

Thought leadership Energy transition perspectives: nuclear power



Energy transition perspectives: nuclear power

Key takeaways

- 1 Nuclear power's renewed role in the energy transition:** Global interest and investment in nuclear power are rising sharply, driven by the need for low-carbon, reliable baseload electricity to support growing demand from electrification, data centres, and industry. Nuclear is seen as an essential complement to renewables in achieving net-zero goals.
- 2 Significant opportunities, substantial challenges:** While new technologies like Small Modular Reactors (SMRs) and lifetime extensions offer promise, the sector faces persistent hurdles: complex regulation, long construction times, skills shortages, high upfront costs, and supply chain constraints. Strong government support, innovative funding models (for example, RAB in the UK), and international cooperation are critical to overcoming these barriers.
- 3 Divergent national approaches and the need for cohesion:** Key nuclear markets (UK, US, Continental Europe) are pursuing ambitious expansion or revitalization strategies, but progress varies due to differences in policy, public perception, and regulatory environments. Unified regulatory, legal, and financial frameworks – especially for new technologies like SMRs – will be essential for nuclear to realize its full potential in the global energy mix.

Interest in nuclear power is at its highest level for decades, and the sector has a significant role to play in the energy transition. However, growth is not without challenges, including regulatory hurdles, long construction lead times and technical complexity. In this extract from a recent webinar, we look at government support and funding models, lifetime extensions, SMR development and critical issues for investors in key markets around the globe.

“Nuclear power is on track to benefit from billions of dollars of investment in the coming years,” says Ed Bretherton, a London-based Partner in Clifford Chance's International Construction Group. It is currently the second largest low emission source of electricity worldwide after hydroelectric power. Nuclear power plants deliver stable electricity with high power density, i.e., they: use significantly less land for each megawatt of generation capacity than any other proven generation technology; provide by-products such as heat for industry and district heating; and, at the same time, contribute to energy security by reducing reliance on imported fossil fuels.

Investment was in decline around the turn of the century, but this is changing rapidly. An investment peak of more than US\$75 billion is predicted in 2025, double the level of a decade ago. There are about 70 utility-scale reactors currently under construction. Over 90% of those reactors are based on Chinese or Russian designs, and half are located in China.

Many countries, including Belgium, Japan and France, are enabling lifetime extensions of existing plants. In the US every reactor which has been operational for at least 30 years has now applied for a lifetime extension.

New nuclear utility-scale capacity is also planned and, following COP29 in 2024, 31 countries have signed a pledge to triple nuclear capacity by 2050, many working alongside large corporate and industrial energy users.

What is driving the renewed interest in nuclear power?

Electricity use has increased at twice the rate of total energy use over the past decade due to population increase and new uses for electricity including electric vehicles, artificial intelligence and data centres.

“Nuclear power is an obvious solution because it can be an abundant source of electricity and is carbon neutral,” says Gauthier Martin, a Partner based in Clifford Chance's Paris office. “It is an easily dispatchable source of energy with around-the-clock baseload availability, which addresses the intermittency issues that renewables can have. Because of that, nuclear is often seen as a good complement to wind and solar in a balanced energy mix.”

The second key driver is the technological advances that have been made in small modular reactors (SMRs) and larger, Generation IV reactors. SMRs are easier to connect to grids, while the new Generation IV reactors show potential in terms of fuel efficiency, safety and the management of proliferation risk.

However, there are challenges. “A lack of nuclear construction in Europe and the US in recent years has resulted in a need to strengthen skills and knowledge, while strict regulatory regimes make it easier to bring challenges against new projects, meaning that plants are taking longer to build. Given the scale of these projects and the sheer amount of capital that is needed, strong governmental support is key to securing financing,” says Martin.

The UK nuclear energy market

“The UK was originally at the forefront of nuclear power, deploying the world’s first commercial scale nuclear power plant, and subsequently rolling out a fleet of Magnox reactors,” says Emma Clarke, a senior associate in Clifford Chance’s London office. “At its high point in the 1990s, nuclear power contributed around 25% of the UK’s energy generation. However, nuclear has now fallen to around 13% of the UK’s energy generation.”

The UK currently has nine operational reactors at five sites, all of which, save for Sizewell B, will be decommissioned by 2030. This leaves the UK facing a potential cliff edge in terms of nuclear capability and energy price shock as a proportion of domestic baseload goes offline.

There have been some specific drivers of this decline. The UK is one of the most expensive places in the world to develop nuclear power, in part due to long construction periods. It has a world-leading nuclear regulator, but this has led to challenges on new builds with, for example, an alleged 7,000 design changes being required for Hinkley Point C. A lack of investment has led to the need to rebuild nuclear expertise with a gap of an estimated 40,000 skilled personnel in the nuclear supply chain. There are also ongoing issues around public perception, following nuclear incidents such as Chernobyl and Fukushima, concerns around waste and, until recently, a lack of sustained government support.

However, the UK government is now aiming for a nuclear renaissance and plans to deliver 24GW of nuclear energy by 2050. The Roadmap to 2050 is designed to indicate a clear commitment to nuclear, setting out Britain’s long-term strategy, covering siting, financing, streamlined regulation, fuel cycle and commitments to both new gigawatt-scale plants and technologies.

In addition, we have seen the establishment of Great British Energy Nuclear (GBEN), a body with statutory powers to facilitate the design, construction, commissioning and operation of nuclear energy generation projects, and other tangible steps including: the development of the regulated asset-based (RAB) funding model (see more below); the Future Nuclear Enabling Fund; Destination Nuclear; the Nuclear Regulatory Task Force, and continued international cooperation, including the recent landmark cooperation deals with the Czech Republic and the United States on SMRs. The EN 7 National Policy Statement, which implements the Roadmap, is designed to facilitate the rollout of both large-scale reactors and SMRs, unlocking wider siting choices, and decoupling development consent from licensing.

Hinkley Point C, the first new nuclear power station since Sizewell B in 1995, is deploying EPR technology and is to be funded by way of a contract for difference (CfD). Once online, Hinkley will provide about 7% of the UK’s electricity. Next on the list is Sizewell C, the UK’s first nuclear power plant to be funded by way of the RAB funding model and which has now achieved a final investment decision (FID). Sizewell C will be a replica of Hinkley Point C, providing enhanced economic benefit from a build-and-repeat model, benefiting from the lessons learned, including a replicated supply chain and collaboration arrangements. Seventy per cent. of the construction spend for Sizewell will be in the UK, securing domestic nuclear expertise, contributing £8 billion to the UK supply chain and reducing cost for consumers.

In addition, the National Energy System Operator (NESO) predicts that there will be more than 40 SMRs in the UK by 2050, with significant government support, including a GBEN-backed competition, which resulted in Rolls-Royce being awarded a £2.5 billion contract for the delivery of three SMRs due to come online in 2030.

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Gauthier Martin
Partner

In terms of longer term strategy, high-assay, low-enriched uranium (HALEU) is used for many of the next generation designs under development, including advanced modular reactors (AMRs) and SMRs; currently, only China and Russia can produce this fuel at scale. To mitigate the risk that this presents, the UK has committed to the regeneration of the UK's domestic fuel cycle capabilities, aiming to remove Russian supplies and to position the UK so it has the leverage to use new technologies

as they come online. There is also support for ongoing research and development of AMRs and international cooperation in relation to fusion.

"The UK is at a critical transition stage in its nuclear journey," says Clarke. "There is clear ambition, but consistency and execution will be key if the UK is to reassert itself and remain a nuclear leader."

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Emma Clarke
Senior Associate

The US nuclear energy market

"A lack of long-term government policy and public support has hampered the development of nuclear reactors in the US," says Peter Hughes, a counsel in Clifford Chance's Washington, DC office. "Since the 1950s, nuclear has been a key part of the US electricity generation mix, but growth leveled off in the 1990s. Since then we have started to see a slight decline as plants have gone offline and/or been decommissioned."

Nuclear currently accounts for nearly 20% of total annual US electricity generation. There are 94 nuclear power reactors operating at 54 plants. Twenty-two of these reactors are targeted for decommissioning, but applications have been made to extend their lifetimes. The newest reactors to come online in the US, Vogtle Units 3 and 4, use Westinghouse's AP1000 3rd generation reactor technology and faced significant delays and cost overruns coming online.

There is now strong support for nuclear, both from the private and public sectors, to address electricity demand. The industry has had to navigate complex national and state-level politics and regulatory regimes, including energy market forces in different states and regions. In recent years there has been bipartisan support in Congress for nuclear development, and legislation has been passed to incentivise research and development and deployment. For example, the 2024 ADVANCE (Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy) Act and the Advanced Reactor Development Program at the Department of Energy (DOE) were established during the first Trump

Administration under the Energy Act of 2020, to foster collaboration between the private sector and DOE to research and fund advanced nuclear reactors.

The Inflation Reduction Act (IRA), passed during the Biden Administration, created tax incentives for nuclear projects; those tax credits were largely left intact by the passage of the recent One Big Beautiful Bill Act (OBBBA). That was largely seen as a win for the nuclear industry, when tax credits for other clean energy technologies were cut.

Congress has given the DOE's Loan Programs Office (LPO) significant authority to fund new nuclear projects and restarts under the IRA. An example of this is the recent LPO loan to restart the Holtec Palisades nuclear plant in Michigan, and LPO was critical to funding Vogtle Units 3 and 4. The Secretary of Energy, Chris Wright, has publicly stated that he would like to use LPO's remaining loan authority to fund nuclear projects, which will be critical for developing advanced nuclear in the US.

President Trump signed four executive orders in May 2025 with the goal of establishing a US nuclear revival. It is a very broad approach to reinvigorating and restarting US domestic nuclear energy by trying to speed up the development cycle. The Administration is seeking more co-ordination between cabinet level agencies, such as the DOE and the Department of Defense, to facilitate the siting and development of new projects and facilities to test reactors, potentially on federal land. The executive orders also call for regulatory reform to streamline the licensing process at the Nuclear Regulatory Commission (NRC), and to develop a domestic fuel supply and disposal capability to reduce reliance on Russia.

“There are no new reactors coming online yet in the US, so it will take some time for the policies to translate into action. The new legislation and executive orders are helpful, as they send a strong signal to the market, but the reality is that a gap remains between the policies and the long-term investment needed.”



Peter Hughes
Counsel

“There are no new reactors coming online yet in the US, so it will take some time for the policies to translate into action,” says Hughes. “The new legislation and executive orders are helpful, as they send a strong signal to the market, but the reality is that a gap remains between the policies and the long-term investment needed.”

In the near term, lifetime extensions of existing projects will be a priority. There is likely to be a push for more restarts and more federal and state-level policies to facilitate new nuclear deployment. For example, the Governor of New York State, Kathy Hochul, recently announced a plan to build a new advanced nuclear reactor by 2030, and Microsoft and Constellation Energy plan to restart a reactor at Crane Clean Energy Center at Three Mile Island.

The Continental Europe nuclear energy market

“Several European countries, including France, the Czech Republic, Finland, Hungary, Bulgaria, the Netherlands, Romania, Slovakia, Slovenia, Sweden, Poland, and Italy, are seriously contemplating either beginning nuclear activity or strengthening their existing nuclear activities,” says Martin. “The interesting thing is that some are planning both conventional reactors and SMRs, but others are just looking at SMRs. For example, France is considering rolling out 4GW of installed SMR capacity by 2050 and the Czech Republic is planning 3GW.”

Not every country in Europe is pro-nuclear power. Some countries, including Germany, Austria and Spain, are not in favour and this has led to debate at the European Union level. While these debates are perfectly legitimate, they can have an impact on the speed of rollout of new capacity, as there is a need to determine whether nuclear power will be treated as clean energy for the purposes of European law and what associated subsidies might be available.

France has historically been a strong nuclear power. It has the second largest nuclear fleet worldwide after the US, with 65% nuclear power in its energy mix. The fleet is aging, an average of 37 years after having been commissioned, and many reactors have 40-year licences. As a result, France is working on extending the life of the fleet, building additional renewable capacity and planning to build six Evolutionary Power Reactor 2 (EPR2) reactors at an estimated cost of EUR67 billion. The financing is likely to include a mix of State guarantees, preferential loans or CfDs and will have to be cleared by the European Commission. A programme of eight additional EPRs is also under consideration.

The Czech Republic has six reactors and plans to build two more, with the aim of increasing the share of nuclear in its energy mix to 68% by 2040. The state-owned ČEZ Group has contracted with South Korea's KHNP for the construction of two new reactors at Dukovany with an estimated cost of US\$18.7 billion. The project will be financed by a state-backed loan and a CfD. ČEZ has also established a partnership with Rolls-Royce for the development of up to 3GW of SMR capacity.

Poland is a newcomer to the nuclear market and is transitioning from a mainly coal-fired energy mix to renewables and nuclear. The first nuclear plant will have a capacity of 3.75GW and be based on AP1000 Westinghouse technology developed in a consortium with Bechtel. The plant is expected to be operational by 2039 with an estimated cost of EUR45 billion, financed with support from the Polish state and the United States' Exim Bank.

What makes constructing a nuclear plant different?

“There are some overarching considerations for nuclear plant construction,” says Bretherton. “Some will have a reduced impact upon SMRs, but generally they apply to whatever nuclear technology is in play.”

The leading technology providers each have preferred contract structures – from heavy multi-contract disaggregation to single point engineering, procurement and construction (EPC) wraps (at least on paper). Since the technology partner is locked in very early on a nuclear project, it can push its preferred procurement model. Developers need to seek specialist advice in negotiating these structures to ensure that they have the protections needed.

Liability for nuclear incidents is potentially significant. In jurisdictions with civil nuclear programmes; a combination of international treaties and national law ensure that nuclear liability is channelled to the plant operator – regardless of fault – before the host government and other international nuclear treaty signatories take some of the pain. However, there is still scope for unchannelled liabilities to arise, and it is possible to allocate liability for these contractually between the parties. To the extent that this liability is born by developers, they will typically seek to mitigate that via insurance cover and government support.

Since safety and security are paramount concerns for nuclear plants, operators are required to maintain "Intelligent Customer Capability" for all work that might impact nuclear safety and security, and it is critical to ensure that there are sufficient suitably qualified and experienced personnel within the licensee organisation and its supply chain.

"Regulatory intervention is a common issue, particularly if the regulator is new or understaffed," says Bretherton, "which is more common than might be expected given the current growth in the sector. Regulatory intervention remains one of the most common causes for delays and overruns on nuclear projects and can be particularly disruptive,

and is not typically a risk which can fully be allocated to the supply chain."

Supply chain is an issue for the sector globally and currently means working with a relatively limited pool of suppliers which narrows much further once a reactor's technology has been selected. Developers, investors and funders are keen to put in place measures to protect themselves against insolvency in the supply chain; for example, access to drawings and underlying IP. The limited supplier pool, combined with a focus on trying to generate cost efficiencies through repeat production of the same reactor, means that these projects are impacted by sole source procurement risks, and so developers look to offset supplier competitive advantages with contractual levers including KPIs, payment reduction mechanisms and termination/omission-based off-ramps.

"These are massively complex, high-profile projects, with lots of geopolitical risk, and the supply chain needs to be protected, both for work done and some elements of lost opportunity in the event that projects are cancelled. For this and other critical project risks, including loss of insurance cover or protection in the event of a nuclear incident, developers (and their investors) will look to the government support package," says Bretherton.

In terms of construction contract considerations, pricing and payment structures are very important. There will not be a fixed price contract for all of an EPC for the whole of a nuclear power plant. Sponsors, investors and regulators will be keen to ensure that any non-fixed price elements are robustly negotiated. There will be significant work undertaken in the supply chain before any final investment decisions are taken and so suppliers need to be confident that the finances are there, often from sponsors, to meet the significant pre-FID development expenditure levels.

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Ed Bretherton
Partner

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Emma Clarke
Senior Associate

Small Modular Reactors (SMRs)

SMRs have been a central focus of nuclear energy innovation and are seen as a potential solution to meeting both global electricity demand and net zero goals. Current projections have SMRs delivering between 40GW and 120GW of capacity by 2050, with an increase in investment of up to US\$670 billion.

SMRs are smaller in physical size and power output than gigawatt facilities, producing around 300 MW, and are modular, meaning that they can be built off-site in controlled factory facilities requiring limited on-site assembly; for example, 90% of the Rolls-Royce SMR will be built in factory conditions with on-site activity limited to assembly of prefabricated, pretested modules. Beyond these fundamentals, there are no settled SMR designs, with over 80 in existence worldwide, based on a variety of technologies including water-cooled, gas-cooled, metal-cooled and molten salt-cooled. Some of these designs come from key technology players, with significant advances by Rolls-Royce SMR, GE Vernova, NuScale, TerraPower, Holtec, Westinghouse and many others.

“SMRs offer a number of clear advantages both in terms of costs – not only lower CapEx, but given the shorter construction period, lower financing costs – together with the benefits of modularisation, scope for greater competition than is seen at gigawatt level and more streamlined operations once online,” says Clarke. “They also offer flexibility in terms of modularisation, meaning that they can be scaled to meet demand with capacity able to be scaled up or down to meet specific industrial requirements or grid demands.”

Shorter construction periods, between three and five years, mean that revenues should flow more quickly, and there is scope for multiple revenue streams via co-generation capabilities, assuming that site zoning restrictions applicable to gigawatt facilities can be relaxed.

There are, however, some challenges to commercialising SMRs. They are a first-of-a-kind technology which has not been commercially demonstrated. There are not yet any stand-alone SMR regulatory regimes, meaning that SMRs need to meet regulatory requirements for gigawatt-scale nuclear power plants and have costs of design certification, construction and operation not necessarily lower than for large reactors. There are also divergences between national regulatory environments, which may ultimately fetter the rollout of standardised fleets (a crucial facet of the economic rationale for SMRs).

“While in the longer term SMRs seem to offer cost advantages via modular repeatability, and will be cheaper than gigawatt nuclear plants, they are likely to remain more expensive than renewables. It will take time for economies of scale to be realised,” says Clarke.

To overcome these challenges, unified policy, regulatory, legal and security frameworks will be needed, together with concerted government support for financing structures, insurance support, streamlined siting and regulation and, importantly, consistency, to allow supply chains to establish and become resilient.

If SMRs can be deployed commercially at scale they will be seen in a number of contexts. One of the most commonly cited examples is co-location for data centres or gigafactories, with Google and Amazon among others placing orders for SMRs. In industry they could replace fossil co-generation in heavy industries such as chemical processing. They could also be used for desalination and clean hydrogen projects, for areas with limited grid capacity, for marine propulsion, mining, disaster relief, or even space exploration. If and when commercial deployment is achieved SMRs will offer a versatile and potentially game-changing contribution to the clean energy mix.

Financing challenges

Limited recourse project financing is not available for utility-scale nuclear plants for a number of reasons. Firstly, although nuclear operators are generally prepared to take nuclear liability risk, third-party investors typically are not, relying on government support to protect them against those exposures. Nuclear plants also come with decommissioning risk, and operators look to state protection in that regard. Extremely long construction periods without any revenue generation require increased returns to be generated through the operational phase, while interest rolls up during construction and becomes a major component of project costs. The RAB funding model being used on the Sizewell project is targeted at reducing construction period financing costs by allowing revenue to be generated before electricity is generated.

There is also a history of material overruns in the sector, meaning it is harder to size financings, and the lack of an EPC wrap can raise concerns that need to be carefully managed for lenders and investors.

“There are various funding models that have been adopted to address these issues,” says Bretherton. “State-backed financing, which was used for Barakah in the UAE, provides a high degree of support but also ties up a huge amount of capital for host governments. In the Nordic, or cooperative model, which was used for Olkiluoto in Finland, the sponsors pay the construction and operation costs, in exchange for a right to a proportional share of the power offtake. The CfD model, adopted for Hinkley Point C in the UK, removes the power pricing risk. With both these models, the equity providers take the construction risk, there’s no revenue during construction and no return for equity during that phase, so the interest costs roll up and the overall cost of capital goes up accordingly.”

“The RAB model, which will be adopted for Sizewell C, works differently and looks to provide a return on capital and interest on debt paid during the construction period, the risk of cost overruns then being shared between equity providers and consumers, with the intended result being a lower overall cost of capital. It is a heavily regulated model so it can adapt to changes in circumstances over an extremely long operational phase,” says Bretherton.

Clifford Chance nuclear power

Our market leading global nuclear group is active in both developed and emerging markets and advises on both gigawatt nuclear and SMRs across the full spectrum of issues relevant to nuclear development.

We understand the full range of opportunities and legal, policy, technical and commercial challenges that nuclear projects face and have up-to-date knowledge of the whole spectrum of issues affecting the industry, from financing, corporate and commercial matters to construction, IP, insurance, regulation, competition law and dispute resolution.

“Their experience and specialist knowledge in the field of nuclear projects makes them stand out.”

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