Annual Renewables Report

2025

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Contents

Executive summary

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Today we release our second BDO annual report and what a busy year it has been since our last. When compiling this report there seemed to be daily changes and updates on policy and focus. That said the changes were refreshing.

Our last report reflected on the need for stronger government signalling for the renewables industry. In December 2024, within six months of its election, the new UK government issued the Clean Power 2030 Action Plan which set an ambitious course to 95% clean energy by 2030.

Delivering Clean Power 2030 requires unprecedented expansion in generation and storage capacity across technologies over a very short period. A significant challenge, but also a huge opportunity for investors and businesses.

Unlocking grid congestion and dealing with supply chain constraints will be key to faster roll-out in the UK and beyond. The UK is forging ahead with its grid reform process which will prioritise the most viable and strategically important projects. This has caused uncertainty in the short term but by the end of 2025 that fog at least should have lifted.

The impact of global tariffs is hard to predict as they haven't settled, but the geographical redistribution of supply chain capacity could be one longer-term benefit for some.

The more nascent carbon mitigating technologies such as Hydrogen and CCUS have seen positive developments in the past year including project investments and government support, but they still remain some way off scale and have been unable to match the speed of development achieved by the battery storage industry, which in just five years has matured to become the technology of choice for storage and flexibility services needed to manage the growth in intermittent renewables.

Challenges remain in the UK but improved government signalling and, once it emerges later this year, clarity on grid connection priorities should help encourage investment and infrastructure roll-out. The outlook for UK renewables in the medium term looks encouraging.

Key findings

- The UK needs to double onshore wind and triple offshore wind and solar capacity to achieve Clean Power 2030 targets.
- Annual investments of £40bn during 2025-2030 are required to deploy the required capacity under the Clean Power 2030 plan.
- Upgrading the grid by 2030 requires constructing five times more infrastructure in six years than was built over past 30.
- In 2024, the UK's BESS capacity hit 6 GW, needing 17-21 GW more by 2030 across both transmission and distribution.
- The Energy Security Strategy aims for 5 GW of green hydrogen production by 2030, yet the current capacity is around 7 MW.
- AI-based short-term energy load forecasting shows 95% accuracy and 33% greater efficiency, though cyber threats persist.

How global politics is shaping the future of the renewables sector

2024 was a pivotal year for global politics, with elections in 74 countries which could reshape the climate action trajectory.

Decarbonisation and energy security remain a central focus across the G7, but recent and upcoming elections in six member countries could result in advances and recessions or reversals in progress, underscoring the constantly changing landscape for renewable energy policy.

The UK is reliant on importing skilled labour and raw materials to meet its transition needs, which could create both challenges and opportunities for the UK in meeting its targets. The UK Government has renewed its focus on accelerating the energy transition through Clean Power 2030 but faces tough decisions in achieving its ambitious goals.

By contrast, Germany's 2025 elections bring potential uncertainty to the future of climate policies. While the winning CDU/CSU bloc supports the energy transition, it has pledged to abolish the previous government's Building Energy Act[1], reconsider the phase-out of nuclear energy, and reverse the ban on internal combustion engines.

In March 2025, France revealed a draft of an updated ten-year energy plan, removing the pledge to refrain from building fossil-based electricity generation sites and reducing solar power ambitions.

The US presidential election has introduced uncertainty to the future of transformative policies, such as the Inflation Reduction Act (IRA), and resulted in the extraction of the US from the Paris Climate Accords, leading to the redirection of related funds and potential negative impacts on investment in renewables.

The climate policy trajectory of the G7 countries amid 2024-2025 elections

- Backing oil and gas expansion under Conservatives and incentive-based climate initiatives under Liberals.
- Lower solar power ambitions, softer stance on fossil fuel power generation, prioritising energy reliability over a full transition.
- General support for the energy transition with continued renewables rollout, but no clear pathway to net zero.
- Revised decarbonisation and renewable energy targets, alongside the significant role of nuclear energy.
- Increased ambitions to achieve energy security through greater renewables deployment, with a plan for clean power by 2030.
- Focus on energy affordability and security over energy transition, promoting fossil fuel production.

Neutral/uncertain | Downward trajectory | Positive trajectory

The mixed election results reflect a complex global attitude toward climate action. While some nations have embraced leadership focused on decarbonisation, others have seen a shift towards political forces less supportive of strong climate initiatives. This creates challenges for unified global progress, potentially slowing the transition from fossil fuels, but investments in low-carbon technologies are likely to persist.

Source: GOV.UK website; Clean Energy Wire website; Enerdata website; World Economic Forum website; MIT Technology Review website; World Resources Institute website; BCG — After Global Elections, What's Next for the Energy Transition? — 2025; DESNZ — Clean Power 2030 Action Plan — 2024; NESO — Clean Power 2030 — November 2024; Media overview

Notes: (1) In force since January 2024, the Building Energy Act requires all heating systems installed in new buildings to be powered by at least 65% renewable energy; (2) According to NESO' Further Flex and Renewables scenario

How politics is shaping the future of the renewables sector in the UK

The new UK government has renewed its commitment to decarbonising electricity generation by 2030 and increasing renewable capacity targets.

The Clean Power 2030 plan has been launched, outlining a framework to accelerate the deployment of clean energy technologies, including renewables, hydrogen, carbon capture and energy storage.

Selected Clean Power 2030 plan targets and forecasts

95% of electricity from clean energy

3x solar capacity to 45-47 GW

2x onshore wind capacity to 27-29 GW

3x offshore wind capacity to 43-50 GW

287 TWh[2] Total UK consumer electricity demand

Hydrogen

The UK Government has introduced a National Wealth Fund to support major infrastructure projects, including green hydrogen development. The fund announced a £500m investment to advance green hydrogen and pledged to double the UK's green hydrogen production target to 10GW by 2030.

Carbon capture and storage

A £21.7bn package over 25 years was announced to subsidise projects in Teesside and Merseyside, including carbon transportation and storage.

Improvement of the planning system

Planning reforms were announced in July 2024, and the revised National Planning Policy Framework was published in December 2024 to streamline the planning process for major infrastructure projects.

Summary

The UK Government has made various announcements regarding its plans to facilitate the energy transition to net zero. Time will tell how successful these are, particularly with the current economic and global uncertainty which has been seen in recent months.

Source: GOV.UK website; Clean Energy Wire website; Enerdata website; World Economic Forum website; MIT Technology Review website; World Resources Institute website; BCG — After Global Elections, What's Next for the Energy Transition? — 2025; DESNZ — Clean Power 2030 Action Plan — 2024; NESO — Clean Power 2030 — November 2024; Media overview

Notes: (1) In force since January 2024, the Building Energy Act requires all heating systems installed in new buildings to be powered by at least 65% renewable energy; (2) According to NESO' Further Flex and Renewables scenario

What effects are the UK Government's initial actions having on the renewables sector?

Since the July 24 election, the UK Government has implemented several measures to advance the transition of the electricity system towards net zero.

The de facto ban on onshore wind farms in England has been removed, enabling the growth of one of the most cost-effective renewable energy sources. Three major solar farms with a combined capacity of 1.3 GW were approved, and the Solar Taskforce was reactivated to accelerate solar development and advance progress towards the 2030 clean energy targets. The Clean Power 2030 plan outlined specific actions across all sectors of the power system, with a focus on removing some of the roadblocks to rolling out renewables and reducing the UK's reliance on expensive and price volatile fossil fuels.

Selected areas and planned actions in the Clean Power 2030 plan

Planning and consenting

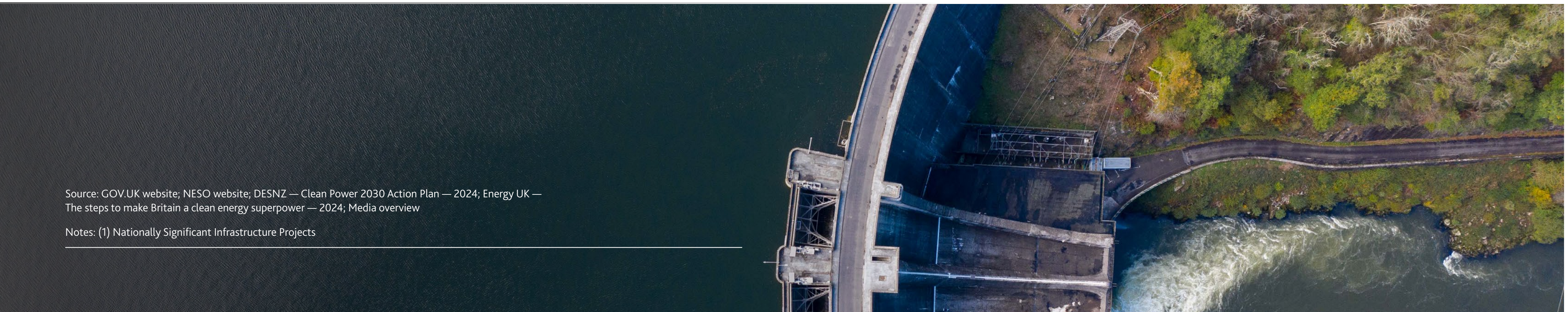
- Updating National Policy Statements for Energy and Planning Policy Guidance in 2025
- Reintroducing onshore wind into the NSIP[1] regime at a new threshold of 100 MW and adjusting the threshold for solar to 100 MW
- Introducing a Planning and Infrastructure Bill
- Reviewing secondary legislation and other legal requirements regarding the planning process for energy infrastructure.

Electricity networks and connections

- Aligning the grid connections process with the 2030 Action Plan, issuing updated grid connection offers by 2025
- Amending the Strategy and Policy Statement to prioritise 2030 goals in network investment decisions
- Tightening incentives and penalties for Transmission Owners and Distribution Network Operators
- Expanding planning consent exemptions for low voltage connections and increasing flexibilities for electricity substations.

Renewable project delivery

- Reforming the CfD scheme, including a relaxation of eligibility criteria for fixed-bottom offshore wind projects, a review of auction parameters, etc.
- Leveraging Great British Energy and deploying further policy measures to increase the rollout of local and community generation
- Addressing the expiration of the UK-wide Renewables Obligation by enabling access to CfD for repowered onshore wind and supporting asset life extensions.



Source: GOV.UK website; NESO website; DESNZ — Clean Power 2030 Action Plan — 2024; Energy UK — The steps to make Britain a clean energy superpower — 2024; Media overview

Notes: (1) Nationally Significant Infrastructure Projects

What effects are the UK Government's initial actions having on the renewables sector?

Since the release of the Clean Power 2030 plan, several actions have been taken towards the UK's decarbonisation targets.

1

In January 2025, new grid connection applications were paused to enable the delivery of connection reforms planned for 2025. The reforms will replace the existing 'first-come, first-served' system with the 'first ready, first connected' approach to fast-track projects needed for the 2030 target. Future projects will need to connect within designated windows and must meet key progress milestones and strategic alignment criteria before they can proceed. The UK Government estimates that the new system will unlock £200bn of private investments.

2

In February 2025, the Government launched the Clean Industry Bonus for offshore wind developers investing in industrial communities, particularly those associated with the oil and gas sector. The scheme offers additional funding for fixed and floating offshore wind applicants participating in AR7, providing £27m per GW of offshore wind capacity. Total funding could reach up to £200m for projects totalling between 7 and 8 GW. These initial steps evidence an attempt to deal with a number of the challenges that have been facing the uptake of renewables in the UK, but they will take time to embed.

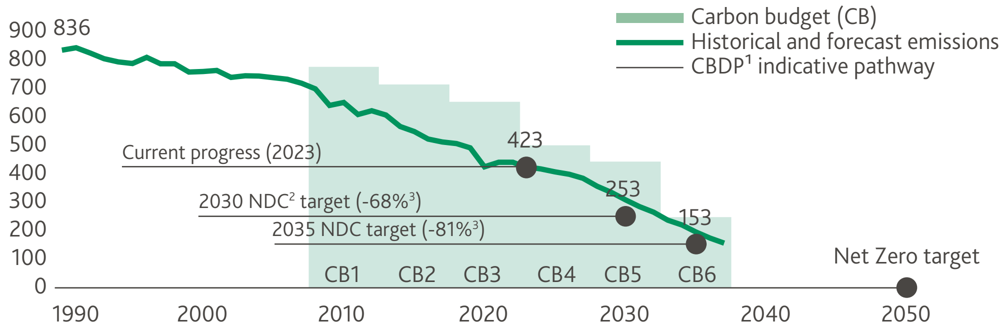
It will be interesting to see how the UK energy industry responds to the Clean Power 2030 plan in 2025, and to also see how the Government adjusts its plan to encourage stakeholders to engage. 2025 is poised to be a pivotal year for UK renewables. The success and effectiveness of the initiatives will have far-reaching impacts on the economy and play a critical role in shaping the path to net zero in the years ahead.

Pace and coordination are key for Clean Power 2030 goals and sustaining momentum

The UK has achieved significant emissions reductions, with territorial emissions being lowered by over half compared to 1990 levels. The first UK target set in line with net zero is only five years away, but the country is not on track to hit this interim target despite significant progress achieved by 2023. Notably, more than half of the emissions reductions seen over the first three carbon budgets were from the decarbonisation of the energy network. In all other sectors, the current pace of emissions reduction needs to accelerate.

(-81.4%) Electricity supply emissions reduction in 2023 compared to 1990 in the UK

Total greenhouse gas (GHG) emissions in the UK, $MtCO_2e$ capacity to achieve clean power demand by 2030, GW[6]

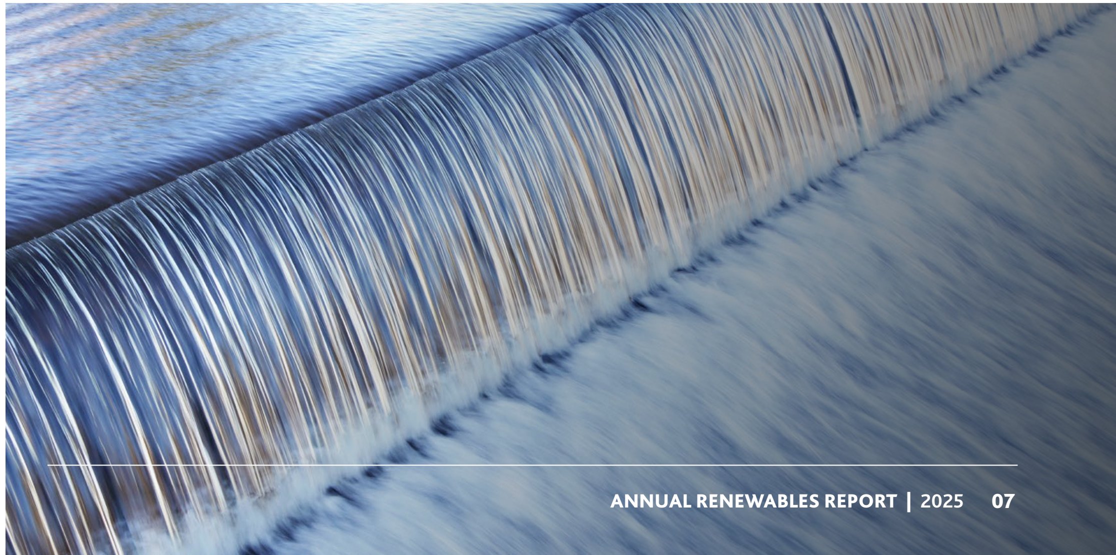


Are the UK's targets achievable?

The NESO[4] Clean Power Scenarios provide the most recent assessment of the UK's ability to reach its 2030 targets. It estimates renewables to account for between 84.2%-88.5% of electricity generation by 2030. Prior to the Clean Power 2030 plan, the historic DESNZ[5] forecasts projected a lower renewable share ranging from 62% to 72% for the longer-term outlook of 2050. According to the Climate Change Committee, current installation rates for offshore and onshore wind and solar are off track to achieve the 2030 decarbonisation target. To meet this goal, key supply-side technologies will need to scale up deployment at a pace surpassing their highest annual installation rates to date.

Scale up needed in selected technologies' capacity to achieve clean power demand by 2030, GW[6]

	Existing capacity, as of 2023		Demand in 2030
Solar	15.1	3x →	47.4
Batteries	4.7	4x →	27.4
Onshore wind	13.7	2x →	27.3
Offshore wind	14.7	5x →	50.6



Source: Climate Action Tracker website; DESNZ — Clean Power 2030 Action Plan — 2024; Climate Change Committee — Progress towards reaching Net Zero in the UK — July 2024; NESO — Clean Power 2030 — November 2024; DESNZ — Energy and emissions projections: 2023 to 2050 — 2024; Media overview

Notes: (1) Carbon Budget Delivery Plan; (2) Nationally Determined Contribution; (3) Below 1990 levels; (4) National Energy System Operator; (5) Department for Energy Security and Net Zero; (6) According to NESO's Further Flex and Renewables scenario

Pace and coordination are key for Clean Power 2030 goals and sustaining momentum

The deployment of required capacity under the Clean Power 2030 plan requires annual investment of £40bn during 2025-2030, of which £30bn will be allocated for generation assets and £10bn for transmission infrastructure, much of which is expected to be from private sources.

To be able to achieve this deployment, construction also needs to begin within the next 6-24 months. Key legislation changes are expected in 2025 to expedite the approval process.

As many projects need construction to start within the next 6-24 months, planning reforms are set to bring changes to legislation in 2025 and expedite approval processes. Grid connections, another major bottleneck, are set to see a new system in spring 2025, replacing the first-come, first-served model. This change should accelerate new offers by year-end, with the first projects connected and operational by 2026.

Grid expansion is essential to fully harness renewables, including capacity increases for electric vehicle charging, heat pumps, and offshore wind connections. To meet the 2030 deadline, major UK transmission operators have announced a £67bn plan to upgrade the national grid.

Battery storage is crucial for short-term flexibility, with 23-27 GW needed by 2030. Additionally, increasing long-duration storage from 2.7 GW to 7-15 GW by 2050 will support the UK's net zero goals and energy security.

The Clean Power 2030 Plan also highlights the role of nuclear power, requiring life extensions for existing plants, the delivery of Hinkley Point C, final decisions on Sizewell C, and construction of Small Modular Reactors by 2030, which could compensate for under-delivery in other areas. Dispatchable low-carbon technologies such as carbon capture and storage (CCS) and hydrogen will also likely be essential to balancing the grid. Addressing supply chain and workforce shortages will be a challenge, requiring long-term policy certainty, training and investment. Immediate action needs to focus on addressing workforce shortages, particularly in offshore wind, and creating a sector skills plan.

The last 12 months have certainly seen some key changes for the renewables sector. While there is nothing revolutionary in the announcements made through the Clean Power 2030 plan, the framework does set out what the UK government feels is needed to support the UK's energy transition and what the focus areas are expected be for the next five years. Transitioning the UK energy network is a huge infrastructure project which needs centralized policy to provide direction to the investment community.

The plan is a strategy and doesn't have all the details but the recent announcements, for example in January, on how to deal with the connection queue is seen as one of the first actions to come from the plan. It has been viewed both as welcome from those who have experienced delays in connecting good renewable projects to the grid and raises questions for others.

Of course, the ability of the UK to transition the energy network to net zero is not just down to the type of generation but also down to the wider transmission, distribution and storage available to transport and store the power as well as being able to attract the significant investment which is needed to realise the strategy.

The Clean Power 2030 (CP30) plan does reaffirm the UK's commitment to renewable energy with the hope of increased investment and ultimately reducing and less volatile pricing for householders. It will be interesting to see how the energy markets and the investors react in the longer term to these changes coupled with the interplay of an increasingly volatile geopolitical landscape.

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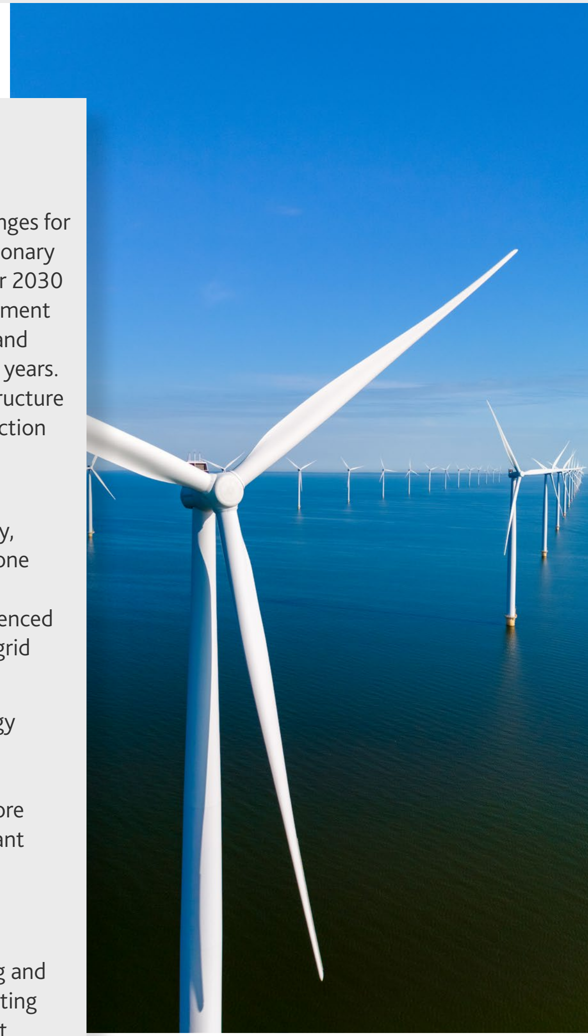


Changes to the sixth CfD Allocation Round (AR6) led to a record number of secured projects

A key factor in driving renewables build out is the ability to obtain Government support by way of pricing or subsidies.

This has been achieved in recent years through 'Allocation Rounds', where project owners bid the lowest per MWh price they feel they need to generate their required return (these are known as Contracts for Differences or CfDs).

In 2023, the AR5 auction was deemed to be unsuccessful in securing significant capacity primarily due to the low strike prices that failed to attract any bids for new offshore wind projects, which was seen at the time as a key investment area. To prevent a repeat, the budget for AR6 was increased by £530m to a record £1.6bn and administrative prices (the upper limit placed on bid prices) were increased significantly: offshore wind saw a 66% increase, while solar and onshore wind rose by 30% and 21%, respectively.

Since the strike prices in AR5 were too low (£37.35/MWh for offshore wind), AR6 allowed successful AR4 bidders to re-bid for new 'Permitted Reduction' CfDs, covering 25% of their original capacity. This led to 131 clean energy projects with a total capacity of 9.6 GW, 2.5 times higher than in AR5. Notably, AR6 secured 10 new offshore wind projects, with bids 19% below the price cap, although still above AR5's proposed rates.

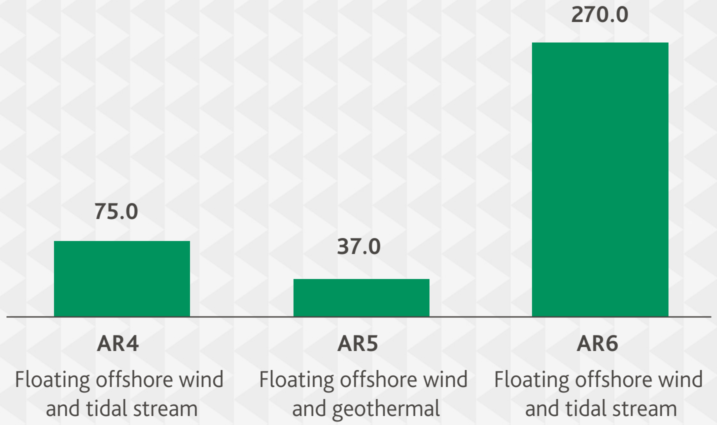
Looking ahead, the Government has announced several amendments for AR7, including support for repowering onshore wind and extending the phasing process for floating offshore wind, aiming to build on AR6's success and further refine the CfD scheme.

Capacity procured in AR5 and AR6

Technology type	Amount, GW (AR6)	Amount, GW (AR5)	Number of projects (AR6)	Number of projects (AR5)	Final strike price in AR5 £/MWh	Final strike price in AR6 £/MWh
Offshore wind	3.4	0	2	0	37.35	58.87
Offshore wind permitted reduction	1.6		7		-	54.23
Solar PV	3.3	1.9	93	56	47.0	50.07
Onshore wind	1.0	1.5	22	24	52.29	50.90
Floating offshore wind	0.4	0	1	0	116.0	139.93
Tidal	0.03	0.05	6	11	198.0	172.0

AR6 | AR5 | Administrative strike price where no projects were secured

Allocated funding to emerging technologies and selected awarded technologies under recent ARs, £m[1]



Since AR4 in 2022, emerging technologies, such as tidal stream and floating offshore wind, have started to secure CfDs. In AR5, for the first time, CfDs were granted for three geothermal projects with a total potential installed capacity of 12 MW. In 2024, the latest AR6 secured 400 MW of floating offshore wind and 28 MW of tidal stream energy.

Source: GOV.UK website; Carbon Brief website; Energy UK — Allocation Round Six — 2024; DESNZ — Contracts for Difference Allocation Round 5, 6: results — 2023, 2024; Media overview

Notes: (1) The allocated budget specifically targeted Pot 2 technologies, referred to as less-established technologies, which also encompassed Advanced Conversion Technologies, Anaerobic Digestion, and Dedicated Biomass with Combined Heat and Power

What can we learn from countries which have increased their renewables output in 2024?

As the UK navigates its way through a resetting of the agenda for renewables, there are some clear success stories in Europe showing what can be achieved.

Since 2010, the share of renewables in Europe's electricity mix has grown significantly, with several countries like Norway, Albania, and Iceland providing around 100% of their electricity from renewables over the entire year in 2024, primarily leveraging natural geographical resources and hydropower.

At the same time, other countries managed to raise their renewable power generation by implementing strong policy measures, such as feed-in tariffs, subsidies, and tax incentives. For instance, Sweden has become a leader in renewable energy due to a combination of forward-looking policies and incentives, favourable geography and long-term investments, for example the carbon tax, introduced in 1991, made fossil fuels more expensive, stimulating the shift to renewables. In 2003, the Electricity Certificate Scheme further accelerated the growth of renewables by providing market-based incentives, where for every MWh of renewable energy produced, a certificate is earned that can be sold, offering additional income above the market price for electricity.

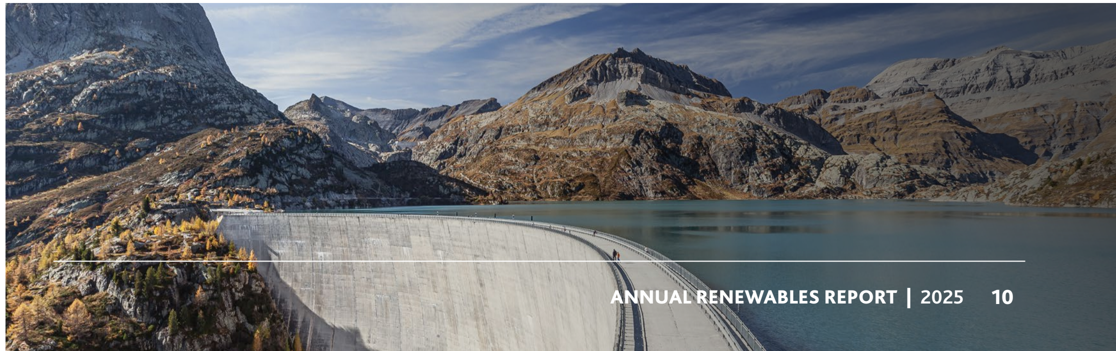
Sweden further promotes renewables through investment incentives such as the Climate Leap, which supports small scale local and regional projects aimed at reducing emissions.

The Netherlands has also expanded renewables through its SDE++ subsidy scheme, which provides multi-year operating grants for renewable projects, including offshore wind. Additional financial incentives like the Energy and Environmental Investment Allowances and net metering further encourage green investments.

Germany fuelled its renewables growth with the Renewable Energy Sources Act (EEG), which introduced a renewables surcharge and guaranteed feed-in payments for producers. This system helped rapidly scale up wind and solar power before transitioning to auction-based support in 2017 to ensure cost-effective expansion.

Share of renewables in electricity generation, selected countries

Share of renewables, 2010	32.1%	9.5%	16.9%	18.6%	55.3%
Share of renewables, 2024	88.0%	50.8%	57.5%	49.8%	69.5%
Share of Top-3 main renewable sources, 2024	Wind 57.9%	Wind 27.0%	Wind 28.0%	Wind 21.7%	Hydro 37.7%
	Bioenergy 18.8%	Solar 17.7%	Solar 14.9%	Solar 21.5%	Wind 23.6%
	Solar 11.3%	Bioenergy 5.9%	Bioenergy 9.6%	Hydro 5.4%	Bioenergy 6.0%
Share of renewables, 2030	99.2%	76.0%	75.0%	81.5%	100% (by 2040[1])

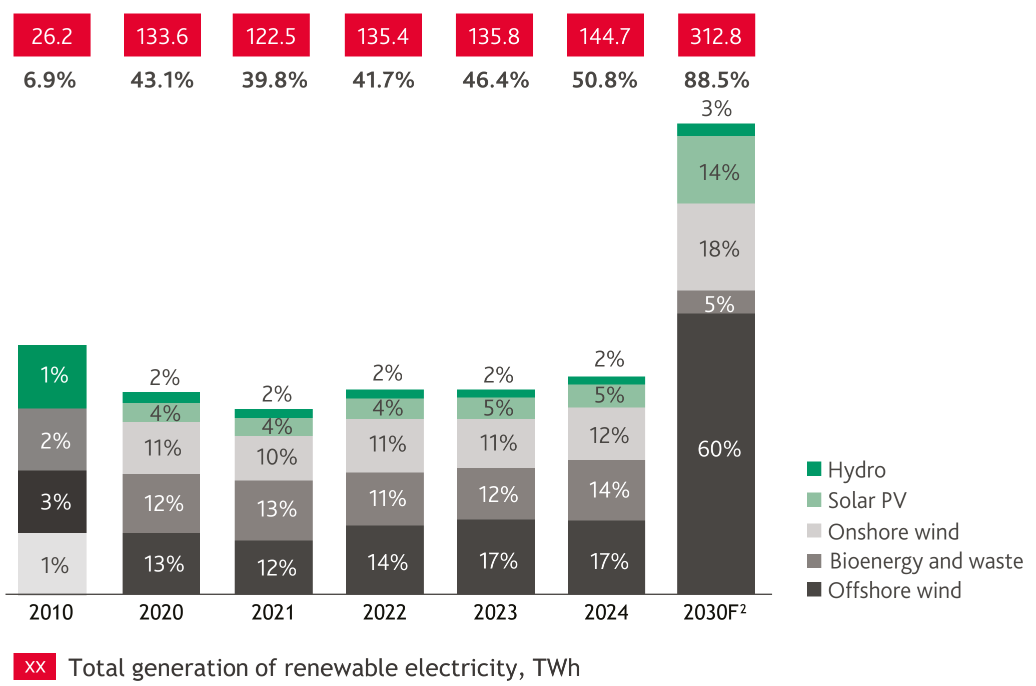


Source: Eurostat website; Ember website; Electricity Maps website; RenewableUK website; Sweden.se website; CMS website; Renewable Energy News website; Carbon Credits website; DESNZ — Energy Trends — March 2025; WindEurope — Wind energy in Europe: 2023 Statistics and the outlook for 2024-2030 — 2024; IRENA — 30 Years of Policies for Wind Energy. Denmark — 2013; UN ESCAP — Case Study - Wind Power takes flight in Denmark — 2012; UNFCCC — Wind Energy in Denmark — 2023; Media overview

Notes: (1) In June 2023, the Swedish parliament revised the target to aim for 100% fossil-free electricity by 2040, allowing for the inclusion of nuclear power alongside renewable sources to meet the country's objectives

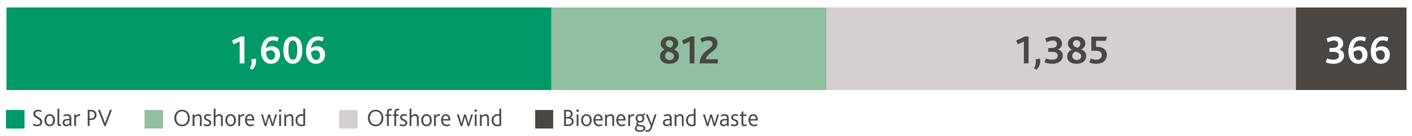
What can we learn from countries which have increased their renewables output in 2024?

Renewables' share of total electricity generation in the UK



The UK has increased its share of renewable electricity generation from 6.9% in 2010 to around 51% in 2024. This has been a remarkable achievement, however, a lot more is needed to meet the Government's Clean Power 2030 plan. The Clean Power 2030 report suggests that offshore wind will likely be the largest contributor to increasing the UK's capacity. The scale of growth may seem unrealistic when looking solely at the growth in offshore wind over the past 15 years, however, it is worth highlighting that offshore wind turbine outputs have significantly increased since 2010, when a turbine of 5 MW was considered large, whereas the turbines of today are getting much larger, pushing the boundaries of electrical output to >24 MW per turbine. This means that fewer turbines will be needed to meet electricity demands.

Added capacity in the UK in 2024, MW



Denmark's renewable energy success

Denmark has been an early leader in decarbonisation and had the highest share of wind energy in the power mix among European countries in 2024. Denmark's success stems from decades of strategic policies, R&D support, and multi-stakeholder engagement.

Starting in the 1970s, wind energy was included in the country's energy plans, while energy taxes on electricity prices were used to support R&D for renewable energy. Wind turbine installations surged from 338 in 1984 to 6,267 in 2001, when the government introduced a feed-in tariff ensuring grid access. The utility sector was required to buy wind energy at a preferential rate, ensuring wind power generators a fixed price of 70–85% of the local retail electricity price.

In 2000, the government replaced the feed-in tariff with a green certificate system. The certificates were issued to renewable electricity producers, who could trade them at a premium with buyers seeking or required to purchase green energy.

Cooperatives played a key role in the development of wind power, with communities benefiting directly through profit-sharing from renewable energy generation. A significant policy, the 2008 Danish Renewable Energy Act, required new wind projects to offer at least 20% of ownership to local residents. Today, Denmark continues to refine its support mechanisms, offering Green Investment Support subsidies for new projects and planning a revised offshore wind tender with more attractive state-backed incentives.

Source: Eurostat website; Ember website; Electricity Maps website; RenewableUK website; Sweden.se website; CMS website; Renewable Energy News website; Carbon Credits website; DESNZ — Energy Trends — March 2025; WindEurope — Wind energy in Europe: 2023 Statistics and the outlook for 2024-2030 — 2024; IRENA — 30 Years of Policies for Wind Energy. Denmark — 2013; UN ESCAP — Case Study - Wind Power takes flight in Denmark — 2012; UNFCCC — Wind Energy in Denmark — 2023; Media overview

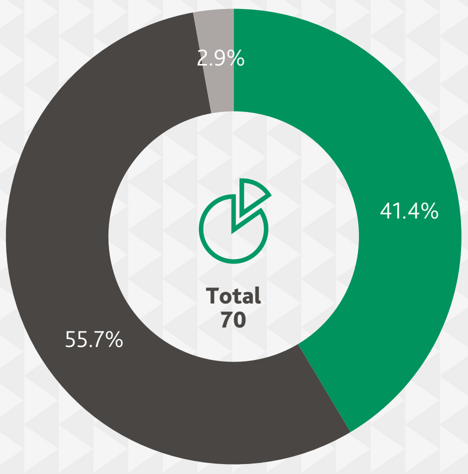
Notes: (2) According to NESO's Further Flex and Renewables scenario. The total share of Renewables includes offshore wind, onshore wind, solar, biomass, and other Renewables. As the source has a different breakdown of categories compared to DESNZ historical data, 'Other Renewables' category is presented under the 'Hydro' category

The path to clean power will require carbon capture technologies along with renewables

Carbon capture and storage (CCS) provides a solution to decarbonise carbon-intensive energy production and could therefore play a key role in the UK's energy transition.

The Clean Power 2030 plan highlights the need for low-carbon dispatchable power to support a renewables-based 2030 system, including up to 2.7 GW of hydrogen to power and gas CCS[1]. However, uncertainty remains both in terms of Government support to promote investment and the feasibility of transporting and storing the carbon produced. The UK had the second-largest CCS project pipeline globally in 2024, after the USA, able to store up to 78btns. In October 2024, the UK announced a £21.7bn investment over the next 25 years of the first Track 1 CCS projects. The funding was allocated to the HyNet cluster in northwest England and the East Coast Cluster, focused around Teesside, along with the necessary CO_2 transport and storage infrastructure for each.

The number of CCS projects in the UK, as of January 2025[2]



Selected current CCS projects

After a Final Investment Decision (FID) in December 2024, two of the UK's CCS projects within the East Coast Cluster in Teesside — the Northern Endurance Partnership (NEP) and Net Zero Teesside Power (NZT Power) — moved into the execution phase.

NEP

Commencing: mid-2025

Operational: 2028

Capacity: up to 4 $MtCO_2$/year[3]

NZT Power

Commencing: mid-2025

Operation: 2028

Capacity: up to 2 $MtCO_2$/year[3]

Despite there being plans for two more projects to be operational by 2030, there is still a lack of clarity regarding their timing, delivery roadmap, and funding allocations which could impact the UK's decarbonisation efforts. For example, the Energy from Waste (EfW) industry, whilst being carbon–intensive, is necessary for the UK to avoid waste going into landfill, which is expected to reach full capacity in 2049 without building large new landfill sites. To reduce the carbon effects of this industry, new EfW plants will have to come with CCUS from December 2024. EfW is considered a key component of the UK's energy mix and waste management systems. Further development of CCUS is essential, as carbon capture can help mitigate emissions from EfW sites.

The adoption of CCS in EfW facilities could capture nearly 20 $MtCO_2$/year, contributing to the UK's 2035 CCS target of 50 $MtCO_2$/year.

Six of the UK's EfW facilities, located near prioritised CO_2 storage hubs, have announced plans for CCS and submitted applications to the UK Government's CCS Cluster Sequencing competition.

30 EfW facilities are strategically positioned to adopt CCS by 2035, paving the way for additional CO_2 hubs and accelerating the decarbonisation of the waste sector.

Source: GOV.UK website; Global CCS Institute website; Northern Endurance Partnership website; Net Zero Teesside website; OEUK — Carbon Capture Utilisation And Storage (CCUS) Insight — 2024; ERM — EfW with CCS: a key pillar for net zero in the UK — 2024; NESO — Future Energy Scenarios: NESO Pathways to Net Zero — July 2024; Media overview

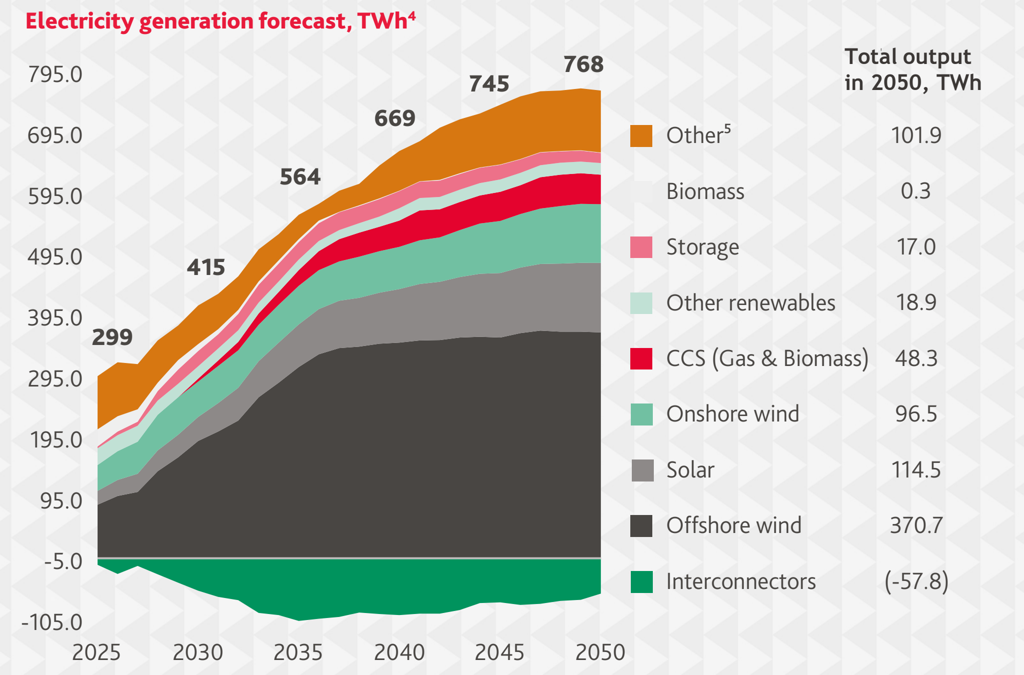
Notes: (1) Required capacity in 2030, according to NESO's New Dispatch scenario; (2) According to the Global CCS Institute Facilities Database; (3) Initial capacity with a possibility to increase to 23 $MtCO_2$/year by 2035 with future expansion of the East Coast Cluster

The path to clean power will require carbon capture technologies along with renewables

As of 2024, the total estimated capital investment opportunity for implementing carbon capture on EfW facilities in the UK was valued at £19bn.

This includes £3bn for large assets strategically positioned within industrial clusters, £7bn for large to medium-sized facilities near industrial clusters with CO2 storage or major ports that could serve as CO2 shipping hubs, and the remainder for small to medium-sized sites that face challenges in deploying CCS due to location constraints, such as being over 100km from CO2 hubs. Large EfW assets located within industrial clusters may be eligible to apply for UK Government financial support; however, unlocking the full investment potential requires incentives for private sector funding. In addition to driving decarbonisation, the investments are expected to create 14,000 green jobs, while the CCUS sector as a whole is expected to safeguard and generate 150,000 jobs across the UK's energy and industrial sectors, contributing over £100bn to the economy by 2050.

NESO scenarios have forecast capacity requirements to be between 281GW to 381GW, with the main sources expected to come from renewables, however, no scenario predicts a 100% renewable share by 2050. Gas will remain necessary to ensure secure and reliable power delivery, but must align with the Net Zero targets, this can be achieved through the adoption of CCS technology or a gradual shift to hydrogen in the longer term. Long-duration storage, interconnectors, and dispatchable clean resources, e.g. gas with CCS, will help manage variations in power supply caused by weather dependent renewable generation and play a key role alongside renewables to displace fossil fuels.



Tax incentives can be an effective government tool to support the energy transition although current incentives tend to favour capital intensive projects and are typically of general application rather than targeted to the renewables sector.

The government has retained uncapped 'full expensing' first year allowances. These tax deductions are available for expenditure incurred on new qualifying plant and machinery investments and can be a valuable benefit for capital intensive projects such as offshore wind farms, battery storage etc. These are not specific to the energy transition although targeted capital allowances for particular green technologies do exist. These include enhanced tax relief for certain electric cars with zero CO_2 emissions, related vehicle charging points and refuelling equipment for gas, biogas and hydrogen.

Tax deductions for capital expenditure can be of limited value though to early stage companies which are not yet profit-making. The new merged R&D scheme does offer an above-the-line credit for qualifying R&D expenditure which can be surrendered for cash payments where companies are loss-making. However this R&D relief is not targeted at any specific renewable or decarbonisation technology and excludes capital spending. This is an area where the UK could potentially offer more competitive tax incentives for innovation in green and renewable technologies and look to match R&D regimes like those in Ireland and France that include capital expenditure.

Sam Boundy
Tax M&A Partner | BDO

Source: GOV.UK website; Global CCS Institute website; Northern Endurance Partnership website; Net Zero Teesside website; OEUK — Carbon Capture Utilisation And Storage (CCUS) Insight — 2024; ERM — EfW with CCS: a key pillar for net zero in the UK — 2024; NESO — Future Energy Scenarios: NESO Pathways to Net Zero — July 2024; Media overview

Notes: (4) In the Holistic Transition scenario, according to NESO's Future Energy Scenarios; (5) Includes fossil fuel, nuclear, and hydrogen

Upgrading the Grid

Over the past decade, UK investments in renewable energy have significantly outpaced grid capacity expansion, leading to major bottlenecks in the UK's energy transmission system.

The grid connection queue now holds projects with nearly four times the power capacity required for decarbonisation, far exceeding actual need. The aging infrastructure struggles to adapt to a system that no longer operates with a stable baseload from power plants but instead requires greater flexibility to accommodate intermittent renewable generation.

At the same time, a mismatch exists between where renewable energy is produced — often in low-demand areas like Scotland — and where it is needed most, such as in the south of England. As a result, grid constraint costs — the payments made to energy generators to curtail output when the grid cannot transport excessive electricity — are rising sharply. UK consumers are expected to pay over £1.8bn in constraint costs[1] by 2025, up from £1.5bn in 2024, as the system struggles to efficiently transmit surplus renewable power.

National Grid is spearheading the £35bn Great Grid Upgrade, the largest UK electricity grid overhaul in decades. The initiative includes onshore upgrades like power lines, 400 kV substations, solar projects alongside offshore wind turbines, and interconnectors. It aims to modernise ageing infrastructure over 50 years old, making it the most ambitious project planned by UK transmission system operators.

National Grid's Great Grid Upgrade key figures

17 major projects

Designed to reach the target of supporting up to 50 GW of offshore wind capacity by 2030.

3,500 km

Upgrade of aging overhead power lines and construction of 1,100 km of new power lines.

25 new substations

To be built by 2030, with another 15 scheduled beyond 2031.

55,000 new jobs

Will be created, emissions will reduce by 50%, and save an estimated £12bn of to consumers.

Factors impacting the transmission system upgrade delivery

Lengthy permitting process

The main challenge for the Grid Upgrade is building five times more networks in six years than was achieved in the last 30. Since the planning system reform in 2012, the approval time for national infrastructure projects has increased to four years from the previous two and a half. The planning reforms expected in 2025 should help to reduce this timeframe.

Public opposition

The project plans include hundreds of kilometres of high-voltage overhead lines supported by pylons across the country. With significant public opposition and the Government's decision against underground cabling, delivering these proposals on time faces serious challenges.

Lack of a skilled workforce

Developing the necessary resources and capacity for the upgrade will require training the specialised electrical commissioning engineers, which can take up to eight years. This will necessitate plans to establish new training centres for overhead line technicians and engineers.

Such challenges could threaten project execution and decarbonisation efforts, leading to expensive delays for taxpayers (up to £4bn per year for one project).

Source: NESO website; NESO — Clean Power 2030 — November 2024; National Grid — The Great Grid Upgrade — 2024; Infrastructure Investor — Ofgem: How the UK plans to tackle the transition's transmission trouble — 2024; WEF — Grid Development in Europe: Five Actions to Strengthen the Business and Economic Case — 2024; Ember — Putting the mission in transmission: Grids for Europe's energy transition — 2024; Media overview

Notes: (1) Constraints refer to limitations that prevent the efficient flow of electricity, often due to issues such as transmission line capacity or unexpected high demand

Upgrading the Grid

Private investment in transmission infrastructure is increasingly seen as essential for upgrading the UK's power grid.

The Clean Power 2030 plan suggests that much of the £10bn needed annually for transmission infrastructure from 2025 to 2030 is expected to come from private investments. Large-scale transmission projects, particularly east-west and north-south reinforcements, aimed at upgrading and expanding the high-voltage electricity grid to improve power flow between different regions, presents opportunities for investment, innovation, and technology like smart conductors[2] and dynamic line ratings[3].

Ofgem is exploring competitive auctions for onshore transmission, inspired by the successful Offshore Transmission Owner (OFTO) model, under which offshore windfarm developers construct both the windfarm and interconnector, then sell the interconnector to an infrastructure investor, using the proceeds to repay debt. The model has attracted institutional investors due to its low-risk, long-term returns. However, onshore auctions would involve construction risks, attracting a different pool of investors. While auctions could boost capacity and efficiency, concerns remain over ensuring fair consumer costs, particularly under a government focused on regulatory scrutiny.

Germany-Netherlands case in grid development

TenneT – New framework agreements in Germany and the Netherlands

Problem: Dutch transmission system operator TenneT must connect more than 40 GW of wind energy in the North Sea to the shore by 2030, up from 12 GW today. It has developed a new 2 GW platform approach, under which it will build at least 14 systems.

Action: framework agreements tender HVDC4 platforms and cables on a large scale instead of tendering each system separately.

Outcome: boosted market capacity and streamlined production.

Source: NESO website; NESO — Clean Power 2030 — November 2024; National Grid — The Great Grid Upgrade — 2024; Infrastructure Investor — Ofgem: How the UK plans to tackle the transition's transmission trouble — 2024; WEF — Grid Development in Europe: Five Actions to Strengthen the Business and Economic Case — 2024; Ember — Putting the mission in transmission: Grids for Europe's energy transition — 2024; Media overview

Notes: (2) Enhance grid efficiency by optimising electricity flow and reducing losses; (3) Adjust transmission capacity in real time based on weather and load conditions; (4) High-Voltage Direct Current; (5) The numbers are converted from Euro to GBP due to the average exchange rate by the ECB; (6) Planned investment in national transmission grids, average annual over transmission system operator plan timeframe; (7) The Italian Regulatory Authority for Energy, Networks and Environment

The challenges faced by the UK and other European countries highlight a shared set of issues, including grid constraints, delays in permitting and approvals, shortages of skilled workers, supply chain disruptions, and regulatory uncertainty. To achieve the UK Government's vision of a clean, secure, and decarbonised energy system, swift, coordinated, and sustained action is imperative. Collaboration across all segments of the energy sector, government, regulators, and local communities is essential, along with ensuring tangible benefits for investors and the wider economy.

Upgrading energy infrastructure is not a UK-specific issue but is a global challenge as well. Europe will need nearly £677.3bn[5] in transmission and distribution investments over the next decade to deal with demand and supply constraints as well as improved security.

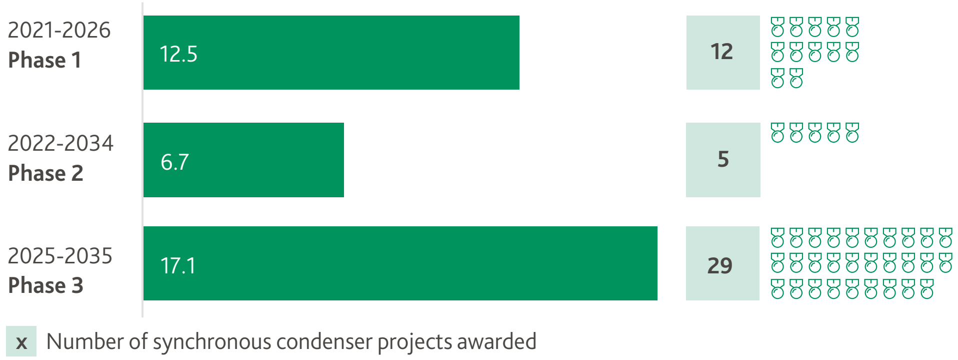
Leading countries in anticipated spending[6], such as Germany (£11.5bn[5]), the Netherlands (£2.6bn[5]), and Italy (£1.8bn[5]), also showcase best practices in grid development. Notable actions include TenneT's new framework agreements in Germany, Integral Programming Infrastructure in the Netherlands, where grid operators and local governments collaborate to align industrial sector plans, and Italy's ARERA[7] regulatory framework, requiring grid plans to demonstrate positive cost-benefit outcomes based on a predefined methodology.

Making improvements to grid stability

While physical upgrades to modernise the grid are essential, grid balancing services are equally vital for maintaining grid reliability and smooth electricity delivery by moderating supply and demand.

Renewable generators lack inertia, which helps counter sudden frequency drops caused by renewables, giving the grid time to rebalance. As more renewable power supplies are integrated, inertia on the UK energy network declines, increasing the need for grid balancing services alongside renewables. Synchronous condensers (SCs) have re-emerged as a reliable solution, enhancing stability by mimicking the inertia traditionally provided by thermal power plants. In addition, SCs can both supply and absorb reactive power, delivering voltage support and dynamic regulation. NESO currently seeks to maintain a minimum inertia level on the grid of 140 GVAs, although this is looking to be reduced to 102 GVAs.

Inertia capacity contracted under Stability Pathfinder Phases, GVAs[1,2]

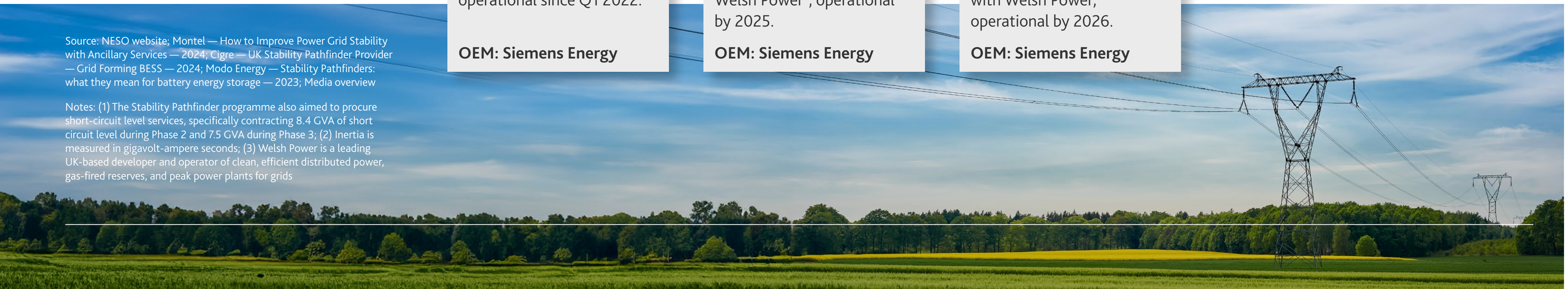


Largest contractors awarded to provide synchronous condensers stability services in each phase

Phase 1: Uniper	6.3 GVAs	Four projects were deployed at Killingholme and Grain operational since Q1 2022.	**OEM: Siemens Energy**
Phase 2: Quinbrook	1.7 GVAs	Four projects located across Scotland, developed with Welsh Power[3], operational by 2025.	**OEM: Siemens Energy**
Phase 3: Quinbrook	8.3 GVAs	Two projects in England and Wales to be developed with Welsh Power, operational by 2026.	**OEM: Siemens Energy**

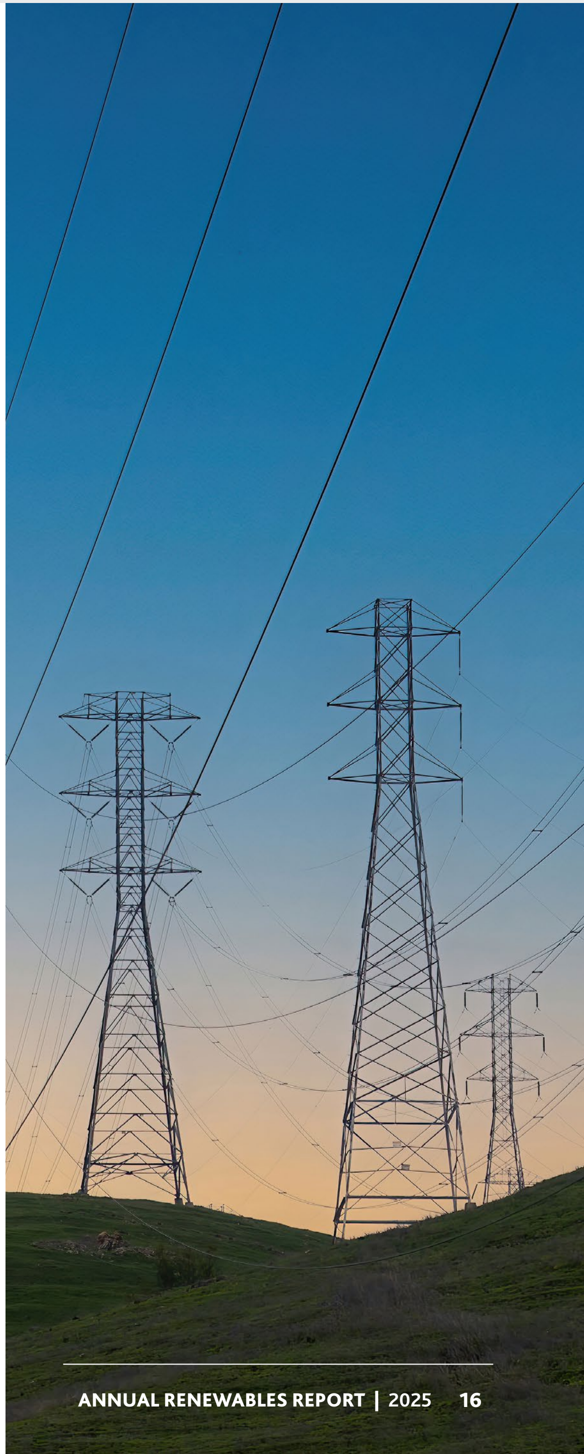
In 2019, National Grid Electricity System Operator (NESO) announced the Stability Pathfinder programme to find greener ways of generating inertia, aiming to identify new technologies. The first phase secured 12.5 GVAs of inertia by 2026, which is estimated to deliver savings of £52m–£128m.

During the second phase, worth £323m, ten projects were selected for the pathfinder projects including five synchronous condensers providing 2.3 GVAs. The third phase secured 17.1 GVAs of inertia and was projected to save £14.9bn by 2035 while cutting nearly 6.0 $MtCO_2e$, emphasizing the environmental benefits provided by the programme.



Source: NESO website; Montel — How to Improve Power Grid Stability with Ancillary Services — 2024; Cigre — UK Stability Pathfinder Provider — Grid Forming BESS — 2024; Modo Energy — Stability Pathfinders: what they mean for battery energy storage — 2023; Media overview

Notes: (1) The Stability Pathfinder programme also aimed to procure short-circuit level services, specifically contracting 8.4 GVA of short circuit level during Phase 2 and 7.5 GVA during Phase 3; (2) Inertia is measured in gigavolt-ampere seconds; (3) Welsh Power is a leading UK-based developer and operator of clean, efficient distributed power, gas-fired reserves, and peak power plants for grids



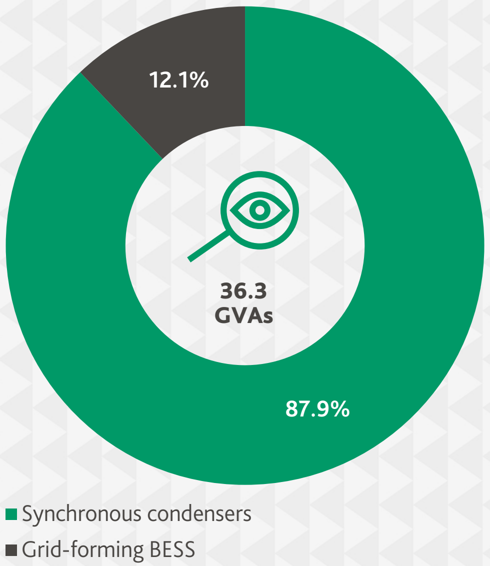
Making improvements to grid stability

After the Stability Pathfinder programme, NESO advanced towards a stability market design to procure services on a day-ahead, year-ahead, and four-year-ahead basis.

NESO continues to explore other solutions, such as grid-forming battery energy storage systems (BESS), which can set its own frequencies without the inertia required from large spinning hardware. They are used to address locational grid stability challenges and deployed based on specific system needs. However, the technology rollout remains limited and received only 12.1% of all inertia contracted in the Stability Pathfinder process, which prioritised synchronous condensers.

Only five grid-forming BESS secured year-long contracts in the second phase, which focused on maintaining short-circuit levels in Scotland. They provide virtual inertia, replacing the mechanical inertia of SCs, and help reduce curtailment of intermittent renewable energy. However, due to the high cost, they have yet to achieve widespread adoption. Some of the contracted systems, coming online in 2025, will be Europe's largest to use the technology.

Inertia capacity contracted under Stability Pathfinder Phases, by technology



The Stability Pathfinder programme encouraged developers to propose innovative solutions supported by forward-thinking system operators. Such a collaborative process fostered innovation and maximised value for operators and developers. Its structured approach, with separate feasibility and commercial stages, ensured that only credible solutions advanced to tender. The second phase became a world-first to procure stability services from zero-carbon inverter-based resources, enabling cheaper, greener electricity and more significant wind generation potential. However, synchronous condensers are anticipated to be phased out over time, with batteries in 'virtual synchronous' mode set to take their place. Developing strong, flexible markets for innovative technologies, especially grid-forming BESS, alongside expanded contract opportunities, will drive further innovation and unlock the full potential of BESS solutions.

BDO model audit has supported numerous renewable energy generation projects.

Increasingly we are supporting greenfield project financings of utility-scale energy transition projects, such as carbon capture and storage, battery energy storage systems ('BESS'), hydrogen production, synchronous condensers, interconnectors, electric vehicle charging infrastructure and long-duration energy storage.

In 2024, we supported landmark carbon capture and carbon storage projects for the first time. The Net Zero Teesside ('NZT') project is the world's first commercial scale gas-fired power station with carbon capture providing 724MW of flexible, low carbon electricity by capturing 2m tonnes of CO_2 each year. The associated Northern Endurance Partnership ('NEP') is the CO_2 transportation and storage infrastructure for the East Coast Cluster (Teesside and Humberside) that each year will store up 23m tonnes of captured CO2 in saline aquifers over 1,000m below the North Sea. These landmark transactions were financed by over 20 banks and financial institutions. In addition, we supported the financing of six synchronous condensers which provide grid inertia to help maintain the voltage of the electricity network under the National Grid's Stability Pathfinder programme.

In 2025, we are supporting a diversity of emerging technologies including green hydrogen (produced using renewable energy), blue hydrogen (produced using natural gas, but combined with carbon capture), biomethane (from fish sludge and fish silage) and liquid air energy storage projects amongst many others.

The ability of such energy transition projects to raise long-term senior debt financing demonstrates the maturity of the technology, scalability, and robustness of the revenue streams and support mechanisms so that banks and financial institutions are willing to provide debt to meet the financing requirements of energy transition projects required to enable a more electrified and decarbonised economy.

Andy Hucknall
Advisory FMAS Director | BDO

How can the UK increase its BESS generation to reach its 2030 targets

Currently the UK capacity for BESS stands at 8.9GWH which is only c.5% of the overall target under the Clean Power 2030 plan.

Storage is a core system component required to address the intermittent nature of renewable energy sources, ensure grid balancing, and manage electrical load, thereby reducing curtailment and power-outages. The UK's most substantial sources of flexibility are batteries. The industry has seen significant investment in recent years with capacity expanding by 93% in the UK, however, more needs to be done by DESNZ under the Clean Power 2030 framework to close the significant gap in capacity.

Recent UK Government policy commitments regarding future utility-scale battery storage support

- National Energy System Operator and industry regulator Ofgem continue to work on grid connection reform.
- The Government finds ways to support grid-scale BESS through future planning reforms.
- The Government consults with the industry players on how BESS can be included within environmental permitting regulations.

The UK's total planned BESS capacity stands at 85.0 GW/175.0 GWh as of the end of 2024. The future deployment will depend on a strong business case, which requires a strategic approach to investment, ensuring financial viability, alignment with market demand, and competitive economic returns. Notably, the Government has lifted asset size restrictions and actively supports front-of-the-meter battery deployment through its Capacity Market. Utility-scale operators can also maximise revenue by leveraging up to five different revenue streams: capacity market, frequency response, DC/DM/DR[1], wholesale market, and balancing mechanism.

In November 2024, the UK Government reaffirmed its commitment to the Zero-Emission Vehicle (ZEV) mandate, maintaining EV sales targets despite manufacturers' concerns over weak consumer demand. The mandate requires EVs to make up 22.0% of new car sales in 2024, rising to 28.0% in 2025 and 33.0% in 2026. With regard to infrastructure, in 2024, the UK Government launched the second phase of V2X (Vehicle-to-Everything) Innovation Programme, with up to £9.4m funding for projects that develop and demonstrate small-scale bi-directional charging technologies. In February 2024, Octopus Energy launched the first 'mass' V2G (Vehicle-to-Grid) tariff in the UK, providing free charging for EV owners who return energy from their vehicle batteries to the grid during peak demand periods.

By the end of 2024, the UK's battery storage capacity reached 6 GW which is equivalent to 8.9 GWh, driven primarily by large-scale utility installations, representing a 90% year-on-year growth. Looking ahead, the market is set to expand significantly, with capacity surging to 24.0 GW by 2030. This rapid growth can potentially attract investments of up to £16bn[2], reinforcing the UK's role as a key global player in energy storage.

Source: GOV.UK website; Energy Storage News website; NESO — Clean Power 2030 — November 2024; SolarPower Europe — European Market Outlook for Battery Storage 2024-2028 — 2024; RystadEnergy — Charging Up: UK utility-scale battery storage to surge by 2030 — 2023; Media overview

Notes: (1) The Dynamic Response Services suite includes Dynamic Containment (DC), Dynamic Moderation (DM), and Dynamic Regulation (DR); (2) The numbers are converted from USD to GBP due to the average exchange rate by the FRED

How can the UK increase its BESS generation to reach its 2030 targets

UK BESS estimated installed capacity as of the end of 2024, compared to the rest of the world

	Cumulative BESS installed capacity, GWh	GWh of storage per GW of VRE[3]	YoY Growth	Driver	Global share
China	168.0	0.12	+151%	Utility-scale BESS rollout	46.3%
USA	86.6	0.32	+90%	Utility-scale BESS rollout	23.9%
Germany	19.0	0.11	+50%	Residential storage additions	5.2%
Italy	11.4	0.26	+72%	Utility-scale BESS rollout	3.1%
UK	8.9	0.19	+93%	Utility-scale BESS rollout	2.5%
Austria	3.0	0.25	+38%	Residential storage additions	0.8%
Czech Republic[4]	2.4	0.60	+67%	Residential storage additions	0.7%

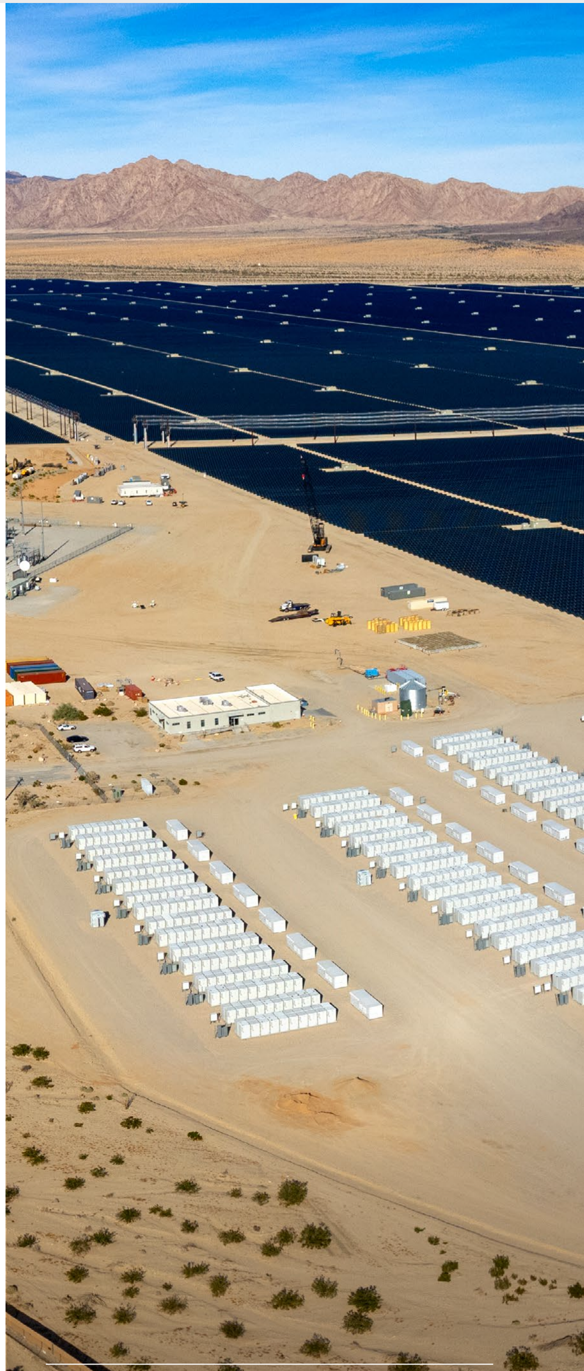
Utility-scale BESS rollout | Residential storage additions

In 2024, global battery storage energy capacity reached nearly 363.0 GWh, driven primarily by China's market dominance. The USA followed, propelled by state targets, utility procurements, and a favourable merchant economy in states such as Texas. In Europe, residential storage additions boost the market, led by Germany, where grid fee exemptions and subsidies drive adoption, alongside support from day-ahead and intraday markets. In Italy, Terna[5] plans to tender 71.0 GWh of storage by 2030 under fixed-price arrangements, allowing for long-term contracts. Zero tax applied to PV systems up to 35 kW peak and associated battery storage systems since January 2024 drove installations in Austria, while in Czechia, which has the largest ratio of storage to operational generation capacity, the European Commission has approved a £235m[6] scheme to support 1.5 GWh more of energy storage projects through direct grants in March 2025.

China

The country has reached and even surpassed its 2025 'new' energy storage target two years ahead of schedule.

China leads globally, both in terms of its domestic deployments of BESS and the manufacturing of battery cells and storage systems. By the end of 2023, the country had 31.4 GW of 'new type'[7] energy storage, nearly quadrupling from 8.7 GW in 2022 and reaching its 30 GW 2025 target. This rapid growth was driven by policy incentives, large-scale projects, and mandatory storage requirements to include a certain amount of energy storage capacity alongside new generation projects. For the UK to increase its BESS output, action to promote battery manufacturing in the UK should be prioritized both for energy storage and to support the expanding EV market.



Source: GOV.UK website; Energy Storage News website; NESO — Clean Power 2030 — November 2024; SolarPower Europe — European Market Outlook for Battery Storage 2024-2028 — 2024; RystadEnergy — Charging Up: UK utility-scale battery storage to surge by 2030 — 2023; Media overview

Notes: (3) Variable renewable energy sources such as solar and wind; (4) The 2024 capacity estimates are based on SolarPower Europe's forecast; (5) The owner of the Italian national transmission grid for high and extra-high voltage electricity; (6) The numbers are converted from Euro to GBP due to the average exchange rate by the ECB; (7) Electrochemical energy storage, compressed air energy storage, flywheel energy storage, superconducting energy storage, supercapacitor energy storage, and hydrogen energy storage

Storing energy in hydrogen and derivatives

The UK's initial hydrogen strategy positioned hydrogen as a decarbonisation tool, aiming to create a hydrogen-based economy, but it is increasingly being recognised for its role in grid flexibility.

Green hydrogen storage can absorb excess electricity when wind or solar generation exceeds demand (which would reduce expensive curtailment payments which can cost £180,000/hr) and provide short-term storage for periods ranging from a few hours to several days, helping to balance the grid when battery reserves are insufficient.

By 2029, the UK is expected to have enough curtailed wind power to produce 455,000 tonnes of green hydrogen, which could fully decarbonise the UK's 7 million tonnes of annual steel production. However, policy interventions such as incentivising electrolyser providers to take surplus power off the grid at peak times will be required to reduce curtailment payments. This may involve modifying the UK's Contracts for Difference (CfD) scheme to create stronger incentives for generators to use excess power more productively.

To drive the expansion of hydrogen production, a strong and sustained demand is crucial not just through the need for power in the grid. Recognising this, the Government has prioritised key sectors for hydrogen adoption in its 2024 strategy update and is shown in the table below:

The 2024 update of the UK Hydrogen strategy outlines the UK Government's expectations on hydrogen use, including:

Power

Hydrogen is projected to contribute 2-7 GW of flexible capacity by 2030.

Industry

The £500m IETF[1] supports over 150 sites shifting to low-carbon technologies.

Transport

The Tees Valley Hydrogen Transport Hub is testing hydrogen use in transport.

Aviation

From 2025, the SAF Mandate requires 2% of jet fuel to be from sustainable sources, rising to 10% by 2030.

Off-road machinery

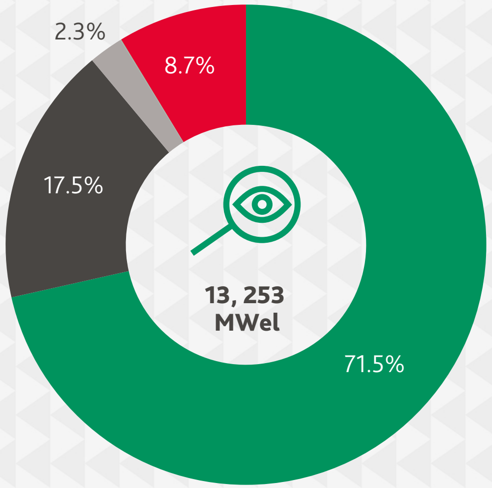
Regulations for off-road machinery are to be finalised and will take effect in 2025.

Source: IEA website; Hydrogeninsight website; Energy Monitor website; Department for Energy Security and Net Zero — Hydrogen strategy update to the market — December 2024; IEA — Global Hydrogen Review — 2024; Policy Exchange – Turning Wasted Wind into Clean Hydrogen – 2024; Hydrogen UK — UK Hydrogen Supply Chain Strategic Assessment — 2024; Centrica — Developing a whole-systems approach to explore pathways to Net Zero — 2024; Media overview

Notes: (1) Industrial Energy Transformation Fund

Storing energy in hydrogen and derivatives

UK green hydrogen production capacity, by project status[2]



The 2022 Energy Security Strategy set a goal of 10 GW hydrogen production by 2030, with at least 5 GW from green hydrogen. The UK's current green hydrogen operational production capacity is around 7 MWel[2]. Larger electrolysers are currently rare but will be needed to meet the 5 GW target by 2030; however, high marginal prices and significant upfront costs for hydrogen production and transportation hinder early adoption.

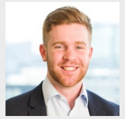
	Number of projects	Capacity MWel[4]
Concept	15	9,473
Feasibility Study	19	2,315
FID[3]/construction	24	307
Operational	6	7
Other/unknown	5	1,151

In December 2024, the UK advanced its Hydrogen Allocation Rounds (HARs), with the Low Carbon Contracts Company signing three HAR1 contracts, marking a key step toward commercial-scale hydrogen projects. Moreover, in January 2025, the UK drew up a £1.5bn plan to fund green hydrogen production by levying gas companies. The growth of the UK's green hydrogen economy hinges on maintaining strong demand, optimising production efficiency, and establishing a reliable transport infrastructure for distribution. The HAR system is not yet fully refined, with at least three UK electrolysis-based projects announcing cancellations[5] citing a range of challenges associated with the complexity of the technology not being sufficiently scalable to justify the investment. Successfully reaching these goals necessitates sustained financial support while accepting short to mid-term operational losses.

Hydrogen could play a crucial role in balancing the grid by absorbing surplus renewable energy and providing short-term storage. Converting wind and solar excess into green hydrogen not only helps reduce expensive curtailment costs but also offers a pathway to decarbonise industries such as steel production. However, significant policy adjustments are needed. For instance, incentivising electrolyser providers are critical steps towards stimulating uptake.

There are also many early-stage challenges in hydrogen infrastructure, including scalability issues with larger electrolysers and costs of storage methods. On a positive note, developments are underway in long-term storage options, like salt caverns and ammonia production, indicating a growing commitment to build a robust hydrogen infrastructure.

Hydrogen can be a cornerstone for a low-carbon future, but only if these hurdles can be addressed. Policy trends and technological advancements will determine how quickly hydrogen can move from potential to mainstream adoption.



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Source: IEA website; Hydrogeninsight website; Energy Monitor website; Department for Energy Security and Net Zero — Hydrogen strategy update to the market — December 2024; IEA — Global Hydrogen Review — 2024; Policy Exchange – Turning Wasted Wind into Clean Hydrogen — 2024; Hydrogen UK — UK Hydrogen Supply Chain Strategic Assessment — 2024; Centrica — Developing a whole-systems approach to explore pathways to Net Zero — 2024; Media overview

Notes: (2) According to the IEA Hydrogen Production and Infrastructure Projects Database updated in October 2024; (3) Final investment decision; (4) The listed capacity is not exhaustive and includes only projects for which this data is available; (5) According to the GlobalData database

Current Hydrogen Infrastructure in the UK

Transportation

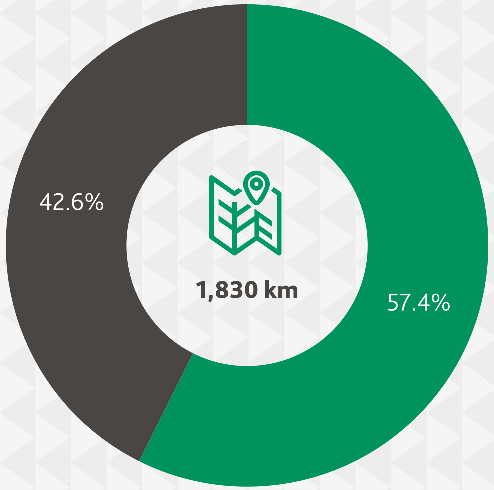
Road transport

The challenges of transporting hydrogen by road and storing it long-term stem from the need to liquefy it at -253°C. The long distances between fuelling stations lead to costly boil-off gas losses, making road transport at scale less efficient and expensive.

Gas networks

In 2023, the UK Government supported the potential integration of up to 20% hydrogen by volume into the gas distribution network. A three-year National Gas trial confirmed that the UK's gas infrastructure can be adapted for both blended and 100% hydrogen with minimal modifications. However, due to its higher flammability and lower ignition energy, stricter safety measures and improved leak detection systems will be essential. The next phase of the trial will focus on evaluating the challenges of compressing hydrogen using existing infrastructure.

UK hydrogen pipeline length by project type[2]



	Number of projects	Pipeline length, km[6]
Repurposed and new	2	1,050
New	4	780
Repurposed	1	n/a

- Repurposed and new
- New
- Repurposed

Long Term Storage

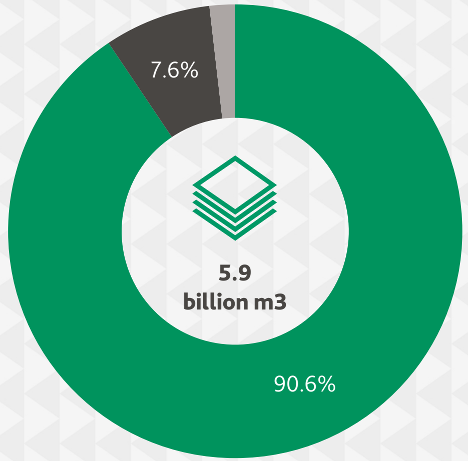
Chemical compounds

Storing hydrogen as green ammonia is a proven method but remains in the early stages of development, with large-scale adoption limited by high costs and infrastructure challenges. The UK has four ammonia production projects in development, with H2 Green — Shoreham Port — Phase I leading the way as the first to enter the construction phase in February 2025.

Geological storage

Salt caverns, known for their high storage capacity, safety, and cost efficiency, are well-suited for large-scale hydrogen storage in the UK. However, 97.9% of the planned capacity remains in early-stage development and research. UK Energy Storage is set to construct the country's largest hydrogen storage facilities, with a capacity of up to two billion m^3. This would account for approximately 20% of the UK's projected storage demand by 2035, effectively doubling the nation's current salt cavern storage capacity pipeline.

UK hydrogen storage projects by stage[2,7]



- Repurposed and new
- Feasibility study
- FEED[8]

	Number of projects	Capacity bcm
Concept	5	5.4
Feasibility study	3	0.4
FEED[8]	1	0.1

Source: IEA website; Hydrogeninsight website; Energy Monitor website; Department for Energy Security and Net Zero — Hydrogen strategy update to the market — December 2024; IEA — Global Hydrogen Review — 2024; Policy Exchange – Turning Wasted Wind into Clean Hydrogen – 2024; Hydrogen UK — UK Hydrogen Supply Chain Strategic Assessment — 2024; Centrica — Developing a whole-systems approach to explore pathways to Net Zero — 2024; Media overview

Notes: (2) According to the IEA Hydrogen Production and Infrastructure Projects Database updated in October 2024; (3) Final investment decision; (6) The listed pipeline length is not exhaustive and includes only projects for which this data is available; (7) The projects also include depleted gas fields; (8) The purpose of the Front End Engineering Design study is to enable a final investment decision

Ensuring sustainable electrification is a key goal of the UK's infrastructure expansion

In mid-2025, the UK Government is expected to unveil the National Infrastructure Strategy, which seeks to achieve the vision necessary to unlock combined private and public investments.

Their goal is to raise £80.0bn per year in the 2030s, up from an average of £55.0bn per year over the past decade[1]. With the growing emphasis on electrification across multiple sectors, integrating renewable energy will emerge as a top priority.

Key objectives to drive infrastructure development in the UK for 2030-2050

Regional growth

New industrial 10-year plan Invest 2035

Rail connectivity

Up to 75% growth in rail freight volumes by 2050

Net zero transport

300,000 public charging points by 2030

Digital networks

100% gigabit capable coverage by 2030

Role of renewable energy sources across infrastructure sectors

The UK Industrial Strategy is set to be published in the spring of 2025, targeting eight key growth-driving sectors[2]. Emphasising regional development and net zero practices, the strategy will aim to unlock the potential of city regions, clusters, and industrial hubs, stimulating public and private investments in skills, industries, and infrastructure.

Rail transport is becoming a vital part of the UK logistics system. However, around 40.0% of railway lines were electrified in the UK in 2024, compared to 56.9% in the EU in 2022. This gap highlights the significant untapped potential for renewable energy integration, which ongoing expansions[3] and the renationalisation plan[4] can further accelerate.

A wider public charging network will enhance the accessibility of EVs. With 80.0% of new car sales projected to be zero-emission by 2030, there is a significant demand for renewable-powered charging. Integrated with smart technologies, off-grid solar EV chargers can play a vital role in balancing local grid loads and reducing charging costs[5].

The ongoing expansion of 5G infrastructure and advancements in artificial intelligence will drive significant growth in data centre infrastructure. By 2030, data centres are projected to account for 6.0% of total electricity consumption in the UK, up by 3.5 p.p. compared to 2024, thereby driving higher demand for renewable energy procurement.

Key challenges in integrating renewables into emerging infrastructure sectors

Uneven regional expansion in EV infrastructure

Despite a record 37.0% YoY growth in installed EV charging points in 2024, regional disparities persist. As of 1 January 2025, only 15.4% of public chargers were installed in rural England, reflecting market-coordinated charging point distribution, power grid access issues, and lack of local authorities' engagement.

Potential solutions

Off-grid charging technologies powered by solar power and mobile charging solutions.

Power constraints

Existing grid infrastructure cannot adequately address the expected six-fold increase over the next decade in data centre power consumption. Consequently, power supply limitations are recognised as the biggest constraint on data centre expansion by 90.0%[6] of data centre stakeholders in the UK.

Potential solutions

Ultra-high voltage onshore transmission network and development of AI Growth Zones[7].

Source: GOV.UK website; National Infrastructure Commission (NIC) website; NIC — Infrastructure Progress Review — 2024; Media overview

Notes: (1) According to the National Infrastructure Commission's estimations; (2) Including advanced manufacturing, clean energy industries, creative industries, defence, digital & technologies, financial services, life science, and professional & business services; (3) Including High Speed 2 Phase 1, Northern Powerhouse Rail, and East West Rail; (4) The Labour Party plans to fully nationalise rail network in five years; (5) A UK household can save up to £400 per year on average in charging costs by using solar panels instead of the grid; (6) According to the survey of UK data centre stakeholders conducted by iXConsulting in autumn 2024, n=n/a; (7) Reconstructing of deindustrialised areas into AI infrastructure hubs, supported by enhanced power access and various incentives

Microgrids are promising for the UK's energy transition, but adoption remains limited

The UK Government plans to build 1.5 million new homes by 2030. This expansion will place significant pressure on the country's power grids.

The role of the private sector in mitigating grid concerns is becoming increasingly critical, bolstered by advancements in technology. One option being considered are Microgrids which are localised, small-scale power systems that enable decentralised and independent electricity supply. By linking local power producers and consumers, electricity losses are minimised, ensuring an uninterrupted supply of renewable energy.

Microgrids - key technical advantages

15% Greater efficiency is estimated for microgrids compared to traditional energy distribution networks, as they reduce transmission losses.

85% Saving on bills per year, due to smart energy management which reduces demand during peak hours, avoiding high tariffs[1].

Despite the potential, the latest available data shows that in 2020, Europe accounted for less than 10% of the world's total microgrid power capacity, significantly trailing behind the USA (33%) and the Asia-Pacific region (40%). As of 2021, the UK had around 3,000 community energy projects, including microgrids, primarily driven by local initiatives, with some of the most successful examples found on islands. There are also major developers securing rollouts across the country at scale. A notable case is Cepro, a company designing and developing microgrids since 2015, which, in 2023 successfully raised £600,000 to advance more community microgrid projects following the completion of its first two initiatives. Over the past year, even more promising microgrid initiatives have been announced in the UK, signalling the sector's growing appeal.

Source: Microgrid Knowledge website; AceOn website; Wood Mackenzie website; GivEnergy — What is microgrid? — 2024; PSC — How microgrids are changing the UK electric network — 2023

Notes: (1) According to the estimate of the microgrid solutions provider GivEnergy

Microgrids are promising for the UK's energy transition, but adoption remains limited

Recent advancements in UK microgrids deployment driven by different stakeholders

Carpenters Yard
February 2025

Octopus Energy and residential developer gs8 launched Carpenters Yard, a 113-home community in Thornwood, Epping, Essex, designed to eliminate electricity bills for at least five years. Each home is equipped with solar panels, heat pumps, and a centralised battery storage system that efficiently distributes power among residences.

Eclipse Power Optimise
January 2025

Eclipse Power introduced Eclipse Power Optimise, a new business unit dedicated to designing, building, and maintaining microgrids for residential, commercial, industrial developments, and data centres. This initiative aims to expedite grid connections, reduce associated costs, and mitigate delays from DNOs[2] and TOs[3].

Hook Norton
June 2024

The UK village of Hook Norton launched a community-led microgrid to power new affordable housing of 12 homes, allowing residents to purchase energy at a reduced rate. The microgrid includes a 68-kWp rooftop solar array on the homes, a 5-kWp array at the Sports & Social Club, and a 100-kWh battery for efficient renewable energy use.

The UK government has policies, such as financial support for community energy projects through the Community Energy Fund or 0% VAT on battery storage installations which may promote further investment in microgrids. However, unlike countries such as the USA, the UK has not yet developed a clear framework or strong incentives for microgrid deployment. Integrating microgrids into the existing grid system presents technical and regulatory challenges, particularly in ensuring seamless interconnectivity between microgrids and centralized grid systems. While microgrids are efficient and sustainable, scaling them to meet the demands of larger communities remains a challenge that requires further development.

USA

Rapid microgrid deployment led by both government support and a compelling business case.

By 2035, microgrids are envisioned by the United States Department of Energy to be essential building blocks of the future electricity delivery system to support resilience, decarbonisation, and affordability. The increasing demand for resilient power, particularly in commercial, utilities, and residential sectors, has been a key driver of growth in the microgrid market. Since 2017, the sector has expanded at an annual rate of 32.0%, reaching 8.6 GW by the end of 2023. The growth was supported by federal funding and grants. The Bipartisan Infrastructure Law allocated £8.2bn[4] for grid resilience, funding microgrid development through the Grid Resilience and Innovation Partnership, while the Department of Energy and National Renewable Energy Laboratory support research on the technology. The shift toward the microgrid-as-a-service (MaaS) model has reduced end-user ownership while attracting long-term investors. If this momentum continues, annual capacity installations could see a year-on-year increase of more than 20%.

Source: Microgrid Knowledge website; AceOn website; Wood Mackenzie website; GivEnergy — What is microgrid? — 2024; PSC — How microgrids are changing the UK electric network — 2023

Notes: (2) Distribution Network Operators; (3) Transmission Operators; (4) The numbers are converted from USD to GBP due to the average exchange rate by the FRED

Integrating IoT and AI into the grid can accelerate the UK's Clean Energy Transition

As discussed earlier in this report, managing the electrical load on the grid is one of the critical requirements of moving to a low carbon energy system.

One of the leading technologies in achieving this is thought to be 'The Internet of Things' (IoT) which will allow the grid system to automatically forecast and respond to demand and supply. In 2024, 55%[1] of energy utilities globally had a formal IoT strategy, up from 48% in 2021. The highest potential for IoT is in power transmission operations, such as metering backhaul (55%[2]), recloser (54%), substation monitoring (52%), and energy generation (51%).

Key IoT applications in grid infrastructure

Integration

IoT enhances the seamless integration of renewables into the power grid.

Distribution

By balancing supply and demand, IoT minimises power fluctuations and the risk of outages.

Maintenance

IoT sensors enable real-time monitoring of grids, allowing for predictive maintenance.

Forecasting

Leveraging data analytics, IoT can use historical data for climate monitoring.

IoT as a part of the UK's energy transition

In 2022-2023, the UK Government launched a £1.8m programme to research the technical and commercial feasibility of Smart Meter System-based IoT sensor devices, emphasising the importance of IoT for the UK energy transition strategy. In 2023, Vodafone and Data Communications Company (DCC), a key smart meter supplier in the UK set up under UK Government mandate to manage the data and communications infrastructure behind smart meter rollout, signed a 15-year agreement to develop and operate managed IoT connectivity, ensuring 4G coverage for the UK's smart meter network.

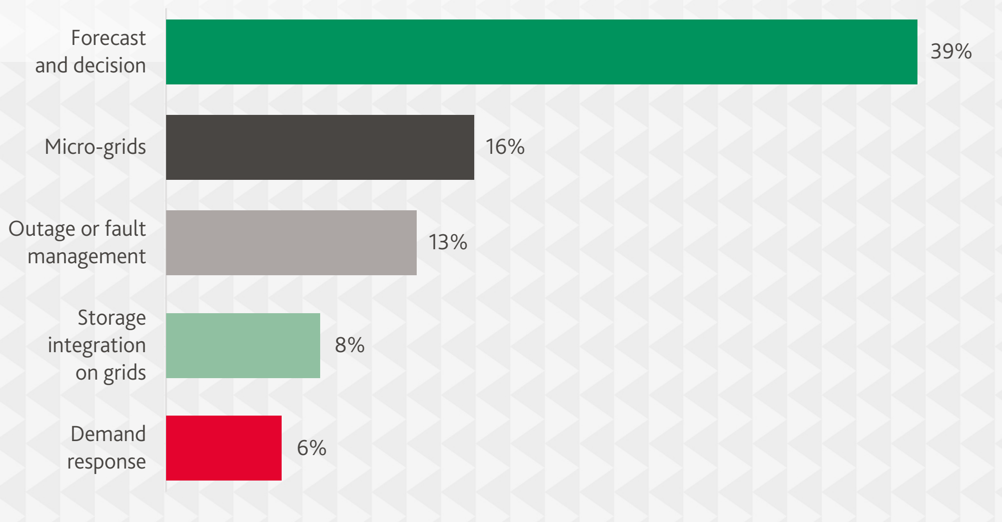
AI and Machine Learning (ML) are being increasingly applied in the energy sector, offering opportunities to enhance efficiency and speed up planning, generation, and consumption. AI is expected to leverage smart meter and substation data to ease renewable connection delays, reduce network congestion, and accelerate decarbonisation while lowering consumer costs. In 2024, the UK launched the Manchester Prize AI initiative: round two, a decade-long £2m commitment by the UK Government to support cutting-edge innovations which use AI, focused on clean energy systems, while Innovate UK, the UK's national innovation agency, allocated £1.2m for projects on digital twins, data interoperability, and cyber resilience to strengthen the UK's energy infrastructure through advanced digital modelling.

Source: GOV.UK website; National Infrastructure Commission website; Viasat — The State of Industrial IoT in 2024 — 2024; NIC — Infrastructure Progress Review — 2024; IEA — Patents for enhanced electricity grids — 2024; UK Parliament POST — Energy security and AI — 2024; IBM — X-Force Threat Intelligence Index — 2023; Media overview

Notes: (1) According to the survey of global utilities that approached IoT conducted by Viasat in March-April 2024, n=120; (2) Percentage of utilities planning to implement or already implementing selected technologies

Integrating IoT and AI into the grid can accelerate the UK's Clean Energy Transition

Top-5 smart grid technologies targeted by AI-related patents globally between 2011 - 2022



AI impact on the UK's energy grid efficiency

95%

Accuracy in short-term load forecasting with AI, which enables more precise estimations of peak usage times, making it easier to balance supply to the network.

40%

Time savings in project planning can be achieved as innovative technologies like AI have the potential to reduce consenting timelines from five to three years.

33%

Improvement in solar forecasting with the use of AI, which helps reduce the cost of running the grid, as reported by NESO.

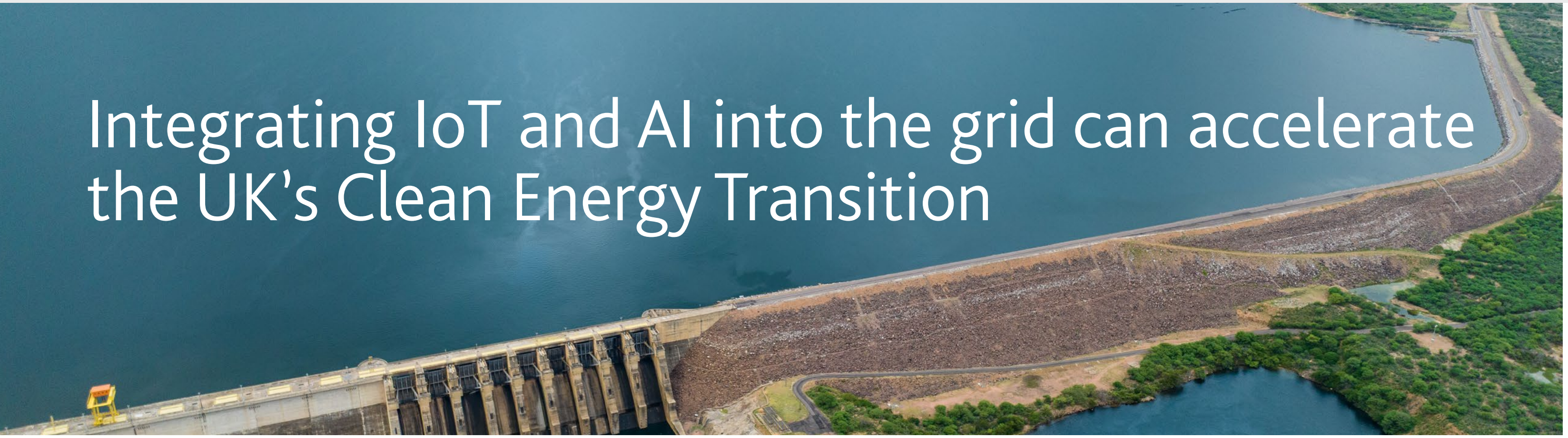
The UK's energy network is at a pivotal step towards meeting its 2030 climate targets. With just five years to achieve significant progress, the clock is ticking and the UK is working hard to transition towards a more electrified energy system. It is not just about reducing carbon emissions; it's about reshaping the way we produce, distribute, and consume energy.

The exciting part of this for me is the potential for innovation and technological advancement, as pressures mount and engineers have to rise to the challenge to find practical solutions to solve technical problems. We're looking at a future where renewable energy sources like wind and solar play a dominant role, supported by smart grids and a broad range of energy storage solutions. This transformation promises not only environmental benefits, but also economic opportunities, creating jobs and driving growth in the green technology sector.

The path to electrification is not without its challenges! Upgrading grid infrastructure and ensuring grid stability are key issues that the industry is grappling with today. There are several bottlenecks in the system such as a continuous shortage of offshore installation vessels, long waiting lines to connect to the grid and issues in maintaining grid stability when renewables power generation assets come online. Collaboration between Government and industry feels like it is improving, but much more work is required.

As we move forward, it's essential that the industry does not forget to keep a focus on accessibility and affordability. The benefits of electrification should be felt by all, whilst ensuring that clean energy is available to every household.

Edward Eddy
Tax R&D Senior Manager | BDO



Integrating IoT and AI into the grid can accelerate the UK's Clean Energy Transition

Key barriers related to harnessing AI in grids

Technical barriers

- AI models in energy function as 'black boxes'[3], reducing transparency. Given the electricity system's role as Critical National Infrastructure, traceability is essential
- AI model quality relies on data volume and accuracy, but the General Data Protection Regulation and Data Access and Privacy Framework restrict smart meter data to energy suppliers and Distribution Network Operators, creating siloed datasets[4]
- Energy stakeholders call for regulatory adaptation to keep pace with rapid AI advancements, ensuring innovation, investment incentives, and ethical use.

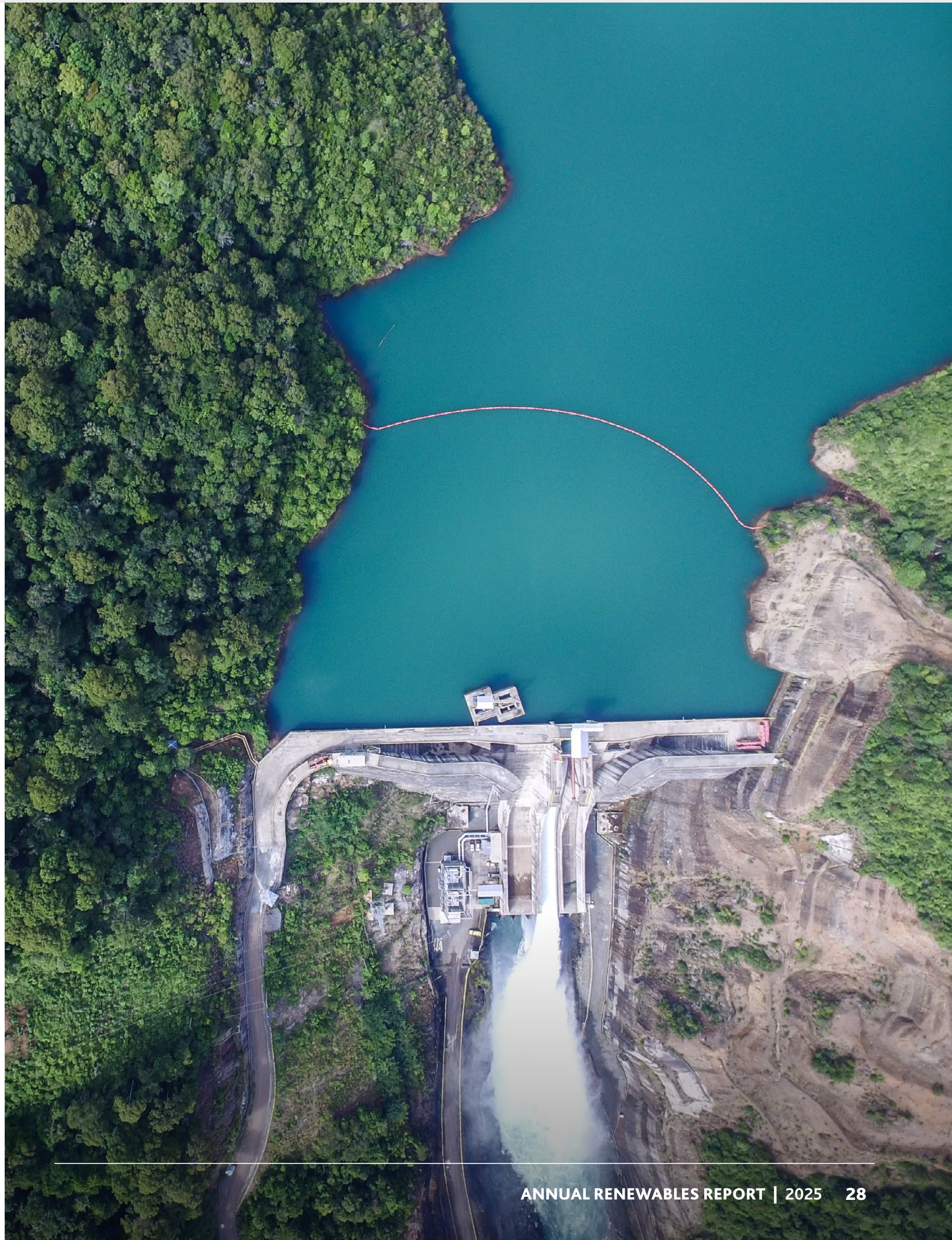
Infrastructure barriers

- Smart grid digitalisation faces challenges due to outdated infrastructure, high AI integration costs, and interoperability gaps. The Energy Digitalisation Taskforce (2022)[5] calls for updated standards to enhance communication, while stakeholders stress the need for co-planning infrastructure with communication networks
- AI's growing computing demands pose challenges in scalability, connectivity, and environmental impact of data centres, making efficient and sustainable computing power essential for the expansion of AI-driven energy systems.

The growing adoption of digital technologies within the electricity system has led to heightened cybersecurity risks, particularly as the integration of distributed energy sources, interconnected with digital networks, creates additional entry points for potential threats. In 2022, the UK's energy sector accounted for 16% of all cybersecurity incidents nationwide. By 2024, the UK's renewables sector faced as many as 1,000 attempted cyber-attacks per day. AI plays a dual role in this landscape. While AI-driven applications have the potential to improve security measures, they also introduce new vulnerabilities, such as false data injection attacks, where attackers manipulate datasets to corrupt models and disrupt system operations. At a recent international conference in 2024, the UK government highlighted the increasing use of AI to disrupt the UK power grid, presenting an escalating security challenge.

Source: GOV.UK website; National Infrastructure Commission website; Viasat — The State of Industrial IoT in 2024 — 2024; NIC — Infrastructure Progress Review — 2024; IEA — Patents for enhanced electricity grids — 2024; UK Parliament POST — Energy security and AI — 2024; IBM — X-Force Threat Intelligence Index — 2023; Media overview

Notes: (3) In 'black box' models, the decision-making process is opaque, making it challenging to interpret and explain how a specific outcome was reached; (4) Siloed datasets refer to data that is stored in separate systems making it difficult to access, integrate, and analyse holistically; (5) The Energy Digitalisation Taskforce, commissioned by BEIS, Ofgem, and UK Innovate recommended developing a 'digital spine'— a sector-wide data-sharing mechanism to enable seamless and secure information exchange across the energy



The UK possesses the resources and expertise to effectively harness emerging renewables

Emerging technologies, such as tidal streams, floating offshore wind, long duration energy storage and geothermal energy, represent the potential energy breakthroughs of the future and bear opportunities for the UK to lead in new developments.

It is estimated that the UK has over 11 GW of accessible tidal stream capacity, which, when harnessed, could provide over 11% of its electricity supply. As of 2024, the UK already has 78 MW of operational capacity over two floating wind projects and one commercial geothermal power plant commissioned in 2023. As part of AR6, the UK Government awarded 16.9% of the budget to emerging technologies such as floating wind and tidal stream. The transition to a greener future relies on innovative solutions and creative thinking from individuals, businesses, and governments.

Selected examples of unconventional clean energy technologies

Piezoelectricity to harness kinetic energy
(Readiness: known in the UK with initial applications)

Piezoelectric systems generate electricity by converting mechanical stress, such as pressure or vibration, into electrical energy using piezoelectric materials. These systems are being explored for energy harvesting in high-traffic areas and on roadways.

In 2017, Pavegen, the UK tech company, launched the world's first 'Smart Street' in London's West End, integrating its kinetic paving technology to convert pedestrian foot traffic into energy.

Algae biofuels
(Readiness: known in the UK with initial applications)

Algae biofuel technology leverages the natural ability of microalgae to grow rapidly and produce oils. The process involves cultivating algae in controlled environments and converting the biomass into fuels suitable for use in conventional engines.

In 2024, HutanBio, a British biotech company[1], secured £2.3m[2] in funding from the Clean Growth Fund to advance the commercialisation of its HBx biofuel.

Osmotic power
(Readiness: in global R&D or moving toward commercialisation)

Osmotic power harnesses the salinity difference between freshwater and seawater, using a semipermeable membrane to let freshwater flow into the saltwater side, creating pressure that drives a mechanical generator producing energy.

Sweetch Energy, a French company, pioneers large-scale clean electricity from osmotic power using INOD® technology — nano-scale membranes for enhanced ionic selectivity and transport.

Artificial photosynthesis
(Readiness: in global R&D or moving toward commercialisation)

Artificial photosynthesis mimics the natural process used by plants to convert sunlight, water, and CO_2 into energy. The goal is to produce hydrogen fuel from water through a light-driven reaction without reliance on fossil sources during the production.

In 2023, researchers at the University of Rochester, received £1.6m[2] three-year grant from the US Department of Energy to create the 'living bio-nano system' to produce solar hydrogen.

Space-based solar power
(Readiness: early development or concept stage)

Orbiting solar panels collect uninterrupted sunlight, free from atmospheric and weather interference, to generate space-based solar power. The captured solar energy is converted into microwaves or laser beams and transmitted wirelessly to Earth.

In 2023, Solaren, US company raised £2.0m[2] in its initial Series D financing round, intended to support the continued development and deployment of its innovative space solar power systems.

Jellyfish cells-based solar panels
(Readiness: early development or concept stage)

Jellyfish contain a green fluorescent protein (GFP) that can absorb photons under UV light and release electrons. GFP could be a potential alternative to silicon cells in solar panels since silicon cells are energy-intensive to produce and challenging to recycle.

The concept of using GFP from jellyfish to develop solar cells has been explored in academic research. While promising, the technology remains in the experimental stage.

Technology readiness for application in the UK:

- ● The technology is known in the UK with initial applications
- ◐ The technology is in global R&D or moving toward commercialisation
- ○ The technology is in early development or concept stage

Source: GOV.UK website; Navitasoft — Today's dreams, tomorrow's reality — [2024]; Media overview

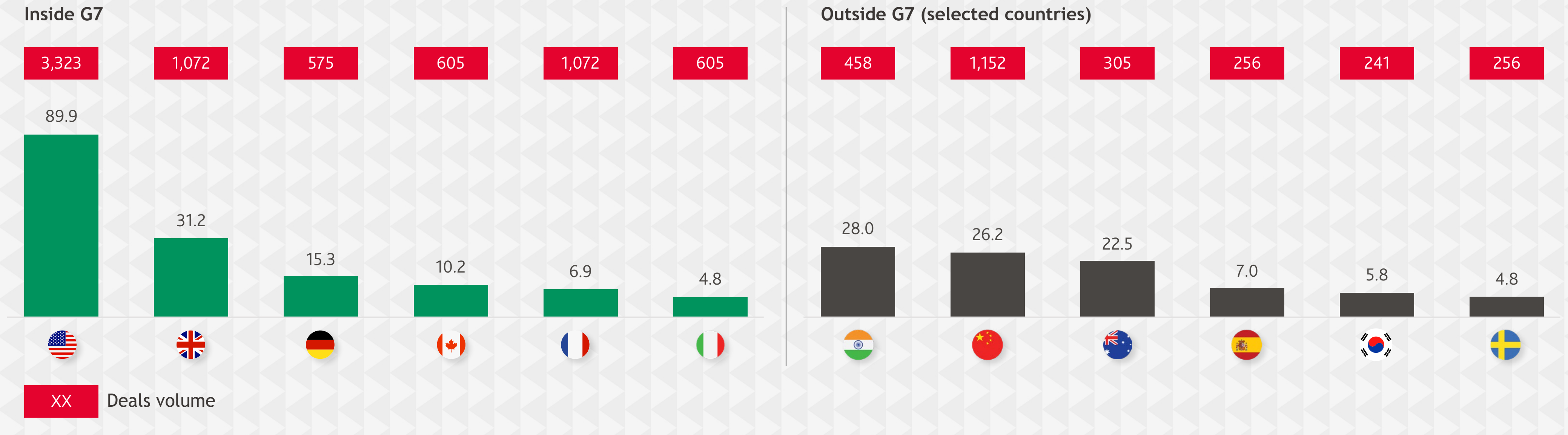
Notes: (1) Founded by scientists from Cambridge University; (2) The numbers are converted from USD to GBP due to the average exchange rate by the FRED

By late 2024, the UK saw a rise in large-scale energy M&A activity, with solar the main focus

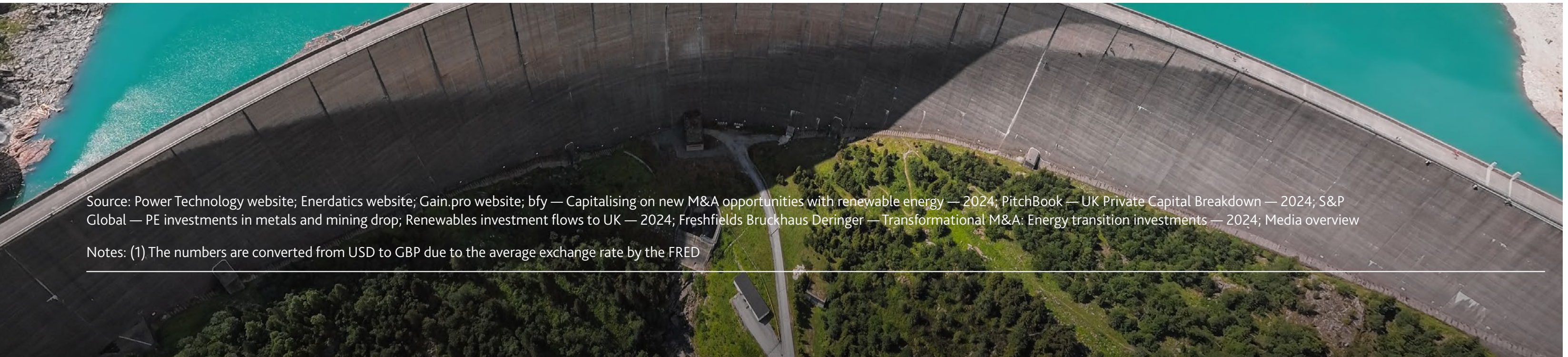
Global M&A activity related to the energy transition remained resilient in 2024, fuelled by rising investment in solar energy, small-scale renewables, energy storage, EV infrastructure, microgrids, and Energy-as-a-Service models.

Key players included private equity, infrastructure funds, and strategic investors, who focused on acquiring platforms, rotating assets, and expanding into new markets. By year-end, renewable energy activity reached £91.5bn across nearly 700 transactions (including PE) — mainly in solar (51.4%), wind (26.0%), and battery energy storage systems (7.2%). Demand for BESS is expected to surge in 2025 due to growing grid flexibility needs.

Countries ranked by capital invested and M&A deals in climate transition sector over 1 January 2023 – 24 May 2024, £bn[1]



From January 2023 to May 2024, approximately 11,714 deals (a relatively broad category) with a total disclosed value of £296bn were completed worldwide in the climate transition sector. The UK accounted for 10.6% of global transactions. By the end of the year, the UK ranked second in solar M&A deals, just behind Spain.



Source: Power Technology website; Enerdatics website; Gain.pro website; bfy — Capitalising on new M&A opportunities with renewable energy — 2024; PitchBook — UK Private Capital Breakdown — 2024; S&P Global — PE investments in metals and mining drop; Renewables investment flows to UK — 2024; Freshfields Bruckhaus Deringer — Transformational M&A: Energy transition investments — 2024; Media overview

Notes: (1) The numbers are converted from USD to GBP due to the average exchange rate by the FRED

By late 2024, the UK saw a rise in large-scale energy M&A activity, with solar the main focus

The YoY change in the number of clean energy M&A deals[2] by technology in the UK vs worldwide (excl. UK) in 2024

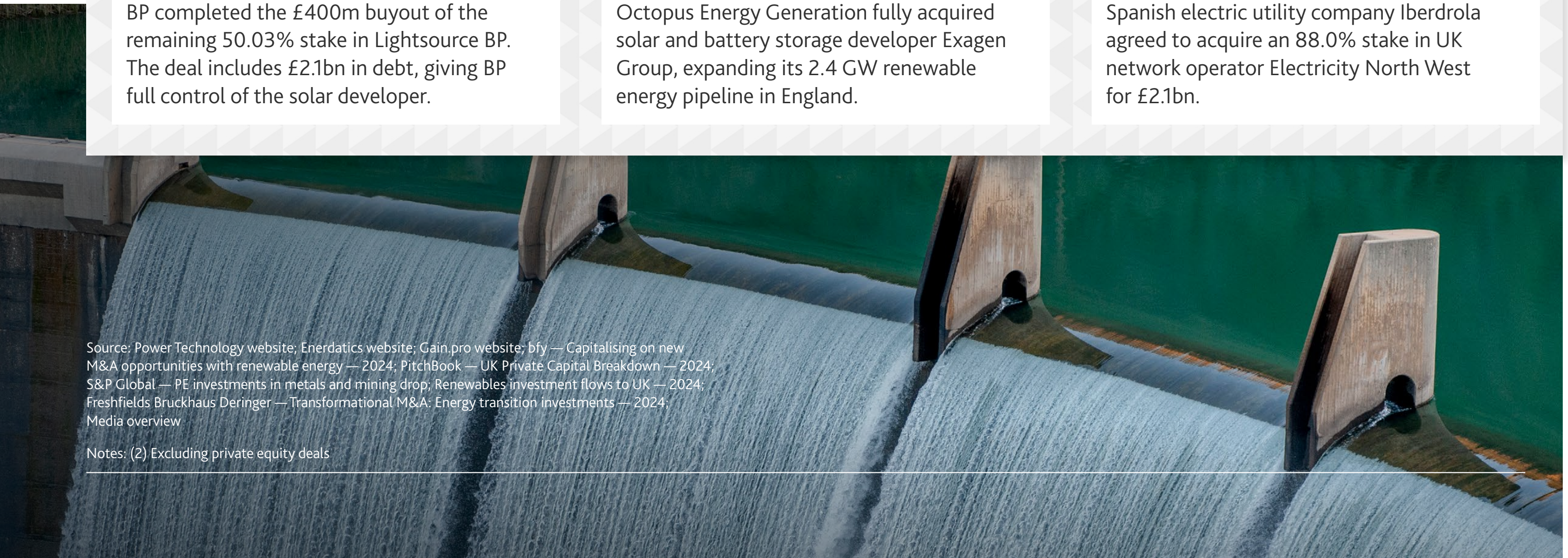
	Total	Solar PV	Energy storage	Onshore wind	Offshore wind	Biomass & waste-to-energy	Transmission infrastructure	Energy efficiency	Geothermal	Green Hydrogen
UK	153 (-15.9%)	72 18.0%	24 (-29.4%)	21 (-12.5%)	11 (-35.5%)	9 (-10.0%)	3 (-25.0%)	3 (-40.0%)	1	1 (-80.0%)
Worldwide (excl. UK)	698 (-30.7%)	378 (-21.6%)	41 (-25.5%)	144 (-23.0%)	35 (-22.2%)	12 (-55.6%)	5 (-70.6%)	5 (-79.2%)	6 (-60.6%)	15 (-44.4%)

Largest selected M&A deals[3] in the UK renewable sector in 2024

November 2024
Solar energy
BP completed the £400m buyout of the remaining 50.03% stake in Lightsource BP. The deal includes £2.1bn in debt, giving BP full control of the solar developer.

October 2024
Solar and BESS
Octopus Energy Generation fully acquired solar and battery storage developer Exagen Group, expanding its 2.4 GW renewable energy pipeline in England.

August 2024
Electricity networks
Spanish electric utility company Iberdrola agreed to acquire an 88.0% stake in UK network operator Electricity North West for £2.1bn.

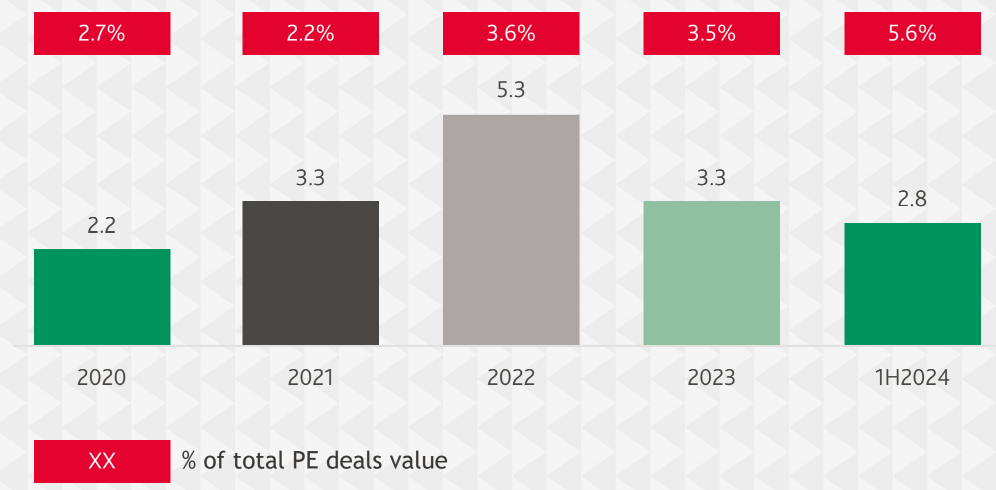


Source: Power Technology website; Enerdatics website; Gain.pro website; bfy — Capitalising on new M&A opportunities with renewable energy — 2024; PitchBook — UK Private Capital Breakdown — 2024; S&P Global — PE investments in metals and mining drop; Renewables investment flows to UK — 2024; Freshfields Bruckhaus Deringer — Transformational M&A: Energy transition investments — 2024; Media overview

Notes: (2) Excluding private equity deals

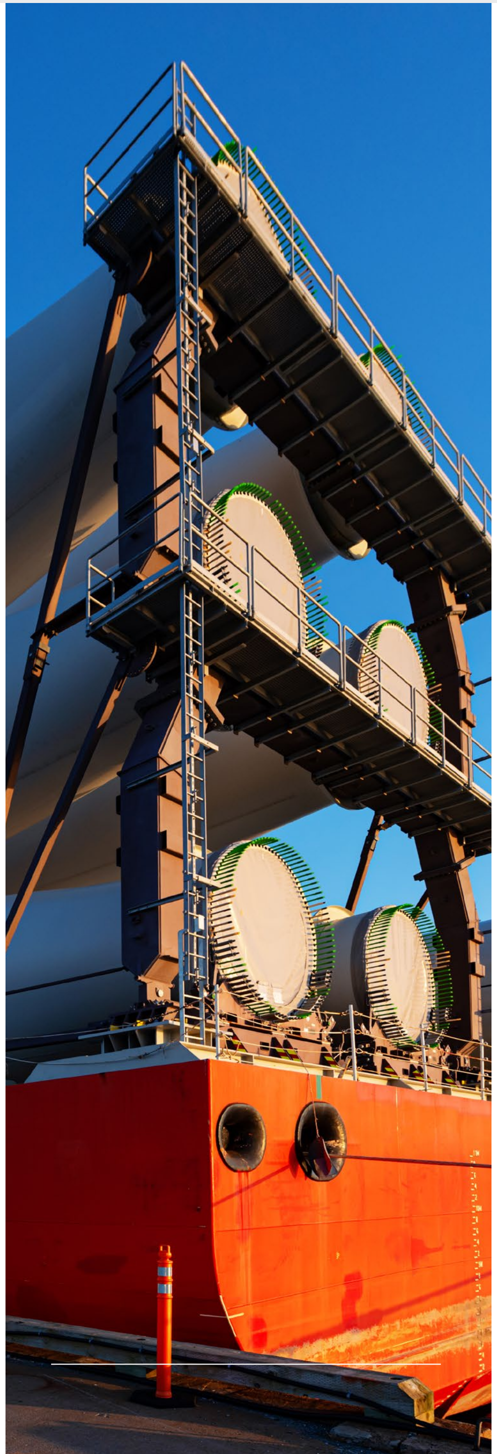
By late 2024, the UK saw a rise in large-scale energy M&A activity, with solar the main focus

UK cleantech and climate tech PE deal activity, £bn



UK private equity gained momentum in 2024, with deal values rising sharply year-on-year. Q2 2024 marked a two-year high, while the UK dominated Europe's private equity activity, accounting for half of H1 deals. H1 2024 saw 20 deals totalling £2.8bn in the UK. With the UK's ambition to become a 'clean energy superpower', deal flow is expected to rise, along with the share of cleantech in total PE volume. Grid reform could kick start a short-term boom in M&A.

PE and VC-backed investments in the UK renewables sector also surged in value, reaching £6,199.6m[1] in 9m2024, a 542.0% year-on-year increase from £965.8m[1] in the whole of 2023. However, we note that the surge was largely attributed to Energy Capital Partners LLC's acquisition of Atlantica Sustainable Infrastructure PLC, announced in May 2024, which accounted for 98.9% of all investments. The UK also attracted more private equity investment than the USA, which recorded only £841.2m[1] in PE-backed renewable transactions between January and September.



Source: Power Technology website; Enerdatics website; Gain. pro website; bfy — Capitalising on new M&A opportunities with renewable energy — 2024; PitchBook — UK Private Capital Breakdown — 2024; S&P Global — PE investments in metals and mining drop; Renewables investment flows to UK — 2024; Freshfields Bruckhaus Deringer — Transformational M&A: Energy transition investments — 2024; Media overview

Notes: (3) Revenue is estimated based on data from public sources Clean Energy Pipeline DB misses full year 2024 for PE etc for bottom table.

Selected latest mid-market PE investments in the UK energy transition sector[3]

Energy engineering — **January 2025**

Averroes Capital (UK) is set to acquire Glacier Energy, a specialist in energy and industrial solutions. The company serves wind, oil and gas, nuclear, and chemicals while advancing low-carbon technologies.

Target revenue, 2023: £30.0m

Energy storage — **December 2024**

LDC (UK), part of Lloyds Banking Group, invested in Mansfield-based Power Saving Solutions, a specialist in battery storage and hybrid power systems, to support the company's growth.

Target revenue, 2023: £14.3m

Low-carbon heat networks — **March 2024**

Corran Capital (UK), in £80m bid, acquired a 30% stake in Vital Energi, a leading UK owner and operator of low-carbon heat networks, to accelerate the country's net-zero transition.

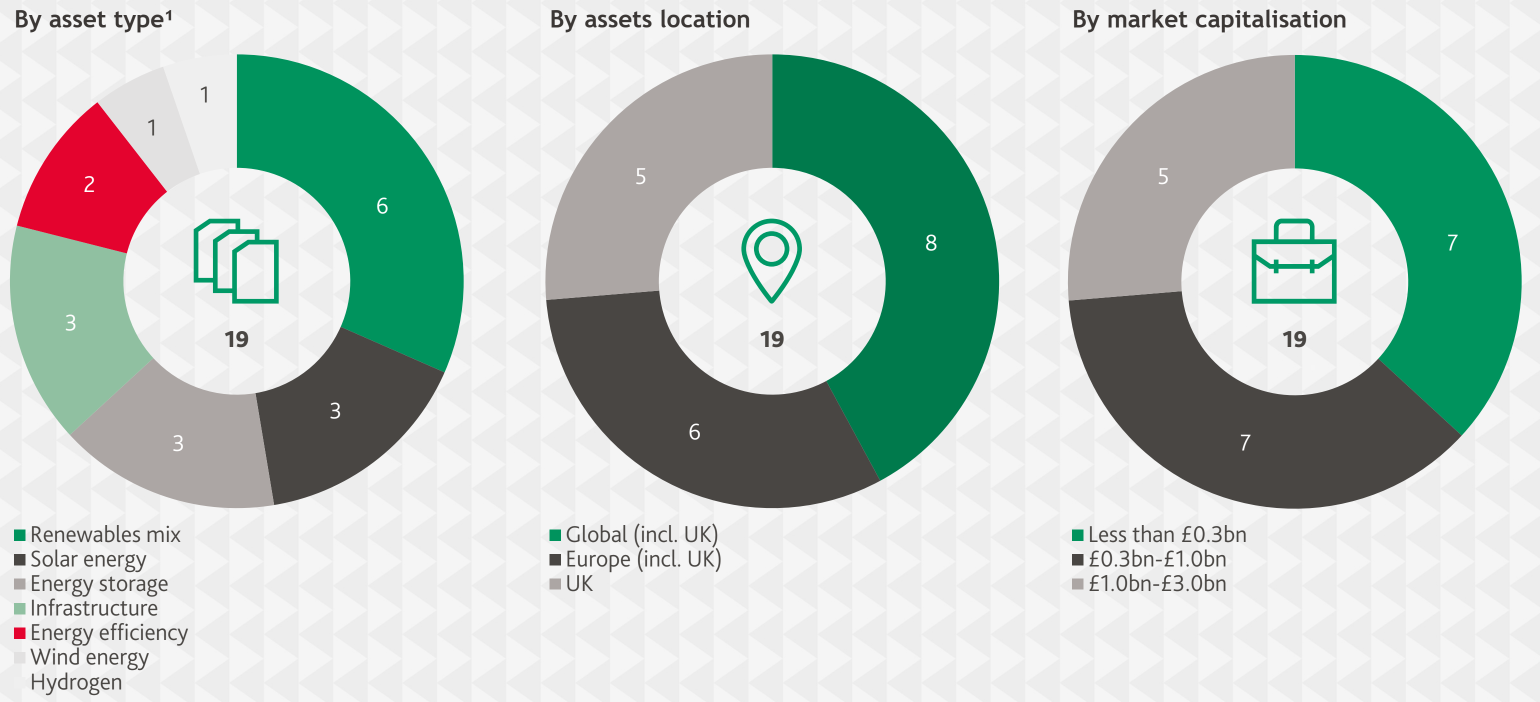
Target revenue, 2023: £225.6m

Infrastructure funds have provided investors with access to renewable energy assets but they have faced valuation challenges in recent years

London-listed renewable energy infrastructure funds now invest in a range of technologies, from conventional wind and solar farms to battery storage, energy efficiency and other distributed energy resources.

These investments are set to generate a stable revenue stream, often linked to inflation, making them appealing to investors seeking consistent income. The demand for investment in the renewables market is on the rise: in the UK, the wind energy sector, currently valued at £100.0bn, is projected to grow to approximately £275.0bn by 2030. While the UK Government's pledge to accelerate clean energy and bring forward the target for a fully decarbonised power grid to 2030 may bolster investment opportunities for the funds, provided the market price to NAV gap closes and they can raise equity funding from the market.

UK renewable infrastructure funds as of January 2025



The UK listed renewable energy infrastructure funds landscape consists of a diverse mix of primarily smaller and niche investment vehicles. As of January 2025, 19 UK renewable energy infrastructure funds were listed on the London Stock Exchange, with 11 being constituents of the FTSE 250. They boast a combined market capitalisation exceeding £15.1bn and assets valued at nearly £25.7bn. The funds primarily invest in offshore and onshore wind and solar power assets across the UK, Europe, and other global markets, including the USA. Collectively, UK-based funds hold assets with a renewable energy generation capacity of nearly 10.0 GW[2], complemented by 3.5 GW of battery energy storage across the UK and globally.

Source: Hargreaves Lansdown website; Infrastructure Investor website; S&P Global website; CityWire website; Financial Times — Renewable energy trusts are not for the faint-hearted — 2024; Infrastructure Investor — What's ailing UK listed infra funds? — 2024; Media overview

Notes: (1) Renewables-focused funds based in the UK were considered among 30 funds listed on London Stock Exchange; (2) The numbers are converted from CAD and JPY to GBP due to the average exchange rate by wise.com

Infrastructure funds face challenges, but their role in net zero should not be underestimated

Renewable energy infrastructure funds activity among G7 countries²

There are about 350 private and public closed-ended infrastructure funds focused on renewables worldwide[3]. The major ones among G7 are traded on the NYSE[4], TSX[5], and TSE[6], while others are also present in Germany.

£3.6bn

Average market cap of the Top-4 largest NYSE renewable infrastructure.

£2.0bn

Average market cap of the Top-5 largest TSX renewable infrastructure funds.

£96.1bn

Average market cap of the Top-5 largest TSE renewable infrastructure funds.

UK renewable infrastructure funds average discounts as of 29 January 2025, by market cap

Average discount	Market cap
(-24.2%)	£1.0bn- £3.0bn
(-37.6%)	£0.3bn- £1.0bn
(-48.8%)	Less than £0.3bn

UK infrastructure funds have been experiencing NAV discounts for several years, ranging from 15.6% to 77.2% as of January 2025. Funds specialising in hydrogen and battery storage had the largest average discount of 55.4%. While larger and more diversified funds performed better, all funds struggled to secure new capital given the NAV discount, despite an increase in investment opportunities.

If the current trend persists, 2025 could be a pivotal year, particularly for smaller funds. Some may undergo a continuation vote, potentially leading to the liquidation of their assets. A case in point is Triple Point Energy Transition, which in January 2025 [approved] a plan for members' voluntary liquidation and the sale of its assets under a tender. Another option is consolidation, which is increasingly becoming a means of survival, or acquisition, such as Atrato Onsite Energy plc, which was acquired by the Brookfield fund in 2024. However, despite current challenges, the sector still holds hope since infrastructure funds see themselves as a crucial channel for directing capital towards net zero goals. Declining interest rates will be a key positive factor, making infrastructure assets more appealing compared to government bonds, while rising power prices and strong long-term growth prospects in renewable energy will further support the sector's recovery.

UK transaction activity has felt relatively lean in recent years. London capital markets activity has been virtually non-existent and M&A transaction volumes – the buying and selling of infrastructure assets - has been far from stellar. Various factors account for this. The interest rate and inflation environment, policy uncertainty around a change of government, grid congestion and supply chain challenges and the listed renewables investment trusts being virtually absent from the buyer pool have all contributed in some way to buyer caution.

The outlook isn't quite so bleak. Clean Power 2030 while challenging, provides some much-needed clarity over the UK's longer-term plans for the sector. The articulation of the UK Government's ambition should help instil investor confidence. The grid reform process in the UK should bring renewed impetus for successful projects once the grid connection winners and losers emerge later this year. This should reinvigorate fundraisings and M&A activity in the UK as projects move into construction and operation. The asset pool should grow and those assets will need funding and, in many cases, new homes.

There will of course be losers from the grid reform process (for the first time we could see significant distress in the renewables industry, particularly around development activity). Other constraints such as supply chain capacity and the recent escalation of tariffs on the global stage could yet spoil the party over the next few years, however it is too early assess with any confidence what the tariff landscape will be and what impact it will have.

David Bevan

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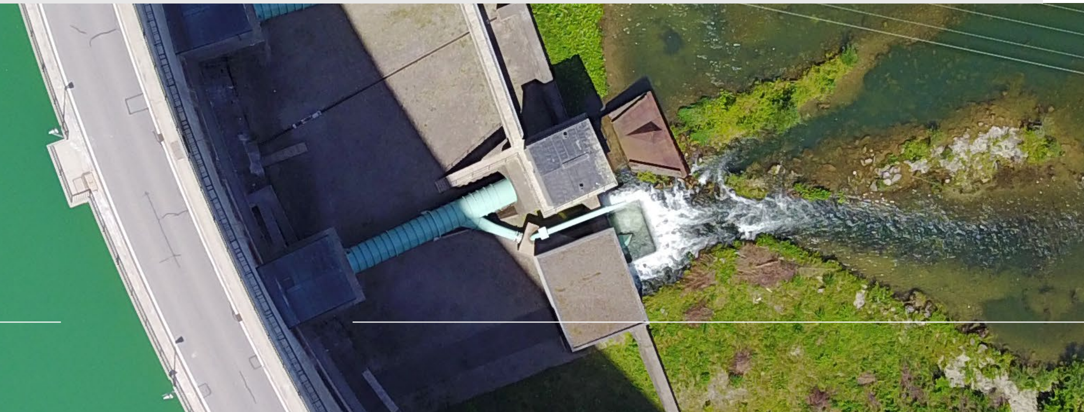

Source: Hargreaves Lansdown website; Infrastructure Investor website; S&P Global website; CityWire website; Financial Times — Renewable energy trusts are not for the faint-hearted — 2024; Infrastructure Investor — What's ailing UK listed infra funds? — 2024; Media overview

Notes: (3) According to the Infrastructure Investor database; (4) New York Stock Exchange; (5) Toronto Stock Exchange; (6) Tokyo Stock Exchange

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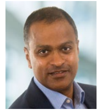

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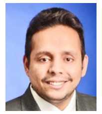

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