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Electric Insights Quarterly

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Headlines

This quarter we focus on the phase-out of coal at home and abroad, and the impacts of Britain's heat wave on demand and renewables. Electricity generation from coal has again fallen to new lows in Britain, to the point where summer months are almost coal-free. However, growing consumption in Asia means that the global phase-out of coal is at a complete stand-still.

[Article 1](#) explores the global trends in coal-fired electricity, and how the world has changed in the last 30 years. [Article 2](#) looks at the year so far in Britain, and how the summer has seen coal fall to less than 1% of the generation mix.

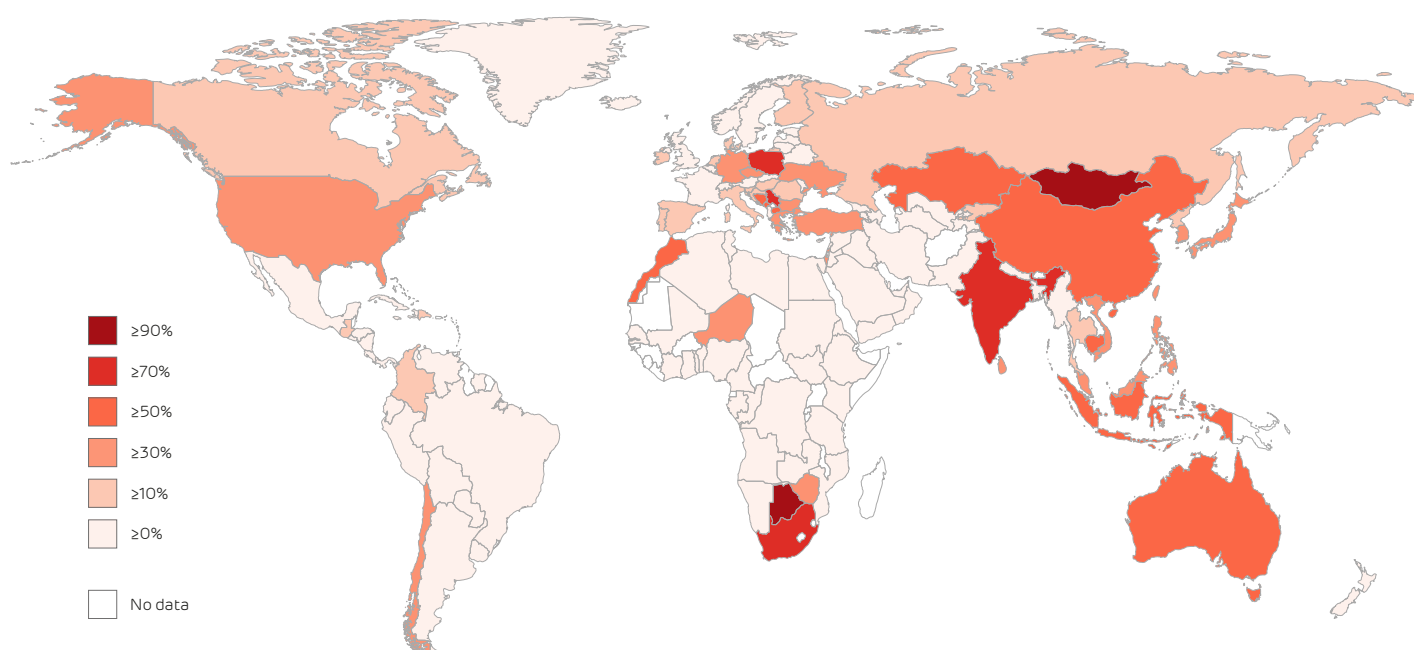
Last month the Committee on Climate Change released its progress report to Parliament, which sets out how Britain's power sector has made 'excellent progress', while cleaning up heat, transport and industry 'has stalled'.

[Article 3](#) asks whether progress in the power sector is about to get a lot harder? Coal is all but eliminated, investment in renewables is slowing, and new nuclear is still a decade away.

June 23rd marked the start of the strongest heat wave for a generation.

[Article 4](#) shows how this impacts on electricity demand due to air conditioning and refrigeration, with each extra degree of heat adding the equivalent of a million extra households to national demand. With the hot weather came clear and calm skies, meaning solar power was up and wind power down significantly on last year. Despite news of a 'wind drought' in Britain, [Article 5](#) shows that the calm periods were offset by increased solar and biomass output. [Article 6](#) finishes with statistics on the capacity and production for the quarter.

The share of coal in national power systems during 2017¹



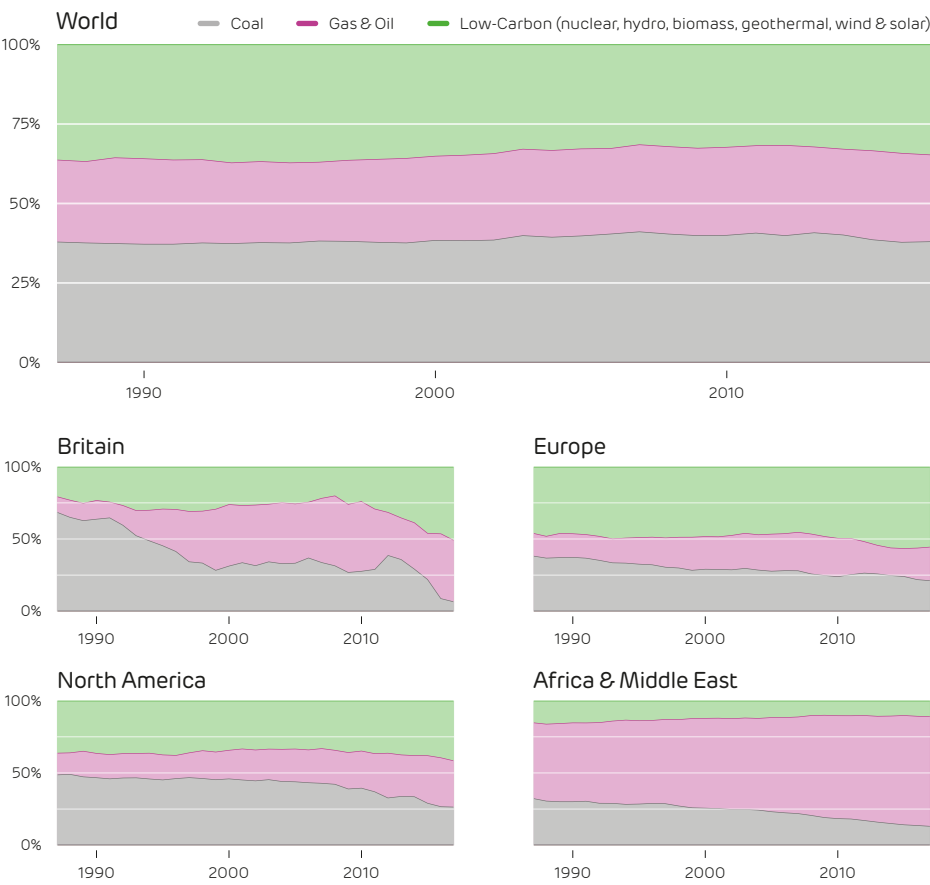
¹ Data from BP and the IEA. For countries where 2017 data were not available, the share of coal was estimated based on the trend from the most recent year available.

1. (Lack of) progress in global electricity generation

So much for powering past coal. Thirty years ago, coal provided 38% of the world's electricity. Today, it still provides 38%. This lack of movement on the global scale masks very different national trajectories (see charts, below). Progress in Europe and America is being counteracted by the rise of coal across Asia.

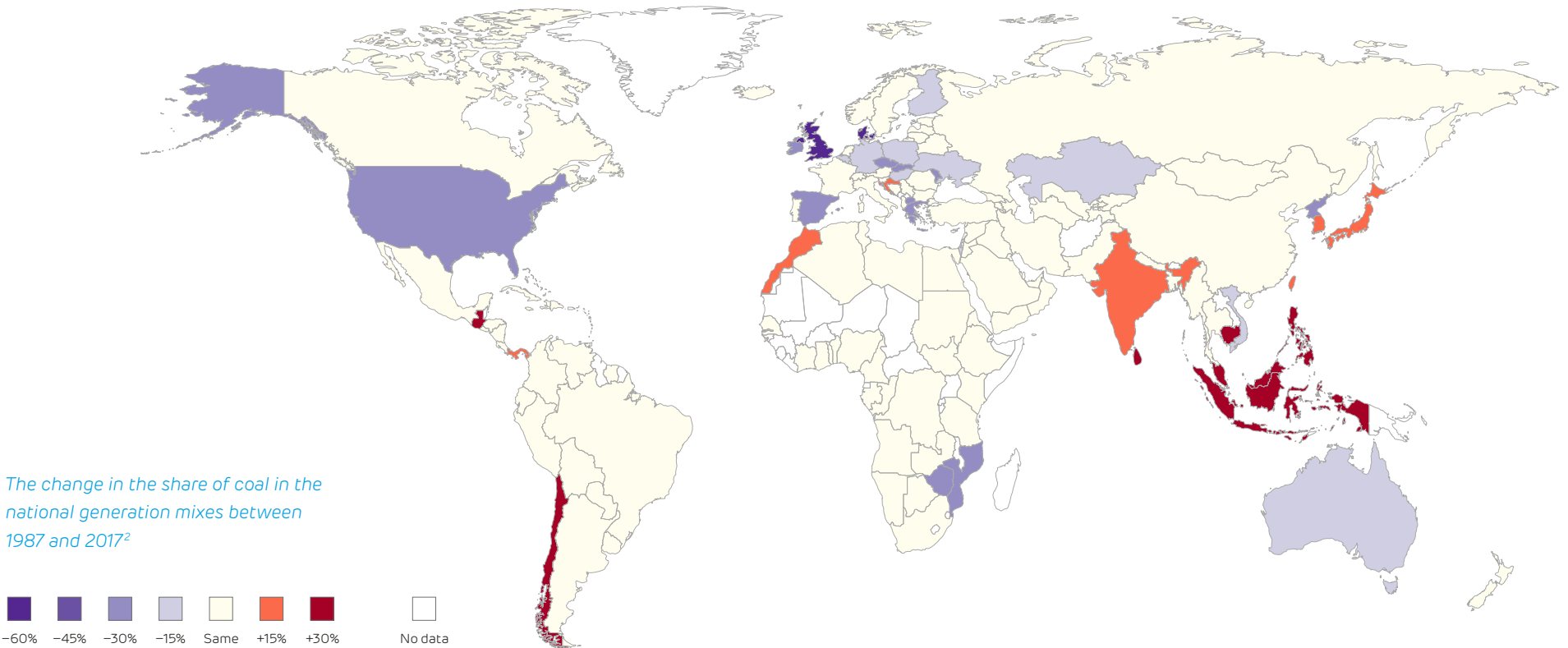
This may come as a shock given the rapid progress made with renewable energy over the last decade. Globally, some \$300 billion a year is being invested into new renewables, which has seen their share quadruple from 2% to 8% of electricity generation since 2007. However, this has done little more than to offset the fall in nuclear power and growth in demand for electricity.

The global share of electricity generation simplified into three categories²

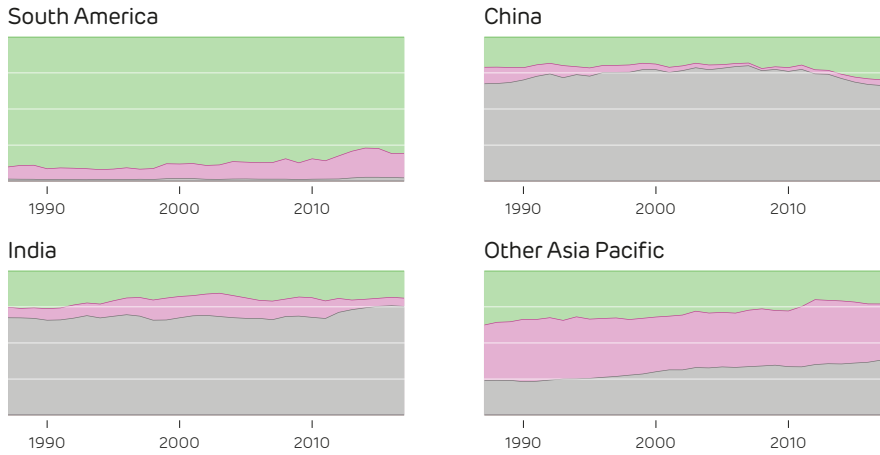


Coal has declined steadily in Europe (from 39% to 22% of electricity generation over the last thirty years), but it is still a significant source in Eastern Europe, particularly Poland and Serbia. The US has always used more coal than Europe, but is also falling steadily (from 57% to 31%). The latest pro-coal policies cannot trump the simple economics that gas is the cheaper fuel to use in America.

Africa and the Middle East mostly rely on their abundant supplies of natural gas and oil. The notable exception is South Africa, which still gets 88% of its electricity from coal.



The change in the share of coal in the national generation mixes between 1987 and 2017²



South America uses very little coal for its electricity due to the abundance of hydropower. While the share in most countries is rising, the average is from 1.7% to just 2.6% last year.

The Asia Pacific region has by far the heaviest reliance on coal, led by China and India. China's share steadily grew to a peak of 81% in 2007, but has since fallen to 67% as the government focused on improving air quality. Australia is the world's fourth largest coal producer, which powered five-sixths of its electricity generation until 1997. Over the last decade this has fallen to 61%.

Many Asian countries are strengthening their their reliance though: India maintained a two-thirds share of coal for the 1990s and 2000s, then increased it to 76% over the last 10 years. Indonesia (the world's 4th most populous country) has doubled its coal share from 30% to 58%; Japan has grown steadily from 15% to 34%; and South Korea from 28% to 46%. Of all the countries in Asia, North Korea is an unlikely climate champion for having halved its coal reliance to 20%.

As global demand for electricity is growing (especially in Asia), the trend in the absolute amount of coal used is bleak. China, South Korea and Indonesia now burn 10 times more coal for electricity than they did 30 years ago. Only 7 countries use less coal today than they did 30 years ago: Germany, Poland, Spain, Ukraine, the US, UK and Canada.

Last year the UK and Canada launched the Powering Past Coal Alliance, to promote the rapid phase-out of coal. Membership has grown to 60 countries, states and companies; however, further work is needed to recruit nations who are highly dependent on coal and cannot switch to other forms of generation without building new infrastructure.³

Still, the UK is leading by example: coal generation has fallen by four-fifths in just five years. If the world followed suit, one can only hope that in another thirty years, coal does not still provide 38% of global electricity.

² Data from the BP Statistical Review of World Energy and the IEA World Energy Balances.
³ I.A.G. Wilson and I. Staffell, 2018. Rapid fuel switching from coal to natural gas through effective carbon pricing. Nature Energy, 3, 365–372.

2. Britain edges closer to zero coal

For the third summer in a row, coal is edging closer to extinction in Britain, producing nothing for 12 days during June. Coal supplied just 1.3% of Britain's electricity over the quarter, and its share fell below 1% for the first time in June.

Britain is racking up more 'zero-coal' hours than ever before. No coal power stations were running for 812 hours during quarter 2 (37% of the time). There were as many coal-free hours this quarter as in the whole of 2016 and 2017 combined. Britain went for three days straight with no coal (76 hours) from the 21st to 24th of April, and saw two other runs more than 48 hours. The previous record was 40.5 hours in 2017.

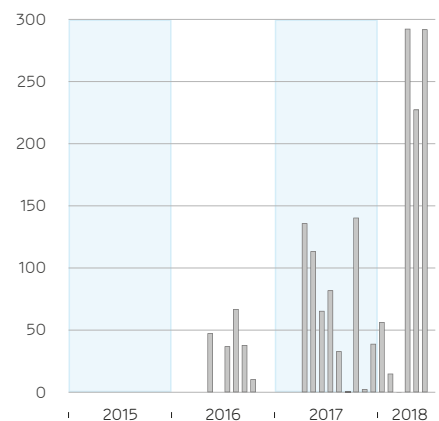
At the times when coal is running, it is now at a bare minimum. Apart from two cold spells in April, coal rarely went above 1 GW – just half the peak output of one of Britain's remaining coal-fired power stations. Overall, the fleet ran at just 3% of its rated capacity across the quarter. One question is why is this small amount still needed – could Britain simply run with no coal over the whole summer?

Yes, it likely could. Much of the coal output during May and June has been for system stability rather than providing bulk energy. National Grid called on specific coal stations in the North of England to balance the system, predominantly overnight. During June, coal stations produced 50% more output overnight than during the day, despite demand being one-third lower.

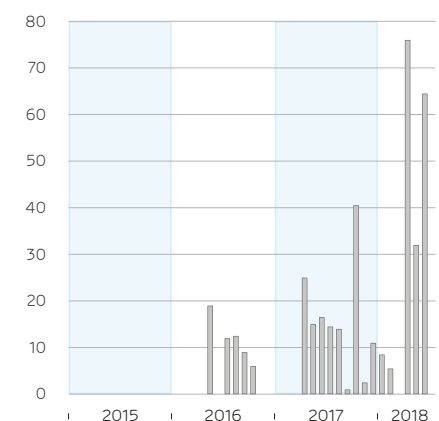
Coal was responsible for 6% of carbon emissions from generating electricity over the quarter (less than 1 million tonnes of CO₂). Meanwhile, gas supplied 41% of demand, and was responsible for 82% of emissions (11 million tonnes). So, while it would be a clear symbolic victory to remove coal from the system for entire months at a time, its impact on the climate in summer months is no longer significant. Using coal for balancing, if it happens to be in the right place and at the right price may be sensible [until there are more low-carbon forms of generation for system balancing](#).

The number of hours in each month with no coal output

Total zero-coal hours

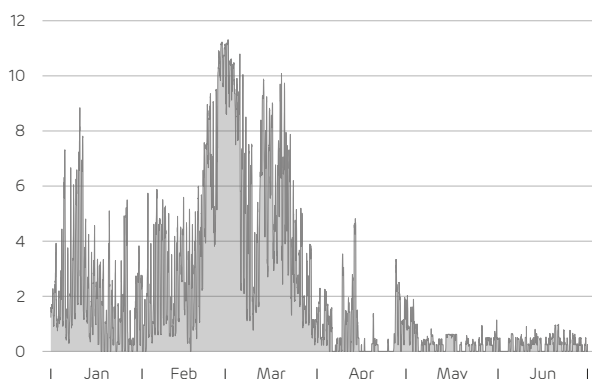


Longest zero-coal run



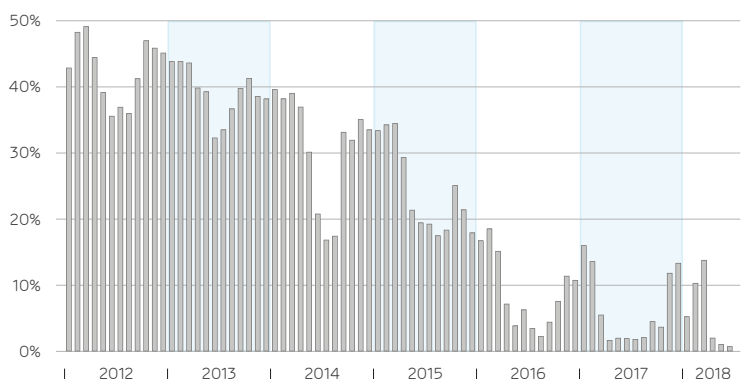
Hourly coal output during 2018

GW



The monthly average share of the generation mix

Share of generation from coal



3. Has Britain's power sector decarbonisation stalled?

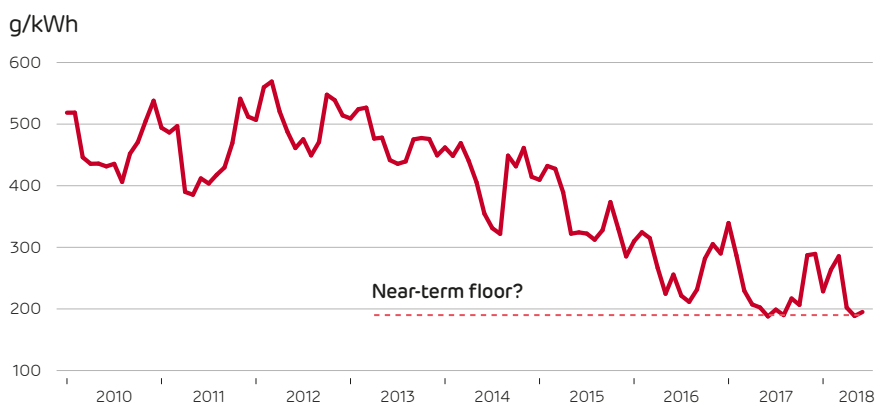
The UK has seen a remarkable reduction in carbon emissions from the power sector, but this rapid progress may be about to slow down. For the last four years, emissions reductions have been in the range of 12–24% per year, thanks to gas replacing coal, and renewables (plus imports of French nuclear power) displacing fossil fuels. Such progress could never go on indefinitely, and three factors mean that future emissions reductions are likely to be tougher and much slower:

1. the easiest option of removing coal is almost at its end;
2. growth in renewables is a more gradual process and is facing uncertainty; and
3. Britain will lose nuclear capacity as old plants will have retired before new plants can be built.

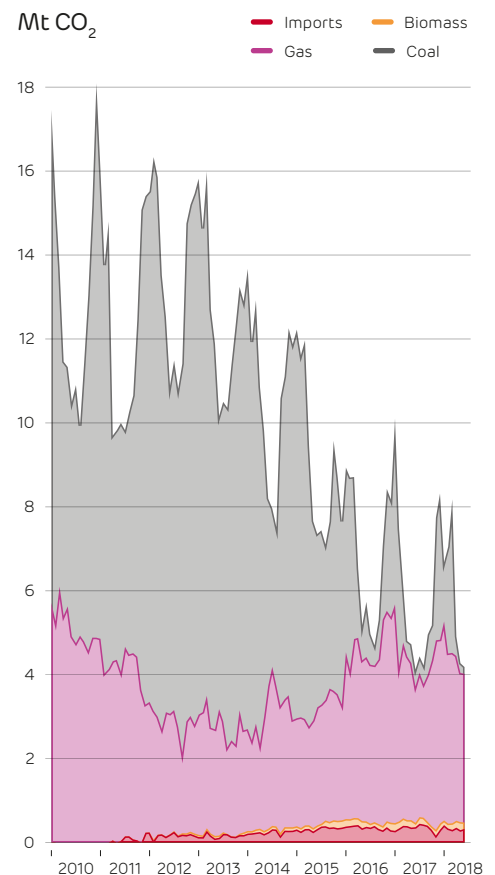
The era of slow progress may already be upon us. The carbon intensity of electricity generation in Quarter 2 averaged 195 g/kWh – a new record for Britain, but only 2% lower than achieved in Quarter 2 of 2017 (see chart below left). The reason is that generation during the summer months has settled on a similar pattern: 25% nuclear, 25% renewables, 40% gas, 8% imports and 2% coal. Until these shares start shifting, the recent experience of 200 g/kWh in summer and 275 g/kWh in winter will not budge.

Phasing out Britain's coal consumption has been a major success story. Coal has gone from supplying 43% of Britain's electricity in 2012 to 7% during 2017. This only fell slightly, to 6%, in the first half of 2018. Britain's coal power stations have gone from annual emissions of 129 to just 19 million tonnes of CO₂ over the last five years (see chart below right). This has corresponded with a small increase in emissions from gas, but the main issue is simply that the bulk of the emissions savings from closing coal plants have already been made. Government expects to phase out the remaining coal by 2025, meaning that future savings will happen at one-eighth of the current pace (19 Mt in eight years, versus 22 Mt per year over the last five years).

The monthly-average carbon intensity of electricity consumed in Britain



Carbon emissions from generating electricity each month by source



The growth of renewables has been the other big success. Output from renewables has increased five-fold since 2010, and now consistently supplies a quarter of Britain's electricity (see chart below left). However, while they have grown consistently, they have done so relatively slowly; increasing their share gradually by 3 percentage points per year.

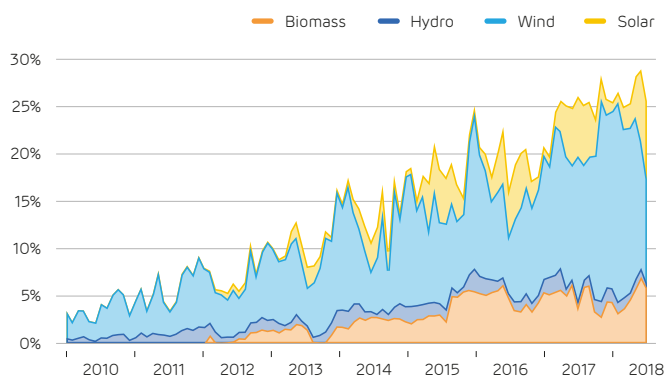
This growth has been fostered by policies that are either defunct or where future growth will be limited. Around 25 GW of renewables have a contract through the Renewables Obligation (RO), 10 GW with Contracts for Differences (CfDs), and 6 GW with microgeneration Feed-in Tariffs (FiTs). However, the RO is now closed to new entrants, it is not clear whether there will be further CfD auctions for the most mature technologies (onshore wind and solar), and the FiT for rooftop solar will close in April 2019. This leaves only the CfDs for less mature technologies (mainly offshore wind and onshore wind on remote Scottish islands), where the [government will allocate up to £557m](#) across multiple CfD auctions into the 2020s. It is perhaps less clear than ever how Britain's renewable capacity will grow over the next 10 years.

Thirdly, it is also unlikely that new nuclear power stations will plug the gap in emission reductions. Britain's nuclear fleet is growing old, and [half are expected to close for safety reasons by 2025](#), before [Hinkley Point C comes online](#). EDF, which operates all British nuclear plants, is seeking lifetime extensions for the existing plants, but it is widely expected that nuclear capacity will dip in the coming decade before recovering in the 2030s (see chart, below right).

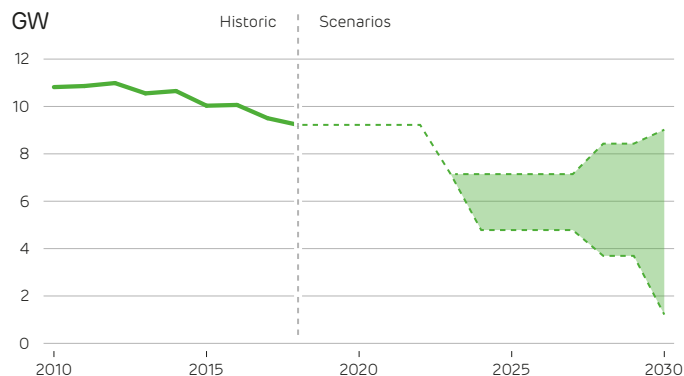
While falling emissions from UK power generation offer much to celebrate, it looks as if progress is set to slow down in the next few years as the coal phase out culminates, renewables growth slows and new nuclear cannot stem the impending stream of retirements. Uncertainty also hangs over the future of other emerging low-carbon technologies such as [carbon capture and storage](#), [tidal lagoons](#) and [small nuclear reactors](#).

Continued progress can be achieved, but will require renewed focus to translate the switch from coal to gas into a switch from gas to low-carbon sources. The key question is whether government is willing to continue intervening in the electricity market to maintain its world-leading status on carbon reductions and to provide investors with the long-term security they need to finance construction, whilst maintaining [public support towards clean energy](#).

The share of generation from renewable sources each month since 2010



National Grid's scenarios for Britain's future nuclear capacity⁴



⁴ <http://fes.nationalgrid.com>

4. How the heat wave affects electricity demand

16.5 degrees Celsius is the Goldilocks temperature for the Brits – not hot enough for air-con, not too cold to put the heating on. In March we saw how the [Beast from the East](#) caused a surge in demand, now the long summer heat wave is doing the same.

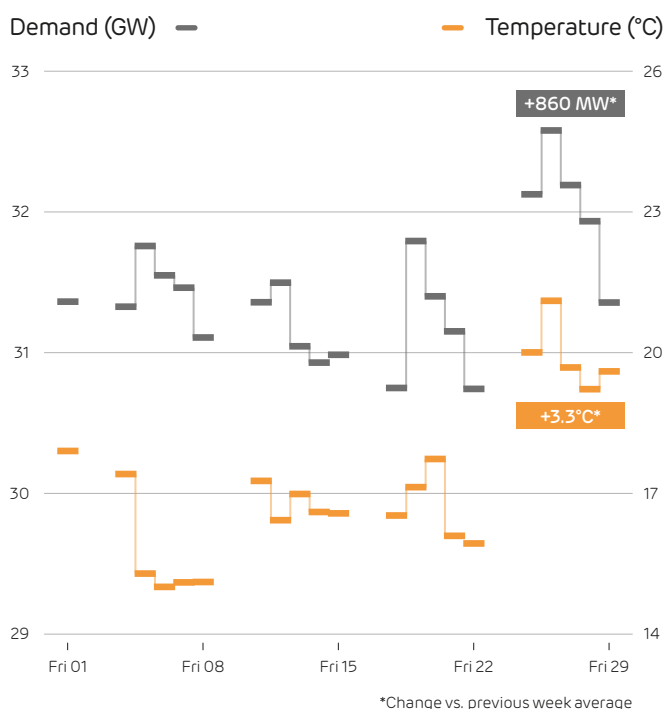
June 23rd marked the start of the heat wave, with daytime temperatures surpassing 30°C in Scotland and Wales. The last week of June was 3.3°C warmer than the previous week, and demand was 860 MW higher (see chart, below left). This rise is equivalent to the power demand from an extra 2.5 million households.⁵

This reflects the growing role of air conditioning and refrigeration in shops, and cooling for data centres. Global electricity [demand from cooling](#) is rising dramatically, and is seen as a 'blind spot' in the global energy system. This will become more important as global temperatures, and more importantly, global incomes rise. However, it is easier to deal with than cold spells during winter because demand is low and solar PV output is high.

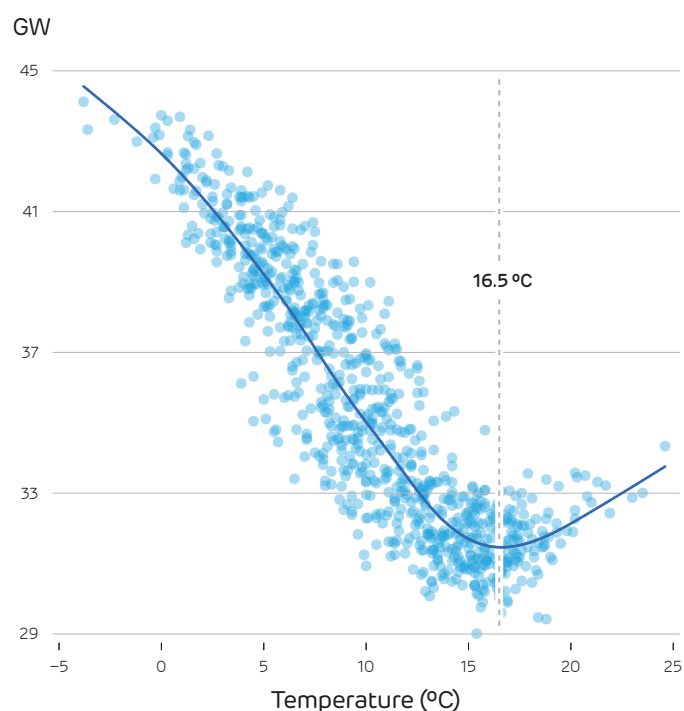
Below 14°C, demand increases by 750 MW for every degree it gets colder as buildings need more heating. Around a tenth of British homes have electric heating, as do half of commercial and public buildings.⁶ And while the British weather is not synonymous with air conditioning, demand rises by 350 MW for each degree that temperature rises above 20°C.

This effect may well grow stronger in the coming years. National Grid expect that the peak load from air conditioners will triple in the coming decade. Perhaps events such as the current prolonged heat wave may spur more households to invest in air conditioning.

Average temperature and demand during June 2018 weekdays, weekends are excluded as demand is lower



The relationship between electricity demand and temperature in Britain during 2016–18, showing daily averages on weekdays



⁵ Assuming annual consumption of 3,100 kWh per household (for homes without electric heating).

⁶ <https://www.gov.uk/government/publications/international-comparisons-of-heating-cooling-and-heat-decarbonisation-policies>

5. The summer wind drought and smashing solar

Wind output fell by 60% between January and June, but Britain's 'wind drought' was balanced out by a record-breaking summer for solar panels.

Low wind output during the summer heat wave [has been widely reported](#), as the high pressure sitting over the country has kept the skies calm.

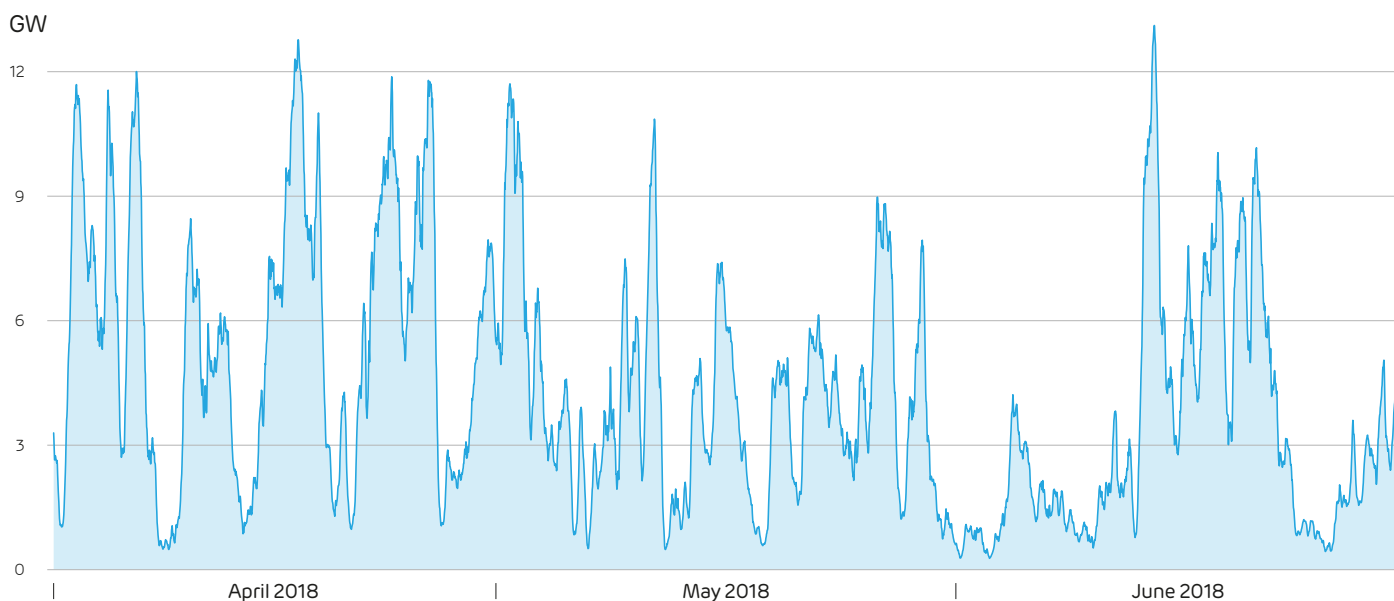
For three weeks in June, wind output hovered between 0.3 and 4.3 GW, well below the 13 GW peak output over the quarter. The minimum of 273 MW was the lowest instantaneous output seen in two years.

While this might sound severe, wind output during Quarter 2 was up 2% on the same period last year. That said, Britain's wind capacity has grown by a sixth over the last year, so its productivity this summer has been lower. The fall has been magnified as we move out of an extremely windy winter. Given that summer demand is low, National Grid confirmed "[we're comfortable with the level of spare generation we have available.](#)"

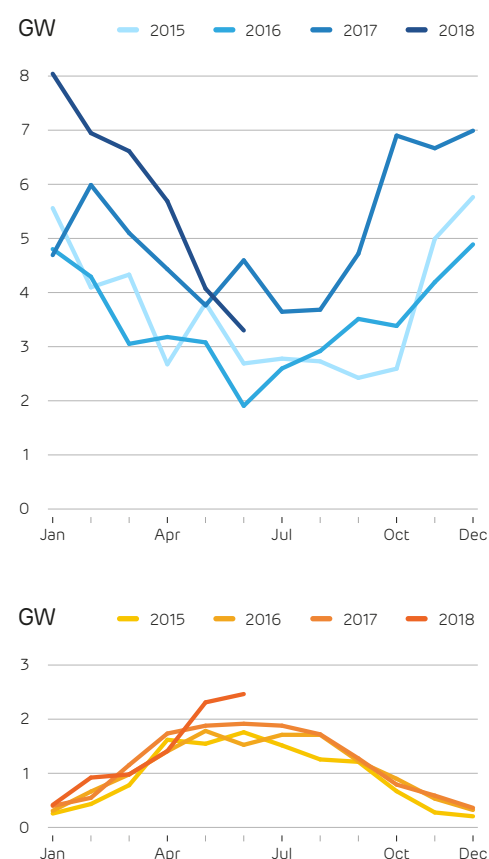
The fall in wind output coincides with a record period for Britain's solar panels. As Britain's solar fleet overtook the installed capacity of coal power stations ([see Article 6](#)), solar output broke past 9 GW in May to a new record of 9.39 GW at lunchtime on 27th June.

Britain saw 13 days in June where solar peaked above 8 GW, including every day of the last week (during the heatwave). The average capacity factor of Britain's wind farms was just 17% in June, less than the 19% recorded by solar panels.⁷

Output from Britain's wind farms during Quarter 2



Monthly-average generation from wind (top) and solar (bottom) over the last three years



⁷ Capacity factor shows the average power production relative to the amount produced if the installed capacity ran at full output all the time.

6. Capacity and production statistics

This quarter, low carbon sources produced 55% of Britain's electricity and gas produced 41%. Of the low-carbon sources, 50% was British nuclear and renewables, and 5% was French nuclear.

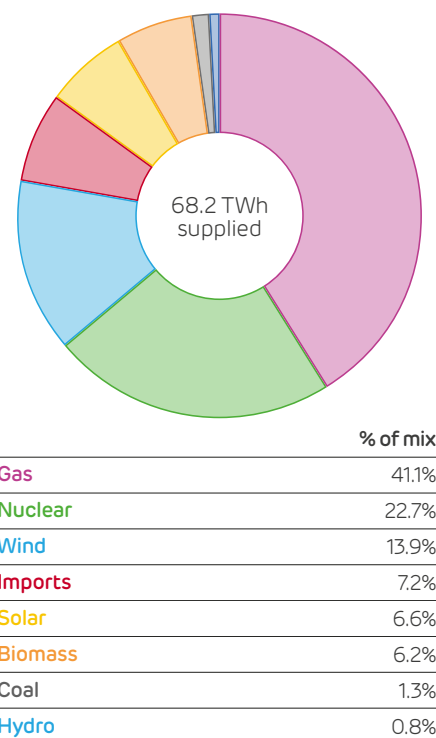
The carbon intensity of electricity hit a new low of 195 g/kWh averaged over the quarter. Of this, 82% of emissions came from burning natural gas, and approximately 5% each from coal, biomass and imports from the Netherlands.

Demand was 68.2 TWh, unchanged from 2017 Q2. However, demand net of variable renewables (which must be met by fully-controllable generators) hit its lowest ever level of 54.1 TWh (1.2% below Q2 last year). This 'net demand' fell below 10 GW for the first time, reaching 9.85 GW on June 14th. Demand net of renewables and nuclear fell to just 2.4 GW, continuing the rapid descent towards net-zero that [we reported on previously](#).

Installed coal capacity fell below 13 GW as [Drax closed its fourth unit for conversion to biomass](#). This 5% drop meant that Britain now has less coal than it does solar generating capacity – highlighting the dramatic shifts in the power sector.

Meanwhile, wind capacity surpassed the milestone of 20 GW installed,⁸ and Lynemouth biomass conversion began operating, pushing up biomass capacity and output by a quarter.

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



Installed capacity and electricity produced by each technology⁹

	Installed Capacity (GW) 2018 Q2	Annual change	Energy Output (TWh) 2018 Q2	Annual change	Utilisation / Capacity Factor 2018 Q2	
					Average	Maximum
Nuclear	9.5	~	15.5	-1.1 (-7%)	75%	82%
Biomass	2.6	+0.4 (+18%)	4.2	+0.7 (+21%)	77%	97%
Hydro	1.1	~	0.6	+0.1 (+26%)	24%	69%
Wind	20.0	+2.5 (+14%)	9.5	+0.2 (+2%)	22%	65%
Solar	13.1	+0.7 (+5%)	4.5	+0.5 (+12%)	16%	72%
Gas	27.7	-0.7 (-2%)	28.0	+0.3 (+1%)	47%	82%
Coal	12.9	-0.6 (-5%)	0.9	-0.4 (-30%)	3%	37%
Imports	4.0	~	5.5	-0.1 (-2%)	64%	93%
Exports			0.4	+0.2 (+90%)	5%	41%
Storage	3.1	~	0.6	-0.03 (-5%)	9%	61%

⁸ Note that sources for installed wind capacity differ notably. Elexon report 21.1 GW (including projects currently being commissioned), whereas RenewableUK report 19.3 GW. We take the average of these.

⁹ Other statistical sources give different values because of the types of plant they consider. For example, BEIS Energy Trends records an additional 900 MW of wind, 600 MW of biomass and 500 MW of solar, respectively producing 1.4, 1.2 and 0.2 TWh extra per quarter. These plants and their output are not visible to the electricity transmission system operator and so cannot be reported on here.



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