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Thematic Insights

Nuclear power(ing up) – opportunities for investors

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At a glance

- COP 28 saw over 20 countries commit to tripling nuclear power capacity by 2050. Energy security, electrification and AI growth are strong drivers supporting the investment thesis.
- Nuclear power can provide round-the-clock energy and be an important component of the broader mix. Higher initial costs and extended delivery times pose a challenge.
- Small Modular Reactors (SMRs) promise cost-effective solutions and their development is attracting significant investment.
- We project that a powering up of the nuclear sector will result in a $550 billion investment opportunity over the next decade or so as capital is deployed for new installations, restarts and recommissions.
- Sectors and industries set to benefit include uranium producers, specialist engineering and construction names, reactor manufacturers and select utility names.

What's driving the surge in interest?

At COP 28 in November 2023, over 20 nations committed to tripling nuclear power capacity by 2050. As a result, broader interest in nuclear energy has surged dramatically.

Key catalysts underpin the thesis for investing in nuclear energy. These include a pressing need for energy security and independence, the accelerating pace of electrification across economies, and the burgeoning growth of power-hungry AI (see our previous article on Power hungry AI – investment implications in the era of the energy transition).

Governments and major tech companies increasingly recognise nuclear energy's unique value proposition – its reliability as a baseload power source and its relative cleanliness. The growing appetite is translating into tangible actions: new policies are being drafted, significant investments are being made, and numerous projects are underway to expand nuclear capacity. In addition, existing nuclear plants are being upgraded and life extensions considered, while previously closed plants are being recommissioned. A notable trend is a fresh wave of investment in innovative technologies like Small Modular Reactors (SMRs), which promise to revolutionise the sector by offering quicker and more cost-effective nuclear power.

We view the growing momentum behind nuclear energy as a driver of numerous investment opportunities.

Nuclear power – the basics

Key to nuclear energy's resurgence is its perceived value as a reliable and clean baseload power source. Unlike renewables, nuclear power offers consistent, round-the-clock energy generation, which in turn makes it a potentially stable and important component of the broader energy mix.

Higher initial costs and extended construction timelines, however, pose a significant challenge to new nuclear capacity relative to other types of power generation. These barriers are being tackled through solutions such as the development of SMRs. These small and modular reactors are designed so that they can be constructed more quickly and at a lower cost than traditional large installations.

It is important to note, however, that SMRs remain in the early stages of development and associated costs remain uncertain. Nonetheless, their potential role in transforming the nuclear energy landscape is significant.

Large reactors vs SMRs: a comparison

Large Nuclear reactor

reactor with power output **>1GW**

- 1. Baseload Power Generation
  - provides continuous and reliable electricity 24/7
- 2. High Energy Density
  - Has an unparalleled energy density, requiring far less fuel and land than renewables.
- 3. Grid Stability and Resilience
  - Unlike intermittent renewables, nuclear plants deliver consistent power, hence maintaining grid stability
- 4. Very long life-span: generally, up to 80years
- 5. Low-Carbon Energy: produces zero direct CO_2 emissions

Small Modular Reactors (SMR)

nuclear reactors with a power output between **80–500GW.** Generally, **300GW**

- Because its smaller size results in lower cost and lower construction requirements (land, water)
  - Smaller size: 80-500MW
  - Modular construction
  - Economies of scale, serial production
  - Lower cost per reactor but higher cost per output
- Allows for off the grid solution
- But same regulatory process and supply chain dependencies

Source: Columbia Threadneedle Investments

High costs and skills gap pose a challenge

In more developed economies, deploying large nuclear projects can take around 15 years from regulatory approval to construction and launch. The process involves significant costs. Capital investment accounts for 70%-80% of a nuclear plant's total project costs, with capital goods companies receiving around 50% for equipment, instrumentation and control systems. Around 12% is allocated to construction materials. Despite high initial costs, nuclear remains economically viable because, once up and running, operational and maintenance expenses are lower. Typically, these account for only 20% of total costs with the uranium fuel costs around 10% of total capital required.

Historically, however, large nuclear projects have typically resulted in substantial cost overruns and delays. The recent construction of the Votgle plant in Burke County, Georgia, in the US, exemplifies this trend. Costs tripled to $32 billion and the timeline doubled to 13 years. Similar cost escalations and delays have been observed in nuclear projects in France and the UK.

A critical factor in the challenges associated with new capacity is the multi-decade underinvestment in nuclear infrastructure. This has led to inadequate project management expertise and a shortage of skilled labour, both of which pose a significant obstacle to future developments. But these issues aren't necessarily global – South Korea has demonstrated superior project management capabilities and the ability to consistently deliver projects on time and within budget.

The cost of new nuclear projects varies significantly by region. China and India enjoy some of the lowest nuclear costs, primarily due to cheaper labour and shorter construction timelines.

Conversely, extending the life of existing infrastructure presents a more cost-effective alternative. Indeed, such projects are estimated to be 80%-90% less costly than new ones and their delivery can be expedited through a quicker regulatory process. Restarting previously shutdown operations can also be materially cheaper – but costs will vary in accordance with the condition of the plant. For example, Constellation's restarting of the Three Mile Island facility in collaboration with Microsoft is projected to cost $2 billion and set to reopen in 2028.

Given the cost and time challenges, we anticipate that most nuclear projects in more developed economies over the next decade will relate to life extensions and restarts. Notably, Japan plans to reopen 21 nuclear plants, and the US is considering a handful of restarts. Currently, only South Korea, the UK and France have tangible new nuclear build plans. Asia leads the way in terms of new construction with China maintaining the strongest nuclear pipeline globally, followed by India.

SMRs: current state of play

SMRs represent an array of innovative nuclear technologies. SMRs vary in size and typically include compact units capable of producing up to 500 MW. Most currently in development are focused on outputs around 300 MW which, for context, is approximately a third of the capacity of conventional large reactors that typically generate about 1 GW.

As investors, we need to be mindful of risks typically inherent in first-of-a-kind technologies. Designs are relatively untested, there will be increased regulatory scrutiny and uncertainty remains around cost structures. Today's leading SMR designs are being developed by established firms such as Rolls-Royce, GE-Hitachi, Westinghouse and Holtec and pure player NuScale Power. These are based on existing light-water reactor technologies and rely on conventional low-enriched uranium fuel. These designs are the most likely to be realised within the next decade.

Generation IV reactors encompass a range of advanced technologies aimed at enhancing the efficiency of current reactors. These facilities predominantly use high-enriched uranium and are in the preliminary design stages. It is premature to predict which designs will prevail, but companies such as Oklo, X-Energy, Kairos, and Terra Power have initiated regulatory processes and garnered customer interest.

Comparing reactor types

Reactor Generation	SMR technology	Type of Fuel	Description	Benefits	Drawbacks	Relevant Companies	Expected timeline
Gen III Reactors	**Light Water Reactor (LWR)**	Conventional Low-enriched uranium (LEU)	Conventional Pressurized (PWR) Boiling water (BWR) reactor designs	Proven tech Regulatory acceptance Set supply chain	Power density Water resources Long-lived waste	Rolls-Royce GE Hitachi Westinghouse Holtec NuScale	>2030-2035
Gen IV Reactors	**High-Temperature Gas-Cooled Reactor (HTGR)**	HALEU (High-enriched uranium)	helium as a coolant	High efficiency Enhanced safety	Complex fuel specialized infrastructure.	X-energy	2040
	Molten Salt Reactor (MSR)	HALEU	Uses molten salt		Corrosive salts Complex waste	Kairos Power Terra Power	2040
	Sodium-Cooled Fast Reactor (SFR)	HALEU	Uses liquid sodium		Sodium is reactive	TerraPower GE Hitachi	2040
	Lead-Cooled Fast Reactor (LFR)	HALEU	lead as a coolant	Stable at high temperatures	Corrosion risk	Oklo	+2030
	Gas-Cooled Fast Reactor (GFR)	HALEU	high-pressure helium or CO_2 as a coolant	High efficiency heat applications	Complex design, fuel management		

Source: Columbia Threadneedle Investments

Assessing the extent of the investment opportunity

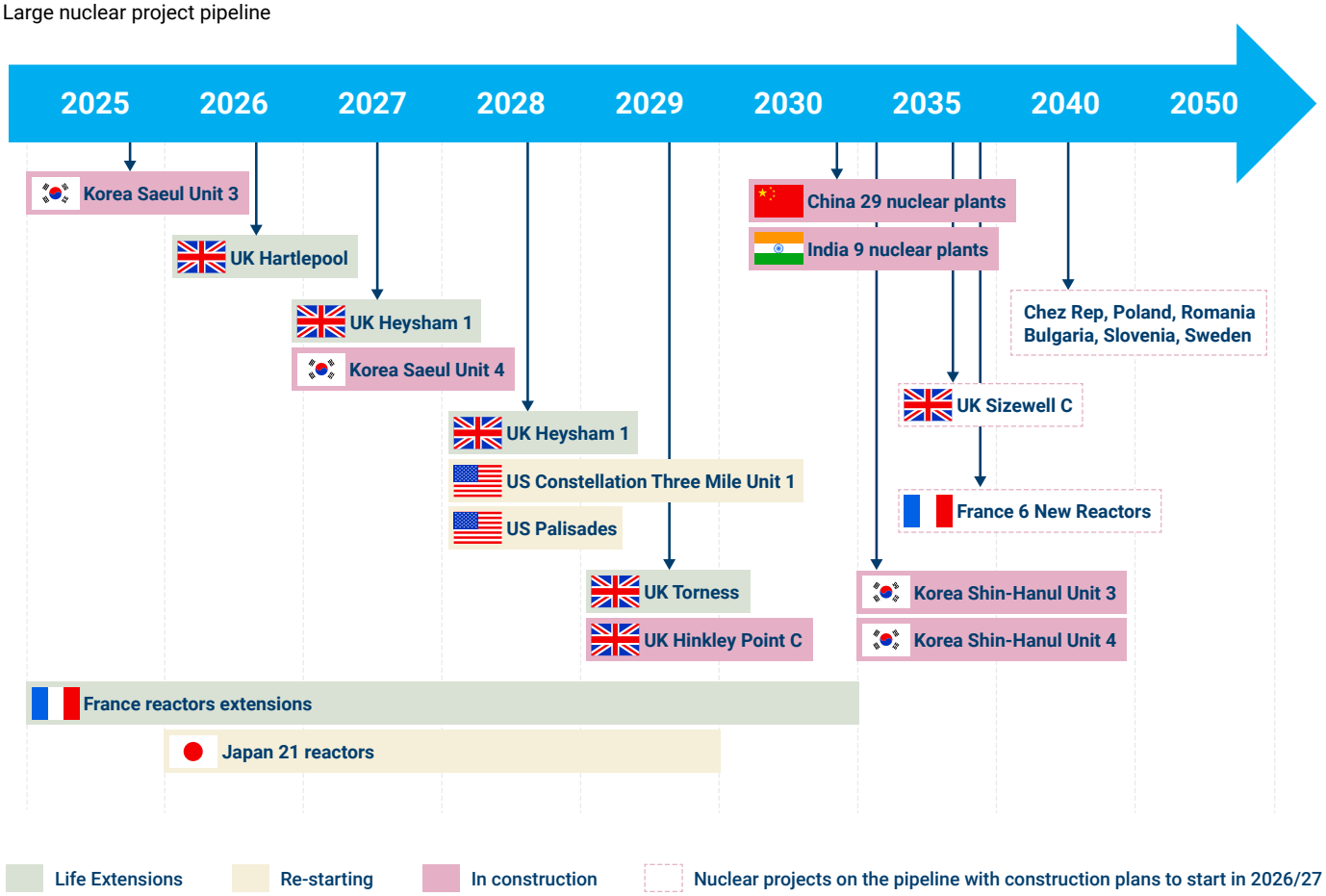
The growing interest in nuclear energy is set to channel substantial capital towards its expansion. However, the development of large-scale nuclear projects will likely span decades, extending beyond market current expectations.

At Columbia Threadneedle Investments, we have developed a framework to quantify the market size and assess related investment opportunities, based on a comprehensive bottom-up analysis. This has allowed us to project potential nuclear capacity resulting from the current global pipeline over the next decade.

Our base case forecasts around $550 billion investment opportunity. A significant portion of this capital will be directed towards France (new constructions and extensions), the UK (new builds), Japan (restarts) and China (new builds). The US will account for a relatively modest 6% of total new investment and here the primary focus will be on extensions and a limited number of restarts. There are no new US nuclear plant constructions currently in the pipeline.

We believe, nonetheless, that the investment landscape could expand further as additional plans come to fruition. Notably, several eastern European countries are on the cusp of finalising initiatives and starting construction within the next couple of years. Furthermore, several EU countries are contemplating policy reversals to reinvigorate their nuclear ambitions.

Large nuclear project pipeline



Source: Columbia Threadneedle Investments

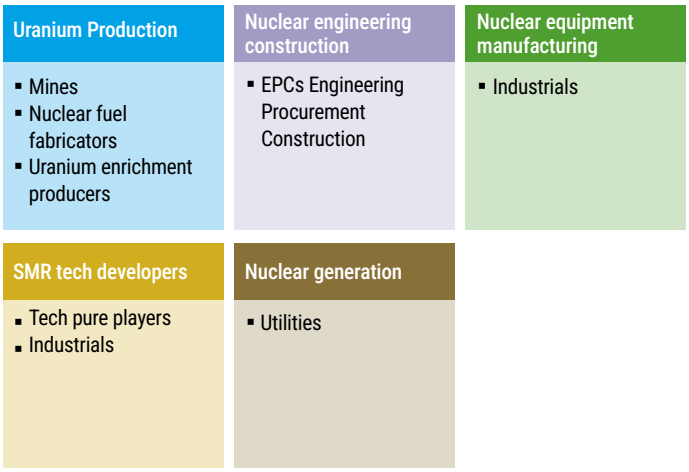
With technology in its infancy, SMRs are not expected to be commercially viable until the mid-2030s. Consequently, the investment opportunities in this area remain limited for the near term. Given this area's undoubted potential, however, we have devised a robust framework to evaluate proposals and track industry players, closely monitoring their progress. The SMR market is dynamic, with frequent deal announcements creating the illusion of depth. However, firm customer orders remain scarce, with most agreements being provisional.

Costs for SMR technologies are uncertain, as none have received regulatory approval or entered the manufacturing stage. Our bottom-up analysis, which assesses the current regulatory, manufacturing and commercial status of leading players, suggests that SMRs will play a modest role compared to large-scale nuclear and other power sources over the next decade.

Investing in the nuclear theme

The nuclear sector is concentrated, with a limited number of key players dominating the market. There are simple reasons for this: nuclear power development is complex, there are close ties to national security, and regulatory frameworks are stringent. As a result, state-owned enterprises maintain a strong presence and incumbents are protected by high barriers to entry. Competition is minimal.

In terms of investment opportunities, we view segments involved in life extensions, restarts, uprates and new nuclear projects, as well as the supply chain for existing nuclear infrastructure, as offering significant potential. The sector's growth is poised to benefit these areas, offering potentially lucrative avenues for investment.



Opportunities this decade

Uranium producers – present a compelling investment opportunity due to the rising demand for nuclear fuel. This demand is driven by plant extensions, restarts and new constructions. The market's supply deficit, caused by decades of underinvestment in uranium exploration, has supported higher uranium prices. In addition, the push to reduce reliance on Russian uranium, coupled with the US's impending ban on Russian imports, is set to boost demand for western uranium producers. Cameco, a market leader, stands out as a significant non-state-owned company. Other notable players include US and Canadian miners.

Engineering and construction – attractive prospects for those with nuclear plant-related operations. Leading industrial companies providing comprehensive services, including engineering, construction and plant management, look set to benefit from the growing pipeline of nuclear projects. Firms, such as Hyundai, Doosan, MHI and Hitachi dominate the market, and thanks to high entry barriers have limited competition. North American infrastructure players with nuclear expertise also boast significant potential.

Nuclear reactor manufacturers – another market segment characterised by low competition and strong market concentration. South Korean and Japanese companies remain dominant in this space, with US players such as GE Vernova also holding noteworthy positions. The exacting nature of related manufacturing requirements mean that only a few players can compete effectively.

Looking further out towards the mid-2030s, we expect to see emerging SMR tech developers benefiting from the commercialisation of their technologies. Currently, however, investment opportunities appear sparse. Additionally, select utility names look poised to gain from incremental nuclear capacity. These include EDF and Centrica in Europe, and Southern Co and PEG in the US.

The bottom line

Today's focus on energy security means nuclear power is a crucial lever. Governments are increasingly announcing nuclear plans or reversing previous anti-nuclear stances.

Nuclear energy is also being pursued by those seeking greater energy independence. In eastern Europe, for example, many countries are keen to reduce reliance on Russian energy sources. Broader geopolitical considerations remain a driver of momentum. Unlike other clean technologies where we see the dominance of Chinese manufacturers, nuclear reactor manufacturing is led by western companies, and they are keen to cement this dominance.

Significantly, there's a growing appetite to leverage nuclear power for advancing power-hungry AI development, particularly in the US. While this is not the primary catalyst, it adds another compelling – and high profile – force behind the push to nuclear and announcements by big technology companies with SMR developers.

Challenges around bringing new capacity online look set to persist but after decades of underinvestment we are seeing growing interest in nuclear power and its potential role as a key component of the energy mix. And as the sector transforms, we believe that attractive opportunities will present themselves to the selective investor.

Get to know the author

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Natalia joined the Thematic Research team in 2020 and focuses on analysing the investment risks and opportunities coming from climate change and the energy transition across sectors and companies. She collaborates very closely with investment teams and engages with companies exposed to these themes. Previously, she worked as a credit analyst at Goldman Sachs. She also teaches sustainable finance at business schools.

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CTEA7729053.1- | WF2717848 (03/25)