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Authors:
Dr Iain Staffell, Professor Richard Green, Professor Tim Green and Dr Malte Jansen
Imperial College London

Professor Rob Gross
UK Energy Research Centre

Professor Matt Hannon
University of Strathclyde

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Electric Insights was established by Drax to help inform and enlighten the debate on Britain's electricity. Since 2016 it has been delivered independently by a team of academics at Imperial College London using data courtesy of Elexon, National Grid and Sheffield Solar.

1. Introduction

After a 12 month hiatus Electric Insights is back, relaunching into one of the most turbulent times in Britain's electricity system's history. Our first article focuses on the cost-of-living crisis that is engulfing the nation, and the central role played by energy prices. The wholesale cost of coal and gas have risen to 5-10 times their usual levels over the past two years, and as gas is the largest source of electricity production, the cost of power has shot up too. These price rises have made their way into consumer bills, bringing extreme hardship for households, businesses and industrial consumers alike.

These huge price rises have sparked intense debate about whether energy markets are fundamentally broken, who is profiting from the crisis, and should they be allowed to? Our second article explores whether renewables are being paid more than they should, and the government's Review of Electricity Market Arrangements which is exploring these topics.

These problems are not just limited to the UK: energy prices have been spiralling upwards across the whole of Europe. Several factors are colliding on the continent, including gas shortages in Germany and prolonged nuclear outages in France, meaning Europe's power systems are facing additional pressures. So, despite British electricity being more expensive than ever, it is cheap in comparison to our European neighbours. Our third article details how Britain has become a net exporter of electricity for the first time in 10 years, with 5% of the electricity generated here sent abroad over the last three months. This comes at a time when Britain's energy security is becoming a cause for concern.

This situation has been complicated further by the extreme weather affecting the UK and much of the world. This summer saw a series of unrelenting heat waves, with temperatures soaring past 40°C for the first time ever, coupled with the driest start to the year ever recorded. We examine how the extreme heat has impacted electricity demand and supply, and the longer-term implications for the power system.

The price of fossil fuels over the last three years, relative to their averages from 2010-19

2. The cost of energy crisis

A cost-of-living crisis is consuming the UK, Europe and much of the world alike. A major component of this has been the dramatic increase in the price of electricity and gas. As this filters through into consumer bills it has become a major driver of inflation, which has risen above 10% for the first time in decades. Average household bills had been forecast to rise more than five-fold to over £500 per month. This led to fears of civil unrest, and dire warnings of thousands of businesses forced to fold and 'a catastrophic loss of life' due to fuel poverty this winter.

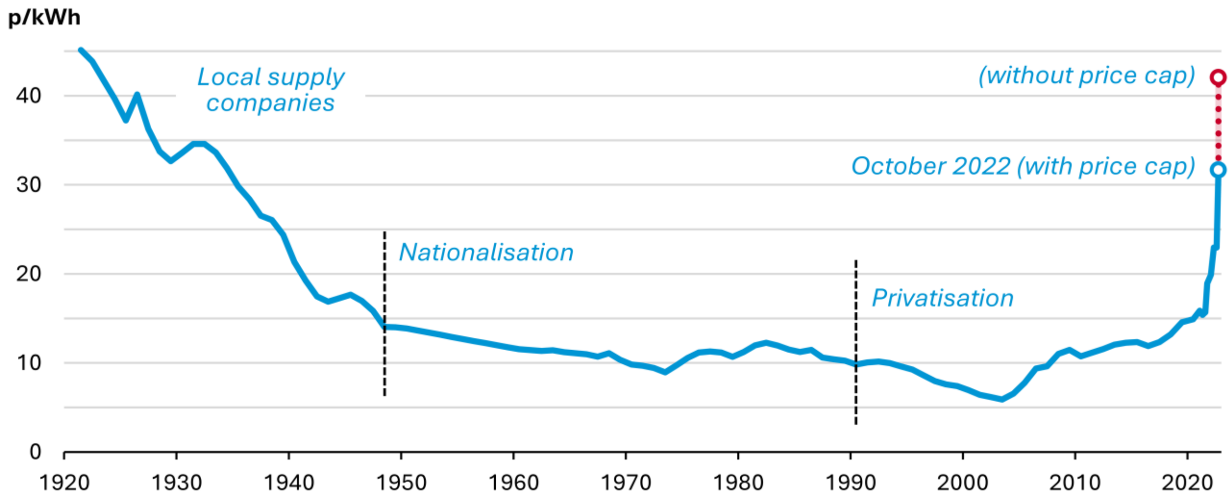
The incoming Truss government announced a new Energy Price Guarantee that will freeze the bill for a typical household at £2,500 per year from October, with support also going to small businesses. This will soften the immediate financial impacts to consumers, but in the long-term, high energy costs will weigh heavily on the economy.

Without this intervention, the retail price of electricity to households would have hit 52 pence per kWh at the start of October. Britons would have been paying more for electricity than at any point since 1923, when there were just 1 million consumers of 'light and power' and "keeping just five bulbs going for a day would cost a week's wages". Households will now instead pay 34 p/kWh for electricity and 10.3 p/kWh for gas, still more than at any point since 1935.

What is driving up energy prices?

Coal and gas prices started rising in the summer of 2020, initially rebounding from the historic lows during the first COVID lockdown. Prices continued rising through 2021 as global supply chains struggled to adjust to the repeated closing and reopening of economies. A year of reduced coal and gas production resulted in low stock levels going into the harsh winter of 2020-21 and then an extremely hot summer in 2021 across China, Europe and the Americas. The extreme weather pushed energy demand higher at a time when supplies were constrained.

The retail price of electricity in Britain in real terms (2020 p/kWh), averaged across all consumers (residential, commercial and industrial).



By the start of 2022, British wholesale electricity prices had already risen to £200/MWh, quadruple the average during the 2010s. As winter eased and demand for heating fell, prices would normally have eased back. However, on February the 24th, Russia's invasion of Ukraine had dire consequences for energy geopolitics and security.

Europe's reliance on Russia for 40% its natural gas has proven its Achilles Heel. Germany has become a flashpoint as the sanctions imposed on Russia have meant NordStream 2, a major gas pipeline that took ten years to build, will no longer go into operation. Russia's Gazprom has then turned the screws on NordStream 1, posing a severe threat to Germany's energy security coming into winter.

The UK does not directly import gas from Russia, although around 4% of our gas does come indirectly through the interconnected European markets. However, as gas is traded widely on the global market, shortages abroad will lead to price rises at home. Analysts from Cornwall Insight and the World Bank expect gas prices to remain high for next 18 months at least.

Household bills at their highest ever

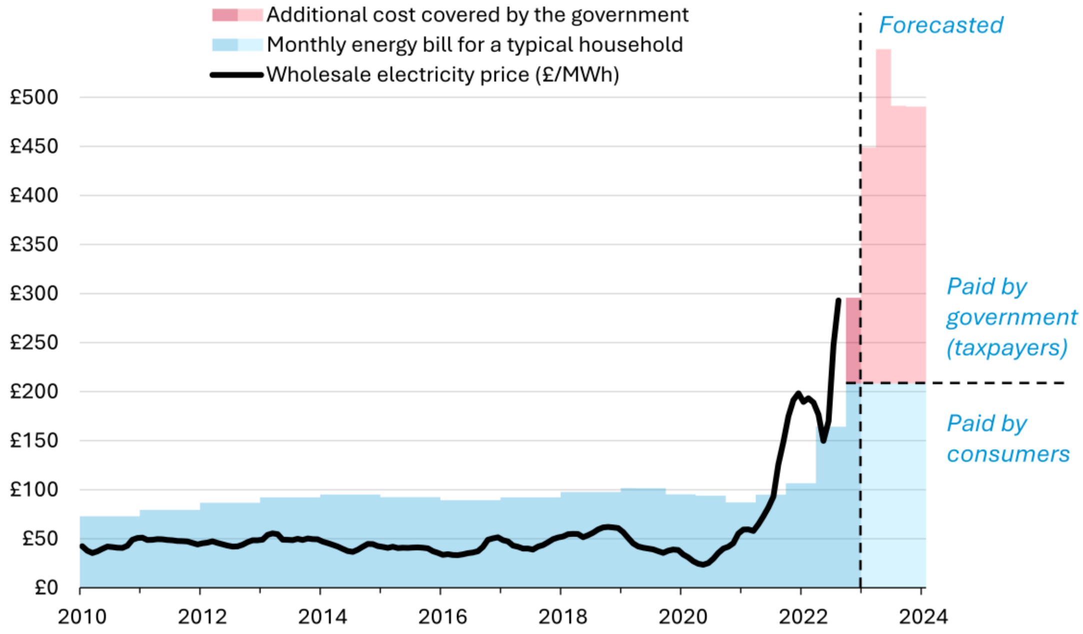
Ofgem sets an energy price cap on the maximum price (per kWh of gas and electricity) that suppliers can charge their consumers on standard variable tariffs. The cap was intended to protect consumers that did not switch regularly between fixed tariffs from 'price gouging' by the big energy companies. With fixed tariffs now largely unavailable or unattractive, most consumers are now likely to be on variable standard tariffs, and so pay these capped prices.

The bill for gas and electricity in an average household has varied between £70 and £100 per month over the 2010s. In the space of just a year, these bills have more than doubled. In April of this year, the cap for an average dual-fuel household increased to £164/month, and then in October it was scheduled to increase by another 80% to £295/month.

The government's Energy Price Guarantee now limits the amount that households will pay directly (shown by the blue area in the chart below) to £208/month on average. This does not make the underlying energy sources any cheaper though, so retailers (the companies that sell gas and electricity to consumers) will still need to receive the original (higher) price cap set by Ofgem to stay afloat.

So long as the wholesale cost of gas and electricity remains high, the taxpayer will be picking up the additional bill (shown by the red area). Over the next two years this is expected to add £150 billion to the national debt (around £6,000 per household), which will have to be recovered by future taxation or reduced public services.

The wholesale cost of electricity has risen to five times the levels during the 2010s. The retail bill for an average British household has followed, and for winter 2022/23 the cost of a typical household's energy is projected to hit over £500 per month.



The price caps set by Ofgem limit how much firms can charge for the things they can control, such as network and operating costs, and profits. Other expenses – most notably wholesale energy prices – are beyond the control of any one company (or country), as gas prices depend on international circumstances, and electricity prices are driven by gas prices. Ofgem allows suppliers to pass these changes onto consumers, hence the cap increases when wholesale prices go up, and decreases when they go down (as was seen briefly in the Summer of 2020). There is a lag between the two, hence the first big rise in the cap came in April 2022, more than a year after wholesale prices started to rise.

It is important to note that the increase in gas prices is responsible for 96% of this bill rise. Green levies have not changed over the past year, but these have now been waived to fund part of the Energy Price Guarantee (reducing tax take for the Exchequer). Ofgem has shown that UK CfDs (mainly for offshore wind) are now reducing energy bills.

The speed and size of the recent price changes caught many smaller suppliers off guard, leading to the collapse of 29 companies as their costs overtook their revenues. This has added £85 to the average annual electricity bill. The bankruptcy of 'Bulb', which supplied 1.4 million homes, is expected to add another £150 onto the average energy bill.

Low building efficiency spells a looming catastrophe

The tripling of household energy bills since 2021 is made worse by the low energy efficiency standards of British housing stock. The UK has some of the oldest and least efficient housing stock in Europe, which lose warmth much faster than in neighbouring countries. Three in five homes are rated EPC D or worse, meaning they use more than 100 kWh per m^2 per year, and cost upwards of £30 per m^2 per year to heat.

Improving energy efficiency is a key route out of this crisis, but one we have failed to capitalise on as a country. The uptake of home energy efficiency measures is at a 10-year low, which can be largely attributed to the Cameron government "cutting the green crap". This resulted in a major redesign and shrinkage of energy efficiency supplier obligations. The consequences of low efficiency housing stock are now magnified, adding an estimated £2.5 billion onto UK energy bills.

Even with the government's Energy Price Guarantee, many households will be plunged into energy poverty this year, spending more than a tenth of disposable household income on energy bills. Around 13% of English and Welsh homes are already energy-poor, along with a quarter in Scotland. Fuel poverty in Wales tripled with the April 2022 price cap rise, and this will only worsen with the October rise.

Many households now face the agonising choice over whether to heat or eat. This will have catastrophic health impacts for the country. Excess winter deaths are almost three times higher in the coldest 25% of housing than in the warmest 25%. Cold weather directly increases the rates of heart attacks, strokes, flu, falls and injuries and hypothermia. Before COVID, there were 32,000 excess deaths each winter, over and above the mortality rates across the rest of the year. Of these, nearly 10,000 deaths were avoidable, caused by under-heated homes – equal to the number of people who die from breast or prostate cancer each year.

The Bank of England is expecting a recession in 2022, as energy prices impact on inflation and growth, with most businesses having to pass on energy costs to consumers. Small businesses are most at risk and may have to down-size. More than half expect to stagnate or shrink due to escalating costs, with fuel costs mentioned by two-thirds of businesses.

Getting away from gas

This crisis has stemmed from high gas prices which are affecting the whole of Europe, but the UK has been worst hit out of all countries. Gas prices are particularly affecting British consumers in three ways: (1) increasing the cost of heating our homes, (2) increasing the cost of electricity from gas-fired power stations, and (3) increasing the price of goods and services, as the cost of heating, lighting, cooking and industrial production soars.

The UK is addicted to gas for heating our homes, as 88% of English homes use gas boilers for central heating. At the same time, the share of heat from low-carbon sources has been broadly flat since 2017, even in new-builds. The installation of heat pumps has doubled in 2021, but remains very low at 70,000 per year, again trailing the developments in Europe. In comparison, Germany has installed more than twice as many heat pumps in 2021, with half of new-build home opting for heat pumps. The Netherlands have made heat pumps mandatory from 2026 onwards for all new-builds. The UK has an ambitious target of 600,000 new heat pumps per year within just six years, but shows little signs of progress towards meeting this.

Britain's electricity market is also more heavily exposed to gas prices than any major European country. Around 40% of Britain's electricity comes from gas, yet it sets the electricity price 80% of the time. Progress moving away from gas was slowed down with curbs on the development of onshore wind and ground-mounted solar PV. A new generation of nuclear power (starting with Hinkley Point C) is also running into severe delays, and is not expected to be delivering power before 2027.

So what can be done?

The policy options for mitigating the impact of gas price rises fall into two categories. Initial action has been taken to reduce the short-term financial impacts on households and businesses, and now longer-term measures are needed to reduce our exposure to fossil-fuel prices.

Measures to reduce power and gas consumption are paramount. For example, explaining to consumers how to lower the flow temperature of their gas boiler so it can go into condensing mode could save 6-8% of gas consumption, or £180 per year, with no change in comfort levels. Collectively, even small reduction in energy consumption can reduce the pressure on gas prices, further reducing the bills.

In the medium and long term, re-energising efforts to retrofit home insulation, while building more renewable and nuclear generation and storage are all vital. As the country transitions towards net-zero, the energy system will become more independent and lower cost, shielding us from future fossil-fuel price shocks. For this purpose, the government is currently performing a Review of Electricity Market Arrangements (REMA) to explore future arrangements in a low-carbon, low-generation-cost markets, to prevent minority shares of fossil fuels setting the marginal price.

Conclusion

The UK is facing its worst energy crisis in fifty years. A combination of high reliance on gas for both heating and electricity and inefficient buildings makes the UK the worst-hit country in Europe. Addressing this must be the highest priority for any new government, or the consequences for households and businesses will be severe. Quick action can mitigate the worst effects, but there is no quick fix for the underlying causes, which will require a sustained move away from fossil fuels in our energy system.

3. Do renewables deliver value for money?

The government has launched a Review of Electricity Market Arrangements (REMA), covering practically every aspect of wholesale electricity trading. This is only the second such review since the industry was privatised in 1990. A review in 1997 replaced centralised dispatch with the current system of independent power exchanges and bilateral trading. Then the Energy Act of 2013 added contracts for differences (CfDs) to support low-carbon technologies and the capacity market to support 'firm' generators that help with security of supply. Will the current review lead to a similarly big shake up?

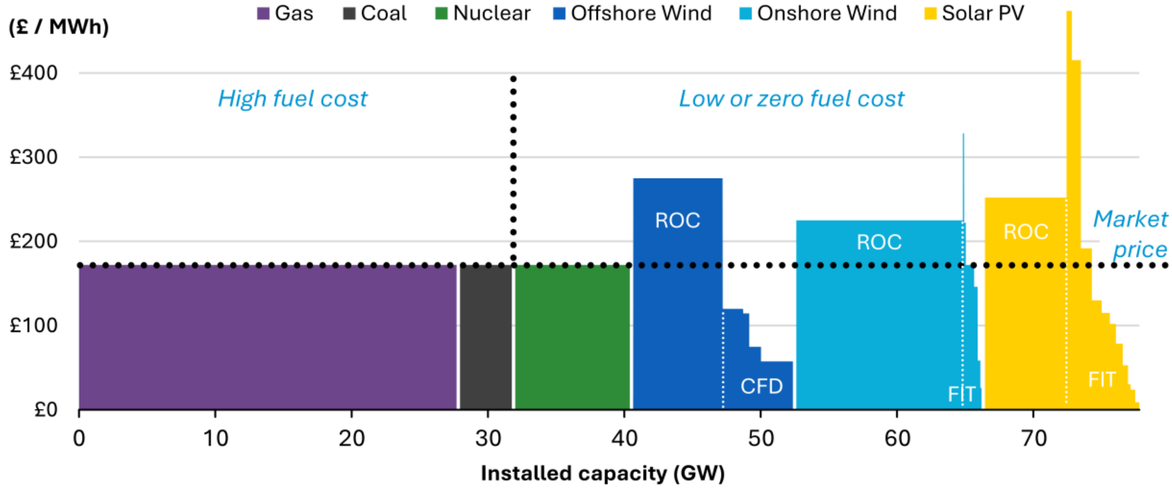
Under the current British Electricity Trading and Transmission Arrangements (BETTA), the National Grid is charged with keeping the power system stable, balancing the system in real time, buying and dispatching reserve capacity, adjusting generation (and occasionally demand) to keep power flows within the limits on transmission lines, and procuring various other ancillary services. As the proportion of renewable generation grows, it becomes harder to manage the power system, and the cost of providing these services will grow. This makes a thorough review worthwhile. The options range from "very little change" to some quite radical proposals, a few of which seem to be untested anywhere else in the world (though, of course, someone has to be first).

Most attention has gone to the suggestion that the market must change so that nuclear and renewable generators (with very low marginal costs) no longer receive the market price set by gas-fired generators (with much higher marginal costs). This is not a new complaint. One motivation for the first review back in 1997 was the claim that it was wrong for gas-fired generators to be able to undercut more expensive coal stations when bidding into the centralised market, but still receive the same System Marginal Price.

However, that review's change to bilateral trading at mutually agreed prices did not put a stop to this. In a free market, companies naturally want to get 'the going rate' for their product. While there was nothing in the rules that said a nuclear station will automatically receive the same price as all other stations running at the same time, that is what the traders selling their output managed to achieve. Ultimately, nuclear, gas, wind and any other types of power station sell the same product: electricity; so it attracts the same price.

That said, it is wrong to think that all low-carbon generators are receiving the current (and very high) market prices for their electricity. The present system already pays newer power stations less because they sell their electricity through Contract for Differences (CfD). These initially provided high prices, as the first new-build nuclear reactors and offshore wind farms were expensive to build. Hinkley Point C and the East Anglia wind farm were both awarded over £100/MWh in today's money, which was expensive compared to fossil fuels at the time. But even these earliest contracts are now well below the average wholesale price of electricity. The newest offshore wind farms have been contracted for less than £40/MWh, so once operational they would be giving three-quarters of their revenue back to the government at current prices. Now that market prices are higher than their strike prices, those contracts pay money from the generators

The average revenue received by each technology in the wholesale market during H1 of 2022. Wind and solar capacity are split by support type, and vary based on installation size and date (as tariffs were reduced in line with technology costs).



back to the government-sponsored Low Carbon Contracts Company, which distributes the rebates to retailers. The retail price cap takes this into account, so that households are paying less for renewable energy from newer stations.

Some small generators, such as rooftop solar PV, were supported with feed-in tariffs and so also receive fixed prices. However, older renewables that pre-date CfDs were given Renewables Obligation Certificates (ROCs) as a second revenue stream on top of selling in the wholesale market, and the existing nuclear fleet also sell at wholesale prices. This does not necessarily mean that the plant owners are the ones profiting from the high gas prices. Generators tend to sell much of their expected output in multi-year fixed price contracts, to give some revenue stability. This means the windfall profit goes to the company that bought the contract, and as these can be resold indefinitely, the true home of the windfall profits difficult to uncover.

How could the government make sure these generators get a lower price? Professor Rob Gross and researchers at the UK Energy Research Centre suggested in April that the government could auction CfDs to existing generators are a quick way to reduce 'overpayment'. Some may find it attractive to swap a risky future with unknown market prices for a stable price, even one that was lower than current wholesale prices. Generators did sign up for equivalent contracts during the Californian Energy Crisis of 2000-01 (which saw power prices rise 800%), helping to end the crisis.

Although nuclear and renewable generators are cheap to run, they cost a lot to build. Older stations should have paid back that cost years ago, but newer stations won't be able to if the prices they can charge are held too low. One option in the consultation paper combines a rule forcing generators to bid their variable costs into an auction (used in some markets around the world) with an auction rule that pays winning bidders their own bid. That rule is also used in a wide variety of auctions, but never in combination with the first one – as together they would guarantee that stations could never recover their fixed costs. Such interventions could deter future investors and derail the longer-term transition away from fossil fuels, so care must be taken in any market redesign.

4. Britain becomes an electricity exporter

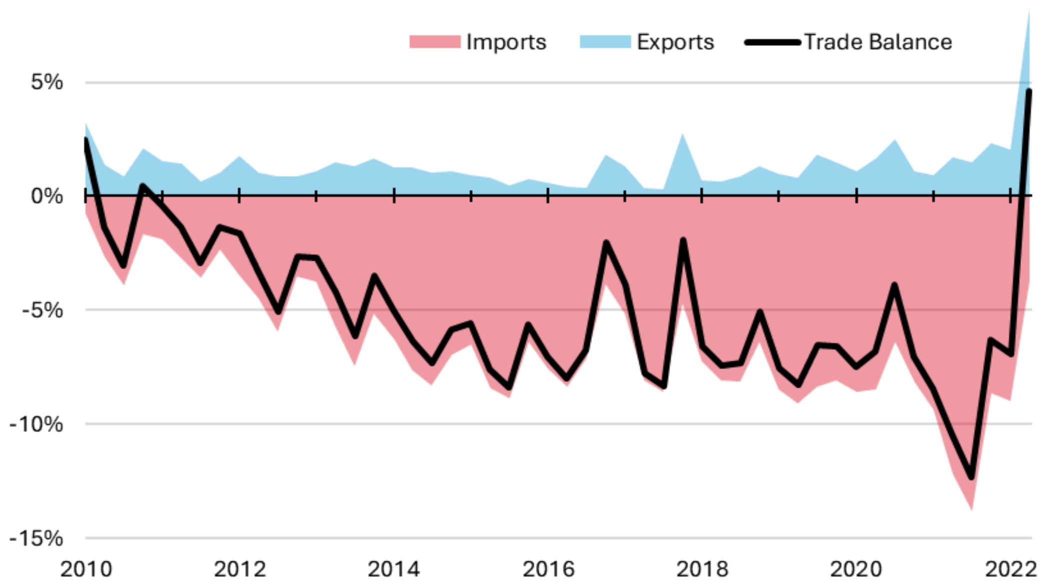
For the first time in over a decade, Britain has become a net exporter of electricity. The 3 months to June saw 8% of the electricity generated here (5.5 TWh) get sent abroad, the largest amount ever recorded. This stands in sharp contrast to other forms of energy: Britain imports around ¼ of its oil, ½ its gas and ¾ of its coal.

Britain had a trade surplus of 5% of electricity generated (8% exported minus 3% imported), with a net value of £500m per month. Britain's exports could have been higher if it wasn't for a fire at the IFA interconnector to France back in September 2021. This halved the link's capacity from 2 to 1 GW, with full service not expected until the end of this year.

Historically, Britain has been an importer of electricity, with an average of 8% of electricity coming from our neighbours over the last decade. This long-term trade imbalance stems from it being historically cheaper to import power than to generate more power here. France had cheap electricity from its large fleet of nuclear reactors, and more recently British power stations face an additional tax on the CO_2 they produce.

So, why the turnaround? Prices on the continent have risen even further than in Britain because of low capacity and gas supplies. France has suffered from extensive capacity shortages, with more than half of its 56 nuclear reactors offline either for summer maintenance, to repair corrosion and cracking in the reactor cores, or because they could not be cooled during the summer heatwaves. Germany is also suffering from a chronic shortage of gas as Russia is withholding exports.

Share of British electricity that was imported and exported each quarter.



A growing export market is good for producers, as they can earn more for their generation by selling abroad, and good for the country's balance sheet (the current trade deficit is £10 billion per month). But it can be bad news for consumers, as more competition for the electricity that is generated here pushes up prices – particularly unwelcome when prices are already at a crisis point.

Norway has threatened to impose export controls on electricity to protect consumers, as its hydro reservoirs fall to their lowest levels since 1996. Norway has been exporting more than usual to Germany, Denmark and the Netherlands in response to power shortages on the continent. Britain's electricity trade with Norway is more balanced though, importing 0.66 TWh and exporting 0.44 TWh over the last 3 months. Effectively, the UK has been paying Norway £117/MWh to use their enormous hydro storage to balance out our wind and solar farms.[1]

This suggests there is value in increasing the amount of pumped hydro energy storage in the UK. This is the main technology used for long-duration energy storage, which unlike batteries can charge for 8 or more hours at a time. This is essential for balancing weather-dependent renewable sources, such as solar power which needs to be shifted between day and night time, and wind has shortfalls and surpluses over timescales of days or even weeks. Britain has just under 3 GW of pumped hydro storage capacity, less than half that of comparable countries like Germany. Given that there is now 39 GW of wind and solar power, it is no wonder that the job of balancing their variability is being outsourced to neighbouring countries.

While the country's focus is all on the cost of energy, the threat of neighbours restricting their exports to us, or needing to import electricity from us, raises the issue of Britain's energy security. Coal-fired power stations are being paid around £250m to stay online for the coming winter, rather than continue their decommissioning. In August, the Rough gas storage facility gained approval to reopen after closing on economic grounds in 2017, nearly doubling the UK's capacity for storing natural gas. Meanwhile, National Grid conducted a four-day wargame exercise to prepare the energy system for all eventualities, amid fears of rolling blackouts if gas supplies fail to materialise during winter.

[1] The average wholesale price of electricity in Britain weighted by the amount imported from Norway, minus the price weighted by the amount exported to Norway.

5. How heat waves will change the power system

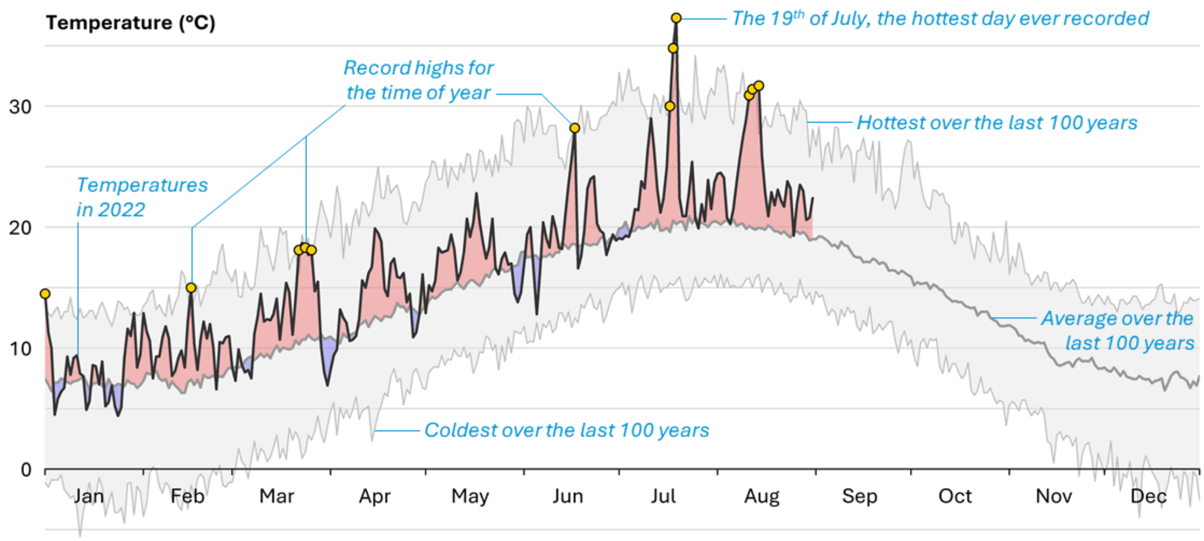
Never before has the UK experienced a 40-degree summer's day – temperatures normally reserved for holiday destinations like the south of Spain. On July the 19th Lincolnshire reached 40.3°C, breaking the national record by over 1.5 degrees. This was a big test for the country's infrastructure: railways buckled, airport runways melted, but the power system remained largely unscathed.

Heat waves are increasingly causing major problems for power systems around the world. Many of France's nuclear reactors had to shut off because the rivers were too hot to cool them. Meanwhile, low water levels in Germany's rivers threatened shortages of coal deliveries to power stations.

Closer to home, the heat wave left the UK 'very close' to a shortfall in electricity supply. This was not caused by plant outages, but rather the hot weather simply made power stations and transmission wires less effective. Thermal power stations need to cool steam back to water as part of their thermodynamic cycle (hence the iconic cooling towers seen at many power stations). This is harder to do when it is hotter outside. At 40°C (a typical summer temperature in Saudi Arabia), a gas-fired power station can expect its capacity to be reduced by 13%, and its efficiency by 7% compared to when running at 20°C (the UK's typical summer temperature).[2] Now that the UK has experienced Saudi temperatures, its power station output was similarly degraded.

It is not only supply, but also demand that has been impacted. Across the US, Texas, California and Illinois had to ask citizens to turn down their air conditioning to prevent blackouts. Japan had to scale back industrial production and limit air conditioner use,

Maximum daily temperatures in central England through 2022, set against the range of temperatures seen from 1922–2021. Red areas indicate days that were warmer than average, blue areas show those that were colder than average.



[2] Ambient temperature derating data from Wärtsilä and ADG Efficiency.

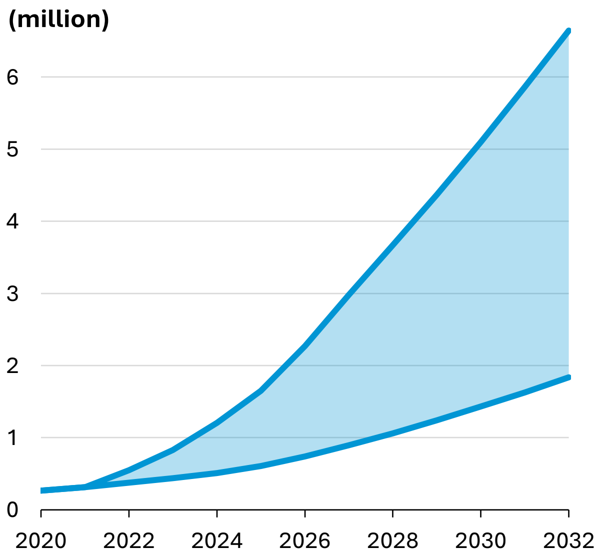
and parts of China have suffered the worst heat wave ever recorded, with several provinces completely halting industrial production for several weeks to keep the lights on.

Britain also saw increased electricity demand during the heat wave due to air conditioning and refrigeration loads. The effect was muted though, with demand on the 19th only 6% higher than the same day the week before and after. Even so, there was a 70% expected chance of demand outstripping supply on July the 18th, as this increase came at a time when demand would normally be low, and so power stations were offline for routine maintenance. Electricity prices surged to nearly £750/MWh the following day (high, even by current standards), in much the same way as they do during the coldest winter spells.

Currently only 1 in 20 UK homes have air conditioning. This will undoubtedly increase as people struggle with the increasingly hot weather, and sales of air conditioning systems soared in the weeks around the heat wave. As part of the efforts to decarbonise heating, it is expected that millions of households will install heat pumps over the coming years. Air-to-air heat pumps can also operate as air conditioning units, and National Grid's modelling expects these to take off rapidly in the coming decade. Ten years from now there could be between 7 and 25 times more units installed than at present, meaning the demand surges we see in future summers could be much more difficult to accommodate.

Going forwards, Britain should not only expect more frequent and more intense heatwaves, but also that these will have a stronger effect on electricity demand due to changing consumer preferences.

Number of UK homes with heat pump air conditioners.
Range of projections from National Grid's Future Energy Scenarios.



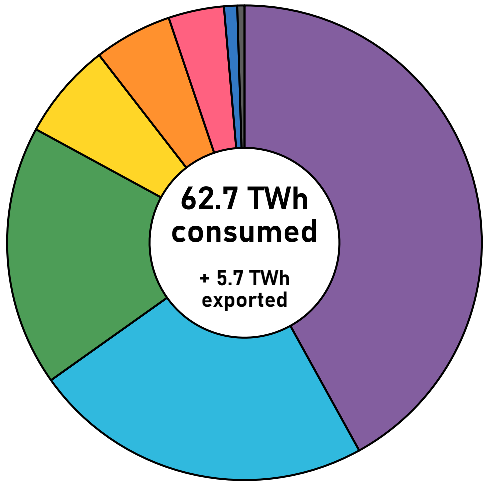
6. Capacity and production statistics

Despite gas prices reaching record highs, the share of electricity produced from gas actually increased over the last year. It supplied more than two-fifths of electricity over the past quarter.

Wind output was up by two-fifths on this time last year, a welcome relief that stemmed the increase in gas generation somewhat.

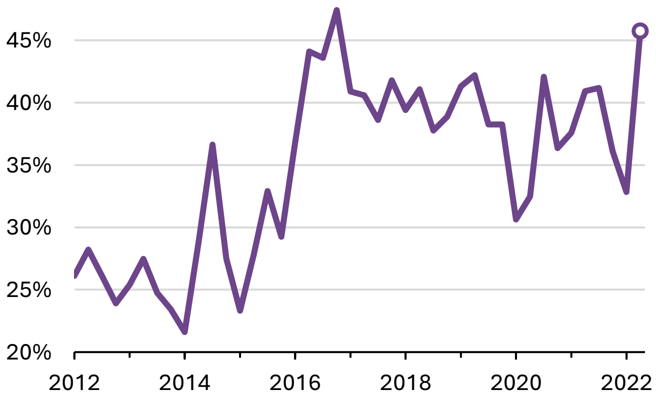
These changes were dwarfed by the change in trade though, exports were five times higher than the same quarter last year, and imports down two-thirds.

Britain's electricity supply mix in the second quarter of 2022



Share of the mix	
Gas	42.0%
Wind	23.2%
Nuclear	17.8%
Solar	6.6%
Biomass	5.3%
Imports	3.8%
Hydro	0.9%
Coal	0.5%

The quarterly average share of electricity from gas



Installed capacity and electricity produced by each technology [3] [4]

	Installed Capacity (GW)		Energy Output (TWh)		Utilisation / Capacity Factor	
	2022 Q2	Annual change	2022 Q2	Annual change	Average	Maximum
Nuclear	8.4	~	12.1	+1.4 (+13%)	67%	77%
Biomass	3.8	~	3.6	−1.4 (−28%)	44%	100%
Hydro	1.2	~	0.6	−0.0 (−6%)	25%	62%
Wind	25.3	+1.0 (+4%)	15.9	+4.5 (+39%)	29%	79%
..of which Onshore	13.6	~	7.5	+2.6 (+52%)	26%	78%
..of which Offshore	11.7	+1.0 (+9%)	8.3	+1.9 (+29%)	33%	84%
Solar	13.5	+0.2 (+1%)	4.5	−0.0 (−1%)	16%	67%
Gas	27.7	+0.1 (+0%)	28.7	+1.6 (+6%)	48%	76%
Coal	3.8	~	0.3	−0.2 (−39%)	4%	39%
Imports	7.4	+1.4 (+23%)	2.4	−4.6 (−66%)	15%	70%
Exports			5.5	+4.5 (+453%)	34%	77%
Storage discharge	3.1	~	0.4	−0.0 (−4%)	7%	63%
Storage recharge			0.4	−0.0 (−1%)	6%	51%

[3] Other sources give different values because of the types of plant they consider. For example, BEIS Energy Trends records an additional 0.7 GW of hydro, 0.6 GW of biomass and 3 GW of waste-to-energy plants. These plants and their output are not visible to the electricity transmission system and so cannot be reported on here.
[4] We include an estimate of the installed capacity of smaller storage devices which are not monitored by the electricity market operator. Britain's storage capacity is made up of 2.9 GW of pumped hydro storage, 0.6 GW of lithium-ion batteries, 0.4 GW of flywheels and 0.3 GW of compressed air.

7. Power system records

Britain's wind farms hit a major milestone back in May, producing more than 20 GW for the first time. National Grid reported peak output hitting 19.916 GW, but our data which combines National Grid and Elexon data registered the total as 20.002 GW.

Over the first half of 2022, thirty of the records that we track were broken, mostly relating to renewable and low carbon generation hitting new highs, and fossil fuel output reaching new lows. Renewable energy sources (wind, solar, biomass and hydro) provided more than half the country's electricity throughout the month of February, and peaked at an instantaneous share of 73% of the country's demand.

Britain saw its cleanest ever electricity on New Year's Day, with the generation mix producing only 55 grams of CO_2 per kWh, the lowest ever for a day. This means 1,550 tonnes of CO_2 were produced by the electricity sector that day. This compares to 6,200 tCO_2 on New Year's Day last year, and a staggering 21,100 tCO_2 from the first day of 2009.

Given how electricity prices have risen, you might expect that the price records would have tumbled, but only the monthly-average price hit an all-time high. Extremely high but short-lived price spikes are common in normal times, as they are about acute shortages of capacity in specific hours. The current situation is a chronic increase in fuel prices which affects all hours.

The tables below look over the past decade (2009 to 2022) and report the record output and share of electricity generation, plus sustained averages over a day, a month and a calendar year.[5] Cells highlighted in blue are records that were broken in the first half of 2022. Each number links to the date it occurred on the Electric Insights website, so these records can be explored visually.

	Wind – Maximum	
	Output (MW)	Share (%)
Instantaneous	20002	64.8%
Daily average	17672	53.4%
Month average	14525	40.4%
Year average	7817	24.9%

	Solar – Maximum	
	Output (MW)	Share (%)
Instantaneous	9680	33.1%
Daily average	3386	13.6%
Month average	2651	10.0%
Year average	1372	4.4%

	Biomass – Maximum	
	Output (MW)	Share (%)
Instantaneous	3831	16.8%
Daily average	3316	12.9%
Month average	2849	8.8%
Year average	2216	7.1%

	All Renewables – Maximum	
	Output (MW)	Share (%)
Instantaneous	27852	72.8%
Daily average	21301	66.3%
Month average	18334	51.0%
Year average	11896	37.9%

[5] The annual records relate to full calendar years, so cover the period of 2009 to 2021.

	Gross demand	
	Maximum (MW)	Minimum (MW)
Instantaneous	60070	16934
Daily average	49203	23297
Month average	45003	26081
Year average	37736	30709

	Demand (net of wind and solar)	
	Maximum (MW)	Minimum (MW)
Instantaneous	59563	5094
Daily average	48823	8385
Month average	43767	18017
Year average	36579	21520

	Day ahead wholesale price	
	Maximum (£/MWh)	Minimum (£/MWh)
Instantaneous	1983.66	–72.84
Daily average	666.90	–11.35
Month average	236.85	22.03
Year average	112.66	33.88

	Carbon intensity	
	Maximum (g/kWh)	Minimum (g/kWh)
Instantaneous	704	18
Daily average	633	55
Month average	591	135
Year average	508	172

	All low carbon – Maximum	
	Output (MW)	Share (%)
Instantaneous	35104	92.1%
Daily average	27282	82.5%
Month average	23754	66.1%
Year average	18287	58.3%

	All low carbon – Minimum	
	Output (MW)	Share (%)
Instantaneous	3395	8.3%
Daily average	5007	10.8%
Month average	6885	16.7%
Year average	8412	21.6%

	All fossil fuels – Maximum	
	Output (MW)	Share (%)
Instantaneous	49307	88.0%
Daily average	43085	86.4%
Month average	36466	81.2%
Year average	29709	76.3%

	All fossil fuels – Minimum	
	Output (MW)	Share (%)
Instantaneous	1700	5.3%
Daily average	3476	11.7%
Month average	7382	24.3%
Year average	11336	36.1%

	Nuclear – Maximum	
	Output (MW)	Share (%)
Instantaneous	9342	42.8%
Daily average	9320	32.0%
Month average	8649	26.5%
Year average	7604	22.0%

	Nuclear – Minimum	
	Output (MW)	Share (%)
Instantaneous	2488	8.1%
Daily average	2665	10.3%
Month average	4232	12.9%
Year average	4956	15.4%

	Coal – Maximum	
	Output (MW)	Share (%)
Instantaneous	26044	61.4%
Daily average	24589	52.0%
Month average	20746	48.0%
Year average	15628	42.0%

	Coal – Minimum	
	Output (MW)	Share (%)
Instantaneous	0	0.0%
Daily average	0	0.0%
Month average	0	0.0%
Year average	499	1.6%

	Gas – Maximum	
	Output (MW)	Share (%)
Instantaneous	27131	72.6%
Daily average	24210	62.2%
Month average	20828	54.8%
Year average	17930	46.0%

	Gas – Minimum	
	Output (MW)	Share (%)
Instantaneous	1556	4.7%
Daily average	3071	9.5%
Month average	6775	19.9%
Year average	9159	24.6%

	Imports – Maximum	
	Output (MW)	Share (%)
Instantaneous	5906	22.5%
Daily average	5047	17.6%
Month average	4276	15.3%
Year average	3333	10.3%

	Exports – Maximum	
	Output (MW)	Share (%)
Instantaneous	-5662	-20.6%
Daily average	-4763	-14.1%
Month average	-3098	-9.8%
Year average	-731	-1.9%

	Pumped storage – Maximum[6]	
	Output (MW)	Share (%)
Instantaneous	2660	7.9%
Daily average	409	1.2%

	Pumped storage – Minimum[6]	
	Output (MW)	Share (%)
Instantaneous	-2782	-10.8%
Daily average	-622	-1.7%

[6] Note that Britain has no inter-seasonal electricity storage, so we only report on half-hourly and daily records. Elexon and National Grid only report the output of large pumped hydro storage plants. The operation of battery, flywheel and other storage sites is not publicly available.

Drax Group plc
Drax Power Station, Selby, North Yorkshire, YO8 8PH
www.drax.com
@DraxGroup

Imperial Consultants
58 Prince's Gate, Exhibition Road, London, SW7 2PG
www.imperial-consultants.co.uk
@ConsultImperial