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Electric Insights Quarterly

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Headlines

This quarter, Britain's power system hit a major green milestone that would have been unthinkable just a few years ago. The installed capacity of renewables has overtaken that of all fossil-fuelled technologies combined. A third of Britain's coal, gas and oil capacity has retired over the last five years, while the capacity of wind, solar, biomass, hydro and other renewables has tripled (see Article 1). Now standing at a combined 42 GW, renewables now dominate Britain's electricity generating infrastructure.

The rising costs of gas and carbon emissions have had effects throughout the power sector this quarter. In August, coal replaced gas as the cheapest fuel for generating electricity, sparking fears about carbon emissions from the power sector rising. These cost increases have passed through into the price of electricity, which rose to its highest levels for a decade. The cost of balancing the power system also hit a 10-year high as more weather-driven renewables and fewer flexible gas stations were producing.

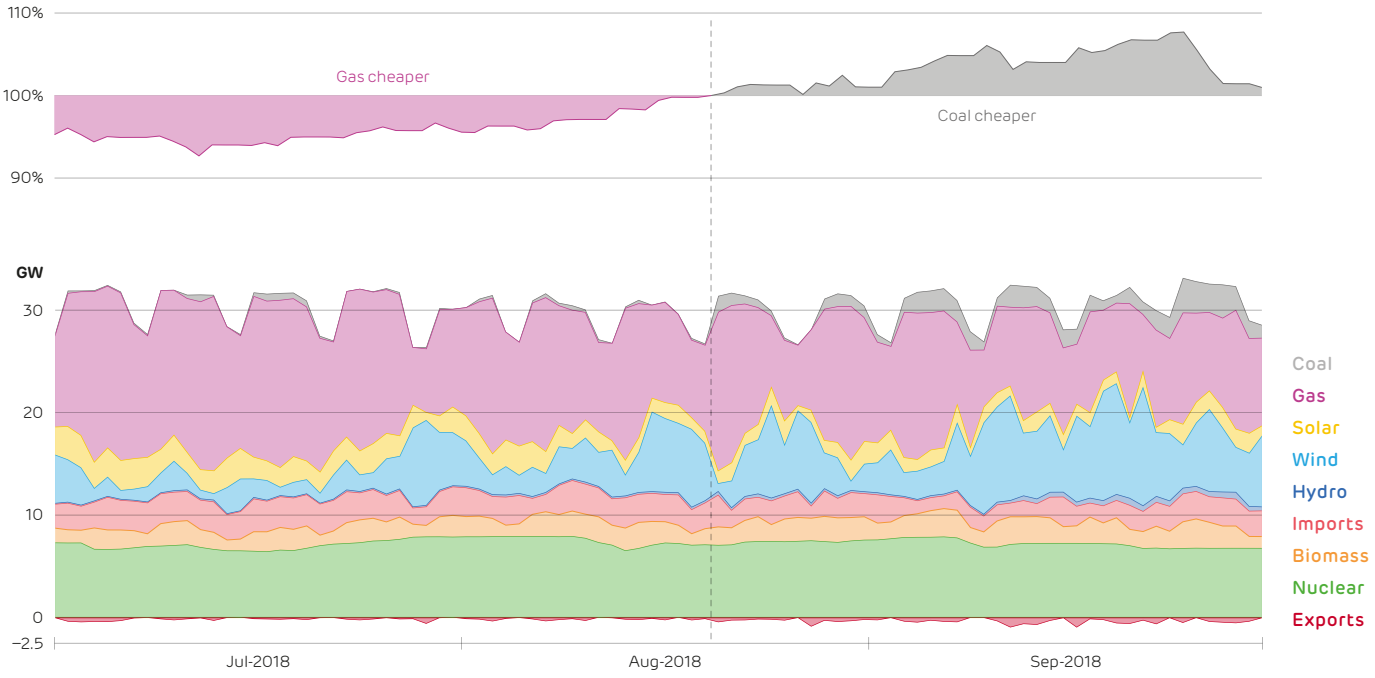
Around August 20th it became cheaper, on average, to generate electricity from coal than from gas for the first time since 2015. Article 2 explores the impacts of coal being 'in the money' once again as gas and carbon become more expensive, and the competing pressures now facing the sector: wanting to contain price rises whilst not reversing the progress seen in decarbonising electricity.

Article 3 looks at the impact that rising costs have had on wholesale electricity prices. Day-ahead prices have risen 50% over the last twelve months to reach a 10-year high. This will spell bad news for consumers if those costs get passed on.

Continuing the theme of rising prices, Article 4 reveals that the cost of running the transmission networks has also hit a 10-year high. The cost of keeping the system stable has doubled in the last four years, partly due to the increased cost of using gas for balancing actions, but also the increasing share of wind and decreasing share of flexible generation.

Article 5 finishes with statistics on the capacity and production for the quarter.

The cost of generating electricity from gas relative to coal (top), and the generation mix over the quarter (bottom)

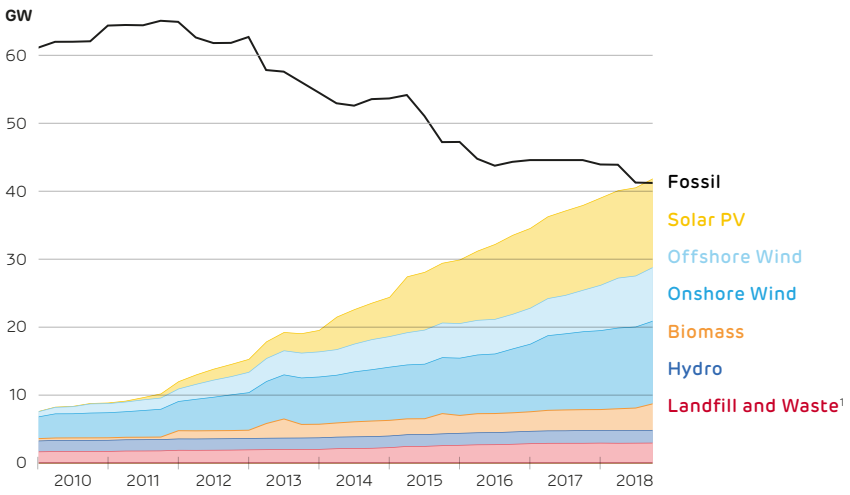


1. Renewables leapfrog fossil capacity

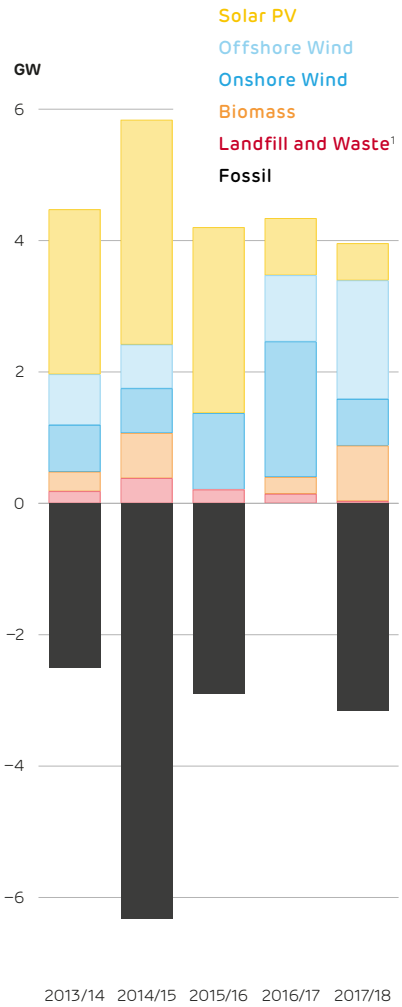
Britain's power system is slowly but surely walking away from fossil fuels, and this quarter saw a major milestone on the journey. At the start of this decade, Britain had seven times more generating capacity from coal, oil and gas as it had from renewables. But since their peak, 40% of Britain's fossil-fuelled plants have retired as they reached the end of their lives or became uneconomical, meaning Britain now has just 41.2 GW of fossil capacity. Meanwhile, renewable capacity has grown six-fold since the start of the decade; so wind, solar, biomass, hydro and waste[1] now stand together at 41.9 GW of capacity, outstripping fossil plants for the first time.[2]

The roll-out of new renewables has eclipsed the capacity growth seen during the 1990s 'dash for gas'. At its peak, Britain was building 2.4 GW of new gas-fired power stations each year. So far this decade, an average of 3.8 GW of new renewable capacity was built, made up of 1.0 GW of onshore wind, 0.8 GW of offshore wind, 1.4 GW of solar and 0.4 GW of biomass.

The total installed capacity of renewable and fossil power stations in Britain



Capacity additions and retirements over the last five years (ending October)



Wind farms form the largest share of Britain's renewables, and wind smashed through the 20 GW mark in September. RenewableUK report that it took 19 years to build Britain's first 5 GW of wind capacity, but only 2 years to build the most recent 5 GW. There are 13 GW of onshore wind farms, about two-thirds of which in Scotland. The 7.2 GW of offshore capacity makes Britain the world's leader, with 45% of global capacity. So far this year, Galloper, Rampion, Race Bank and Walney 3 have come online, making Walney the world's largest offshore wind farm (at 0.66 GW).

Solar power has the second largest capacity of renewables. 13 GW of solar panels are distributed across 960,000 rooftop systems and numerous larger farms, primarily across the south of England. Capacity growth has slowed in the last two years (see chart above right, and chart below), but subsidy-free solar projects are beginning to appear as the cost of panels continues to fall.

1 Includes landfill gas, energy to waste, anaerobic digesters and animal biomass.
2 This article shows all types of renewable and fossil capacity, including smaller generators that are normally invisible to Electric Insights. Data is taken from BEIS Energy Trends, RenewableUK and Electric Insights databases. In particular, this article includes waste-to-energy plants, diesel engines, and smaller hydro and biomass plants do not participate directly in the electricity market or report their output to National Grid.

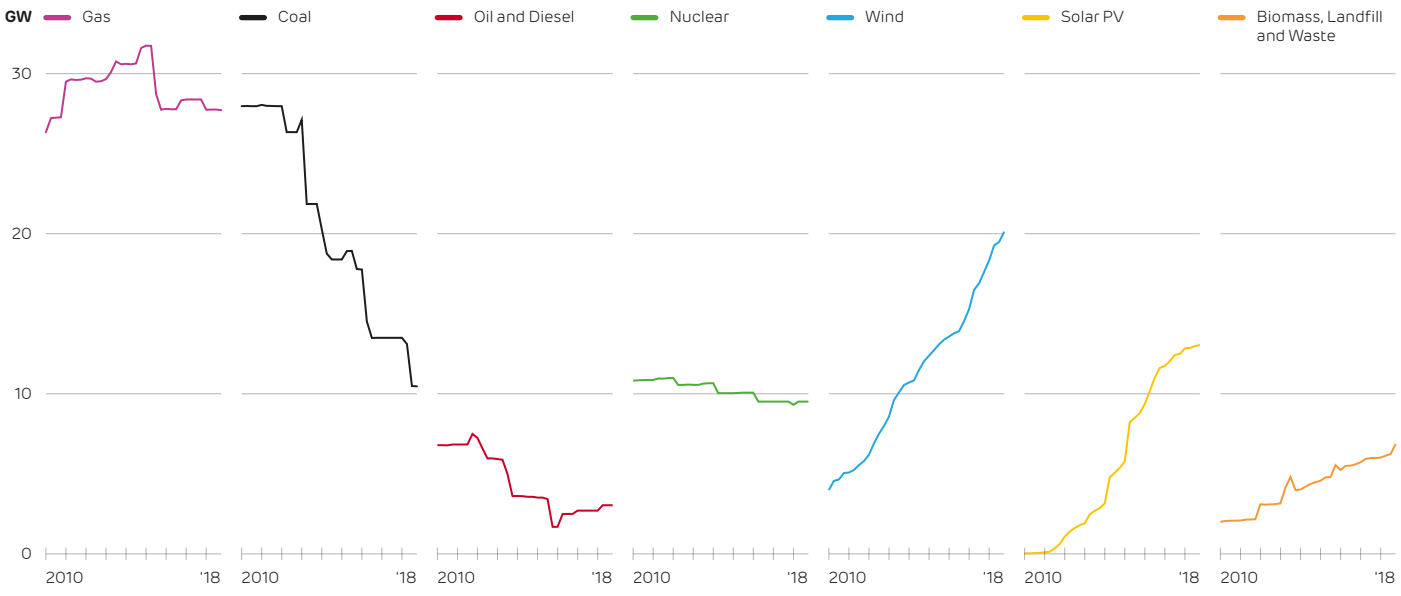
Biomass is now the third largest renewable generator, and formed one-fifth of new renewable capacity added in 2017/18.[3] Two coal-to-biomass conversion plants came online, Lynemouth in Northumberland, and Drax's Unit 4 in Yorkshire, together adding more than 1 GW of capacity. Britain also has hundreds of smaller plants which produce electricity by burning various forms of waste.

The fall in fossil capacity has come mostly from coal plants retiring (see chart below). A quarter of the country's coal capacity has retired in the last year, leaving just six generators in the country. The remaining stations have contracts in the capacity market which keep them economically viable, but some of these expire as soon as 2019.

However, unabated gas capacity will remain for the next few decades, and may soon increase as a new gas power stations are being developed in Keadby, Lincolnshire and on the site of the recently-closed Eggborough coal power station in Yorkshire. Similarly, small gas and diesel reciprocating engines are appearing throughout the country, as a cheap (but polluting) supplier of peak capacity and balancing services.

The evolving capacity mix will undoubtedly change how the power system operates. These stats show we are making rapid progress on shifting generation capacity to renewable and low-carbon sources. The next challenge is to make the most of these sources in order to deliver savings to consumers and the environment. That requires a smarter and more flexible power system, as recommended by the National Infrastructure Commission and the government's Smart systems and flexibility plan. Big questions remain on how best to integrate weather-driven renewables, how far we should decentralise the power system and how to make the markets work for smart and flexible technologies.

Installed capacity for different types of generation (fossil left, renewable right)



3 The twelve months to October 2018

2. Coal comeback pushes up UK's carbon emissions

10-year high gas prices4 have prompted a resurgence in coal-fired power across Britain – and with it a 15% increase in carbon emissions from electricity generation. If coal-fired electricity remains cheaper than gas-fired (as analysts predict), we could see the first year-on-year rise in carbon emissions from Britain's power sector in six years. This highlights the importance of retaining a strong carbon price if we are to ensure the successful decarbonisation of the power system is not reversed.

After dropping to a historic low of just 0.2 GW during June and July, Britain's coal power generation doubled in August, and has shot up to peaks of over 5 GW during September. The last time coal output was this high was during the Beast from the East, when temperatures plummeted in March.

With these coal power stations running instead of more efficient gas plants, Britain is producing an extra 1,000 tonnes of carbon dioxide (CO_2) every hour.[5] Carbon emissions from electricity generation are up 15% as a result. These coal plants are not running solely because they are needed to meet peak demand, but because gas prices have risen sharply and carbon prices have not kept up, making coal power stations more economic to run than gas-fired ones.

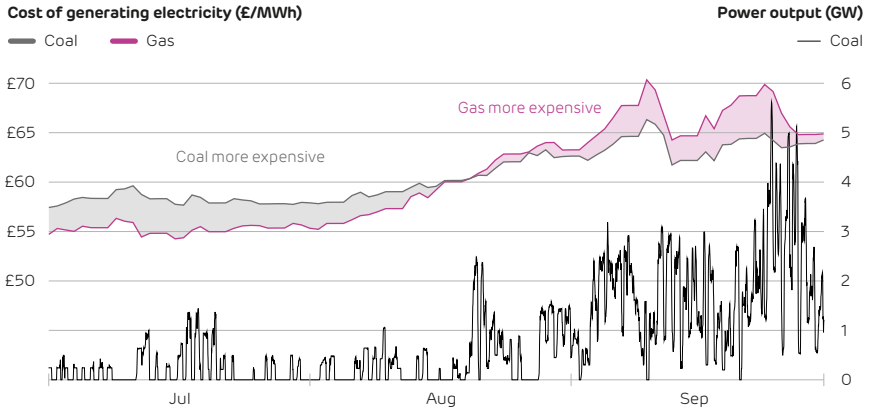
It became cheaper to generate power from coal than from gas (see thick lines, chart below) in late August. Even though carbon prices now double the cost of generating electricity from coal,[6] coal plants are consistently "in the money" at the moment, meaning they can generate power profitably all day and night.

4 The three-month average cost of generating electricity from gas exceeded £60/MWh for the first time since 2009. Short-term price spikes have been higher than this, such as the first week of March during the Beast from the East.

5 Extra generation from coal reduces the output from gas plants, which are their main competitors, as nuclear, wind and solar already run as much as possible. Calculation based on 1934 MW of coal generation (the average during the first week of September) emitting 937 gCO_2 per kWh (1812 tonnes per hour) instead of gas generation which would have emitted 394 gCO2 per kWh (762 tonnes per hour).

6 The coal that must be burnt to produce 1 MWh of electricity now costs around £31, and the CO_2 pollution costs an extra £31 on top. For comparison, producing 1 MWh of electricity from gas costs £50 for the fuel and £15 for the CO_2.

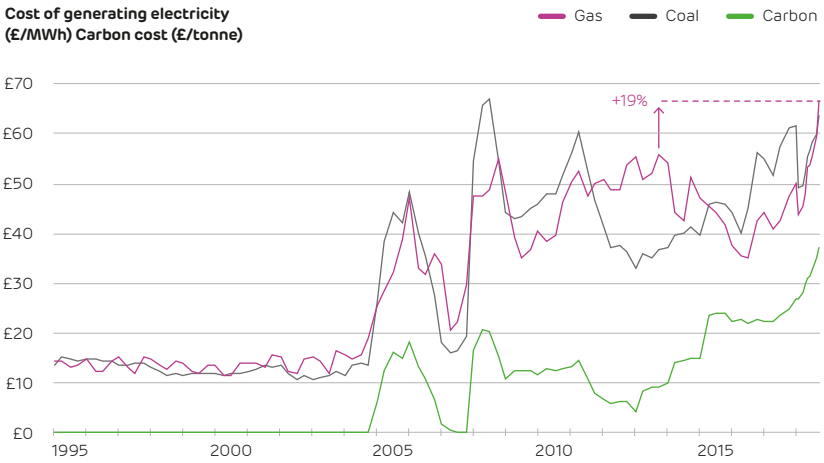
Estimated cost of generating electricity from coal and gas in Quarter 3 (thick lines), and the output from coal power stations in Britain (thin line)



The cost of emitting CO_2 has increased sharply, up 45% so far this year due to the ongoing rally in European Emissions Trading Scheme (EU ETS) prices. Rising carbon prices should make gas more economical to burn as it emits less than half the CO_2 of coal.

However, wholesale gas prices have also risen 40% since the start of the year, as supplies and storage are squeezed in the run up to winter. Gas prices are at a ten-year high, currently 19% above their previous quarterly-average peak back in 2013 (see chart below). These rising costs are feeding through into wholesale power prices, which have risen by a third over the past year to hit £60/MWh.

The estimated cost of generating electricity from fossil fuels over the last 20 years, along with the cost of emitting CO_2



Britain's carbon price strengthened dramatically through 2014–15 due to the government implementing a Carbon Price Support scheme. This caused gas to become competitive against coal for power generation, leading to carbon emissions from the power sector halving. Unless Britain's carbon price can once again make up the gap between coal and gas prices, we risk rolling back some of the world-leading gains made on cleaning up our electricity system.

The Committee on Climate Change has made it clear that power is the only sector that is pulling its weight when it comes to decarbonising the UK. Clean electricity could power low-carbon vehicles and heating, but this opportunity will be wasted if the electricity comes from high-carbon coal.

So what can be done? The sharp rise in gas prices hints at a lack of flexibility in the energy system. Britain came uncomfortably close to gas shortages in March, in part due to the closure of the country's largest gas storage site. With nearly half of the electricity generated in Britain coming from gas, plus five-sixths of household heat, diversifying into other – cleaner – energy sources would help insulate consumers and businesses from price spikes.

No one country has the power to determine international fuel prices. Several factors have come together to push up gas prices, including a lack of transmission capacity, depleted stores of gas after the long hot summer and a lack of wind power increased output from gas-fired stations. Suppliers which don't wish to be caught short after the Beast from the East, are also stocking up on gas.

Any knee-jerk reaction to try and lower the cost of electricity (for example, slashing the cost of carbon emissions) may only have a short-term impact, and could easily lead to longer-term damage (such as the resurgence of coal) which would require further interventions in the future.

Britain does have control over its carbon price. Its power stations and industry currently pay the Emissions Trading System price (determined on the Europe-wide market) which has fluctuated wildly over the past week between €25 (£22) and €19 (£17) per tonne, plus £18 per tonne in Carbon Price Support which goes to the Treasury. This needs to be maintained or strengthened further to save the power system from backsliding, and to show strong climate leadership on the international stage.

3. Wholesale power prices hit a 10-year high

Power prices have risen by 50% in the last year due to the rising cost of gas and carbon emissions, and uncertainty around Brexit weakening the pound. Electricity on the day-ahead market averaged £60/MWh over the quarter, up from £42/MWh this time last year. Rather than seeing extreme price spikes as in previous years or during specific events such as the Beast from the East, day-in day-out baseload prices have been creeping up as the year progresses. Consumers may see price rises going into the winter, giving the opportunity to switch to a cheaper, and greener, tariff.

Electricity generators are facing sustained pressure on three fronts: the cost of natural gas has been climbing since August, the price paid for emitting CO_2 emissions has risen throughout the year, and the pound remains weak against foreign currencies.

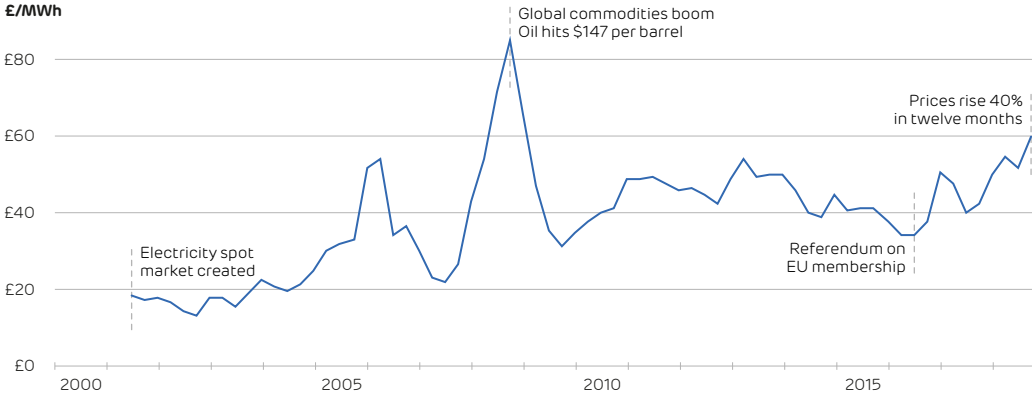
Gas prices have risen 50% since June. The growth of liquified natural gas (now 9% of Britain's gas supply) has globalised the gas market, and so soaring demand from China pushes up gas prices at home. This is especially important as gas power stations exert six times more influence in setting the price of power than any other technology in Britain. Gas stations are more dominant in Britain than in other European markets, and more dominant now than ever before, as they are the primary source of flexible capacity.

Secondly, the price of emitting CO_2 on the European Emissions Trading Scheme (ETS) has quadrupled in the past 12 months. This comes after many years of hovering around €5 per tonne as many governments had issued so many permits to pollute that the market was flooded.

Thirdly, energy is an international commodity. Gas prices are linked to oil (traded in US dollars), carbon permits are priced in Euros, and even domestically produced fuels (now just 44% of the UK's gas) can be exported easily, so their value is determined internationally. This matters because the pound fell against the Euro and Dollar since the EU referendum. Analysis for Ofgem shows that the Brexit vote caused an 18% increase in electricity prices, primarily because of the currency devaluation.

Little can be done about international fuel prices. Weakening Britain's carbon price support could make electricity cheaper, especially from coal-fired stations. But the six remaining coal stations have little ability to set power prices, so price reductions would be muted while the cost of gas remains high. A longer-term strategy would be to further diversify into other energy sources, particularly renewables which can lock-in long term fixed prices and break free from the volatility of fossil-fuel markets.

Average wholesale electricity price each quarter since the electricity spot market was created in 2001



4. The cost of staying in balance

Not only has the cost of generating electricity been rising, the cost of balancing the system has also hit a 10-year high. The day-to-day costs of running the transmission system, which National Grid passes on to all generators and consumers (but not to interconnectors), has doubled over the last four years.

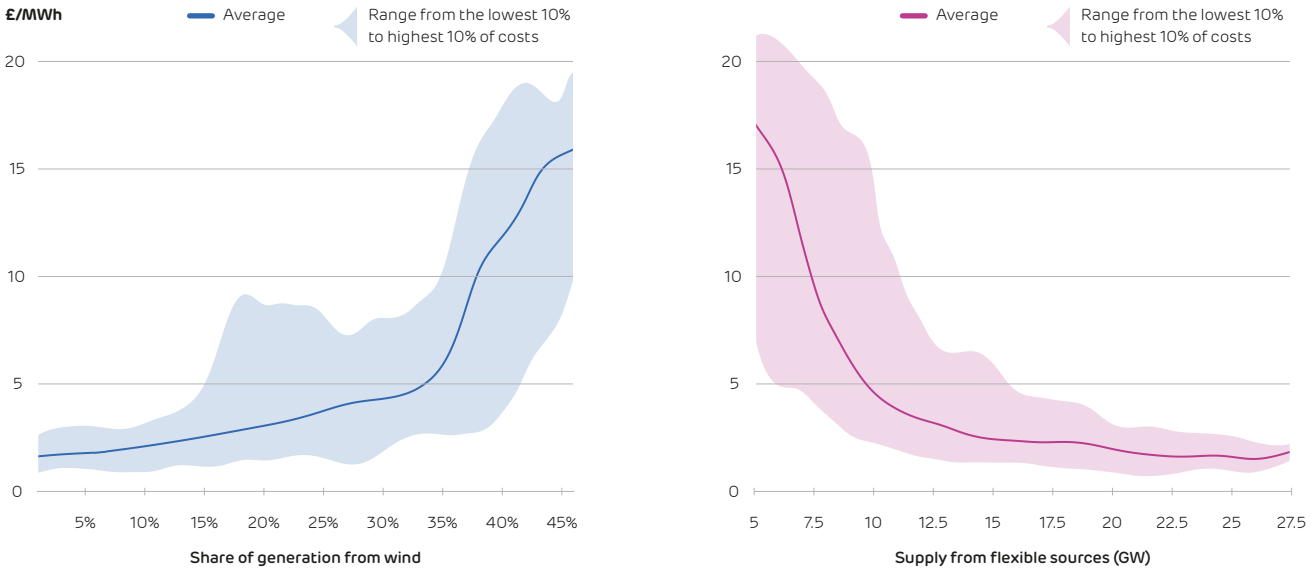
Balancing the power system cost £3.8m per day over the quarter, adding 6% to wholesale prices. On three days this quarter, the cost of keeping the system stable exceeded £10 million per day. This daily cost has been gradually increasing since 2010, but the cost this quarter was one-sixth higher than the previous record (2017 Q3).

These balancing costs include deploying fast-responding generators for backup and reserve, and adjusting the output of generators around the country to keep the transmission system within operating limits. The growing costs highlight the importance of when and where – rather than just how much – electricity is produced and consumed. Over the quarter, there were 58 hours when managing electricity flows around the system cost more than generating the electricity in the first place.

During September, the balancing costs spiked several times when wind output was high. The chart below left shows how balancing costs increase sharply once wind farms supply more than a third of Britain's electricity. Wind cannot be forecasted with perfect accuracy, and generation occurs far from places where electricity is consumed, causing network constraints. Both of these must be corrected using short-term dispatch of flexible sources, which incurs balancing costs.

The amount of flexible generation on the system is another key driver of the balancing cost. The chart below right shows that balancing costs rise when the output from flexible generators (gas, coal, biomass and hydro) is below 10 GW. Having a 'brittle' power system with limited room for manoeuvre will be expensive to control. More flexible generation, storage and demand-side response will be critical to minimising these system costs in future.

Influence of wind and flexible generation on the balancing cost[7] during 2018 Q3



7 The Balancing Services Use of System (BSUoS) charge.

5. Capacity and production statistics

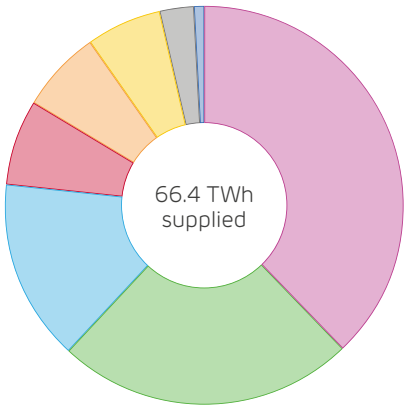
Low-carbon sources reached an all-time record by producing over 60% of Britain's electricity in September. Over the quarter they averaged 57%, also a new record.

Biomass, wind and solar each produced 11–24% more electricity than in Q3 2017, while gas produced 10% less. Coal output was also down by 3% (0.7 TWh) compared to the same three months of last year. Comparing 2018 to 2017, coal output was 70% lower in both July and August, and then 50% higher in September – highlighting the strength of coal's comeback.

Gross electricity demand was similar to this quarter last year, but demand net of variable renewables (i.e. supplied by major power stations) reached record lows. Over the quarter, net demand averaged 23.8 GW, and in September it fell to 22.5 GW.

Over the past twelve months, biomass capacity has increased almost 50% to 3.2 GW, whilst coal capacity fell by nearly a quarter. Nuclear and biomass stations were the most intensively used over the quarter, whilst coal power stations were among the least utilised. That said, the average capacity factor of coal plants increased by a fifth compared to this quarter last year, due to September's surge in output.

Britain's electricity supply mix in the third quarter of 2018



	% of mix
Gas	37.8%
Nuclear	24.1%
Wind	14.7%
Imports	7.2%
Biomass	6.5%
Solar	6.2%
Coal	2.6%
Hydro	0.8%

Installed capacity and electricity produced by each technology[8]

	Installed Capacity (GW) 2018 Q3	Annual change	Energy Output (TWh) 2018 Q3	Annual change	Utilisation / Capacity Factor 2018 Q3	
					Average	Maximum
Nuclear	9.5	~	16.0	–0.8 (–5%)	77%	84%
Biomass	3.2	+1.0 (+46%)	4.3	+0.9 (+25%)	70%	96%
Hydro	1.1	~	0.5	–0.2 (–26%)	22%	88%
Wind	20.2	+2.3 (+13%)	9.8	+0.9 (+11%)	22%	66%
Solar	13.1	+0.7 (+5%)	4.1	+0.5 (+14%)	14%	70%
Gas	27.7	–0.6 (–2%)	25.1	–0.7 (–3%)	41%	73%
Coal	10.5	–3.0 (–22%)	1.7	–0.2 (–10%)	7%	54%
Imports	4.0	~	5.4	–0.3 (–5%)	62%	94%
Exports			0.6	+0.4 (+210%)	6%	51%
Storage[9]	4.2	+0.9 (+29%)	0.5	–0.1 (–17%)	7%	66%

8 Other statistical 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 small waste-to-energy plants. These plants and their output are not visible to the electricity system and so cannot be reported on here, hence the statistics in this table differ from those in Article 1.

9 This quarter we have begun report the installed capacity of smaller storage devices which are not monitored by the electricity market operator (i.e. batteries). Britain's storage capacity is made up of 2.9 GW of pumped hydro storage, 0.4 GW of flywheels, 0.6 GW of lithium-ion batteries and 0.3 GW of compressed air. The latter two have been installed in the last 12 months.

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