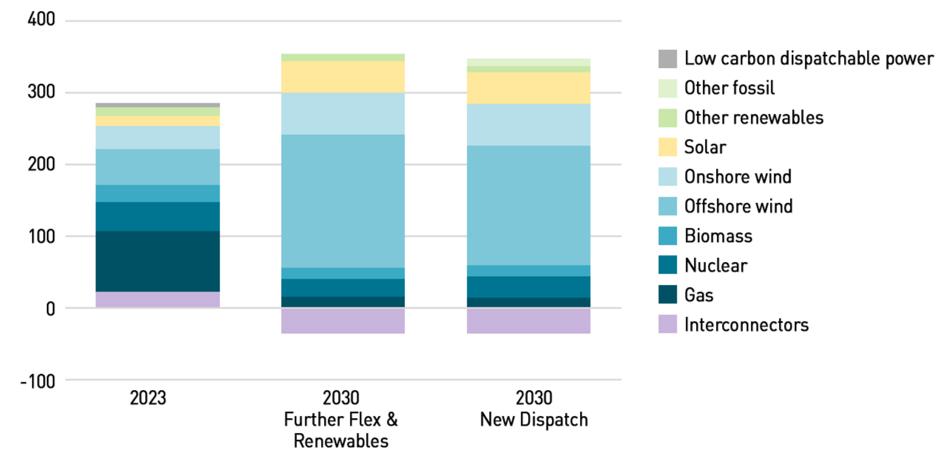
In the summer of 2024, Energy Secretary Ed Miliband, and Chris Stark, head of the Government's "Mission Control" centre for clean energy, wrote[78] to National Grid ESO, the predecessor organisation to NESO, asking it to set out its advice on how a clean power system could be achieved by 2030. The response[79] (from NESO), in the form of an 84 page report plus supporting annexes and workbooks determined that the ambition to achieve a "clean" power system by 2030 is feasible assuming a large number of things all go well at the same time. This is a little bit like saying there is a non-zero probability pigs may fly: it is technically possible but highly unlikely.

> "It is possible to build, connect and operate a clean power system for Great Britain by 2030, while maintaining security of supply. Several elements must deliver at the limit of what is feasible: a key challenge will be making sure all deliver simultaneously, in full and at maximum pace, in a way that does not overheat supply chains, is sustainable and sets Great Britain on the right path beyond 2030,"
>
> - NESO, Clean Power 2030: Advice on achieving clean power for Great Britain by 2030

...this is defined as 95% of average annual generation being met by zero carbon sources of generation with unabated gas only meeting 5% of average annual demand

In this context a "clean" power system is defined as "one where demand is met by clean sources (mainly renewables), with gas-fired generation used only rarely to ensure security of supply, primarily during sustained periods of low wind." NESO goes on to explain that for the purposes of its advice, "clean" power is considered to mean that "by 2030, clean sources produce at least as much power as Great Britain consumes in total and unabated gas should provide less than 5% of Great Britain's generation in a typical weather year." The Government adopted this definition when it published its Clean Power 2030 Action Plan in December ("CP2030").

Generation mix for a clean GB power system in 2030 (TWh)



Source: NESO Clean Power 2030 Advice

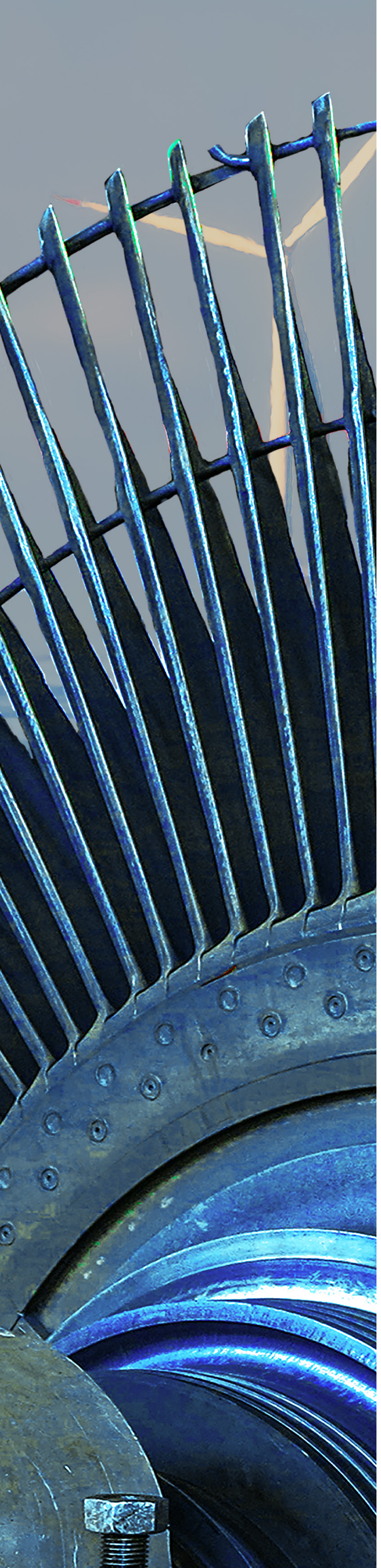
CP2030 is "feasible" but only if a lot of unrealistic conditions are met

NESO determined that CP2030 was feasible but would require certain rather unrealistic conditions are met:

- Spending more than £40 billion every year until 2030, with average annual investment around £30-35 billion higher over 2025-2030 than over 2020-2024. This represents an increase in investment of over 1% of GDP for the entire economy;

78 https://assets.publishing.service.gov.uk/media/66cda5c1e39a8536eac0532e/sos-chris-stark-letter-clean-power-2030.pdf

79 https://www.neso.energy/publications/clean-power-2030



- Contracting as much offshore wind capacity in the coming one to two years as in the last six combined. The rate of delivery of renewables technologies would need to increase significantly;
  - offshore wind delivery would need to increase by a factor of four with capacity rising from 15 GW in 2023 to 43-50 GW in 2030,
  - solar delivery would need to increase by 7X with capacity increasing from 15 GW to 47 GW,
  - onshore wind delivery would need to increase by 5X with capacity increasing from 14 GW to 27 GW.
  - battery storage capacity would also need to increase from 5 GW to over 22 GW to displace gas, meet growing demand and to replace retiring plant;
- Building twice as much transmission infrastructure in the next five years as were built in the past 10, and delivering all the projects on time;
- Reducing residential demand by 20% and increasing demand flexibility by four-to-five times to 2030 to 10-12 GW, with a further 4 GW from storage heating. This is opposite to the current trend of declining demand flexibility[80] and while energy demand has been falling, NESO believes it could increase by 11% to 2030.
- Delivering first-of-a-kind clean dispatchable technologies, such as carbon capture and storage and hydrogen to power.

On top of that, NESO's price assumptions, designed to demonstrate that CP2030 will be cost effective, are highly suspect. It assumes gas prices of 100p /th which is higher than the central DESNZ forecasts[81] of 70p /th in 2030 (low: 41p /th high: 111p /th), and carbon prices are assumed to be £147 /t in 2030, and £25 /t above European carbon prices. UK carbon prices have been consistently below European prices largely because the UK has a surplus of carbon allowances due to the effects of de-industrialisation. Such a large premium above European carbon prices would require policy adjustments to force UK carbon prices higher.

NESO says that it is "non-negotiable that the power system must remain secure". It claims its pathways demonstrate that it is possible to move to a renewables-dominated clean power system by 2030 without compromising security of supply. This is also doubtful.

CP2030 assumes that the entire existing 35 GW gas fleet will be placed in reserve to only meet 5% of average annual electricity demand in 2030. NESO recognises that as gas generators will run at significantly lower load factors than they do today, they will become more dependent on revenue support from the Capacity Market or an alternative, such as a strategic reserve mechanism. It says it will be important for the Government, NESO and Ofgem to constantly monitor the effectiveness and value for money of any arrangements, ensuring there is a plan in place to manage the impact of plant exits from the market on capacity adequacy, and that a decision is needed in time for the publication of the Capacity Market Parameters in July 2025.

However industry insiders doubt that the gas reserve plan is feasible. 33 GW of the 35 GW gas fleet is made up of Combined Cycle Gast Turbines ("CCGTs") which are complex machines designed for higher utilisation rates. Once utilisation falls below certain levels, preservation strategies need to be considered – these will involve either running the plant without generating electricity to ensure everything remains in good working order (ie consuming gas and incurring emissions for no real benefit) or implementing expensive and cumbersome preservation measures[82].

80 https://watt-logic.com/2024/12/29/falling-dsr-participation/

81 https://assets.publishing.service.gov.uk/media/66f3e1a8080bdf716392e855/2024-Fossil-Fuel-price-Assumptions-Publication.pdf?

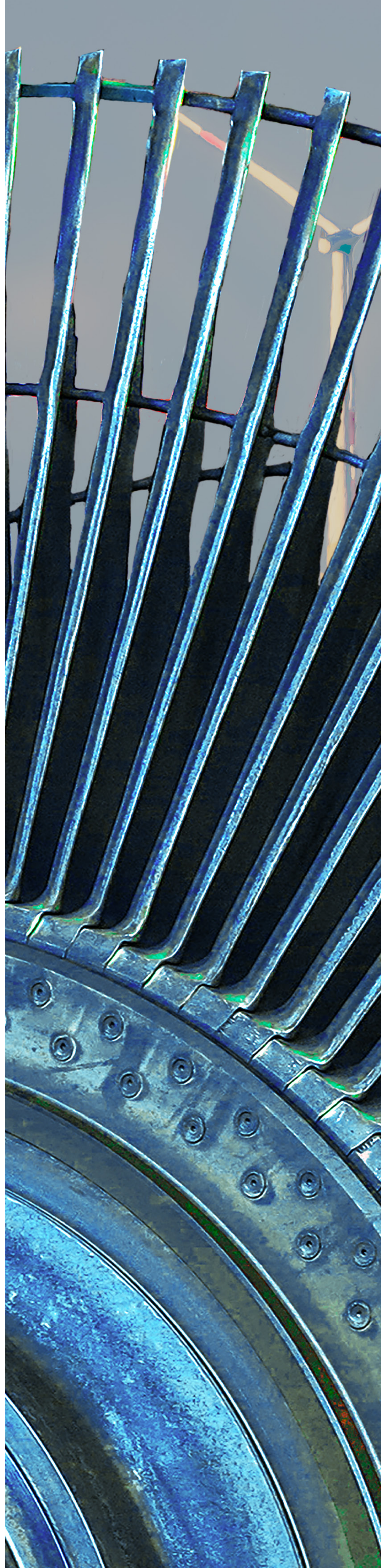
82 https://watt-logic.com/2024/12/19/unrealistic-plans-for-ccgt-fleet/

Some of the physical challenges associated with very low utilisation of CCGTs include:

- Corrosion and oxidation: prolonged idle periods can lead to corrosion of critical components such as turbine blades, combustors, and piping due to moisture or ambient air contaminants;
- Gas path fouling: even with protective measures, dust, oil, and other deposits can accumulate in the compressor and turbine sections, affecting performance during startup;
- Fuel system issues: long periods of inactivity can lead to clogging, varnish buildup, or microbial growth in fuel storage and delivery systems, especially in older systems without advanced filtration;
- Start-up reliability: ensuring the turbine starts reliably after long periods of dormancy requires rigorous maintenance of ignition systems, control systems, and auxiliary equipment;
- Lube oil degradation: lube oil can degrade or develop moisture contamination over time, leading to improper lubrication of bearings during startup;
- Sealing systems: mechanical seals, especially in older designs, may dry out or degrade during periods of inactivity, potentially causing leaks;
- Rotor bowing: prolonged stationary periods can result in rotor bowing due to uneven cooling or settling, especially in older turbines. This can cause vibration issues when restarting;
- Thermal insulation degradation: heat retention systems like insulation blankets can deteriorate during long idle periods, affecting thermal cycling stability upon restart;
- Battery and electronics failure: auxiliary systems (including control system batteries, sensors, and actuators) may fail due to inactivity, requiring replacement or recalibration before restart;
- Preservation of rotating equipment: extended dormancy requires specific preservation strategies, such as turning the turbine manually to prevent rotor bowing, using desiccant systems to maintain dryness, or nitrogen blanketing to avoid oxidation;
- Preservation of Heat Recovery Steam Generators ("HRSGs") and auxiliary systems: HRSGs can suffer from corrosion in idle periods if proper lay-up procedures (wet or dry preservation) are not rigorously followed. Auxiliary equipment such as pumps and valves may seize up if not exercised periodically.

While it is technically possible to do this, generators would need to be paid enough money to cover costs plus an acceptable return for investors and asset owners. The economic challenge is greater than it was for the old oil peakers such as Fawley, Littlebrook and Isle of Grain which ran on a similar basis in the 1990s and 2000s. The fact that oil could be purchased ahead of time and stored on site, while gas is bought just-in-time and piped from the grid makes a difference because the oil price would be locked in and the plant could then be run at very high power prices to cover a year's worth of fixed costs over a small number of runs. For most of the period that the oil peakers operated there was also no carbon cost to consider.

For CCGTs, the gas price tends to be high when the power price is high, compressing available margins in a way that was not the case with oil, and carbon costs must also be considered. While the capacity market is intended to help cover fixed costs, as utilisation rates fall, capacity prices will need to be higher to provide adequate returns to asset owners, otherwise they will simply close and release their capital. Using the Capacity Market to support this gas reserve would be a very expensive solution. To provide sufficient income to these CCGTs, capacity prices would need to be much higher than they are currently, and since the Capacity Market is



paid as cleared to all technologies, the whole market would then be remunerated at the level needed to maintain the 35 GW CCGT fleet. This will be extremely expensive.

In addition, gas turbines rarely operate for longer than their 25-30 year design life, and a good portion of the existing fleet was built in the late 1990s and 2000s, meaning many will be nearing end-of-life by 2030. It is unlikely that operators will be interested in the costs of maintaining end-of-life assets within the Capacity Market framework given the higher risk of incurring non-delivery penalties with old assets. This means it is likely that a portion of the fleet will simply exit the market before 2030. It may be that some of the newer CCGTs decide to bid for four-year refurbishment contracts in upcoming capacity auctions with a view to converting to open-cycle operation which would lower the operational burden of lower utilisation rates.

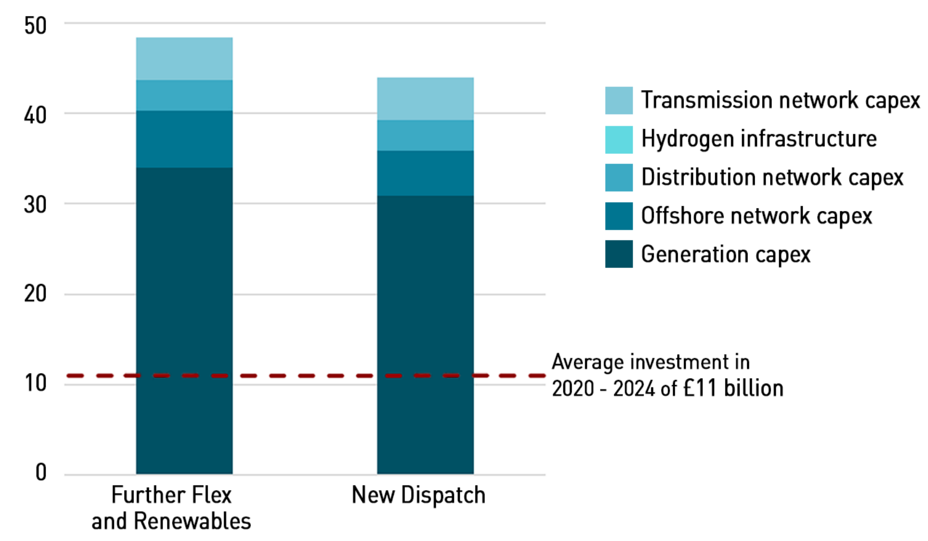
The near-miss blackout event[83] in Britain on 8 January 2025 highlighted the vulnerability of the power system, and has increased the focus on dispatchable generation since the CP2030 report was published. For example, the controversial biomass subsidies for Drax and Lynemouth power stations have been extended[84] to prevent their possible closure after the current subsidies expire in 2027, and it is widely expected that the aging fleet of Advanced Cooled Gas Reactors will see further life extensions. The costs of all of this will be passed on to consumers under the capacity market and contracts for difference levies.

NESO expects average annual investment of over £40 billion to 2030 to meet CP2030 targets, which represents a material increase on investment levels in recent years. In fact, average annual investment will need to be £30-35 billion higher over 2025-2030 than it was over 2020-2024. This is an increase in investment of over 1% of GDP for the entire economy. It expects wider electrification efforts to further drive national investment. The main differences in investment between its CP2030 pathways reflect differences in capacity assumptions. Most of the investment is expected to come from the private sector.

83 https://watt-logic.com/2025/01/09/blackouts-near-miss-in-tighest-day-in-gb-electricity-market-since-2011/

84 https://www.gov.uk/government/consultations/transitional-support-mechanism-for-large-scale-biomass-electricity-generators/outcome/transitional-support-mechanism-for-large-scale-biomass-generators-government-response-html

Average annual investment system costs in clean power pathways 2025-2030 (£ billions)

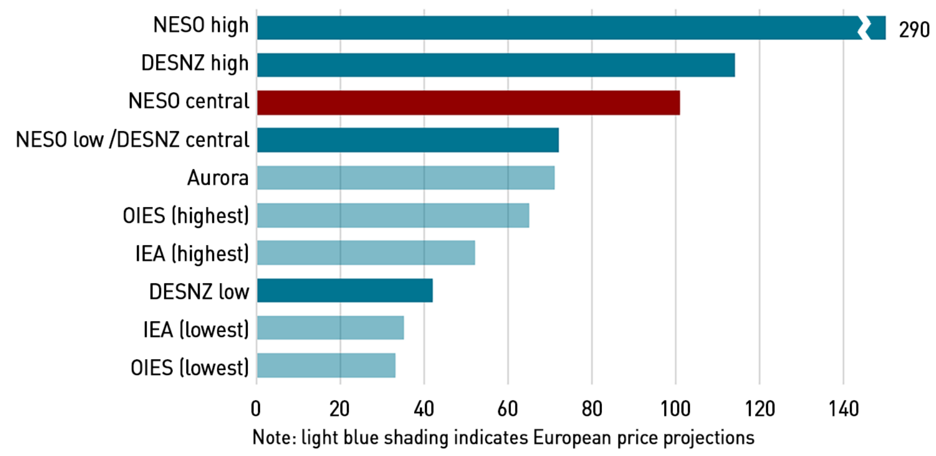


Source: NESO Clean Power 2030 Advice

NESO expects there to be a “slight increase” in bills as a result of a “move to clean power”. It says there will be direct benefits offsetting these, suggesting that overall costs to consumers would not increase as a result. It says there will be cost reductions due to gas setting wholesale power prices less often (based on its inflated gas price expectations). Some of the cost reductions cited by NESO would be achieved regardless as they relate to the expiry of legacy contracts under renewables support schemes such as the Renewables Obligation and Feed-in-Tariffs. NESO also believes there are additional opportunities to reduce bills through energy efficiency and assumes an efficiency improvement in lights and appliances for households will see typical electricity usage drop by c. 5-10% in its clean power pathways.

In other words, NESO’s report, far from supporting Miliband’s claims that clean power will be cheaper than the current gas-based system, indicates that it will be slightly more expensive and that’s only if unusually high assumptions are made about gas and carbon prices and additional carbon taxes are imposed onto gas generators.

2030 gas price projections compared (p/therm)



Source: Centre for Policy Studies

This is explained in detail in a report by the Centre for Policy Studies[85] which points out that buried in an Annex to its main report, NESO acknowledges that its price assumptions drive the desired cost outcome although not in so many words.

It says that using its "reduced gas price assumption" the relative cost of the clean power system would be around £5-10 /MWh higher than the existing gas-based system, and that using DESNZ's central case for traded carbon values would also shift relative costs by around £5-10 /MWh. NESO's "reduced gas price assumption" is actually DESNZ's central case. This means that under the central forecasts produced by DESNZ, the system will be £10-£20 /MWh more expensive under CP2030 than otherwise. If NESO included a genuine low case forecast, similar to the International Energy Agency's, CP2030 would look even more expensive.

> "When that advice was published last month, he [Miliband] was exultant, hailing it as "conclusive proof that clean power by 2030 is not only achievable but also desirable" and promising that it would "lead to lower costs of electricity.
>
> ...the Neso report absolutely does not prove that Miliband's plans will make electricity cheaper. At best, it suggests that they will not make it any more expensive — but only in a world in which gas prices continue to be historically high, we remain hugely dependent on gas, carbon prices are jacked up, we miraculously build all the infrastructure we need on time and on budget and we don't actually decarbonise the grid all the way anyway.

85 https://cps.org.uk/research/the-great-grid-gamble/

> Indeed, the report explicitly states that on his department's own central forecasts for gas and carbon prices, his plans would increase bills — and the gap becomes even bigger if the IEA's gas glut materialises,"
>
> - Robert Colvile,
> Director of the Centre for Policy Studies[86]

Various commentators have criticised the CP2030 plans. Analysis by Cornwall Insight[87] suggests the targets for offshore wind, onshore wind and solar PV will be missed by a combined 32 GW, with a 16 GW shortfall in solar PV reaching 29 GW compared to the 45-47GW Government target. Growth in onshore wind is expected to be 10 GW short of the 27-29 GW goal while offshore wind is projected to be 6 GW short of the 43-50 GW goal.

Analysis by Cornell University[88] suggests the CP2030 plans "do not take adequate account of the consequences of the highly variable nature of wind and solar generations". The authors believe CP2030 overestimates the ability of wind and solar generations to decarbonise the electricity system as they increase in size relative to whole system. Increasing wind generation to only 20 GW, rather than to 30 GW as proposed in the Plan, could halve the proposed cost, potentially saving £120 billion, with little reduction in overall decarbonisation. Concern is expressed that the Climate Change Act of 2008 which requires the UK to meet arbitrary decarbonisation targets is leading government advisors to propose unproven and therefore highly risky technological solutions.

Even Chris Stark, the head of the Government's Mission Control has said the plans are at the "the fringes" of what is possible and will not be delivered without further policy reforms.

Miliband rejects these criticisms and has repeatedly described the CP2030 advice from NESO as "independent"[89] including when challenged in relation to the Cornwall Insight analysis by the Environmental Audit Committee[90]. He has used this claim in attempts to silence critics of the plan on the basis that NESO provided "independent advice" to the effect that it is feasible. This is disingenuous – firstly, NESO can hardly be deemed to be independent when its sole shareholder is the Secretary of State for Energy Security and Net Zero, ie Miliband. Secondly, Freedom of Information requests[91] have uncovered that there was extensive communication and collaboration between NESO, DESNZ and Ofgem prior to the publication of NESO's "independent" advice, and that NESO sought signoff from stakeholders in both the Government and regulator on its content. Therefore the NESO report cannot be considered, on any objective measure, to be independent of the Government.

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Watt-Logic

www.watt-logic.com | kathryn.porter@watt-logic.com | +44 7958 775 745