Bird & Bird

Energy Outlook 2025

Introduction

I'm delighted to introduce the third edition of our Energy Outlook report, where our global Energy & Utilities team anticipate the important developments across key areas of the sector and give an invaluable oversight of what to expect in 2025.

The Energy & Utilities sector continues to change rapidly, with governments and the private sector dealing with increasing energy demand worldwide and continuing geopolitical tensions. The transformative potential of AI is starting to be realised in driving progress in the energy transition. There continues to be a need for large-scale investment to develop clean energy solutions and supplies of critical resources.

Global clean energy investment doubled in 2024, **exceeding $3 trillion for the first time.** With energy demand increasing worldwide, we expect to see even more investment in 2025 to meet that need. Whilst interest rates have meant the era of cheap borrowing has come to an end, the impact on clean energy projects has been offset by fewer supply chain issues and lower prices for components. With solar panel costs 30% lower now than 2 years ago and crucial battery minerals also much lower, the trend on project economics going into 2025 is positive.

Solar and wind continue to dominate the renewables market with a boost in onshore and offshore wind expected in 2025, particularly in Europe and APAC. We are also likely to see a wave of renewables development throughout the Middle East and North Africa as states there look to reduce their reliance on fossil fuels and capitalise on plentiful wind and solar resources. This will be accompanied by a strong M&A market as corporations seek to meet their climate pledges via renewables, particularly as energy demands increase for businesses in the tech and AI space.

As the world transitions towards cleaner energy, innovative energy storage solutions, in particular battery electric storage systems, are gaining prominence, enabling more efficient use of renewable resources. Driven by factors such as declining costs, the increasing supply of renewable energy, and strong government support, the global energy storage market is poised for significant growth in 2025.

Green and low-carbon hydrogen are also emerging as crucial players in the transition to clean energy. Although it is currently more expensive than fossil fuels, the number of low-emissions hydrogen projects reaching FID doubled in 2024 and governments have announced approximately €90 billion in policy support over the past year, indicating a real and growing commitment to low-carbon hydrogen and its derivatives.

The pace of the energy transition accelerated dramatically in 2024, driven by ambitious government policies, industrial strategies, and strong cost incentives. With half of the world's major energy demand nations having elections in 2024, energy and climate issues have taken centre stage in public discourse, especially amid high fuel costs and extreme weather events. Yet even as energy policies evolve, competition for clean energy leadership continues to drive innovation, economic growth, and job creation.

However, the potential for major energy policy upheaval in the United States, and the impact it could have on clean energy investments in the country and imports from China, particularly across solar modules, battery cells and electric vehicles, is an area that could have a significant impact globally and will need to be closely monitored. These geopolitical tensions are set to create a greater need for secure supplies of critical minerals and components.

We can also expect to see some degree of change to approach and policy in countries across Europe, with snap elections in Germany, uncertainty over the leadership in France and a new government in Austria, as well as a new European Commission who took office only on 1 December 2024. As a result, we may see some revisions to energy transition related policies in the region, with closer scrutiny on the speed and cost of change.

"Bird & Bird has *excellent knowledge* of both the UK and EU energy sectors."

Chambers Europe, 2025

“The team has a great capacity to understand *complex energy* sector matters and provide *sophisticated* legal advice.”

Chambers UK, 2024

Technological innovation has been a major driver of recent progress in the energy transition to date, with falling costs and improving capabilities from solar panels to electric vehicles and battery storage, but innovation will need to accelerate further in 2025 to get the energy system on track for net zero.

The transformative impact of AI

The impact of AI and its growth potential is a significant theme across our Energy Outlook this year. The technology offers immense potential to drive energy transition solutions, but also comes with significant energy demand needs.

AI is at the forefront of improving grid efficiency, enhancing data sharing, and supporting the integration of renewable energy sources. It can help adjust energy consumption in real time and ensure regulatory compliance.

It’s application in innovative areas, such as smart vehicle-to-grid integration, could enable more flexible, efficient energy ecosystems, stabilising grids and reducing emissions. Furthermore, the use of AI is enabling autonomous mining technology to improve efficiency and reduce the environmental impact of mines and keep up with the demand for clean energy metals and minerals.

However, the power demands of the data centres used for AI training and inference are enormous and the availability of energy capacity could be a major bottleneck for the growth of AI.

The regulatory landscape, particularly in the EU, means that data centres need to use clean energy for power, and the scale of the renewables projects and grid improvements required to enable growth in this sector are enormous. As such, nuclear power is emerging as a key potential solution for powering AI-driven data centres, including the promise of Small Modular Reactors.

As you’ll see across this year’s report, regulatory frameworks are evolving to address the challenges and opportunities presented by AI in the sector in 2025 and beyond. Companies embracing innovation with AI will undoubtedly lead the charge toward a more sustainable, efficient, and transparent energy future.

The following pages highlight and assess how these market trends will shape the energy sector’s agenda in 2025. I hope you’ll find it an enjoyable read, with anticipation for the developments we’ll see in the transformative year ahead across the energy sector.

Dr. Matthias Lang
Partner
T +49 211 2005 6293
E matthias.lang@twobirds.com

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Renewable Energy

We expect the strong momentum in the renewable energy sector will continue into 2025 as governments, businesses and other organisations continue to push towards achieving their net-zero targets.

A strong 2025 for wind projects

After several years of solar leading the way in the growth of renewables, 2025 is set to be a strong year for wind energy, both onshore and offshore.

Asia-Pacific (APAC) will be leading the pack with China accounting for almost two-thirds of wind capacity in the current market. China's production prevalence, with the country holding 60% of the world's wind turbine production capacity, may also drive wind growth globally by pushing down project development costs in the event that their market leading manufacturers ramp up export to other **jurisdictions**. Whilst Taiwan's offshore development has slightly slowed due to geopolitical pressures in the Taiwan Strait, the country continues to push for 15 GW of installed production by 2030. Japan and Korea are also emerging powers in the APAC wind market. Korea's next grid allocation auction will take place in December 2024, and it seems likely that offshore wind will feature heavily in this round following government initiatives to bolster **development**. Meanwhile **Japan** have set sights on an ambitious 45 GW of operational capacity by 2040 which would take them into the top five wind energy markets.

After several years of solar leading the way in the growth of renewables, 2025 is set to be a strong year for wind energy, both onshore and offshore

In Europe, it is expected that we will see 260 GW of new wind power capacity from 2024-2030 as countries seek to reach national and EU targets. This will be assisted by the EU's Net-Zero Industry Act (NZIA) which seeks to boost the EU's manufacturing capacity for clean tech such as wind turbines and we are likely to see NZIA incorporated into future onshore and offshore wind auctions in the EU. There have also been some notable developments at the state level which will bolster the market in 2025. Hungary has lifted an effective 13-year ban on wind farms (although grid connection bottlenecks will remain an issue). In Poland, there has been a recent relaxation of the restrictive 10H rule for onshore wind as well as the introduction of a dedicated auction support system for offshore wind, although there remain concerns about the adequacy of auction prices. It should be noted that the outlook is less positive in some nations, for example in Finland, onshore wind investments have slowed due to high costs and interest rates, while offshore wind is pending regulatory changes. Spain aims to reach 62 GW of wind capacity by 2030, including 3 GW offshore, but must overcome challenges in regulatory processing, auction design and social acceptance. In Italy, we expect to see a first wave of release of building permits on Off-Shore Projects which have been pre-selected by the Italian Government. However, this will probably help in opening the market to technology companies and infrastructure investors interested in deploying capital demonstrating the feasibility of floating projects in the mediterranean area.

Outside the EU, the **UK's** recently elected Labour Government has lifted the de facto ban on new onshore wind generation projects which has stood since 2015 and they have further pledged to double and quadruple onshore and offshore wind generation respectively ahead of 2030. This was mirrored in the round six contract allocation for the UK Government's 'Contracts for Difference' scheme which saw contracts awarded to 5.9 GW of offshore and onshore wind projects. This was particularly notable as no contracts were awarded to offshore wind in the 2023 round five allocation. It would therefore seem likely that European wind generation projects will carry this strong momentum into **2025**.

Whilst the 2025 offshore wind outlook for the US looked promising pre-election following a 53% increase in the offshore project pipeline from 2023 to 2024, Donald Trump's win has placed the future of US offshore wind in doubt. Prior to his election, growth had been fuelled by the Inflation Reduction Act (IRA) which led to significant increases in investor confidence and a further 15 new, re-opened or expanded onshore wind generation projects being announced since its passing in **August 2022**. Trump, however, has shown great hostility to both the IRA and offshore wind industry, promising to rescind unspent IRA funding and end offshore wind development on day one of **his term**. The US will therefore be a less active market for offshore wind in 2025 and we will likely see investment rerouted to Europe and APAC.

In Europe, it is expected that we will see 260 GW of new wind power capacity from 2024-2030 as countries seek to reach national and EU targets

Hyperscalers to dominate PPA market capacity as AI demand increases

With AI technology continuing to grow in complexity and popularity, technology giants will remain the largest players in the corporate power purchase agreement (PPA) market as the demand for hyperscaler date centres increases.

Corporate PPAs are agreements between an energy generator, usually wind or solar, and a corporate energy consumer; typically for a long period (10+ years). Such agreements carry a number of benefits, including assisting in net-zero goals, locking in price-certainty and allowing an energy deal to be catered to the corporate entity's needs.

Sam Altman, the CEO of OpenAI has described powering AI as the "hardest part" in satisfying the demand for AI. This is because AI computing requires a large amount of energy which will only increase as AI models become more sophisticated and deal with larger data sets. Each search with OpenAI's ChatGPT typically requires 2.9 Wh per request, almost 10 times the 0.3 Wh required for a **Google Search**.

The growth of AI has been exponential and this rate of growth will continue for the next few years at least. Such growth will come with a massive demand on data centres to match the computing requirements and these data centres will need reliable, substantial, and cost-effective energy supply. The risk of price volatility and supply instability when obtaining energy on the open market could be colossal for data centre owners and so tech companies will therefore continue to seek PPAs in order to benefit from long-term stability and price.

The world's top five hyperscaler operators (Amazon, Google, Meta, Microsoft and Apple) have a combined renewables portfolio comprising more than 45 **GW**. This accounts for more than 55% of corporate wind and solar capacity globally. Such dominance in the market would seem likely to continue into 2025 as the demand for hyperscalers will be required to match the growth of AI.

Conversely, AI may also provide the solution in this energy demand conundrum by increasing data centre and grid efficiency by optimising power and cooling or forecasting workloads for resourcing. As various AI use cases evolve, so do the regulatory frameworks in which AI operates, which is explored in the energy digitalisation section at page 16.

For further information on PPAs, please see our Corporate PPA Report Hub here

"An experienced renewables team across legal departments – enabling *a fully commercially focused* legal service level."

Chambers Europe, 2025

A continuing trend for renewables into 2025 will be the prevalence of co-located battery energy storage systems (BESS) in renewables projects

Middle East and North Africa market market to grow substantially

With early signs of growth in 2024, the MENA market will emerge as a major player in the renewables space during 2025. The IEA already estimates that countries in the MENA region will add 62 GW of renewable energy capacity over the next five years in their attempt to meet the pledges made at COP28.

The MENA region has colossal wind and solar potential with the World Bank estimating that 22-26% of all the solar energy that hits the Earth is concentrated in this region. Such potential has the capacity to supply at least 50% of **global electricity consumption**. Meanwhile 75% of MENA has average wind speeds that exceed the minimum threshold for utility scale wind farms. This is coupled with vast areas of land currently not being used for human activity where projects could be located as well as more manageable permitting and licensing regulations in comparison with Europe and the US.

In Egypt, the national energy regulator announced a framework for Peer-to-Peer (P2P) energy projects in 2024 as they aim to increase the share of renewables in their energy mix to 42% by **2035**. A number of energy companies, as well as investors such as the European Bank of Reconstruction and Development have already shown interest, and we will likely see projects announced under this framework in 2025.

Developments in Saudia Arabia such as the Vision 2030 programme are aiming to reduce the Kingdom's reliance on oil with the renewable energy market predicted to grow from 8.33 GW in 2024 to 23.74 GW by **2029**.

In Morocco, there are a number of large-scale renewables projects including the Noor Ouarzazate Solar Complex (the world's largest concentrated solar power plant) and Tarfaya Wind Farm, which are part of the country's aim to generate 52% of electricity from renewables by 2030. In addition, the XLinks project is planning to link Morocco and the UK via the world's longest undersea power cable which demonstrates Morocco's desire to not just increase its own energy security through renewables, but to leverage its solar and wind project friendly geography to boost its economy via energy export in 2025 and beyond.

A boost for BESS co-location

Co-located BESS assists in dealing with renewable power intermittency as it can store excess energy produced at peak generation times and sell when required and most profitable. It therefore assists with grid stability, cost efficiency and project revenue. Co-located BESS projects further benefit from shared infrastructure which reduces the combined project cost in comparison to standalone projects.

This is becoming increasingly useful for stabilising national grids and investment in the area is increasing. For example, the government in the Netherlands has announced €100m in subsidies for solar plus storage in 2025.

Governments are further making regulatory reforms which will boost battery co-location in 2025, including in Australia, where the Energy Market Commission introduced changes in June 2024 for registering co-located BESS and renewables projects under a new category of 'integrated resource providers'. This single registration, rather than having a regulatory registration for each of the battery and generation aspect, streamlines the regulatory process for co-located BESS **developers.** EirGrid, the Irish national grid service, is also undertaking steps to allow co-located systems to participate in the energy market, including the DS3 program for 'fast-acting system services' which offers BESS projects a guaranteed revenue for providing grid assistance.

Will this be a breakout year for blockchain solutions?

Alongside the continued adoption of AI, blockchain solutions will also see increased prevalence in 2025.

AI will be used to provide valuable insights into wind and solar resource availability, power generation forecasting, demand patterns and wholesale price predictions among other use-cases such as predicting equipment failures.

Blockchain, meanwhile, will present an efficient way to allocate generation assets to a specific consumption point which will increase traceability. Given the number of organisations approaching net-zero target dates, such traceability can be crucial in certifying that energy consumed has come from a renewable source. This will be particularly important in corporate PPAs and the secure nature of blockchain allows easy audit and verification.

The decentralised nature of blockchain also facilitates peer-to-peer energy trading via smart contracts. Smart contracts are self-executing contracts which automatically execute when predefined conditions are met – e.g. when a generator is producing more energy than required by a consumer under a PPA, it can automatically sell the excess to another party at a set price.

This has significant use in the context of microgrids which is something we will see more of in 2025 – likely in virtual form. These virtual microgrids will consist of several non-proximate renewable assets and consumers across a national grid trading energy with each other. This blockchain use-case provides flexibility, enhances grid stability, and allows for efficient energy distribution and trading among participants.

Energy storage is dealt with in further detail at page 11

Continued growth in the M&A market

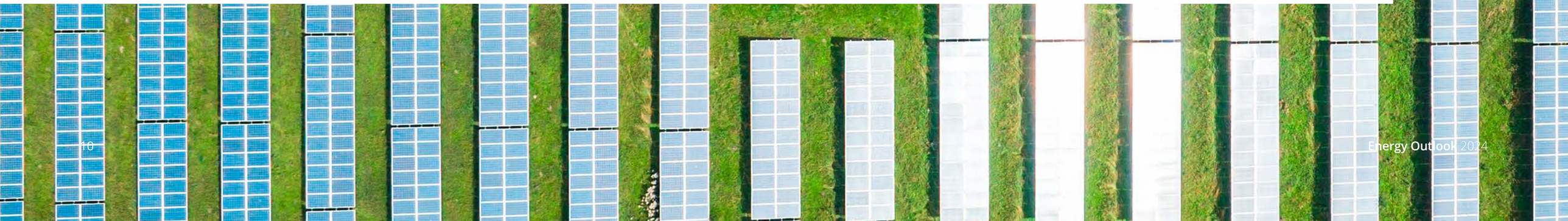
2025 will be another active year for the renewables M&A market as favourable market conditions and looming deadlines for sustainability pledges from key corporate groups will drive significant partnerships, consolidation and investment in the sector; with these corporate groups looking to align with their climate targets and enter into new verticals to support their strategic goals. For example, in the **RE100**, a global initiative for companies committing to procure 100% renewable electricity in their operations, there are 71 members targeting 2025 as their date for 100% renewable supply. This includes global names such as EY, AB InBev, Nike and UBS.

Solar and wind energy projects will be at the forefront of renewable M&A activity; driven by advancements in technology and decreasing costs which presents a perfect market for consolidation. The increasingly favourable project financing outlook will also assist in the M&A market as new renewables projects are **announced**.

Following a **period of sustained high interest rates, valuation gaps and cost inflation**, 2025 looks likely to be characterised by a trend for interest rate cuts across key jurisdictions and decreasing inflation which will bolster the **M&A market**. Government incentives and regulatory frameworks, such as the US Inflation Reduction Act and the European Union's Green Deal, will further stimulate global M&A activity by making renewable investments more attractive. In the UK, the recent establishment of Great British Energy, a new publicly owned energy company focussed on investments in clean energy, will provide investment opportunities for the private sector across the United Kingdom.

Jane Brassington
Partner
T +44 20 7905 6385
E jane.brassington@twobirds.com

Michael Rudd
Partner
T +44 20 7415 6174
E michael.rudd@twobirds.com



Energy Storage

Energy storage is rapidly emerging as a vital component of the global energy landscape, driven by the increasing integration of renewable energy sources and the need for grid stability. As the world transitions towards cleaner energy systems, innovative storage solutions are gaining prominence, enabling more efficient use of renewable resources.

This growing market encompasses a range of technologies, including batteries, pumped hydro, and thermal storage, each playing a crucial role in enhancing energy resilience. With significant investments and advancements anticipated in the coming years, energy storage is poised to reshape how energy is generated, stored, and consumed across Europe and the world.

Driven by factors such as declining costs, the increasing supply of renewable energy, and strong government support, the global energy storage market is poised for significant growth in 2025.

Will we see a dramatic increase in the rate of growth because of COP29?

We expect to see the global energy storage market continue to grow at a rapid pace in 2025. The increasing integration of renewable energy sources, the need for grid stability and government incentives will all contribute to this.

At the end of 2024, the Energy Storage and Grids Pledge of COP29 aimed to increase global energy storage capacity six times above 2022 levels, reaching 1,500 GW by 2030. A lack of energy storage solutions and the need for upgraded grids was raised by participants as a constraint on their ability to increase the share of renewable energy in their power generation. To enhance energy grids, endorsers will also commit to considerably scaling up investments in grids as part of global efforts to add or refurbish more than 80 million kilometres by 2040.

By 2030, the global energy storage market is projected to grow at a compound annual growth rate (CAGR) of 21%, with annual energy storage additions expected to reach 137 GW (442 GWh), and we expect that the COP29 Energy Storage and Grids pledge will increase this rate of growth further.

In Europe we expect to see continued growth in the energy storage market

China will remain a global leader in the energy storage market as they continue to make significant investments in grid-connected batteries, mainly driven by strong government targets, including having at least 40GW of battery storage installed by the end of **2025**. Furthermore, if the price of lithium-ion batteries in China continue to drop in 2025, this will support battery energy storage systems becoming more profitable.

In the United States, the 2022 introduction of the Inflation Reduction Act included an investment tax credit for stand-alone **storage**. Since then we have seen huge growth in the sector in the US, and we expect to see this to continue into 2025, with several large-scale battery storage projects set to complete in 2025. However, the election of Donald Trump has brought the future of the Inflation Reduction Act into uncertainty as he has pledged to rescind unspent funding.

Last year, we shared the European Commission's series of recommendations on energy storage, which includes policy actions to achieve greater deployment of storage in the EU (list of recommendations here). The EU's commitment to expanding renewable energy capacity is driving demand for storage systems to balance intermittent sources like wind and solar and the need to stabilize a continuously expanding grid. The European Commission has also pledged significant funding for energy storage projects through programs like the Horizon Europe fund, which allocates extensive sums to support sustainable energy infrastructure. These investments will spur growth across member states, with particular momentum in countries like Germany and Spain, where renewable energy targets are aggressive and demand for storage solutions is high.

Significant investment is also occurring in the UK, where work is set to begin on the world's first commercial **liquid air energy storage project in 2025, in addition to a number of BESS, pumped hydro storage, hydrogen storage and flywheel systems over the coming years.** The Government has committed to continued growth in the energy storage market, having identified savings of up to £10 billion per year and 24,000 jobs by 2050, which will allow the market to carry strong momentum into 2025 as the UK looks to align with COP29 targets.

Will the decline in battery costs continue despite increased costs for raw materials?

Grid-scale battery storage must grow significantly to support Net Zero emissions by 2050. We expect to see battery storage prices continue to decline in 2025, even as raw material prices rise, due to the oversupply of battery production.

The rapid growth of battery manufacturing, particularly in China and Europe, has outpaced demand, which is exerting downward pressure on pricing. Technological advancements, such as improved manufacturing processes and better economies of scale, are also driving these cost reductions.

Despite the decline in the cost of batteries, market disruption has led to rising costs for key minerals used in battery production, particularly lithium, cobalt, and nickel, due to supply constraints. We expect to see manufacturers innovate to reduce the volume of battery minerals needed to get back on track to meet Net Zero targets.

The European Commission has established the **European Battery Alliance** (EBA), which aims to create a competitive and sustainable battery value chain in Europe. Through this initiative, the EU is focusing on increasing domestic production capacity to reduce dependency on external suppliers and mitigate cost volatility associated with raw material imports. Additionally, the EU's Battery Directive, which mandates stricter recycling regulations, will help offset raw material shortages and contribute to overall cost reductions.

We expect to see the continued price decline make energy storage systems more affordable and accelerate the adoption across residential, commercial and utility-scale applications.

Will any alternatives to lithium-ion batteries become competitive and scalable?

Alternatives to lithium-ion batteries are likely to gain traction in 2025, driven by the need for lower costs and improved performance. Technologies such as sodium-ion batteries, lithium-sulphur batteries, solid-state batteries, and flow batteries are emerging as viable competitors, offering advantages in terms of safety, longevity, and cost.

For example, sodium-ion batteries, which rely on more abundant materials than lithium, are expected to see commercial adoption due to their lower production costs and better safety profiles. Flow batteries, which use liquid electrolytes, are also becoming popular for large-scale, long-duration energy storage, particularly in grid applications. These innovations are critical as they provide diversified options for energy storage, reducing dependency on any single technology or material.

In Europe, the EU's Strategic Action Plan on Batteries is promoting the development of innovative, non-lithium technologies to ensure Europe remains a leader in the global battery market. By diversifying energy storage technologies, the EU is safeguarding against supply chain risks and promoting more sustainable solutions.

Meanwhile, in the US, the Department of Energy opened applications in September 2024 for up to $100 million in funding to support pilot-scale energy-storage projects utilising non-lithium technologies for long-duration systems. We are therefore likely to see some of this funding allocated and projects announced during 2025.

China also launched the world's largest **sodium-ion BESS** in 2024 which indicates that the country is trying to diversify from lithium-ion technology; something which we will continue to see in 2025. Beyond batteries, China is further developing a number of non-battery storage projects including the world's largest flywheel energy storage project (30 MW) which was connected to the grid in 2024. It would seem likely that China will continue developing new systems for energy storage in 2025.

Government support for energy storage is continuing to intensify

What incentives and regulations will make an impact on the market?

Government support for energy storage is continuing to intensify, particularly within the EU. This regulatory environment, paired with direct funding mechanisms, ensures that energy storage will remain a central pillar of the EU's energy transition strategy in 2025, and governments will continue to provide the financial and legislative backing needed to expand storage capacity across the region. For example, the Spanish government approved an update to their National Integrated Energy and Climate Plan in September 2024 which has increased their installed energy storage capacity targets to 22.5 GW by 2030.

In the UK, increased regulatory certainty as a result of the Energy Act 2023, alongside a recently confirmed cap-and-floor scheme and number of initiatives from the national grid, including the Connections Action Plan which promises to reduce connection bottlenecks, will assist the market in growing in 2025 as investor certainty increases.

As mentioned above, the US is also seeing significant continued investment through project development schemes and the Inflation Reduction Act. This latter piece of legislation will be crucial to the future of the US energy storage market and therefore the state of this framework under Donald Trump will need to be closely monitored during 2025 as energy storage developers and investors may be spooked by the President's stance on clean energy.

To learn more about the regulations and revenue opportunities of energy storage projects across Finland, France, Germany, Italy, Morocco, Poland, Singapore, Spain and the UK, please read our Unlocking Energy Storage report.

Powering the Future: Recommendations from the IEA and IRENA

Global incentives for energy storage have gained significant momentum as international organisations recognise its critical role in the transition to renewable energy and achieving climate goals.

The IEA emphasises the need for scalable energy storage solutions to enhance grid reliability and support the integration of variable renewable energy sources. The IEA are monitoring grid-scale storage and have come to the conclusion that, although progress is being made, the projected increase in grid-scale storage capacity is currently falling short of the Net Zero Scenario targets and therefore requires more substantial efforts. In this context, the IEA has published recommendations to enhance the development of energy storage, including considering storage in long-range energy planning and incentivising its deployment, revising the status of storage regulatory frameworks, adjusting market designs to better reward flexibility and targeting policies to incentivise battery recycling. The COP29 Energy Storage and Grids Pledge to increase storage capacity to 1,500 GW by 2030 is taken from the IEA's Net Zero Scenario, so we expect to see these recommendations put into action by governments around the world in order to meet this target.

Also of interest to investors and developers of storage projects, IRENA has published the Electricity Storage Valuation Framework report, which outlines a method to assess storage value and establish favourable investment conditions for solar and wind integration. This will promote revenue stacking, allowing projects to capitalise on multiple revenue streams, and outlines a "five-phase" method which offers a better approach to valuation in order to increase market certainty for energy storage investors. The aim is to further promote the integration of renewables into the wider energy system which will stimulate energy storage growth in turn. Additionally, IRENA has conducted a study on electricity storage costs and markets projected through 2030, with a particular focus on battery storage. IRENA also released an Innovation Outlook on Thermal Energy Storage, further supporting advancements in this critical area.

A strong outlook for 2025

In summary, the energy storage market in 2025 will be shaped by technological advancements, cost reductions, and strong government policy. The COP29 commitment to increase global energy storage capacity six times above 2022 levels, reaching 1,500 gigawatts by 2030, will require governments to further incentivise and regulate the energy storage market in the coming year.

Government initiatives, funding, and legislation will play a critical role in accelerating the adoption of energy storage systems, ensuring they are not only affordable but also environmentally sustainable. The combined impact of these factors will cement energy storage as a key component of the global energy transition.

Dr. Hermann Rothfuchs
Partner
T +49 89 3581 6000
E hermann.rothfuchs@twobirds.com

Tatjana Beck
Associate
T +49 40 4606 36135
E tatjana.beck@twobirds.com

Energy digitalisation

The energy sector has always been a keen adopter of new innovative technologies. These technologies help to drive forward the energy transition and, with it, help manage the increased complexity of the energy markets.

In common with many other industries, we have seen market participants explore the potential benefits of digital technology solutions such as blockchain, AI and data solutions, as well as considering security issues inherent in an increasingly digital environment. 2025 will see some milestone adoptions of new digital regulation affecting the energy sector, as well as opportunities for organisations within it to be involved in shaping future regulation. Governments and (energy) regulators have taken note of this, and 2025 will be another year of major developments in this area.

Data sharing in the energy sector

UK energy regulator Ofgem's consultation on the governance of the Data Sharing Infrastructure (DSI), focuses on enhancing data sharing within the energy sector to support the UK's transition to net zero. The DSI aims to facilitate secure, efficient, and standardised data exchanges among energy companies, promoting greater collaboration and innovation. The current data sharing process is described as manual and inefficient, often leading to data silos and inconsistent standards.

The proposed DSI comprises three main components: a data preparation node, a trust framework, and a data sharing mechanism. These elements are designed to improve market access to energy data, enhance grid security, and support the development of new green industries.

In the EU, sector-specific rules on data, such as those contained in the Directive (EU) 2019/944, Implementing Regulation (EU) 2023/1162, have been recognised as being important to facilitating a more competitive energy sector, in which consumers will be active and empowered. The EU's Data Act and Data Governance Act will soon supplement sector-specific rules, impacting on the overall access to data and connected technology. Meanwhile, the EU Commission's European Strategy for Data provides for the creation of a common European data space, and the new Community Research and Development Information Service (CORDIS) includes research for the development of a Europe-wide DSI for new energy services.

Finally, the Australian energy market operator's Project EDGE (Energy Demand and Generation Exchange) has been testing methods for integrating distributed energy sources in the Australian energy market. See our article for more information.

The EU Data Act

Even though there has been much focus on the EU's regulation of AI, equally important new rules were enacted in 2024 around access to and sharing of data – these will come into force in 2025 as part of the new EU Data Act.

Under the Data Act, users will have the right to directly access or request access to data that is generated by their use of connected products (IoT devices) and related services, or to have the data made available to third parties of their choice. The data covered includes personal and non-personal data and is broadly defined.

For example, relevant metadata, data collected by sensors, or data collected during user inactivity, are all included in this definition. Data access can only be withheld under limited circumstances; trade secrets do not provide a blanket exemption. Under certain conditions, there may also be Business-to-Government (B2G) data access.

The regulation also includes interoperability requirements for data space participants, that will be relevant for the Common European Energy Data Space (CEEDS).

There are still many open questions regarding the precise application of the new rules set out in the Data Act (and its interaction with sector specific regulation), and the European Commission continues to work on a range of implementing measures required by the act, including model contract clauses.

AI regulation affecting the energy sector

With AI in the energy sector predicted to be worth $909 billion in 2030, energy organisations are preparing for incoming regulation (or helping shape the thinking about the best approach to regulation), such as:

- **EU AI Act:** the world's most comprehensive legal framework for AI developers, deployers and importers. The use of AI systems within "critical infrastructure" (which has a specific definition within the Act) are considered "high risk" and involve many obligations for providers and deployers of such AI systems. See our EU AI Act Guide **here**.
- **UK regulator Call for Input:** instead of creating a legislative framework, the UK Government asked sector regulators to publish their AI strategies by April 2024. UK regulator Ofgem published a consultation in April 2024 asking for comments on a number of proposals for its strategy, including an AI use case risk assessment matrix, as well as its recommendations in reaction to a number of identified specific risks of using AI within the energy sector. At the time of writing, Ofgem has not yet published its consultation response.
- **Australian Government Consultation:** on 8 October 2024, a proposal paper titled "Introducing Mandatory Guardrails for AI in High-Risk Settings" was published including 10 proposed mandatory guardrails and three regulatory options to mandate them.

Many regulators across the globe are now also adopting their own approach to AI Regulation. For example, Ofgem's Call for Input outlines the existing energy regulatory framework and suggests that while current regulations are adequate, additional guidance on risk-based AI use will be focused on ensuring that AI technologies are used safely and responsibly while fostering innovation.

See our article for more information

Many regulators across the globe are now also adopting their own approach to AI Regulation

Data Centres

Data-intensive AI has in turn led to a huge demand for, and more intensive use of, data centres. AI processes require data centres to provide considerable and reliable energy resources, the impact of which (on electricity networks and carbon footprints) has attracted a lot of attention in 2024. Organisations have been feeling the pressure of upcoming sustainability reporting obligations mandated by the EU Commission's Corporate Sustainability Reporting Directive, which will require them to understand and manage the carbon impact on their use of AI (for assistance with this, see here). So, as the data centre industry draws up plans to cope with and manage this increased demand for data processing power, we expect to see it develop innovative and sustainable ways to offset power gaps, such as using microgrids and battery storage. We also expect to see increased competition for renewable energy in key locations where data centres are built.

A significant effort has also been put into innovation in the data centre industry around energy and water usage efficiency. Organisations have been looking at how 'waste' heat from data centres can in fact be a useful resource and potentially a source of revenue. Again, location will continue to play an important part here - reusing waste heat that comes from a data centre may conveniently support a nearby district heating scheme.

Cybersecurity

Closely connected with the increasing digitalisation of the energy sector, we expect to see a strong focus in 2025 on the incoming EU regulation around cybersecurity, with the arrival of the NIS2 Directive, the CER (Critical Entities Resilience Directive), and the CRA (Cyber Resilience Act). NIS2 is broad in its scope – covering electricity, district heating and cooling, oil, gas and hydrogen. It contains explicit security, training and notification obligations, as well as express governance requirements (requiring management bodies to approve and supervise cybersecurity risk management measures, and undertake specific training). Management can be held personally liable for breaching these requirements. EU Member States are working hard to implement NIS2, with several Member States such as (at the time of writing) Belgium, Hungary, Croatia, Latvia and Lithuania having already adopted a national implementation act.

The CER focuses on reducing vulnerabilities and strengthening physical resilience of "critical entities" (which the EU Commission has said could include entities within the energy sector, with services such as electricity production and energy storage). Meanwhile, the CRA focuses on products with digital elements; it applies to devices that use IoT, and so could include products like smart meters or smart home devices.

Energy trading using algorithms

REMIT II (Regulation 2024/1106, which came into effect on 7 May 2024), introduces significant new requirements for market participants engaging in algorithmic trading. Its adoption shines a spotlight on an important tool in energy trading.

An exploratory study published on 17 July 2024 by the Dutch competition and financial regulators, examined the growing use of algorithmic trading in wholesale energy markets in the Netherlands, concluding that while it can bring benefits, such as more efficient price formation and increased liquidity, it also carries risks, including increasing volatility and market manipulation.

Under the new REMIT II regulation, a market participant engaging in algorithmic trading is subject to two specific new obligations. The first is to have in place effective systems and risk controls to prevent erroneous orders, and prevent actions that may create or contribute to a disorderly market. The second is to notify the home National Regulatory Authority of its engagement in algorithmic trading.

With the growing use of complex algorithms, REMIT II aims to manage risks and ensure market integrity, fostering a more transparent and secure trading environment. Market participants should watch out for clearer guidelines and proactive measures; understanding and safeguarding algorithm use will be key to reducing risks. See our article for more information.

We hope in this respect that ACER's REMIT guidance, a new edition of which is currently in preparation, will give further guidance on the contents of the systems and risk controls required. Until it does, or if it does not, Nord Pool's existing **Best Practice Guidance** for algorithmic trading provides a good starting point. (Nord Pool is a major power market in Europe providing day-ahead and intra-day trading amongst other services).

Blockchain use cases in energy

Finally, helping shape the future of digital regulation, we draw attention to the European Blockchain Sandbox (which is organised by the European Commission and is open to all sectors. At Bird & Bird, we lead the operation of this sandbox so have insight into the technologies that will impact the energy sector.

The Blockchain Sandbox provides a structured environment where public and private innovators exploring or implementing distributed ledger technologies such as blockchain can engage in regulatory dialogues with national and EU regulators. A third tranche of 20 projects is due to be put through the Blockchain Sandbox in 2025, offering participants legal advice and regulatory guidance in a confidential setting. Blockchain has already been explored in the context of several energy projects in the sandbox. These include:

- Tokenisation of solar panels
- Peer-to-Peer Energy Sharing through tokenisation
- Distributing energy saving measures subsidies through tokens
- CO2 Reporting
- ESG/CSRD reporting
- TSO support in grid balancing

Other blockchain use cases developing in the energy sector include, for example, the use of blockchain to transform electricity supply between members of peer-to-peer virtual energy networks, or microgrids. The regulatory landscape is emerging rapidly. Existing laws and regulations have to be applied on an EU and national level in a decentralised context (incurring novel regulatory questions). We are now seeing further, national regulatory sandboxes becoming operational or under development such as the French Energy Regulator's Regulatory Sandbox, the Hellenic Competition Commission's Sustainability Sandbox in Greece, the Polish Energy Regulatory Office's legal order to introduce regulatory sandboxes in Poland, and similarly in Lithuania, the Ministry of Energy's legal order to introduce a regulatory sandbox for the testing of energy innovation.

Ronald Hendrikx
Co-Head of Energy Digitalisation
T +44 20 7415 6000
E ronald.hendrikx@twobirds.com

Matthias Lang
Co-Head of Energy Digitalisation
T +49 211 2005 6293
E matthais.lang@twobirds.com

Kathryn Parker
Associate
T +44 20 7850 7216
E kathryn.parker@twobirds.com

Energy Networks and Grids

2025 will be a pivotal year for the EU's energy network. Key developments, including the full implementation of REMIT and the EU Electricity Market Reform, will significantly impact TSOs and grid users. These changes will increase transparency, foster flexibility, and mitigate energy price crises.

Additionally, the publication of the Offshore Network Development Plan (ONDP) sets ambitious goals for offshore wind energy and transmission infrastructure. TSOs will face significant challenges in connecting offshore wind farms and ensuring a reliable and sustainable energy supply.

The EU's focus for 2025

Energy networks will face major developments in 2025 as a result of the key milestones reached this year: the adoption of REMIT and of the EU Electricity Market Reform as well as the publication of the ONDP.

The entry into force of REMIT: new obligations for TSOs and clarifications to be expected at the end of 2024/ early in 2025.

Important changes to REMIT entered into force on 7 May 2024, imposing new obligations on market participants, including TSOs. These new obligations include:

- **Inside information –** all market participants are now required to publish inside information (II) on registered and authorised inside information platforms (IIPs). ACER's REMIT Guidance already strongly recommended publication on IIPs, but it now becomes mandatory. Publication on TSOs' websites will not be sufficient unless, as some already are, they are registered as IIPs. Also codifying existing guidance and case-law, TSOs are now required to publish details of "intermediate steps in a protracted process", e.g. updates on evolving outages and returns from outage, where that amounts to II.
- **Algorithmic trading –** TSOs are now required to have in place "effective systems and risk controls" if engaging in "algorithmic trading" as defined in REMIT, as some may be in the case of some balancing and other activities. This includes ensuring that trading systems are resilient, have sufficient capacity, and are subject to appropriate trading thresholds and limits etc.

- **Reporting of balancing products –** as a result of the modification of the definition of organised market places, TSOs' procurement of balancing energy and capacity, and capacity markets, are now likely to fall into this category and TSOs may therefore be required to report balancing capacity and energy contracts, when the revised REMIT Implementing Regulation is adopted in 2025.

The EU Electricity Market Reform: new horizons for TSOs and consumers

Earlier this year, the EU Parliament and Council adopted legislation revising the electricity Regulation and Directive. This reform introduces several changes relevant to TSOs and grid users, notably with the view to enhancing transparency, developing flexibility and mitigating the energy prices in times of crisis.

- **Enhanced transparency regarding connections –** both TSOs and DSOs are now subject to higher levels of transparency with regard to connections. They must publish in a transparent manner clear information about the capacity available for new connections, and must provide system users with clear information about the status of their connection requests. Whereas this obligation is directly applicable to TSOs (as provided under the amending Regulation), Member States have until January 2025 to transpose the obligation for DSOs (as provided under the amending Directive).
- **Flexibility and network development plans –** while the EU Network Code on demand response is currently being developed and should be submitted to the EU Commission by March 2025, the EU Electricity Market Reform further developed the overall EU framework of 'flexibility', i.e. the ability of an electricity system to adjust to the variability of generation and consumption patterns and to grid availability, particularly for the purposes of congestion management, balancing and better integration of renewable resources. More specifically, the reform requires the preparation of national reports on long-term flexibility needs. Among other things, these reports should consider the capabilities of non-fossil flexibility solutions, such as demand response, energy storage, aggregation and interconnection to meet flexibility needs. TSOs are likely candidates for being instructed to produce these reports, using a methodology to be developed by ENTSO-E and EU DSO by April 2025 and approved by ACER. Upon the completion of this report, ENTSO-E, TSOs, and DSOs will be required to update their respective network development plans accordingly.
- **Peak-shaving product limited to energy crises situations? –** In situations of electricity price crises, Member States may ask their respective TSOs to propose and activate peak-shaving products to decrease demand during peak hours. By 30 June 2025, ACER is required to consult with stakeholders to evaluate the potential effects of creating peak-shaving products beyond crisis situations, provided that they do not unduly distort the functioning of the markets and cause a redirection of demand response services.

Offshore Network Development Plan (ONDP): looking ahead to the next 25 years

The ONDP, a new component of the well-established Ten-Year Network Development Plan (TYNDP), falls within the framework provided by the TEN-E Regulation. This Regulation aims to promote a comprehensive approach to offshore infrastructure planning, moving away from a project-by-project approach, and to support the 2050 climate neutrality objective. The ONDP was published in January this year by ENTSO-E and turned Member States' 2023 non-binding agreements on offshore goals into concrete transmission equipment needs and costs per offshore corridor.

The plan is ambitious, providing for a total of 496 GW of generation capacity to be deployed in European waters and connected through the offshore transmission infrastructure by 2050. This means 15 GW/year per country, compared to an average 2.5 GW/year during the last 10 years. This represents a challenge for the wind industry but also for TSOs to ensure connection of offshore systems to their transmission systems (i.e. the so-called "corridors"). Indeed, by 2030, this would represent 11,000 km of cable route for radial connections.

This suggests massive investments, estimated at around €400 bn for the period 2025-2050, which include costs for hybrid transmission corridors, connecting some of the offshore RES clusters to different national systems. TSOs raised the importance of providing incentives to stimulate investments, for example by developing their procurement strategies to ensure clarity, replicability and speed-up processes. Supply in critical raw materials is also one of the challenges raised by TSOs.

The ONDP also takes into account environmental impacts of grid infrastructure on the marine environment, e.g. habitat disturbances, underwater noise and vibration, electromagnetic fields, and heat emissions etc. and provides mitigation measures.

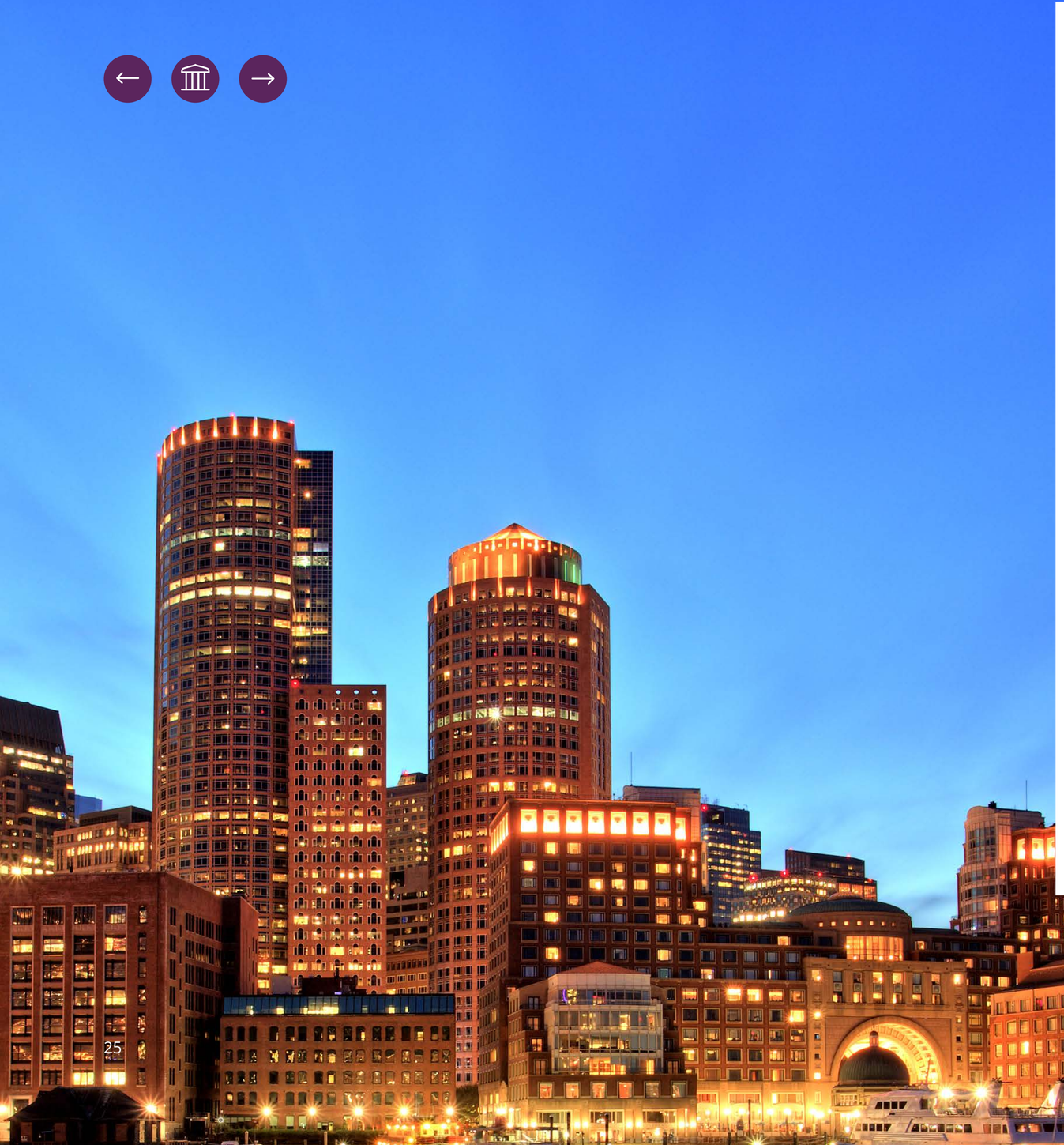
The ONDP will be updated in January 2026, making 2025 a key year to observe how the plan provided in this first edition will be implemented.

Peter Willis
Co-Head of Energy Networks and Grids

T +44 20 7415 6000
E peter.willis@twobirds.com

Clara Desprez
Associate

T +44 20 7905 6209
E clara.desprez@twobirds.com



Energy Solutions

With increased regulatory, environmental, and stakeholder pressures regarding the way in which we use energy across all sectors, it's more important than ever to implement appropriate energy solutions. Whether it be the way in which we operate buildings to reduce energy demand, or the contractual models adopted to deliver carbon reduction projects, energy solutions are not just about remaining compliant; this fast-evolving space is also home to new innovations, technologies, and opportunities.

Here we explore some of the key areas where energy solutions are developing, and the challenges and opportunities that this presents.

Building automation: harnessing the power of AI

Globally, the operation of buildings accounts for approximately 30% of end-user energy consumption, over half of end-user electricity demand, and approximately 26% of energy-related emissions. With rapid growth of global floor areas predicted, even greater consideration for the effective management of energy within the built environment is required.

Building automation (the use of digital tools to monitor and control building-wide systems such as heating, ventilation, air conditioning, lighting, and water) is a critical tool for increasing buildings' energy efficiency. Centralised building automation and control systems (BACS) are already helping buildings use less energy and reduce CO2 emissions, without compromising on safety or comfort.

The implementation of AI-enabled systems, both in new buildings and as retrofitted systems, is growing and becoming more sophisticated. BACS are harnessing the power of AI and machine learning algorithms to analyse building usage patterns and automatically adjust energy consumption to increase energy efficiency. AI platforms can be 'connected' directly to buildings to collect, and dynamically learn from, occupancy and environmental data over time. This data is used to construct contextual models of entire smart building environments known as digital twins, which combine technologies and analytics to form a dynamic model of how people and processes interact with the building. AI-empowered tools can suggest, or even directly implement, adjustments to BACS based on the digital twin and the data used to construct it.

AI is also being deployed to ensure buildings operate with minimal environmental impact, by integrating data from water recycling systems, waste management and on-site renewable energy sources into AI building automation systems.

Energy and Utilities as a Service (EaaS) – reducing the capex burden

Meeting net zero related targets for businesses may not be achievable under their existing capital expenditure policies alone. Businesses can be burdened by the capital-intensive requirements of implementing the solutions designed to help achieve these targets. In light of these challenges, EaaS is an increasingly attractive option to achieving targets, whilst maintaining budget stability and cost competitiveness.

Under a typical EaaS arrangement, an energy service provider (ESP) pays for all project costs; with the building owner having no upfront expenditure, typically treating the transaction as an off-balance sheet financing solution. The services provided by the ESP can vary, as can the technical solution: from the installation of LED lighting to provide an energy savings service within a residential block of flats, to the build and operation of a Co2 recovery plant to provide an availability service on an industrial site. As the EaaS model generally operates on a pay-for-performance model, the ESP bears the performance risks of what is installed or constructed, and the ESP is incentivised to achieve operational efficiencies. The ESP may also provide upgrades to new technology to secure more savings for the building owner.

Whilst the EaaS model is not necessarily a new one, it continues to be deployed in more ambitious and innovative ways. Frameworks through which multiple EaaS solutions can be purchased are being established. And ESPs are offering a more comprehensive package of energy-related services (including consultancy services to identify the most appropriate technical solutions for a building, access to financing, asset installation and energy management services all-in-one). By maximising existing procurement supply chains EaaS projects can be mobilised at scale and more efficiently.

A growing number of ESPs are offering EaaS projects, across different sectors and with different funding sources. The diversification of protagonists active in the market means there is no one-size-fits-all for an EaaS project. Tailoring procurement strategy, delivery model and contractual terms for a project to the requirements and incentives of the customer, whilst maintaining bankability for the ESP is a critical dynamic than can risk resulting in protracted negotiations.

District Utilities – a lower carbon solution?

District heating, a system for distributing heat generated in a centralised location, remains an expanding market, particularly in Europe where there has been an increase in policy support. But despite large potential for the integration of lower carbon and renewable heat sources, as well as recycled heat, fossil fuels continue to dominate heat supplies globally **(accounting for c. 90% of total heat production in 2023)**, and decarbonisation efforts have not yet counterbalanced associated emissions.

Innovation and policy support, however, in the sector is helping. For example, last year Denmark adopted regulation to exempt geothermal heat projects from price regulation, and Finland's first geothermal heating plant commenced operations.

In England, regulation is expected in 2025 to implement zoning policy for heat networks: identifying and designating where heat networks provide the lowest-cost, low carbon heating option.

Whilst Northern and Western Europe is contributing to expanding the district heating market, similar principles are being applied in South-East Asia, where there is a fast-growing cooling market. In Thailand, the first district cooling system project was announced in 2023 and is soon to be completed at the Government Complex Centre in Bangkok. **This project aims to achieve 20% energy savings and reduce carbon emissions by up to 3,000 tons annually.** Singapore's Marina Bay district cooling network, the largest underground cooling system in the world, is set to expand to a further 32 buildings by 2027. **It is estimated that this project alone helps Marina Bay avoid up to 20,000 tonnes of carbon emissions annually.** China and Singapore's joint Tianjin **eco-city** project includes a district cooling system which signals these systems being integrated into cities in the PRC in future. The efficiencies of this system of urban environment cooling will continue to be key to city planning in warmer climates during 2025 and beyond.

Government intervention

As countries race to meet net-zero targets, Government spending and regulation remains a critical tool. In Europe, the EU's **Energy Performance of Buildings Directive**, which came into force in May 2024, has set a target to decarbonise the EU's building stock by 2050 through interventions including minimum efficiency standards and mandatory renovations. In Sweden, **the budget for 2025** includes SKK 320 million to support efficiency technology and reduced electricity and gas use in households. The **UK's Future Homes and Buildings Standard,** set to be mandatory from 2025, further aims to ensure new homes produce 75-80% less carbon emissions by focusing on mandatory improved energy efficiency and easy integration of low-carbon heating systems (in particular heat pumps and heat networks).

Whilst the election of Donald Trump is creating uncertainty as to energy policy in the US, **the Department of Energy has set new efficiency standards** for household appliances which will take effect in 2029, new energy-saving rules for federal buildings, and granted USD169 million for nine projects to accelerate electric heat pump manufacturing at **15 sites across the United States**.

Meanwhile, in APAC, **China's ambitious target** to reduce the amount of energy used per unit of economic growth by 2.5% in 2024 will likely continue into 2025 as the PRC races to meet its wider climate and net-zero goals. In Singapore, **the Energy Efficiency Fund** continues to provide up to 70% financial support to adopt pre-approved energy efficient equipment.

George Matthew
Senior Associate
T +44 20 7905 6240
E george.matthew@twobirds.com

Hadrien Espiard
Associate
T +44 20 7850 7291
E hadrien.espiard@twobirds.com

Josh Gallichan
Trainee Solicitor
T +44 20 3017 6841
E josh.gallichan@twobirds.com

Mining and Minerals

Over the next year, the mining sector is poised to encounter both significant opportunities and challenges. We anticipate a continued rise in merger and acquisition (M&A) activity, leading to greater consolidation across supply chains.

This trend is partly driven by the growing recognition among mining companies of the need to invest in greenfield projects to meet the increasing demand for critical minerals. However, as these minerals are increasingly seen as materials of national significance and security by home nations, private business investments may face interruptions and constraints. Additionally, we believe that the integration of autonomous machinery and blockchain technologies will begin to modernise mining operations, enhancing transparency, efficiency, reliability, and safety.

M&A activity in the mining sector

There has been a sharp uptick in consolidation in the mining sector, with billion-dollar deals in the gold, lithium, copper and nickel sectors. A large aspect of the increase in M&A activity is strategic alignment of asset portfolios as investment markets recognised that the global energy transition needs more critical minerals. As a result, miners need to invest, through exploration or acquisitions, in new greenfield projects to meet growing demand. This demonstrates a shift away from the previous focus on operational efficiency. A snapshot of the latest deals include Anglogold Ashanti's USD2.5 billion offer for UK-listed Centamin in September 2024, Rio Tinto's acquisition of Arcaadium Lithium (which was formed last year by the merger of Allkem and Livent in an all-share) for USD6.7billion, as well as Livent's USD10.6 billion acquisition of Australian lithium producer Allkem, creating one of the world's largest lithium companies in early 2024. The increase in activity has been global and inter-continental, from Australia to the South Americas, and entails a host of considerations such as working in new regulatory environments, obtaining permits, and finding the correct personnel to execute projects. Another aspect of increased M&A activity is that consolidation allows for better financing deals to be struck as companies leverage their size to negotiate better rates as inflationary pressures, though declining, still put miners under pressure.

Critical minerals – continued focus on resource nationalism

Amidst a continued turbulent geopolitical background, governments globally continue to focus on the need for domestic supplies of materials, in particular critical raw materials such as copper, lithium, nickel and rare earth elements, amongst others. These are broadly considered to be crucial to the green energy transition and are critical to facilitate the manufacture of many fast-growing sources of energy such as wind turbines, electric vehicles and battery power.

1. The Western legislative agenda

This is reflected in a broad legislative agenda regionally and nationally amongst western countries, who have been trying to secure access to critical raw materials through limiting or conditioning mineral exports.

For example, the EU's Critical Raw Materials Act **(CRMA)** entered into force in mid-2024 which sought to maintain and establish supply as well as consumption of a list of designated critical materials, which is subject to periodic review. The CMRA sets ambitious future targets, aiming that by 2030, 10% of the EU's annual material consumption must be mined domestically, with 40% to be processed domestically, and that at least 25% of the EU's annual consumption comes from domestic recycling, among other objectives. This is achieved through so-called Strategic Projects which, if they pass sustainability criteria, will allow for less red tape and may benefit from state support. Mining companies will welcome this fast-tracking approach to reduce the burden of red tape. However, these lofty goals are more likely to be achieved in some areas (such as recycling or supply diversification) over extraction or processing targets for certain critical materials.

The UK's Critical Minerals Strategy, which was first published and refreshed in 2022-2023 under the previous Conservative government, also compiled a similar list of designated critical minerals. This strategy aims to secure supply chains of critical minerals through boosting domestic capabilities through the entire critical minerals supply chain, including through recycling and boosting domestic production. However, some have argued that the UK's framework is too little, too late, with lack of clarity around process and direction, and relatively small funds committed to projects in reality. Perhaps with the change of government which has campaigned on its commitment to net zero and has in the past recognised the role of critical minerals in achieving it, this strategy may yet move in a more committed direction.

In mid-2023, Australia's federal government also announced a Critical Minerals Strategy for 2023 – 2030 after extensive public consultation. Australia is an already important force in the mining industry and in the extraction of critical materials such as rare earth elements, tungsten and lithium. This strategy lists 26 critical minerals and provides for a dedicated A$500 million Northern Australia Infrastructure Facility (NAIF) fund.

It aims to diversify the supply chain, increase national capability in processing, utilise existing capabilities to become market-leading in renewable energy, and other goals. Australia has a number of large-scale projects which are focused on exploration of subsurface geology and the possible presence of critical minerals.

2. Growing discontentment in Western Africa

Over the last year we have seen more extreme resource nationalist policies unfolding in West Africa. Whilst West African countries have significant mining capabilities and have been limiting mineral exports, we have seen an increase in nations taking legal action against mining companies to strengthen their commercial position. This has been particularly obvious in countries that experienced military coups, such as Mali, Burkina Faso, and Guinea, but has also occurred in Senegal where there has been a political shift at the presidential elections towards a more nationalist party. Whilst there has not been major comprehensive legal reform, with the exception of a new mining code in Mali and the new Senegal law on local content, there has been an administrative and regulatory offensive from the authorities and in particular tax authorities, to force mining companies to renegotiate their mining agreements with the relevant States.

3. Rising export ban challenges

In Asia, Indonesia is continuously expanding the ban on any export of non-processed minerals, and such an approach has been taken to various degrees in several countries such as Namibia, Ghana, Zimbabwe, Chile and Argentina. We believe that this trend will only continue, making it even more challenging for importing countries, particularly in the West, to meet their import and related industrial goals.

Increased uptake for autonomous mining

Incorporating autonomous machines into mining fields will reduce the margin of human error, therefore increase productivity and decrease the emissions produced. While this will enable the industry to keep pace with the ever-growing global demand for the materials used in the energy transition, it will also reduce the polluting effects of the mining process.

Uptake of these technologies is growing – the market for autonomous mining technology is expected to be worth USD3.68 billion by 2028, while the number of autonomous haul trucks used in mines is predicted to increase by 80% by 2025 from the number used in 2022. The repetitive nature of mining, with vehicles travelling the same route and carrying out the same digging and loading patterns, makes for smoother integration of autonomous machinery into the system.

We expect to see increased innovation in autonomous mining technologies as part of the drive to improve efficiency, reliability and safety

Autonomous equipment will empower the industry to address issues of labour shortages and employee safety. Mining companies can take human operators off the ground, where dust, fumes and noise pose risks, to a remote control centre which allows for enhanced coordination and oversight. Inspection drones are particularly useful in remote locations, able to alert on danger and any accidents more quickly. Sensors in automated hauling trucks limit the number of collisions. We expect, and the industry hopes, that the integration of autonomous machinery will attract more people to the sector, as the jobs offer greater safety and comfort and the opportunity to work with innovative technology.

Recent advancements in the technology include machinery that can operate around the clock, boosting output and profits for mining companies, which can then be reinvested in further efficient technology. AI is key to the efficiency of autonomous technology, as machine learning and smart data analytics enables equipment to learn from errors and improve operations. We also expect that the increased adoption of autonomous equipment will boost productivity in the sector at a lower cost.

Blockchain in mining

We expect increasing adoption of blockchain technologies in the mining sector as part of efforts to promote transparency in the supply chain and compliance with upcoming regulation. Mining companies have the potential to prevent significant cost wastage caused by inefficiencies in the paper-based processes, involving verification of the minerals by each stakeholder along the chain. Technology companies are addressing this issue by offering verification systems based on blockchain technology which automatically encrypts, stores, and verifies data on an immutable ledger. The security inherent to the blockchain will also help to eliminate fraud and human error, promoting greater efficiency across supply chains.

Blockchain technology will become increasingly relevant for the traceability of raw materials. According to an amendment to the EU Battery Regulation, from 1 February 2027 all EV and industrial batteries over 2kWh require a battery passport to be sold into the EU market. These passports, accessible via a QR code affixed to the battery, will provide information including the carbon intensity of the manufacturing process, the origins of the minerals and the identity of each player in the supply chain. Already, companies are offering blockchain-supported battery passports for the mining sector which collect, share and validate information with relevant stakeholders. SQM, the world's largest lithium producer based in Chile, has been working with software provider Circulor to offer end-to-end traceability of SQM lithium in Volvo's electric vehicles. This year, the Global Battery Alliance launched its second wave of battery passport pilots, having previously collaborated with Glencore, LG Energy Solution and Tesla to map and trace the entire cobalt supply chain from Glencore's mine in the DRC to the electric vehicle factory in China.

Mining companies need to begin preparations for adopting battery passports ahead of the regulatory change especially given the industry-wide desire to promote responsible and sustainable practices. The transparency offered by blockchain technology can help to identify and tackle mining companies' inadvertent involvement in conflict minerals, child labour and environmental destruction. Not only will mining companies be empowered to avoid supporting such practices, but they will also be able to demonstrate the level of commitment to ESG that their investors' and customers' demand.

Clive Hopewell
Head of Mining and Minerals
T +44 20 7415 6000
E clive.hopewell@twobirds.com

Michael Dawes
Partner
T +44 20 7905 6230
E michael.dawes@twobirds.com

Stan Andreassen
Partner
T +33 1 42 68 63 54
E stan.andreassen@twobirds.com

Amy Donlevey
Associate
T +44 20 7850 7206
E amy.donlevey@twobirds.com

Electric Vehicles (EVs)

The electric vehicle (EV) market is on the cusp of a transformative era, driven by ambitious government targets and innovative advancements. Despite current challenges, such as stringent quotas and emissions targets set by the UK's ZEV Mandate and the EU's fleet-wide emissions regulations, the future looks promising.

High prices and range anxiety are being addressed through continuous improvements in battery technology and the expansion of reliable charging infrastructure. Additionally, the growing opportunities in emissions trading and the implementation of stricter sustainability standards are paving the way for a more resilient and eco-friendly automotive industry.

EV market slowdown amidst growing government targets

EV adoption has faced headwinds, with many car manufacturers finding the new quotas imposed by the ZEV Mandate in the UK and the EU fleet-wide emissions targets a challenge to meet.

High prices and range anxiety remain common themes featured in the media, compounded also by the perception that charging infrastructure is not sufficiently reliable or available. This has been exacerbated by a number of other factors including higher energy prices raising the cost of charging on public networks and governments across Europe reducing direct incentives to support drivers looking to make the transition to electric mobility.

It is expected that consumer interest will pick up when the price of new battery electric vehicles reaches parity with petrol and diesel cars. The continued evolution of battery technology is hoped to make a significant impact on production costs. Battery packs currently account for 30-35% of the production cost of an EV, which is expected to reduce to 19% by 2030.

Roll out of EV charging infrastructure set to continue at pace

To support the adoption of electric vehicles, charging networks have been rolled out at ever increasing rates year on year, now with fast and super-fast hubs catering for the demands of users of public networks. In the UK, local authorities are beginning to receive funding under the LEVI scheme to improve the availability of charging for EV drivers who don't have access to off-street parking.

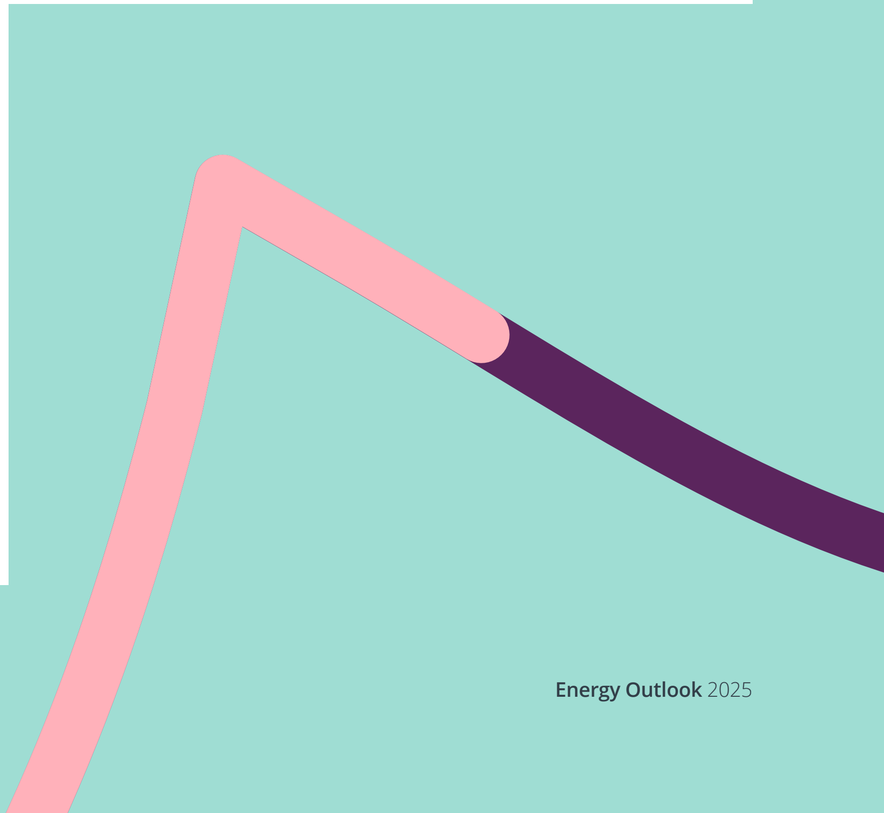
Supporting legislation has been passed to give drivers confidence and to help ensure that the integration of EV charging infrastructure is safe, convenient, and fair. These focus on improving the charging experience, reliability, pricing transparency and data security. Charge Point Operators (CPOs) are facing increasing obligations to demonstrate compliance. This is exemplified by the UK's Public Charge Point Regulations 2023, which require CPOs to show 99% average reliability across their charge points from 24 November 2024. This focus on improving the charging experience is hoped to drive positive EV adoption figures.

Increasing inter-vehicle manufacturer emissions trading opportunities

Inter-vehicle manufacturer emissions trading is expected to become increasingly important for meeting thresholds and avoiding fines. This presents a lucrative opportunity for EV manufacturers solely focused on electric vehicle production, as European car manufacturers retool and upskill their workforce for the transition to electric mobility. European vehicle manufacturers can partner with others to consolidate fleets for emissions compliance and avoid CO2 fines from the European Commission. If you'd like to know further details on EU emissions trading, please **read our article here**.

The UK ZEV Mandate includes a credit system allowing manufacturers to bank unused allowances for up to three years, borrow allowances (75% of the ZEV target in 2024, 50% in 2025, and 25% in 2026), and trade excess ZEV allowances with other manufacturers.

The UK Emissions Trading Scheme has seen total allowances fall from 81 million in 2022 to 69 million in 2024. EV manufacturers and other industries which use significant amounts of energy are expected to continue seeking 'green energy buying' opportunities, with options like Energy-as-a-Service (EaaS) helping bridge the gap to net zero goals.



Stricter sustainability and safety standards for EVs and batteries creating supply chain challenges and opportunities

Stricter sustainability and safety standards for electric vehicles and batteries are reshaping the automotive industry's supply chain landscape. The EU Battery Regulation, effective from February 2024, mandates rigorous sustainability and safety requirements for all batteries sold in the EU market. This includes conformity assessments, electronic battery passports, extended producer responsibility (as discussed next), and material recovery rates. These regulations aim to enhance transparency and accountability, but they also pose significant challenges for manufacturers. Companies must now report sensitive data and ensure compliance with stringent standards, which may require substantial investments in new technologies and processes.

The transition to stricter standards is not just a regulatory hurdle but a chance to build a more resilient and sustainable supply chain. It is expected that the UK will align future battery legislation to ensure it maintains trading relations and environmental standards with the EU.

A “second life” for EV batteries

Recycling degrading batteries has, to date, been economically challenging and therefore unattractive. However, we are seeing an increase in technology companies and research groups working on viable alternatives that give new uses to degrading batteries, which is crucial for environmental sustainability and reducing life-cycle costs. Depending on the type of battery (e.g., lithium-ion battery, lead-acid battery, electric vehicle batteries), different “second life” purposes can be considered. For example, electric vehicle batteries can be repurposed for less demanding applications, such a powering temporary installations like traffic lights, whilst lithium-ion batteries can be dismantled to recover the valuable critical materials (lithium, cobalt, nickel) and recycled into new batteries.

We are also beginning to see regulators developing policies and strategies for managing end-of-life lithium batteries. Globally, there is a huge variety of approaches and infrastructure to support recycling or repurposing. The EU Battery Regulation sets ambitious yearly growth targets per battery type, requiring suppliers to bear responsibility for end-of-life management of batteries, collecting and recycling them free of charge. By the end of 2030, new batteries in the EU must contain a minimum recycled content of 12% for cobalt, 4% for lithium, 4% for nickel and 85% for lead. The US has yet to adopt regulatory recycling requirements, only subsidies for recycled EV battery materials in the Inflation Reduction Act, but we expect this to be reconsidered as more and more early batteries reach end of life stage.

New technologies reshaping the relationship between vehicles and grid infrastructure

New technologies are significantly reshaping the relationship between vehicles and grid infrastructure, creating a more integrated and efficient energy ecosystem. Smart charging systems help load management by adjusting charging speeds to prevent overloading the grid and respond to factors like power prices, renewable energy availability, or grid congestion. This results in cost reductions, reduced carbon emissions, and grid stabilisation.

Bidirectional charging remains another key topic in the evolution of EV charging infrastructure. It allows electricity to flow from the grid to the vehicle and vice versa. This technology, utilised for both Vehicle to Grid (V2G) and Vehicle to Home (V2H) functions, can help balance energy needs, reduce peak demand on the grid, and potentially provide monetary benefits to consumers. Whilst still in its infancy and not yet widely adopted, collaborations between vehicle manufacturers, battery suppliers and energy providers are hoped to make this technology available in the near future.

George Mason
Partner
T +44 20 7850 7136
E george.mason@twobirds.com

Hydrogen

Green and low-carbon hydrogen are emerging as crucial players in the transition to sustainable energy. As the world seeks to meet rising energy demands while addressing climate change, hydrogen offers a promising alternative to fossil fuels.

Green hydrogen: A promising solution for meeting global energy demand and contributing to climate action goals

Green hydrogen, produced by splitting water molecules into hydrogen and oxygen using renewable electricity, shows significant promise in meeting global energy demand while contributing to climate action goals. Although it is currently more **expensive than fossil fuels**, the number of low-emissions hydrogen projects reaching FID **doubled in 2024**, indicating a growing commitment to low-carbon fuels and their derivatives.

In the years to come, low-carbon hydrogen will play a more prominent role in the **shift to renewable energy than renewable hydrogen**, emitting significantly fewer emissions than fossil fuels. However, whilst low-emission hydrogen will remain costly in the near term, prices are projected to decrease considerably by **2030**. This exciting area of development within the energy industry presents opportunities for companies to contribute to a sustainable future.

The EU's draft methodology for low-carbon hydrogen and fuels

The EU's draft methodology for low-carbon hydrogen, leaked in the summer of 2024, is a crucial step in evaluating the emission savings of low-carbon hydrogen and fuels. A call for feedback on the draft methodology was launched in the autumn of 2024, allowing stakeholders to provide input and shape the final regulation. The methodology will be a delegated regulation, required under the revised EU Hydrogen and Gas Market Package that entered into force in the summer of 2024.

The certification framework for low-carbon fuels, according to the draft regulation, aligns fully with the certification framework set out in the EU Renewable Energy Directive. Raw materials used in the production of low-carbon fuels and the fuels themselves will be traced via the EU database, differentiating between individual batches of fuels and raw materials based on the methane performance profile of the supplier. The draft text supplements existing rules for renewable hydrogen and fuels of non-biological origin, aligning with the methodology for life cycle assessment of total GHG emissions.

Feedback from the Commission's consultation will inform their deliberations on the final text, ensuring the regulation reflects the needs and concerns of stakeholders. Once finalised, the text of the delegated regulation will undergo a two-month review period by the European Parliament and the Council of Ministers. If neither object during this time, the delegated regulation will be officially published in the Official Journal of the EU and enter into law. This process highlights the EU's commitment to creating a transparent and effective framework for low-carbon hydrogen and fuels.

The vital role of certification schemes in ensuring sustainability and mitigating risks in the global hydrogen market

Certification schemes are essential in providing assurance to consumers and regulators that internationally traded hydrogen meets sustainability requirements. This assurance is vital in mitigating risks in global markets and ensuring that hydrogen derivatives can be shipped across continents. As such, certification schemes may become increasingly necessary to verify the attributes of these derivatives, particularly as transporting gaseous green hydrogen over long distances poses technical challenges due to its low volumetric energy density.

Regulatory frameworks may evolve to set requirements for acceptable greenhouse gas emission levels associated with the production of "green" or low-emission ammonia or methanol. The EU has been at the forefront of introducing comprehensive sustainability criteria for green hydrogen and its derivatives, requiring producers to demonstrate a 70% emission saving relative to fossil-derived benchmarks. Producers must also demonstrate that the renewable energy used for hydrogen production is newly generated and fulfils requirements of temporal and geographical correlation with the electricity production plant, ensuring that the electricity was specifically generated for hydrogen production. **These rules apply to both EU producers and those outside the EU seeking to export hydrogen to the region.**

While several other countries and regions have established hydrogen regulations with similar emission accounting methodologies, allowable emission thresholds vary across these regulations. As a result, producers may need to comply with multiple, differing standards when considering exports. This highlights the importance of harmonising regulations to facilitate the growth of the global hydrogen economy.

The future of low-emissions hydrogen: Challenges and opportunities for growth

Based on announced projects, low-emission hydrogen production could reach 49 Mtpa by 2030, with an increasing number of projects reaching FID, indicating a fivefold rise in production by 2030 compared to today. However, the majority of this potential production remains in the planning or earlier stages, requiring an unprecedented compound annual growth rate of over 90% from 2024 until 2030 for the entire pipline to materialize. This growth rate far exceeds that of other sectors, such as solar PV during its peak growth periods.

Governments have announced approximately €90 billion in policy support over the past year to promote low-emission hydrogen, with funding directed toward supply 50% higher than that aimed at stimulating demand. To support investment on the supply side, stronger government action will be needed to drive demand for low-emission hydrogen. Industrial hubs, where low-emission hydrogen could replace current high hydrogen demand met by fossil fuels, remain an important untapped opportunity for governments to stimulate demand.

Where policies such as quotas, mandates, and carbon contracts for difference have been introduced, their implementation remains limited in scale and geographical coverage. To fully realise the potential of low-emission hydrogen, governments must take more ambitious and coordinated action to support the growth of this critical sector. Through a combination of funding, policy support, and demand-side measures, low-emission hydrogen could play a significant role in meeting global energy demand while supporting climate action goals.

The EU's Hydrogen and Gas Market Package: A framework for decarbonisation and sustainable energy transition

The EU's Hydrogen and Gas Market Package, comprising a new directive and regulation, was published in the EU Official Journal on 15 July 2024 and entered into force on 5 August 2024. The Commission has 12 months to clarify the definition of low-carbon hydrogen through a delegated regulation, although it aims to implement the rules sooner. EU member states have until 5 August 2026 to transpose the directive's new rules into national law.

The package builds upon other legislation promoting the decarbonisation of the EU, particularly through the extensive use of renewable (and low-emission) hydrogen, and aims to achieve the ambitious target of a carbon-neutral EU by 2050.

The package does not place sustainability above security of supply and consumer protection, which may lead to some ambiguity regarding the treatment of certain types of energy. For instance, the definition of low-carbon hydrogen does not explicitly allow for the inclusion of hydrogen produced with nuclear electricity.

The new legislation seeks to promote the use of low-carbon and renewables gases by enhancing the efficiency of the hydrogen, low-carbon gas markets and providing incentives for stakeholders to transition away from fossil fuels. The key elements include certification, blending into the natural gas system of up to 2% by volume, modification of natural gas and hydrogen infrastructure to build integrated networks at EU level, infrastructure development, i.e., network development and integrated networks at EU level, phasing out of long-term contracts for fossil gas, horizontal (HTSOs), vertical ownership unbundling, security of supply and consumer protection.

Through this package, the EU is taking significant steps towards a more sustainable and decarbonised future, providing a framework for the growth of low-carbon hydrogen and renewable gases while ensuring security of supply and consumer protection.

Sustainable Aviation Fuel (SAF): A promising solution for reducing CO2 emissions in the aviation sector

SAF is emerging as one of the most promising solutions for reducing CO2 emissions in the aviation sector in the near to mid-term, while still utilizing the existing global aircraft fleet. Even after alternative clean propulsion technologies are introduced, **SAF is anticipated to remain significant in the future**. Currently certified SAFs generate approximately 80% less GHG emissions compared to conventional jet fuel, making them a vital component in achieving global emissions reduction **targets**.

The **ReFuelEU Aviation** Regulation, promotes the increased use of SAF as the most effective measure to reduce CO2 emissions in the aviation sector in the EU. The measure is part of the EU Commission's Fit for 55 package aimed at achieving a 55% emissions reduction target by 2030. The regulation establishes requirements for aviation fuel suppliers to progressively increase the propotion of SAF blended into the conventional jet fuel taken on-board aircraft at EU airports. The introduction of SAF in other jurisdicitons, such as the **US**, is also gaining traction.

The definition includes synthetic aviation fuels from renewable hydrogen and captured carbon, advanced biofuels from waste and residues, biofuels produced from oils and fats and recycled carbon aviation fuels. Aviation fuel suppliers may choose to meet the minimum shares by utilizing renewable hydrogen for aviation or synthetic low-carbon aviation fuels and low-carbon hydrogen produced from non-fossil sources and meeting the lifecycle emissions savings threshold of 70%.

As the aviation industry moves towards a more sustainable future, SAF is emerging as a crucial component in reducing CO2 emissions in the sector. The ReFuelEU Aviation Regulation and similar initiatives in other jurisdictions are laying the foundation for a cleaner and more sustainable aviation industry.

Global initiatives and EU auctions drive hydrogen and ammonia adoption

Korea and Japan are promoting the use of hydrogen and ammonia in the energy sector, with companies moving forward with several major demonstrations. The governments have established the first auctions for hydrogen and ammonia-based electricity generation. The EU has also accelerated its hydrogen ramp-up with EU-wide renewable hydrogen auctions, with the winners of the first auction signing grant agreements in October 2024. The Innovation Fund will support these projects, with a fixed premium payment per kilogram of certified and verified renewable hydrogen produced.From the date of the grant agreement signature, the projects have up to five years to commence renewable hydrogen production. Drawing from the experience of this **pilot auction**, the Commission intends to initiate the second renewable hydrogen auction through the Innovation Fund by the end of 2024, with an increased budget of **€1.2 billion**.

Germany has announced plans for three tenders for hydrogen-ready or directly hydrogen-fired power plants with a total capacity of 24 GW. However, as part of the country's power plant strategy, these plans were reduced to 12.5 GW in July 2024. 5 GW of new hydrogen-ready gas-fired capacity and 2 GW of hydrogen-ready retrofits for existing plants will be tendered in a first phase. New plants must switch to hydrogen after the eighth year of operation and existing plants following modernisation to hydrogen firing. Successful tender applicants will receive support with capital cost and operational subsidies to cover the cost difference between natural gas and hydrogen for 800 hours per year. Additionally, there are plans to support 500 MW of capacity that will operate immediately on hydrogen. The first tenders are scheduled for early **2025**, with a second phase planned to tender an additional 5 GW of new gas-fired capacity.

These global initiatives and auctions demonstrate a commitment to driving hydrogen and ammonia adoption in the energy sector, laying the foundation for a cleaner and more sustainable future.

Sibylle Weiler
Head of Hydrogen
T +33 1 42 68 6000
E sibylle.weiler@twobirds.com

Laura Huomo
Co-Head of Oil & Gas
T +35 89 6226 6670
E laura.huomo@twobirds.com

Hilma Huttunen
Associate
T +358 9 6226 6243
E hilma.huttunen@twobirds.com

Oil and Gas

The transformation of the oil and gas industry is picking up speed. We look at issues from shifting LNG demand to increased regulation on emissions and the impact of AI. Furthermore, we explore how the rapid shift towards EVs and the beginnings of a move away from gas stoves are all having an impact on the shape of oil and gas investments.

The future of LNG markets

In recent years, European LNG markets have grown, especially in terms of consumption. Despite the increasing demand for alternative energy solutions, LNG is still expected to play a significant role in Europe's energy mix for the foreseeable future. However, European gas demand has recently been on the decline, primarily due to the widespread deployment of renewable energy and energy efficiency measures. According to IDDEFA's projections, the demand for LNG in Europe is set to decrease by 11.2% from 148 bcm in 2024 to 93 bcm in 2030.

Despite the decline in demand for gas in Europe, LNG continues to play a crucial role in the global energy market, and we expect to see this continue in 2025. The United States has emerged as the world's largest exporter of LNG, while demand in China and India remains strong. The growing interest in Asia can be attributed to the shift from coal to natural gas. With Asia being one of the world's leading economic regions, the LNG market is poised to attract substantial investments in the upcoming years, including in 2025. For instance, out of the 37 regasification terminals expected to come online by the end of 2024, China is set to commission as many as 13. Furthermore, both the United States and Europe are witnessing a surge in regasification capacity, which is expected to come online in the near future.

The LNG distribution network is playing a pivotal role in the distribution of the emerging low-carbon hydrogen market, which has contributed to keeping the LNG market buoyant. The growth of the hydrogen markets is expected to add up to a remarkable 54% increase in low-carbon hydrogen capacity by 2025, with approximately 35 plants currently in the final stages of development.

The EU's expanding regulatory framework for LNG: Addressing emissions reductions and meeting market demands

In response to the rising demand for LNG, the EU has rapidly expanded its regulatory framework to reduce greenhouse gas emissions, which includes tax and other fiscal provisions aimed at allocating responsibilities between market participants.

These provisions include a regulatory framework for cost allocation and changes to legal provisions that specifically address "clean energy". For instance, the EU Methane Regulation came into effect on 4 August 2024, as a significant expansion of the regulatory framework. The regulation mandates new requirements for monitoring, reporting, and verifying methane emissions from relevant activities increasing the responsibilities of market operators in the oil and gas industry, affecting especially LNG importers. Furthermore, the regulation establishes a framework for equivalence requirements and sets a methane intensity threshold for LNG production, apart from the obligations to monitor, report, and verify emissions.

In addition to the expanding regulatory requirements, LNG buyers in Europe, and increasingly in Asia and other regions, are now demanding LNG Sale and Purchase Agreements (SPAs) that clearly outline the carbon intensity of the purchased LNG.

The Methane Regulation not only satisfies the regulators' objectives but also addresses the market operators' growing demand for coherence and clarity in market practices. As a result, there are now more detailed provisions in LNG SPAs regarding the measurement, recording, and verification of emissions associated with LNG cargoes, reflecting the changing attitudes of market operators and the evolving regulatory framework.

Cyber security gains importance

The oil and gas industry is facing increasingly sophisticated cyber threats, including APTs from state-sponsored actors, hacktivists, and criminal syndicates. However, the industry's cyber maturity is low due to financial considerations, lack of knowledge, and relatively low insurance coverage. The industry's remote operations and complex data processes also make it an atypical target for cyber-security attacks. The industry needs to react now to address these issues as data produced in the industry is growing, and AI solutions are becoming more popular. The revamped directive on security of network and information systems in Europe, known as "NIS2," gives a regulatory push to oil and gas companies to improve their cyber security standards and protection by expanding the scope, strengthening and streamlining security and reporting requirements, and introducing more stringent supervisory measures.

The implementation of NIS2 is at different stages in **EU Member States**, with registration obligations already in effect in most jurisdictions and reporting obligations to kick in shortly.

Check out how you may be affected by NIS2 **here**.

Role of AI in the oil and gas industry

The adoption of AI in the oil and gas industry will continue to grow in 2025 with digitalisation increasing the amount of data produced by operators. This has resulted in the need for AI solutions to manage and analyse this data to grow.

AI offers significant possibilities to enhance operational efficiency, amplify production, optimise operations, mitigate regulatory and protocol risks, and contribute to a safe work environment, saving time and effort from the human workforce. Investments in AI in the oil and gas industry are projected to increase by 14.1% globally from 2024 to 2034, reaching a market value of USD13 billion by 2034.

AI not only reduces costs and time but also maintains product quality. Typical applications in the oil and gas industry include safety and environment compliance, exploration and production, refining and distribution, defect detection, quality assurance, and accessing new sites. Furthermore, as the industry shifts toward cleaner energy, automation plays a crucial role in integrating renewable sources smoothly into existing systems. The use of AI in the oil and gas industry will continue to evolve, providing significant opportunities for growth and innovation.

Challenges of AI roll-out for the oil and gas industry

Although the adoption of AI in the oil and gas industry continues to grow, challenges and limitations must be addressed for full AI adaption in the industry to be possible, and we expect these challenges to continue into 2025.

The adoption of new technologies requires significant investment, and the industry has traditionally struggled with data quality rather than quantity, limiting the full adoption of AI in the industry. As AI algorithms demand high-quality data, companies must invest in producing data that matches the algorithms' needs as AI applications increase. Process variability in the industry can lead to incoherent data, hindering AI's efficiency across different processes.

Furthermore, the industry faces difficulties in finding competent professionals to leverage AI systems efficiently, and cybersecurity issues need to be addressed for successful implementation. These challenges must be overcome to fully realise the potential of AI in the oil and gas industry.

Transport electrification: Opportunity or threat for the oil and gas industry?

As the world embraces more sustainable practices, electric vehicles (EVs) are revolutionising the energy landscape, significantly impacting the oil and gas industry. The declining demand for refined oil products traditionally used in transportation is forcing oil companies to expand into renewable energy, hydrogen fuel and energy storage solutions.

Experts predict that global EV sales could reach 10 billion in 2025, reducing oil demand by 350,000 barrels of oil daily. This is prompting oil and gas companies to invest in EV charging infrastructure, diversify retail sales services, and reconsider their refining strategies. We expect to see more oil and gas majors announce new investments in 2025.

As a result, the oil and gas sector is prioritizing non-transportation applications, such as optimising operations for plastics and industrial uses. The growth of EVs is compelling companies to rethink and revitalize their strategies, leading to a shift towards renewable energy and other sustainable solutions.

Phasing out gas stoves

The environmental and health impacts of gas stoves are sparking a growing debate over their ban. These appliances emit harmful pollutants such as nitrogen dioxide (NO2) and carbon monoxide (CO), which have been linked to respiratory issues. As a result, electric alternatives are gaining popularity for being safer and more energy-efficient. While no federal plans in the U.S. exist to ban gas stoves, states such as New York are limiting their installation in new buildings starting in 2025.

In Europe, several countries are already phasing out gas stoves to reduce fossil fuel use and improve indoor air quality. France, for example, plans to ban gas stoves and boilers in new buildings by 2025, with existing appliances phased out by 2040. The Netherlands and Denmark are following suit with similar restrictions, aiming to reduce gas consumption in homes over the next decade. These measures demonstrate a growing awareness of the environmental impact of gas stoves and a commitment to a cleaner, healthier future.

Geopolitical tensions and supply chain challenges for oil and gas

Geopolitical tensions and supply chain disruptions will continue to shape the global oil and gas industry in 2025. Ongoing conflicts, such as the Russia-Ukraine war, have already resulted in significant changes in oil and gas flows, with many countries imposing sanctions on Russian energy exports. The impending expiry of gas contracts will also add to the demand for replacing imports, further complicating the overall gas markets. These circumstances have forced a global reorganisation of energy trade, with Europe seeking alternative suppliers and Russia redirecting its exports toward Asia.

Rising tensions in the Middle East, a crucial region for global oil production, pose an additional challenge. Any disruption, particularly along key shipping routes like the Red Sea, could have serious consequences for global energy security. Oil-producing nations are also feeling the pressure to diversify their economies and energy sources as the global shift toward cleaner energy accelerates. For example, countries like Saudi Arabia are increasing their focus on natural gas production to offset declining oil revenues.

Furthermore, supply chains are under pressure from rising material costs, logistical bottlenecks, and changing trade routes as countries adjust to geopolitical shifts. Oil and gas companies are rethinking their strategies, focusing on building more resilient supply chains and diversifying their energy portfolios to reduce risks. Navigating this increasingly complex geopolitical landscape is essential for companies to remain competitive in the global energy market.

Conclusion – onwards and upwards for the oil and gas industry

The oil and gas industry is at a critical juncture, facing major disruptions such as the growing reliance on LNG, the rise of electric vehicles, rapid digitalisation, and geopolitical challenges. These changes are compelling companies to rethink their strategies to meet sustainability goals, keep pace with the evolving energy market, and comply with regulations.

With demand for traditional oil expected to drop, the industry is exploring new opportunities in areas such as renewable energy, retail services, and petrochemicals to stay competitive.

As global pressure to cut emissions intensifies, innovation and adaptability will be crucial for the future success of oil and gas companies. To remain relevant and meet the growing demand for sustainable energy, companies must be proactive in embracing change and developing new solutions that align with the changing market landscape. The industry must continue to evolve, leveraging new technologies and strategies to meet the demands of a rapidly changing energy market while maintaining a commitment to sustainability.

Daniel Aranyi
Co-Head of Oil and Gas
T +36 1301 8900
E daniel.aranyi@twobirds.com

Laura Huomo
Co-Head of Oil & Gas
T +358 9 6226 6670
E laura.huomo@twobirds.com

Elisa Troberg
Associate
T +358 9 6226 6792
E elisa.troberg@twobirds.com

Anita Molnar
Trainee Associate
T +36 1 301 8925
E anita.molnar@twobirds.com

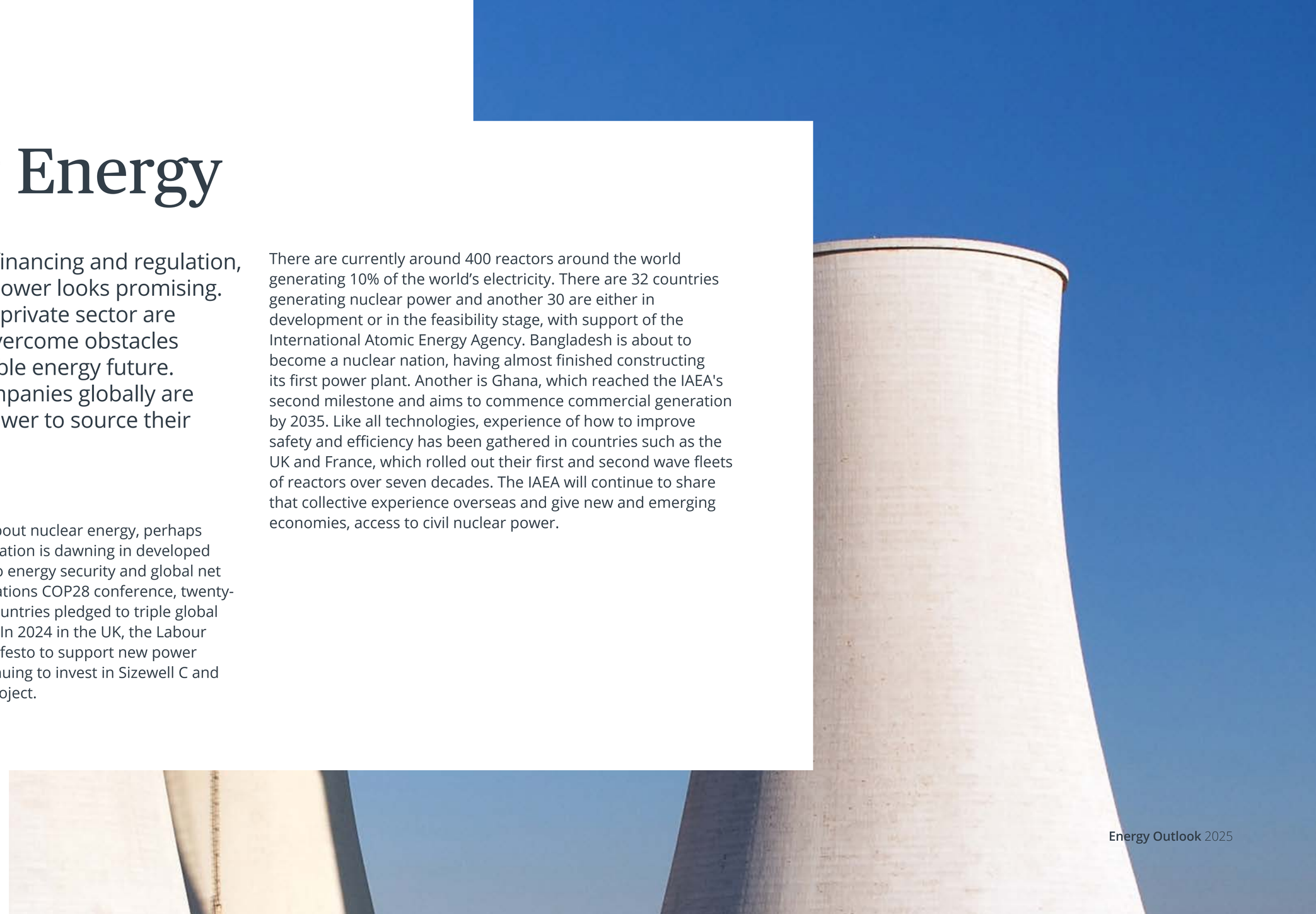
Nuclear Energy

Despite challenges in financing and regulation, the future of nuclear power looks promising. Governments and the private sector are working together to overcome obstacles and ensure a sustainable energy future. Furthermore, tech companies globally are investing in nuclear power to source their data centres.

A nuclear renaissance

There is excitement in the air about nuclear energy, perhaps not seen since the 1970s. Realisation is dawning in developed countries that there is no way to energy security and global net zero without it. At the United Nations COP28 conference, twenty-two of the world's developed countries pledged to triple global nuclear energy output by 2030. In 2024 in the UK, the Labour government pledged in its manifesto to support new power stations - for example, by continuing to invest in Sizewell C and taking a majority stake in the project.

There are currently around 400 reactors around the world generating 10% of the world’s electricity. There are 32 countries generating nuclear power and another 30 are either in development or in the feasibility stage, with support of the International Atomic Energy Agency. Bangladesh is about to become a nuclear nation, having almost finished constructing its first power plant. Another is Ghana, which reached the IAEA's second milestone and aims to commence commercial generation by 2035. Like all technologies, experience of how to improve safety and efficiency has been gathered in countries such as the UK and France, which rolled out their first and second wave fleets of reactors over seven decades. The IAEA will continue to share that collective experience overseas and give new and emerging economies, access to civil nuclear power.



Big nuclear versus SMRs

The term Small Modular Reactor (SMR) has now become well known across the energy sector. SMRs offer a promising alternative to large scale projects for electricity generation, which continue to increase in cost per megawatt hour relative to wind and solar. The term SMR is a broad church. Some are intended to be the size of a single shipping container with an output of only a few megawatts whereas others can be as powerful as 400mW, such as SMR under development by Rolls Royce. The advantage to SMRs lies in the 'M', the fact that these reactors are intended to be modular and cluster relative to demand in the location they are installed.

With the fanfare of SMRs, is the time of the nuclear megaproject over? We don't think so. The UK government identified eight sites as suitable for major plants in the latest National Policy Statement (EN-6), although some are very much edge cases. Our team recently closed the land transaction to allow development of one of those sites, Sizewell C, which is expected to reach final investment decision in 2025. The blueprint for such sites has been set by our team (both freehold and long lease) so there is a clear understanding of how to deliver the land. SMRs are rightly gathering attention although nobody is shipping SMRs on a commercial scale yet. We believe both large scale nuclear and SMRs will play a long-term role in the energy mix of developed nations. Big Tech will likely be the driving force to SMR deployment at scale over the coming five years.

Other countries also pursuing the development of SMRs as part of their nuclear energy strategy include France, with one of their most prominent projects being Nuward, led by EDF (Electricité de France). The goal of Nuward is to develop a commercially viable SMR that can be deployed both domestically and internationally by the early 2030s. The French government sees SMRs as a crucial part of the future energy mix, providing a low-carbon, reliable source of power to complement the country’s existing nuclear fleet. Read more about the nuclear market in France **here**.

Funding of nuclear projects

One of the main obstacles to the nuclear renaissance is the funding gap. In September 2024, the executives of some of the world's largest investment banks including Citi, Barclays, BNP Paribas and Goldman Sachs met in New York in support of the nuclear sector. The meeting came in the wake of an announcement that Three Mile Island power plant in Pennsylvania, USA will re-open in a joint venture between Constellation and Microsoft. Microsoft signed a 20-year contract to purchase power to serve the energy demand of its data centres.

This vote of confidence by big investment banks and big tech is encouraging for future large scale projects. However, it does not solve the problems of future pricing risk and cost-overruns that currently deter private investment. To close the gap, we expect countries to look to share the risk in projects between public and private money. Policies, such as the UK 'contracts for difference' model (CfD), have gone some of the way by giving a generator a guaranteed price per unit of electricity supplied. However, the CfD model does not alleviate the need for developers to pay interest over a long and costly construction period before the first watt is generated. This has held up the development of previously earmarked sites such as Wylfa. The 'regulated asset base' (RAB) funding model was introduced in the UK as an alternative to CfD under the Nuclear Energy (Financing) Act 2022, which enables risk sharing between developers and consumers. This innovative model should facilitate large projects that otherwise would not go ahead as developers can make a return on investment during the build phase.

In the last twelve months, we have noticed that traditional investment banks and infrastructure fund clients are taking more of an interest in the sector. The return horizon could be too long for most private equity houses and still too risky for many pension funds, although we believe the reluctance to invest from these players too will begin to shift – particularly those from the US and Canada. We see the shift taking place when relatively smaller projects look to raise debt and equity, and when greater syndication opportunities with big names exist. We may also see investments coming in when projects are commissioned and are looking to refinance. Aside from the nuclear liability risk, which will be present for any investments in nuclear, removing the construction overrun risk (in part what the RAB model is looking to address) would go a long way to unlocking this capital.

Nuclear fusion in Europe

The future of nuclear fusion in Europe looks promising, driven by continued state support, scientific knowledge (from reactors like the JET reactor at Culham, UK and the NIF, USA) and increasingly ambitious private investment. A sense of optimism stems from shifting energy and environmental policies, with the increased commitment to decarbonisation and a continued belief that fusion is the holy grail solution for abundant atomic energy, without the headache of nuclear waste.

The UK and Europe are very much at the forefront of the development of this technology. We foresee a significant (but future) role for fusion in Europe’s energy transition and opportunities for advancements gained in material science and magnetic and laser confinement to keep things commercially moving forward even before energy net gain or reactor commercialisation is achieved. The International Community continues to heavily invest in ITER, the world’s largest fusion experiment, with the aim of demonstrating that fusion can be a viable, sustainable energy source. ITER's success should lay the foundation for the first commercial reactors by the 2060–70s.

Policy alignment across EU member states remains essential, as regulatory harmonisation will ensure smooth collaboration and licensing for upcoming projects, as well as dictate a clear regulatory flightpath to commercialisation. The European Commission's increased focus on energy independence, spurred by recent geopolitical events, adds momentum to all forms of low carbon, secure energy. With an emphasis on safety and innovation, the UK and Europe are becoming hubs for fusion technology startups, eager to make breakthroughs in reactor designs and efficiency.

Positive though the outlook is, it's clear that this technology will

not be available to meet Europe's ambitious net-zero and energy security aspirations. The next decade will be critical to close the gap and achieve net power gain. Representing several fusion projects, our firm is committed to navigating the evolving legal landscape to support this transformative energy source.

Nuclear power for data centres

Nuclear power, particularly in the form of SMRs, is emerging as a promising solution to meet the growing energy demands of AI data centres.

Whilst the overall consumption numbers for AI data centres are currently unconfirmed, some estimates put the scale of ChatGPT consumption alone at 226 GWh annually. This is roughly equivalent to charging the entire stock of US **electric vehicles**. As AI models increase in number and sophistication, this energy demand will continue to grow as hyperscaler data centres will feed this demand for computing power, bringing with them increased energy consumption.

Whilst many major tech firms are looking to renewable PPAs to power these data centres, nuclear presents an alternative and potentially more suited option due to its reliability and flat output curve, whilst being simultaneously carbon free. SMRs encompass nuclear reactors up to 300 MW which can be prefabricated and constructed on site.

Google signed an agreement with Kairos Power in October 2024 to produce a number of SMRs to generate the energy needed for its AI data centres. The first reactor is expected to be operational this decade, with more to follow by 2035. This move highlights the growing trend of tech companies turning to nuclear energy to power data centres. The deal aims to support clean and reliable energy for AI technologies, though it still requires regulatory approval. Kairos Power, which specialises in advanced reactors using molten fluoride salt as a coolant, recently began constructing a demonstration reactor in Tennessee.

Meanwhile, Microsoft have plans underway to renovate an existing nuclear power station in **Pennsylvania** whilst Amazon are also developing a recently purchased 960 MW nuclear powered data centre from **Talen Energy**. Amazon have further signed an agreement with Energy Northwest, a consortium of state public utilities, to develop a series of SMRs in Washington state.

John Danahy
Partner
T +44 20 7415 6701
E john.danahy@twobirds.com

Boris Martor
Partner
T +33 1 42 68 63 20
E boris.martor@twobirds.com

Patrick Jones
Associate
T +44 20 7415 6085
E patrick.jones@twobirds.com

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Our Energy & Utilities Group

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The global energy transition has for over 20 years been the central part of our work across the energy and utilities sector with an expert team of more than 250 lawyers internationally, giving us a deep understanding of the challenges our clients seek to address.

Our lawyers have been at the forefront of the green economy and global energy transition for over 20 years. We are a number 1 ranked renewable energy team who have advised developers, investors, funders, EPC contractors, off-takers and regulators across a number of jurisdictions around the world.

As an international team, our sector approach is not broken down by offices but into sub-groups that focus on particular aspects of the Energy & Utilities sector.

The combination of our strengths in the global energy transition and the technology specialism for which we are better known, means that we are ideally placed to support stakeholders involved in new methods of energy generation and management.

We understand key business processes and work closely with industry bodies in order to influence and shape markets. We will help you to anticipate change, deliver solutions and implement strategies.

With over 500 green economy cross-border deals in recent years, our expert team knows how to efficiently structure and manage renewable transactions and financings covering all legal and regulatory requirements with a risk-based approach.

Market recognition

We have one of the leading international energy practices in the world. Our Energy & Utilities Group has been recognised by the Clean Energy Pipeline Legal League Tables 2024 for closing 172 M&A and Project Finance clean energy deals globally in 2023 – the highest total of any law firm. This includes being the number 1 firm globally for M&A deals by volume in clean energy in the Clean Energy Pipeline Legal League Tables 2024.

Our energy transition work has won us The Lawyer’s Energy & Infrastructure team of the year in 2021 & the European Corporate Team of the Year Award at The Lawyer European Awards in 2022.

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Retail & Consumer
Technology & Communications

No.1 ranked as the Most Active Law Firm for Clean Energy M&A

No. 3 ranked Most Active Law Firm for Clean Energy Project Financing

Clean Energy Pipeline, 2024

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