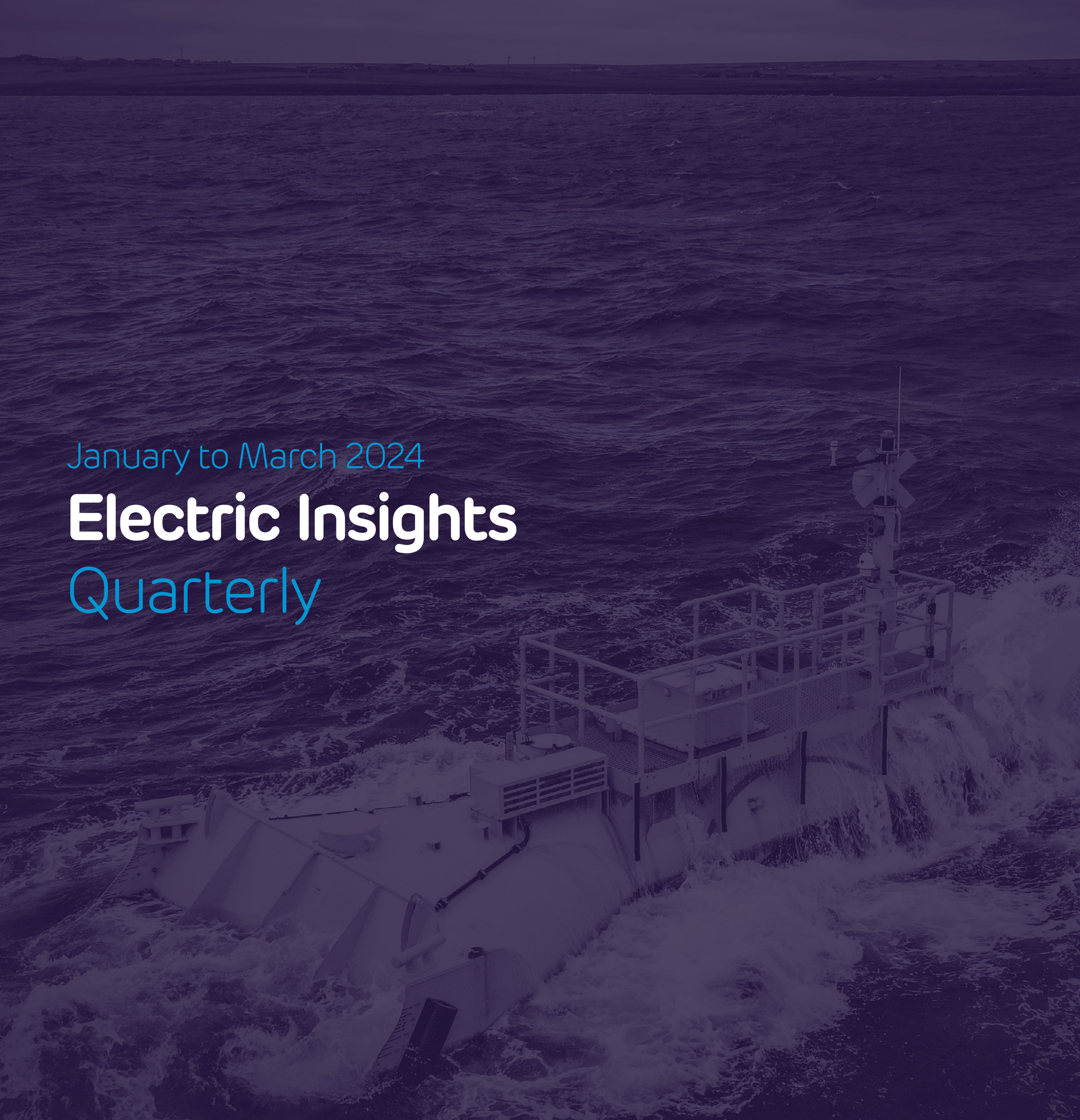


January to March 2024

Electric Insights Quarterly

Authors:

Dr Iain Staffell, Professor Richard Green, Professor Tim Green, and Mr Luke Hatton
Imperial College London

Dr Malte Jansen
University of Sussex

Professor Deborah Greaves OBE
University of Plymouth

Professor Rob Gross
UK Energy Research Centre

Contents

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

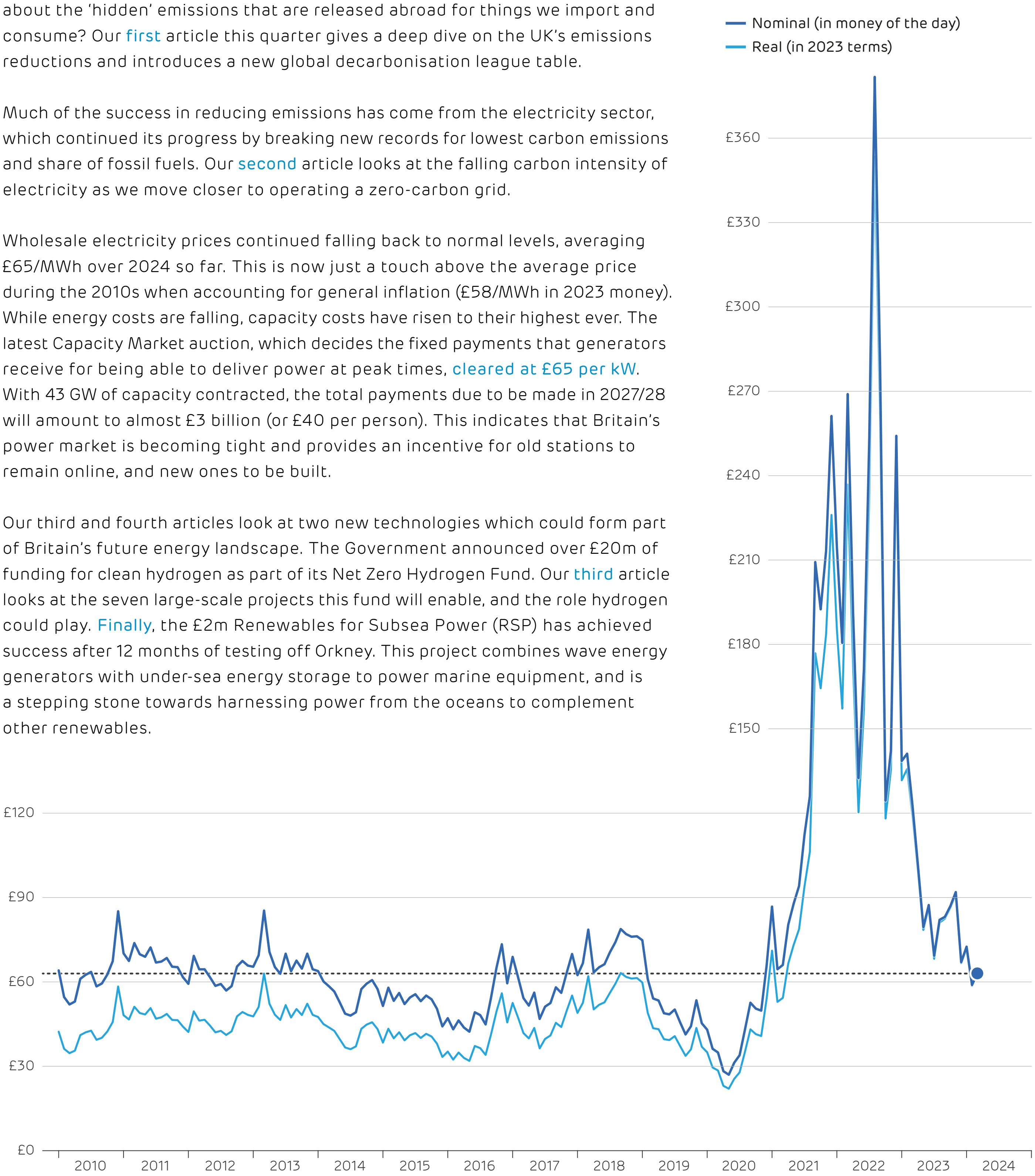
The UK is halfway to reaching Net Zero, having cut its greenhouse gas emissions by 50% since 1990. The Government proudly announced that the UK is the first major country to achieve this, but how far ahead are we, and what about the 'hidden' emissions that are released abroad for things we import and consume? Our first article this quarter gives a deep dive on the UK's emissions reductions and introduces a new global decarbonisation league table.

Much of the success in reducing emissions has come from the electricity sector, which continued its progress by breaking new records for lowest carbon emissions and share of fossil fuels. Our second article looks at the falling carbon intensity of electricity as we move closer to operating a zero-carbon grid.

Wholesale electricity prices continued falling back to normal levels, averaging £65/MWh over 2024 so far. This is now just a touch above the average price during the 2010s when accounting for general inflation (£58/MWh in 2023 money). While energy costs are falling, capacity costs have risen to their highest ever. The latest Capacity Market auction, which decides the fixed payments that generators receive for being able to deliver power at peak times, cleared at £65 per kW. With 43 GW of capacity contracted, the total payments due to be made in 2027/28 will amount to almost £3 billion (or £40 per person). This indicates that Britain's power market is becoming tight and provides an incentive for old stations to remain online, and new ones to be built.

Our third and fourth articles look at two new technologies which could form part of Britain's future energy landscape. The Government announced over £20m of funding for clean hydrogen as part of its Net Zero Hydrogen Fund. Our third article looks at the seven large-scale projects this fund will enable, and the role hydrogen could play. Finally, the £2m Renewables for Subsea Power (RSP) has achieved success after 12 months of testing off Orkney. This project combines wave energy generators with under-sea energy storage to power marine equipment, and is a stepping stone towards harnessing power from the oceans to complement other renewables.

Monthly-average wholesale power prices in the day-ahead market, adjusted for inflation and in nominal terms



2. The UK tops the global decarbonisation league table

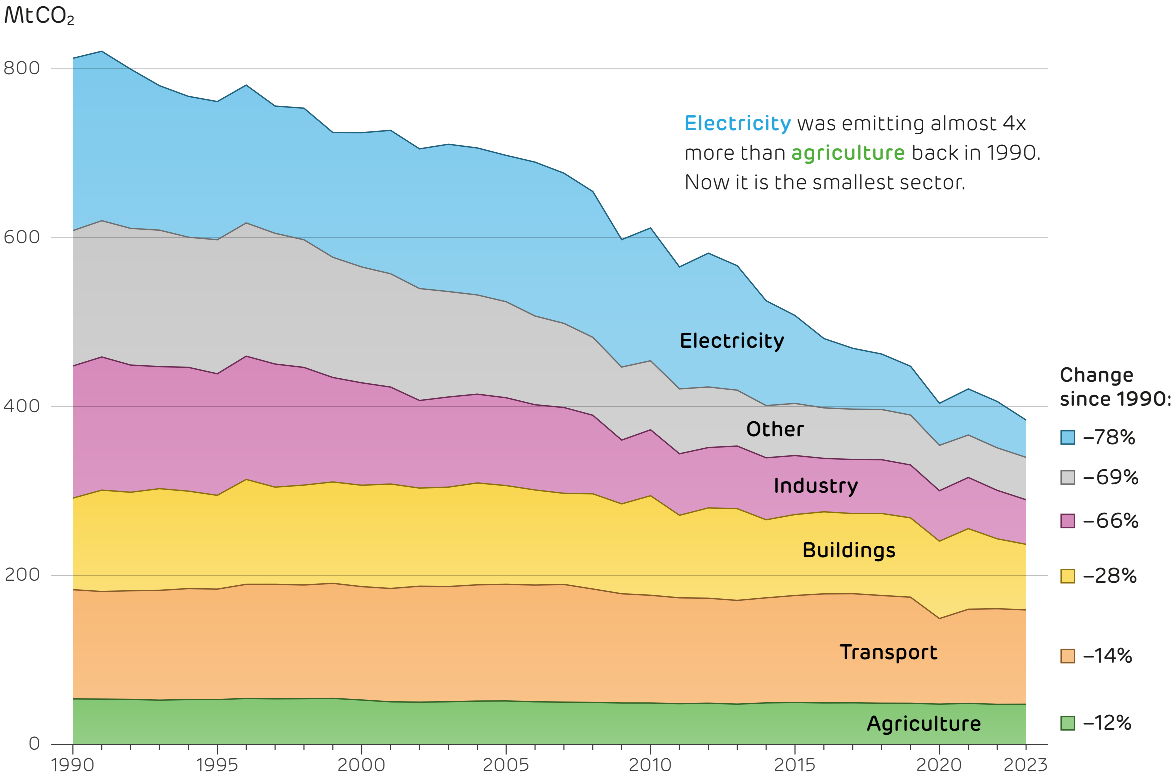
In February, the Government announced the UK was the first major economy to halve greenhouse gas emissions. Between 1990 and 2023, emissions fell by 50% while the economy grew by almost 80%. This marks a key success: we are roughly half-way through the period from 1990 to 2050 by which the UK must hit Net Zero, and we are roughly half-way there. This follows on from the UK's electricity system more than halving its carbon intensity during the 2010s.

How have we reduced emissions?

Emissions have fallen across all sectors, but electricity leads the way with a 78% reduction between 1990 and 2023. It went from being the largest source of emissions as recently as 2014 to contributing less to climate change than agriculture. Power sector emissions fell rapidly due to coal phase out in the 1990s and 2010s, and the rise of renewables. Industry's emissions have also fallen strongly with the shift away from energy-intensive manufacturing, although this coincides with the workforce halving from around 5 million in 1990. "Other" sources of emissions have also fallen rapidly, as methane from natural gas fields and landfill sites is better handled.

The UK's two largest sources of emissions are now heating its buildings and fuelling its vehicles, and both are proving much slower to decarbonise. Clean electricity is now making headway in both sectors though, as sales of electric heat pumps and electric vehicles continue to grow.

The UK's greenhouse gas emissions have fallen across all sectors, although at very different paces



How does the UK compare internationally?

Based on these successes, the Government's claim was that the UK has reduced emissions faster than any major economy. They used 1990 as the comparison year as this is when the Kyoto Protocol – the world's first treaty on climate change – came into force. This is an arbitrary date though, and one that is convenient for the UK as it coincides with a large shift away from coal.

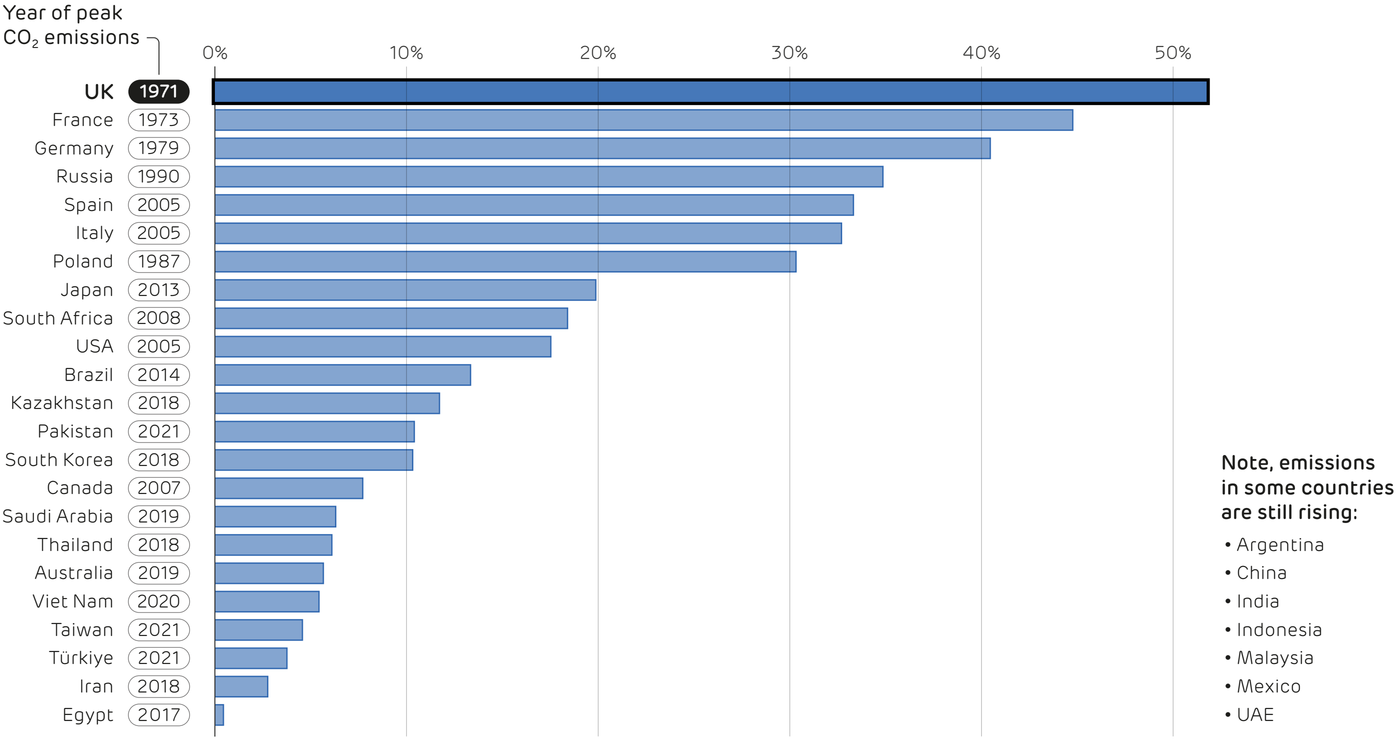
The global decarbonisation league table instead compares each country's emissions in 2022 (the most recent year for global data) against their maximum historical emissions, reflecting the fact that countries have peaked (and will continue to do so) at different times. This is fairer. For example, the Government notes that US emissions have not fallen since 1990, but this neglects the fact that after rising to a peak in 2005, US emissions have fallen rapidly, by 18% in the last 17 years.

On this fairer comparison, the UK still ranks first among the world's largest nations, with emissions having fallen 52% from their peak. European nations fill the top seven spots, with France and Germany coming 2nd and 3rd to the UK.

Japan and the US are on their way, having reduced their emissions by almost a fifth, and many countries across Asia, South America and Africa are also beginning to decarbonise. However, the world's largest countries – China and India – still have rising emissions as their economies continue to grow rapidly while powered predominantly on fossil fuels. China's emissions could begin falling this year due to rapid uptake of renewables and electric vehicles, which would mark a major milestone in the race against climate change.

While the UK takes top spot in the league table of major economies, it is not unique in having halved its emissions. Some smaller countries have decarbonised faster, although not for the best of reasons. Ukraine's emissions have fallen by 81%, in part because their population has fallen by 7 million, and more recently because of Russia's war. North Korea and Venezuela have also decarbonised further than the UK (by 76% and 61% respectively), but both because of faltering economies. Denmark is the only prosperous country to have gone further, also decarbonising by 61%, but it is only one-tenth the size of the UK.

The decarbonisation league table: Reduction in national carbon emissions from all-time peak, across the thirty largest countries which each emit over 200 $MtCO_2$ per year. Calculated using data from the Global Carbon Budget.



But what about the emissions we import?

It is a common counter-argument: yes we have reduced emissions within the UK but only by shifting them abroad to manufacture all the goods that we import. This is true, to an extent. The UK's "consumption-based emissions" focus on what we consume here, regardless of where it was made. These imports add around 40–45% to the UK's emissions, raising them from 4.6 to around 6.6 tonnes of CO_2 per person in 2023. Our imports also knock us off the top spot for decarbonisation: the UK's consumption-based emissions have fallen by 32% since 1990 (when records began), compared to 35% in Russia and 36% in Spain. However, this still means the UK ranks 3rd out of the thirty largest countries.

The UK now emits just 0.9% of global CO_2, so it is essential that all countries, especially the largest ones, rapidly reduce their emissions. That said, our leading role in the industrial revolution means the UK's share of cumulative emissions since 1850 is five times higher, and this is the measure which matters for global temperatures and extreme weather. It is therefore fitting that the UK is again leading the world in reducing emissions, showing that economic growth can go hand in hand with reducing environmental impacts.

The UK's carbon emissions since Victorian times, alongside the emissions estimated for what we consume, regardless of origin. Data from the Global Carbon Budget.

3. Moving towards zero-carbon electricity

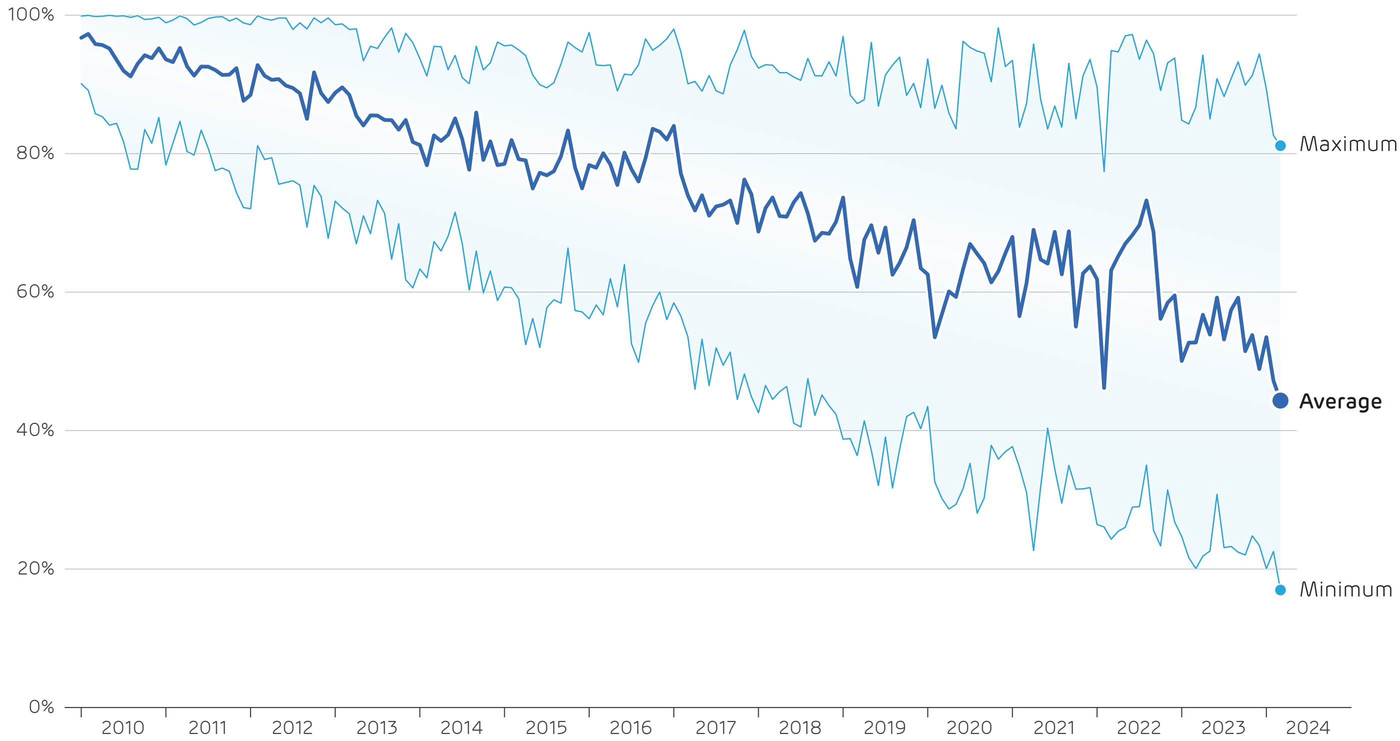
Electricity has played a major role in the UK's national decarbonisation, and the power sector is continuing on its path towards zero emissions. Last year's generation mix was the cleanest on record, and 2024 continued this trend with emissions staying below 150 g/kWh for the third quarter running.

National Grid reported a new record low for carbon intensity on 5 April of just 21 g/kWh.[1] Just 10 days later this record was broken again, reaching 19 g/kWh on 15 April. The latter was recorded on a sunny Tuesday afternoon. Demand was near its highest for the day, at over 39 GW, but wind and solar generation combined were able to meet 70% of this. Nuclear power contributed another 13%, and 10% of demand was imported (counted as zero-carbon when calculating British emissions). Biomass supplied about 3% and hydro another 1%, leaving only 3% of demand to be met by gas and coal.

Wind, solar and imports accounted for four-fifths of demand, which appears to be the current limit for these "non-synchronous" electricity sources. Power stations which use turbine generators (fossil, biomass, hydro or nuclear) are synchronised to the grid, rotating at exactly the same speed: the system frequency. Maintaining that frequency depends on the power flowing into the grid being perfectly balanced with the demand drawn from it. The sudden failure of a generator can lead to a sharp drop in frequency, which could lead to widespread blackouts if not corrected for. Turbines store some energy in the form of "inertia" due to their heavy rotating mass, and this reduces the rate at which the frequency is falling, giving more time for other corrective actions.

Non-synchronous sources of electricity (wind, solar, interconnectors) are instead connected via power electronics and do not naturally provide inertia, which leaves the system more vulnerable. System operators therefore limit the amount of non-synchronous energy they will accept at any given time to keep a minimum level of inertia, even if this means constraining off wind power. Moving forwards, fast-acting batteries can reduce the need for inertia, and system operators have been developing other techniques for running a low-inertia power system. Over the last few years, Eirgrid has steadily increased the maximum proportion of wind power it is prepared to admit onto the Irish power system.

The falling share of synchronous generation in the British electricity mix since 2010



1 Note, we report this as 28 g/kWh when accounting for the emissions from generating the electricity we import.

This is not just an issue at the extremes when carbon records are being broken. Over the last year, Britain has been seen twice as many hours when electricity falls below 50 g/kWh, at which point synchronous generation is typically below 30%.

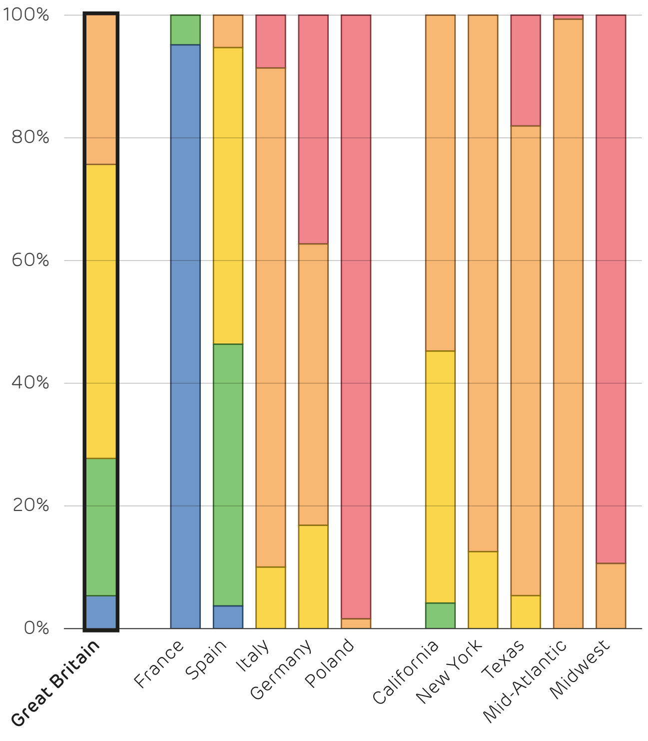
Looking at the biggest countries in Europe, Britain's emissions from the power sector are comparable to those in Spain. Both countries see a wide range in carbon intensities: power is clean when the weather allows for it, and is higher carbon otherwise. Germany and Italy have notably higher carbon intensities, never going below even 100 g/kWh. Despite having high shares of renewables, they are still heavily reliant on coal. Conversely, France almost always benefits from very low carbon electricity due to the high share of nuclear power.

Across the Atlantic, all of the USA's largest markets have dirtier electricity than Great Briain, as they are both behind on renewables share and behind on coal phase out.

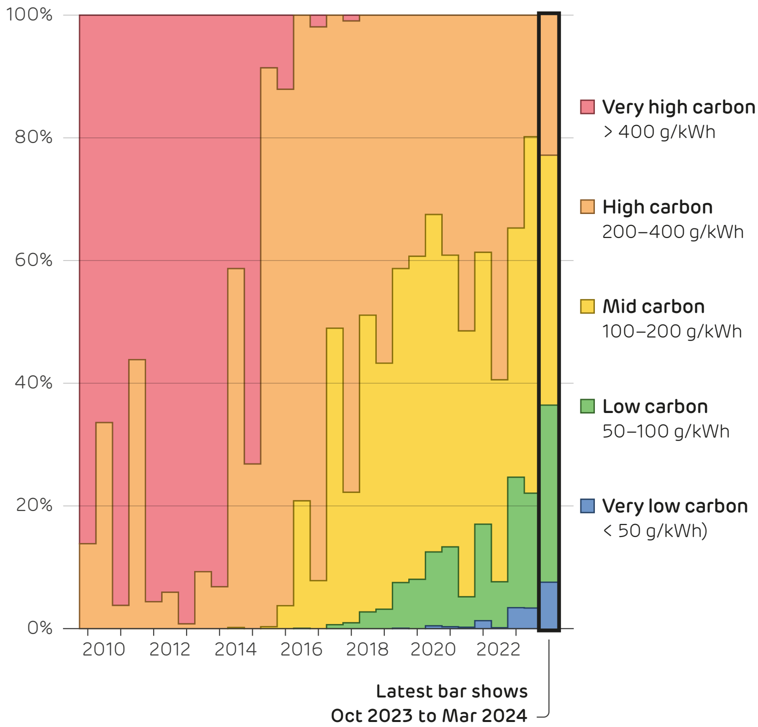
The growing frequency of "very low carbon" generation (under 50 g/kWh) is part of a shift that has been progressing for the last decade – the near-total phase out of coal power and continuing growth in renewable generation. Electricity in Germany or Texas has a similar mix of carbon intensities that Britain had 8 years ago, back in 2016. Poland and the US Midwest are closer to Britain a decade ago. The cleanest electricity in the US is in California, but this is not yet seeing hours with under 50 g/kWh, roughly where Britain was two years ago.

Technical constraints on balancing the grid mean there is a limit on how low carbon our electricity can go. National Grid are working to overcome these barriers, and by next year they aim to be capable of running the power system for hours at a time with zero carbon emissions, meaning that it can remain stable with just the synchronous generation from nuclear, biomass and hydro. This will require many changes: more flexibility (storage, interconnection, and demand side response), and innovation both in system management and market designs.

The range of carbon intensity across all hours of 2023 in Britain, compared to the five largest electricity markets in Europe and the United States



The distribution of carbon intensity of electricity in Britain since 2010, split between winter and summer months



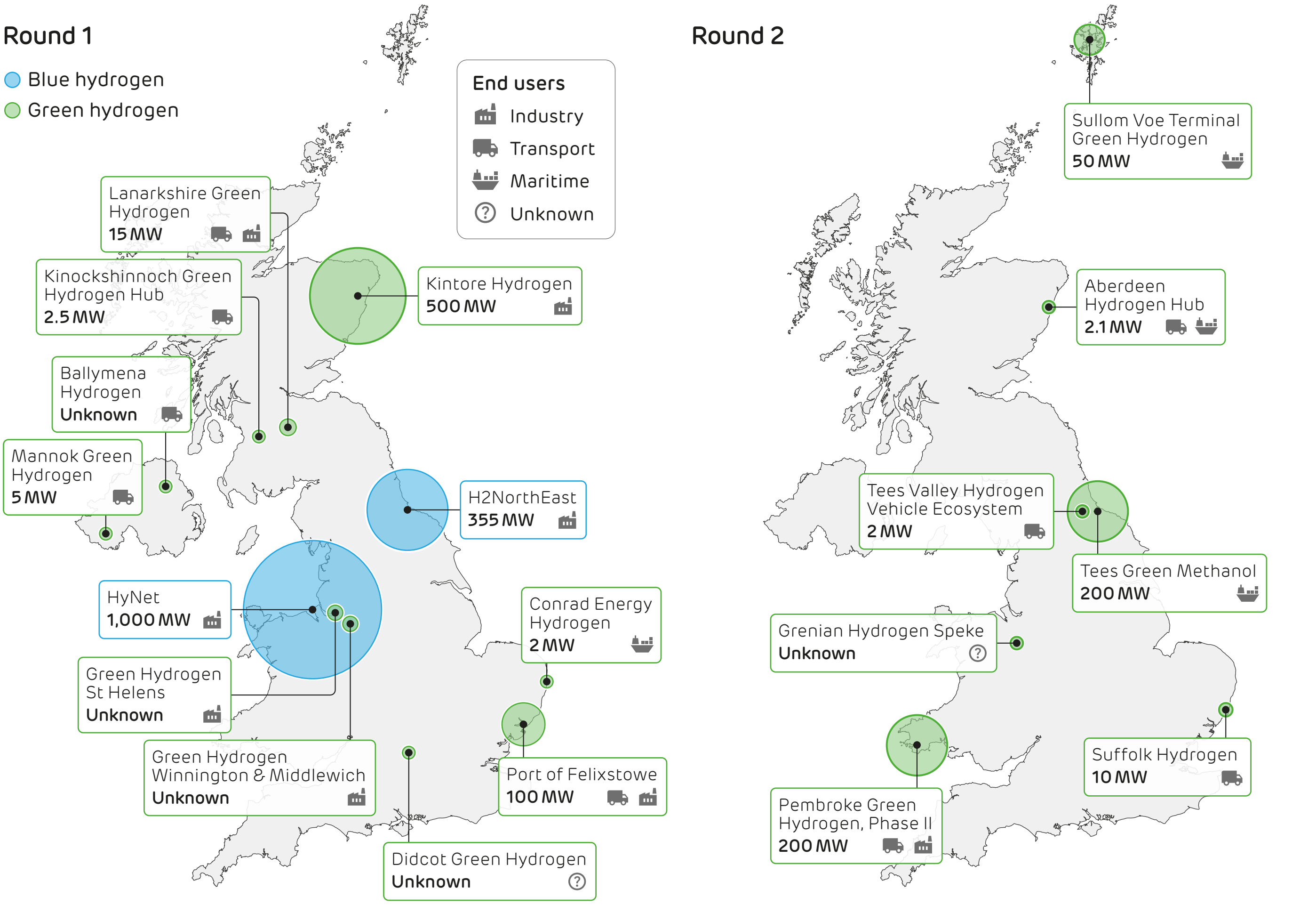
4. New funding for clean hydrogen projects

It has long been recognised that low-carbon hydrogen will play an important role in the UK's future energy system. It offers a route to decarbonise heavy industry, store energy between seasons, or to export excess low-carbon electricity overseas. Particularly in the UK, it is being explored for its complementary role in assisting the integration of offshore wind. The Government is targeting 10 GW of low-carbon hydrogen production by 2030, and has provided £240m of funding to the Net Zero Hydrogen Fund (NZHF). This will provide subsidies and capital investment to projects across the UK.

Almost all hydrogen is currently produced from high-carbon natural gas (referred to as "grey hydrogen"), but the addition of carbon capture and storage could reduce emissions ("blue hydrogen"). Alternatively, renewable electricity could be used to split water into hydrogen and oxygen in electrolysers ("green hydrogen"), reducing production emissions close to zero. The Government believes both green and blue hydrogen are crucial to the deep decarbonisation of power, transport and "hard to electrify" industrial processes. However, the use of hydrogen is becoming an increasingly contentious proposal, with critics highlighting the high costs, technical barriers, and recent global setbacks for hydrogen companies.

At the 2024 Hydrogen Investor Forum, the Government announced £21m of NZHF support throughout the UK. Three of the successful projects will produce clean hydrogen for industry and transport, while the other four will supply hydrogen to sectors ranging from pharmaceuticals to automotive. The seven successful projects are mapped below, alongside the fifteen projects supported through previous rounds of the NZHF.

The geographic distribution of projects supported under Round 1 and Round 2 of the Net Zero Hydrogen Fund (NZHF). Marker colour indicates the colour of hydrogen production being used, and marker size reflects the production capacity being planned.



* 3 other funded projects have since been cancelled

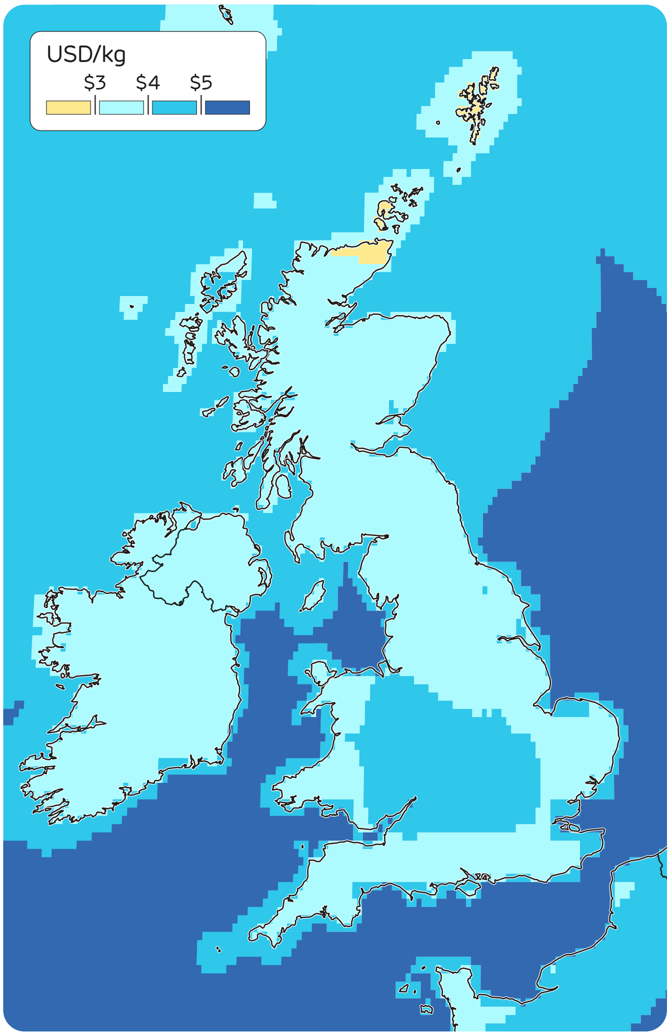
Hydrogen will be competing against established fossil fuels and other emerging low-carbon technologies, including the direct use of electricity (e.g., electric arc furnaces for steel production). How expensive it is to produce and use low-carbon hydrogen will be the key factor shaping its competitiveness, and the sectors which use it for decarbonisation. The average lifetime cost of producing green hydrogen (the "levelised cost") is driven mainly by electricity prices (the input fuel), electrolyser costs (which are expected to drastically fall by 2030), and the cost of financing projects. For blue hydrogen, the levelised cost will be driven by natural gas prices and the cost carbon capture and storage facilities, both of which are highly uncertain.

The UK isn't the only country providing financial support for hydrogen production to help lower the levelised cost. Through the Inflation Reduction Act, the US is providing a Clean Hydrogen Production tax credit worth up to US$3 per kilogram of hydrogen, while the European Union awarded nearly €720m in fixed subsidy support through the European Hydrogen Bank. Many other countries, including Chile, India and Australia, are pushing forward with their own hydrogen subsidy schemes but have been unable to match the scale of the US and EU's financial support.

Depending on how far and fast costs fall, hydrogen could grow to play a substantial role in the UK's future energy system. The Climate Change Committee estimates that the UK's demand for low-carbon hydrogen in 2050 could reach up to 376 TWh, more than current electricity demand of ~300 TWh. Developing a "hydrogen economy" in the UK could provide wider benefits beyond just emissions reductions, with the Government estimating that the sector could be worth £900m and support 12,000 jobs by 2030, rising to up to £13bn and 100,000 jobs by 2050.

Despite fierce debates over the suitability of hydrogen as a low-carbon technology, governments are pushing forward with regulations and policy support driven by the potential economic value of capturing the hydrogen value chain. Around the world, 41 governments now have a hydrogen strategy in place, up from just 15 when the UK published its own Hydrogen Strategy in 2021. Through schemes such as the NZHF, the UK Government is aiming become a world leader in producing and using low-carbon hydrogen. The next decade will show whether the UK is well-placed enough to deliver on that ambition.

The levelised cost of green hydrogen produced from onshore and offshore wind across the British Isles. Data from Bamisile et al., 2023.



5. The emerging role of wave power

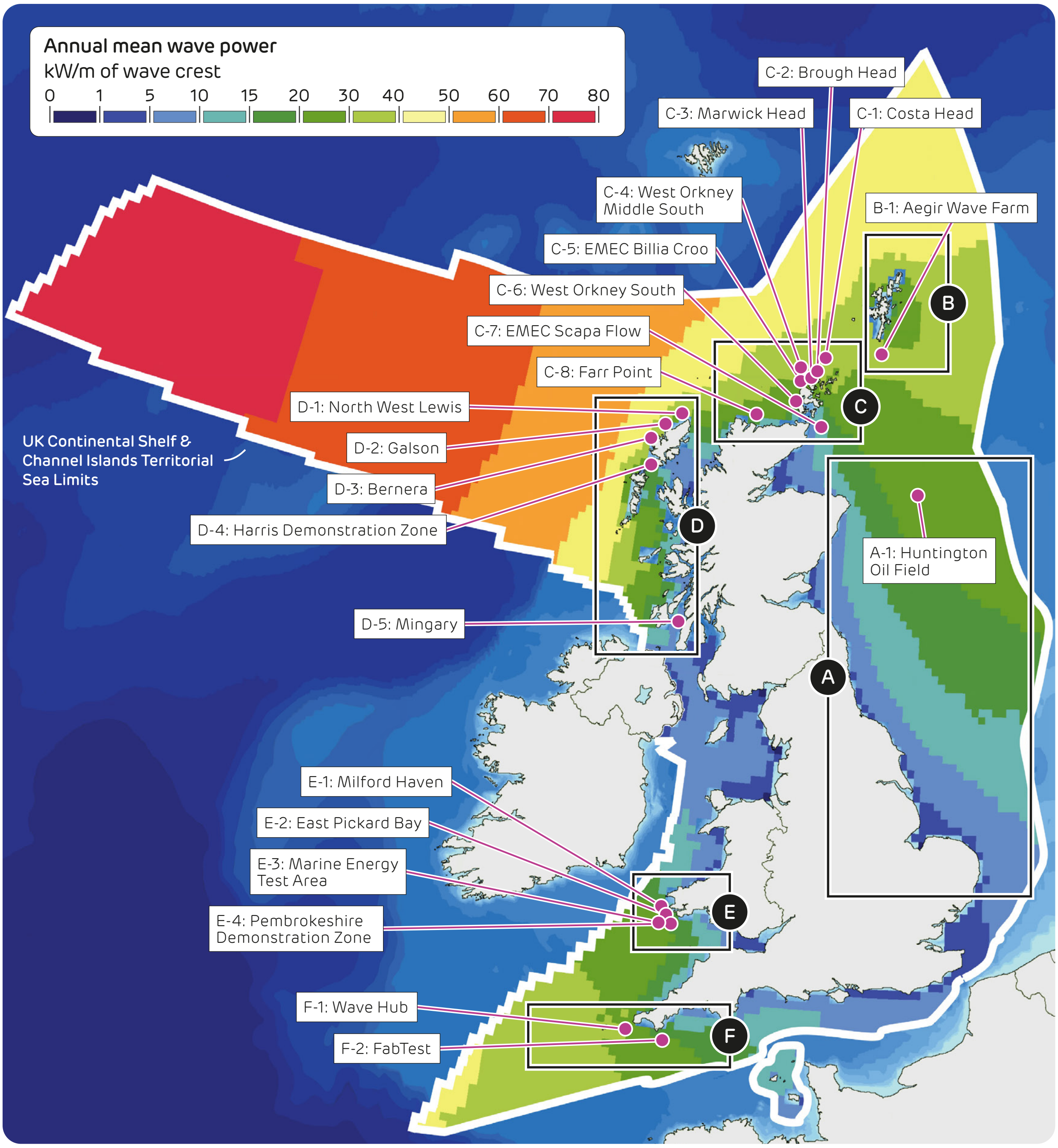
Britain is surrounded by waves, and harnessing their energy could play a role in our transition to Net Zero. The Renewables for Subsea Power (RSP) project is one of the latest demonstrators, operating successfully off the coast of Orkney over the last year. Wave power is still in the early R&D phases, with demonstrators like RSP targeting specialist applications, but with continued work it has the potential to power up to a sixth of Britain's electricity demand.

The marine energy sector covers both wave power, devices that convert the motion of waves into electricity, and tidal power, which uses the height difference between high and low tides to drive electrical turbines. The £2m RSP project combines ocean wave power with batteries located under the ocean. This balances out the intermittency of the waves, providing a continuous power supply to marine equipment such as offshore platforms or autonomous underwater vehicles used in environmental research and safety inspections of subsea cables and pipelines. The project has attracted Shell and TotalEnergies as partners, as major oil and gas companies seek ways to decarbonise their operations. This is an example of a high-value application which can act as a stepping stone towards larger deployments, in much the same way as the space race paved the way for cost reductions that led to terrestrial applications for solar panels.

The Blue X wave energy converter, built by Edinburgh's Mocean Energy, operating off the coast of Orkney within the EMEC Test Centre. The converter is connected to a Halo underwater battery developed by Aberdeen's Verlume.

There are dozens of wave energy sites worldwide, demonstrating machines from 1 kW up to tens of MW in scale. Just as the UK is at the forefront of offshore wind energy, many of these are hosted at UK testing facilities (see map). For example, Orkney hosts the European Marine Energy Centre (EMEC) which is a test bed for multiple technologies from UK and European manufacturers.

The UK's key wave energy hotspots, and the strength of wave energy resource, measured in terms of the average mean power produced per metre of wave converter. For context, the Pelamis design was ~150 m in length, and the Oyster design is ~25 m in width. Reproduced from Jin & Greaves, 2021, with data adapted from the Renewables Atlas.



Scaling up these machines to supply a notable portion of national electricity demand relies on overcoming technical challenges around the extreme marine environment, and especially on reducing costs – as is common among all early-stage technologies. Wave energy converters are currently more expensive than floating offshore wind, which is in turn more expensive than conventional (fixed-bottom) offshore wind. Research investments from UKRI and Wave Energy Scotland are targeting cost reduction, for example through novel materials that are flexible and deformable to replace steel, or new forms of power take-off. Just as conventional offshore wind saw rapid cost declines in the second half of the 2010s, floating offshore wind could follow suit, and give cross-learning that helps wave energy reduce its costs also.

If these challenges can be overcome, the benefits of scaling up wave energy could be two-fold. First, wave energy could bring substantial system benefits as it complements the intermittency of wind farms, reducing the need for flexibility options such as long-duration energy storage (which is also very costly). Wave energy matches the seasonality of electricity demand, being higher in winter than in summer, and its output is offset from the profiles of other variable renewables, as well as being more predictable. Tidal energy on the other hand is available in highly predictable cycles, as tides are controlled by the orbit of the moon. The second benefit is that Britain has an opportunity to capitalise on its leading role in R&D. Extending this into a lead in deployment could potentially secure the manufacturing benefit to the UK, creating high-tech jobs and the potential for a new export industry.

The UK has seen great success in cutting the cost of offshore wind so it could become a central part of our electricity system. This was helped by effective policy frameworks such as Contracts for Differences (CfDs), offering a potential route forwards for marine energy. The UK is leading the world in terms of demonstrations, and the multi-million pound programme of funding by Wave Energy Scotland and UKRI is enabling firms to design, build and test new wave energy devices. Bringing these to market could unlock substantial benefits in terms of reduced system costs and enhanced energy security. By promoting focused investment and supportive policies, the UK could both lead in marine energy technology and also make Net Zero easier and cheaper to reach.

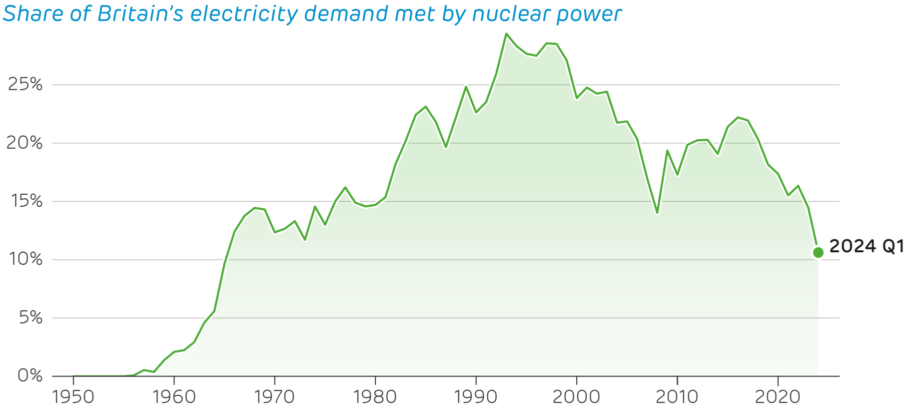
Written in collaboration with the Supergen Offshore Renewable Energy (ORE) Hub – a £16.5 Million Engineering and Physical Sciences Research Council (EPSRC) programme which brings together academia, industry, policy makers and the general public to support and accelerate the development of offshore wind, wave and tidal technology for the benefit of society.

6. Capacity and production statistics

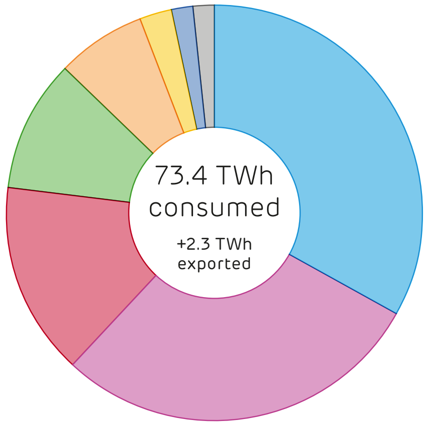
Wind power was Britain's largest source of generation for the second quarter running – the first time it has taken top spot for two consecutive quarters. Over the six winter months (Oct–Mar), wind supplied 20% more electricity than natural gas.

Biomass and hydro output were both up strongly from a year ago, but nuclear output fell to its lowest share of electricity production since 1965. During the first three months it produced just 10.4% of Britain's electricity, with January seeing 6 of the country's 9 reactors offline for maintenance. Hinkley Point C was originally expected to come online last year, more than sufficient to fill the looming gap, but it is now not expected to start operations for another five years.

Share of Britain's electricity demand met by nuclear power



Britain's electricity supply mix in the first quarter of 2024



	Share of the mix
Wind	33.3%
Gas	28.8%
Imports	14.9%
Nuclear	10.4%
Biomass	6.9%
Solar	2.5%
Hydro	1.7%
Coal	1.4%

Installed capacity and electricity produced by each technology [2,3]

	Installed Capacity (GW)		Energy Output (TWh)		Utilisation / Capacity Factor	
	2024 Q1	Annual change	2024 Q1	Annual change	Average	Maximum
Nuclear	6.4	–1.0 (–14%)	7.9	–1.3 (–15%)	57%	73%
Biomass	3.8	~	5.2	+1.0 (+25%)	63%	100%
Hydro	1.2	~	1.3	+0.2 (+19%)	51%	98%
Wind	29.1	+1.5 (+6%)	25.2	+1.3 (+5%)	41%	75%
– of which Onshore	14.4	+0.6 (+4%)	10.3	+0.7 (+7%)	33%	66%
– of which Offshore	14.7	+0.9 (+7%)	15.1	–0.1 (–1%)	49%	81%
Solar	15.6	+1.1 (+7%)	1.9	+0.2 (+12%)	6%	52%
Gas	27.7	~	21.8	–1.6 (–7%)	36%	95%
Coal	1.8	–2.0 (–52%)	1.0	+0.1 (+11%)	26%	100%
Imports	9.2	+1.8 (+25%)	9.9	+0.6 (+7%)	54%	92%
Exports			2.1	+0.1 (+4%)	11%	71%
Storage discharge	3.1	~	0.6	–0.0 (–4%)	9%	75%
Storage recharge			0.6	+0.0 (+6%)	9%	61%

2 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.
3 We include an estimate of the installed capacity of smaller storage devices which are not monitored by the electricity market operator.

7. Power system records

Britain's wind farms produced more than seven-tenths of electricity demand for the first time on 26 January. Output was boosted by strong winds in the North Sea enabling the world's largest offshore wind farm (Hornsea Two) operating at almost 100% capacity factor. The quarter also saw the highest ever share of electricity produced from clean sources, at over 95% on 23 March. That same day also had the lowest ever carbon intensity, 33 g/kWh averaged over 24 hours. Just as nuclear output hit a new low averaged over the quarter, it also fell to record lows for instantaneous and daily-average share on 18 January, and monthly average output across January.

The tables below look over the past fourteen years (2009 to 2023) and report the record output and share of electricity generation, plus sustained averages over a day, a month and a calendar year. Cells highlighted in blue are records that were broken in the first quarter of 2024, or annual records broken in 2023. 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	21,929	70.7%
Daily average	20,877	60.9%
Month average	14,525	40.4%
Year average	9,022	28.9%

Solar – Maximum	Output (MW)	Share (%)
Instantaneous	9,830	34.8%
Daily average	3,480	13.9%
Month average	2,651	10.0%
Year average	1,397	4.5%

Biomass – Maximum	Output (MW)	Share (%)
Instantaneous	3,831	16.8%
Daily average	3,316	12.9%
Month average	2,849	8.8%
Year average	2,216	7.1%

All Renewables – Maximum	Output (MW)	Share (%)
Instantaneous	28,239	78.0%
Daily average	24,262	68.3%
Month average	18,334	51.0%
Year average	12,610	40.4%

Gross demand	Maximum (MW)	Minimum (MW)
Instantaneous	60,070	16,934
Daily average	49,203	23,297
Month average	45,003	26,081
Year average	37,736	29,910

Demand (net of wind and solar)	Maximum (MW)	Minimum (MW)
Instantaneous	59,563	3,365
Daily average	48,823	7,848
Month average	43,767	16,253
Year average	36,579	19,491

	Day ahead wholesale price Maximum (£/MWh)	Day ahead wholesale price Minimum (£/MWh)
Instantaneous	1,983.66	–77.29
Daily average	666.90	–11.35
Month average	353.36	22.03
Year average	198.16	33.88

	Carbon intensity Maximum (g/kWh)	Carbon intensity Minimum (g/kWh)
Instantaneous	704	15
Daily average	633	33
Month average	591	124
Year average	508	148

	All low carbon – Maximum Output (MW)	All low carbon – Maximum Share (%)
Instantaneous	35,172	95.4%
Daily average	30,305	89.2%
Month average	23,754	66.3%
Year average	18,451	59.2%

	All low carbon – Minimum Output (MW)	All low carbon – Minimum Share (%)
Instantaneous	3,395	8.3%
Daily average	5,007	10.8%
Month average	6,885	16.7%
Year average	8,412	21.6%

	All fossil fuels – Maximum Output (MW)	All fossil fuels – Maximum Share (%)
Instantaneous	49,307	88.0%
Daily average	43,085	86.4%
Month average	36,466	81.2%
Year average	29,709	76.3%

	All fossil fuels – Minimum Output (MW)	All fossil fuels – Minimum Share (%)
Instantaneous	1,495	4.1%
Daily average	2,502	7.5%
Month average	7,382	24.3%
Year average	10,234	32.8%

	Nuclear – Maximum Output (MW)	Nuclear – Maximum Share (%)
Instantaneous	9,342	42.8%
Daily average	9,320	32.0%
Month average	8,649	26.5%
Year average	7,604	22.0%

	Nuclear – Minimum Output (MW)	Nuclear – Minimum Share (%)
Instantaneous	2,065	5.0%
Daily average	2,238	5.9%
Month average	3,292	8.9%
Year average	4,372	14.0%

	Coal – Maximum Output (MW)	Coal – Maximum Share (%)
Instantaneous	26,044	61.4%
Daily average	24,589	52.0%
Month average	20,746	48.0%
Year average	15,628	42.0%

	Coal – Minimum Output (MW)	Coal – Minimum Share (%)
Instantaneous	0	0.0%
Daily average	0	0.0%
Month average	0	0.0%
Year average	315	1.0%

	Gas – Maximum	
	Output (MW)	Share (%)
Instantaneous	27,131	72.6%
Daily average	24,210	62.2%
Month average	20,828	54.8%
Year average	17,930	46.0%

	Gas – Minimum	
	Output (MW)	Share (%)
Instantaneous	1,403	4.1%
Daily average	2,444	7.5%
Month average	6,775	19.9%
Year average	9,159	24.6%

	Imports – Maximum	
	Output (MW)	Share (%)
Instantaneous	8,055	34.4%
Daily average	7,299	26.9%
Month average	5,557	18.2%
Year average	3,792	12.2%

	Exports – Maximum	
	Output (MW)	Share (%)
Instantaneous	–5,662	–23.7%
Daily average	–4,763	–14.1%
Month average	–3,098	–9.8%
Year average	–731	–5.8%

	Pumped storage – Maximum[4]	
	Output (MW)	Share (%)
Instantaneous	2,660	7.9%
Daily average	409	1.2%

	Pumped storage – Minimum[4]	
	Output (MW)	Share (%)
Instantaneous	–2,782	–10.8%
Daily average	–622	–1.7%

4 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