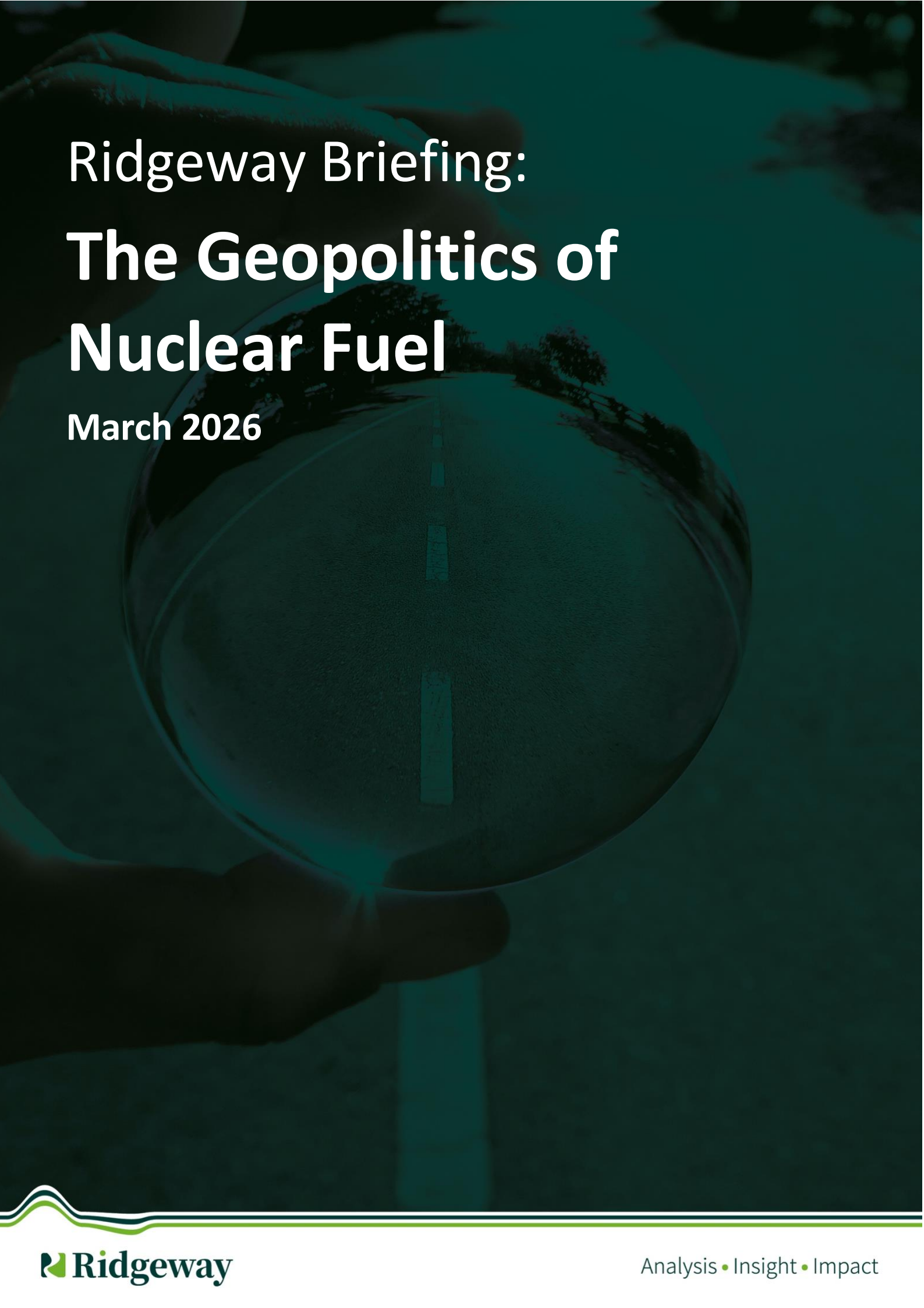




Ridgeway Briefing: **The Geopolitics of Nuclear Fuel**

March 2026

At a glance

- Nuclear fuel is a geopolitical issue. Prior to 2022, western states relied to varying degrees on Russian supplies. Since the invasion of Ukraine, Europe has scrambled to develop alternative (non-Russian) routes for nuclear fuel.
- Thorium has the potential to replace or supplement uranium as a nuclear fuel. Shifting to a thorium-based nuclear fuel cycle would change the geopolitics of nuclear fuel, enabling the US and EU to be less reliant on Russia (and China), but the technology remains in-development and the precise future of the nuclear fuel market remains to be determined.

Ridgeway Analysis

Nuclear fuel is a geopolitical issue. In a sense it always has been; even in the Second World War, British and American diplomats had begun to take steps to secure uranium supplies from around the world to serve projected future needs, both peaceful and military. Today, though, while the market for nuclear fuel has become big business (key players in the industry have market capitalisations running into the tens of billions of US dollars) it is also increasingly beset with political challenges, including around the continued disruption caused by Russia's invasion of Ukraine in early 2022. This briefing outlines some of the key dynamics at play and charts some of the probable developments in the near to medium term.

Mapping the Fuel Cycle

All nuclear reactors need fuel. The 'front end' of the uranium-based nuclear fuel cycle runs through several stages: typically, uranium is **mined** as ore and then **milled** to produce a substance known as 'yellowcake' (U₃O₈). This yellowcake undergoes **conversion**, usually into uranium hexafluoride (UF₆), prior to **enrichment**, which increases concentration of the fissile isotope uranium-235. The next step is **fuel fabrication**, in the course of which the enriched uranium is converted into reactor-ready fuel assemblies. There are technical complexities associated with each of these processes, and few states possess every link in the chain from extraction of ore to the manufacture of fuel. The practical upshot is that uranium might be extracted in one country, converted in another, enriched in a third, fabricated into fuel in a fourth, and then finally loaded into a reactor in a fifth country.

As currently structured, then, the process of obtaining nuclear fuel is almost irreducibly transnational. Partly because of this, and partly because uranium can be traded at any stage, from yellowcake through to useable fuel, the market can be challenging to navigate, with even **prominent traders considering aspects of it 'opaque'**. That said, although the mining and milling stages are relatively diversified, the enrichment and fuel fabrication stages are dominated by only a handful of companies, with the French firm **Orano**, the European multinational firm **Urenco**, and the **China National Nuclear Corporation** figuring as key players alongside the Russian state-owned nuclear company **Rosatom** and its myriad subsidiaries and affiliates.

The Spectre of Dependence

Rosatom's prominence within the world of nuclear fuel supply became a particular problem when Russia invaded Ukraine in February 2022. The desirability of depending on Russia for energy had long been a background concern for EU member states: the invasion brought the issue abruptly to the fore. Over the next four years, western states introduced wide-ranging sanctions regimes and legal structures to create barriers to doing business with Russian firms, especially those closely enmeshed with the Russian state, such as Rosatom. In doing so, European politicians (and voters) were forced to reckon with the reality that, as with their oil and gas sectors, their nuclear supply chains were deeply dependent on a state that was, at best, a geopolitical rival, and that by 2025 the EU Commission was willing to label '**a fundamental threat to Europe's security**'. Energy dependency could no longer be brushed under the carpet: steps would have to be taken somehow to break Europe's reliance.

The **EU response** aims to reduce member states' dependency on Russian nuclear fuel and to develop counterpart domestic capabilities for fuel fabrication across the Union's nuclear reactor fleet. The challenge is particularly acute for five European states (Bulgaria, the Czech Republic, Finland, Hungary and Slovakia) who operate Soviet-designed VVER

reactors, who were, as a result, strongly reliant on Russian-sourced fuel assemblies. Rapid investment to scale up production of Westinghouse's non-Russian alternative VVER fuel assembly was therefore in order. Meanwhile, other countries were, and in part still are, reliant on Russia for other nuclear-fuel related services. (Europe also maintains some dependence on Russia for certain medical radioisotopes, though here, too, steps are being taken to increase domestic production: see, for example, OranoMed's [ATEF](#) in France and ThorMedical's [AlphaOne](#) in Norway, both now in development).

The quest for reliable non-Russian pathways for obtaining nuclear fuel faces a further complication, in that many of the obvious alternatives are not very much more desirable from a geopolitical standpoint. For example, the main (in practice, only) non-Russian route for uranium from Kazakhstan, currently the world's number one producer by a significant margin, passes through China, itself far from a reliable partner in the eyes of western governments.

Meanwhile, parallel with Russian aggression in Ukraine, other factors have placed pressure on the global market for nuclear fuels and fuel services. Growing demand for low- and zero-carbon energy has created consistent upward pressure on uranium prices, as has [political instability in Niger](#), which was formerly a significant source of uranium for Orano. All of this means that both states and nuclear utilities find themselves enmeshed in the complex geopolitics of nuclear fuel, scrambling to develop stable and reliable pathways for their current and future energy needs. By 2027, it should be clear whether or not this effort to build 'fully European alternatives' has succeeded, but for the time being, at least, uranium is an inherently international commodity.

Towards a Thorium Fuel Cycle

Enter thorium. Like uranium, thorium is a radioactive chemical element capable of fuelling a nuclear reactor once appropriately processed. Unlike uranium, it is not presently used in commercial nuclear power generation, although the basic process by which it could be used has long been understood. Thorium is at least three times more abundant than uranium, occurring most commonly in the mineral monazite (itself highly desired as a source of rare earth elements). Thorium in monazite has tended to be seen by rare earth mining companies more as an annoyance than an asset: in fact, mining companies often boast in their promotional materials of how *little* thorium is present in their target deposits. That is, however, beginning to change, as arguments for a thorium-based fuel cycle appear to be gaining traction worldwide.

In theory, a thorium fuel cycle has much to recommend it: quite apart from thorium's relative abundance, its use in a reactor would tend to have safety benefits versus most existing fuels, and in most forms should produce less problematic (read: shorter-lived) nuclear waste. Globally, more than a dozen companies claim to be developing thorium reactor designs or fuel technologies of one kind or another. As things stand, a front-runner technology is a thorium-based molten-salt reactor. A test reactor is currently running in [China](#), and other states have projects working on similar lines: [Copenhagen Atomics](#), in Denmark, also appear to be making progress. As with many other 'Generation IV' reactor ideas, however, not every thorium-based project currently seeking investment is likely to reach fruition: cost and regulatory barriers are still high, and it is far easier to sell the idea of thorium-based nuclear energy than to deliver it.

'Made in America'

Beyond its potential technical benefits, much of the appeal of a thorium fuel cycle is that it seems to offer an escape from the complex geopolitical web of the existing nuclear fuel market. In the United States, for example, much of the advocacy for thorium (both credible and less so) is rooted in nakedly geopolitical arguments. One US-based company spoke darkly of a 'vulnerability... rooted in a near-total reliance on foreign uranium', arguing that reliance on transnational nuclear fuels market amounted to a '[massive and constant national security risk](#)'. (That their own data showed that two-thirds of the United States' enriched uranium came from close allies – the UK, the Netherlands, Germany and France – appeared not to matter: it was, after all, still 'foreign'.) Thorium, the same company claims, represents a chance of '[energy sovereignty and American re-industrialization](#)'. The rhetoric is echoed elsewhere. In May 2025, [Clean Core Thorium Energy](#) signed a Memorandum of Understanding with [Idaho Strategic Resources](#), a US-based resources company that owns the Lemhi Pass Project in Idaho, described as 'the largest domestic source of thorium resources in the United States'. The two companies agreed to 'evaluate the feasibility of thorium mining, processing, and other relevant supply chain steps', with a view to developing a '[Made in America](#)' thorium-based nuclear fuel supply chain.

The Future of Nuclear Fuel

Advocates in other countries have echoed similar sentiments. From [Europe](#) to [South-East Asia](#), companies are developing and promoting thorium as the ‘future’ of nuclear fuel. In each case, part of thorium’s appeal is the fact that it appears to offer an escape from the transnational nuclear fuel market. In Turkey, [ThorAtom](#) pledge to ‘[take] advantage of Turkey’s significant reserves’; in [India](#), a transition to a thorium fuel cycle making use of India’s abundant thorium deposits is part of the country’s three-stage national nuclear strategy. The Chinese, meanwhile, press on with their own research: for them, too, the appeal of a fully ‘domestic’ fuel cycle based on thorium is likely to be significant. China holds significant thorium reserves; enough, by one [recent estimate](#), to meet China’s needs for [60,000 years](#). (Note, however, that prior to that announcement, though, one (European) executive working on a thorium-based technology gave an [interview](#) about his own firm’s efforts to procure thorium in which he noted that ‘any place we have gone to source thorium the Chinese had already been there’. That, he went on, ‘tells us something’.)

How, then, would the future geopolitics of a thorium-based fuel cycle take shape? The key issue would be where and how the thorium itself was obtained. Given that part of the appeal of thorium is its potential contribution to a ‘domestic’ fuel cycle, one would expect countries to try to look inward to their own thorium resources rather than seeking to participate in a notional future market for thorium. The fact that thorium does not require costly enrichment means that thorium fuel cycle would have fewer stages than the uranium cycle, again increasing the likelihood that states might attempt to handle the whole front-end of the fuel cycle within their territory. Of course, the material would still need to be obtained and fabricated into fuel. The first of these steps could be done straightforwardly through mining, either alongside other rare earth elements or, if the economics ever allowed, as the main deposit. This approach would be analogous to that which currently exists for uranium. A second option, for states that already have appropriate existing rare earth mining facilities would be extraction of thorium from tailings. Properly processed, the quantities of thorium present in these waste materials could prove significant, though the separation process is technically challenging and costs are, in current conditions, prohibitive.

Fuel fabrication would be a separate challenge. Although states’ natural preference would be to retain control of this, too, the expense and technical difficulty involved mean that some form of market would likely be necessary if adoption of a thorium fuel cycle were to extend beyond a few already advanced nuclear states. For most, a likelier scenario may be the finance-build-own-operate model articulated by Copenhagen Atomics, whereby the client pays only for the electricity produced. Not every iteration of the thorium fuel cycle leads to ‘energy sovereignty’.

These are all as yet only possibilities. The thorium fuel cycle is not yet here. In fact, it may never arrive: significant technical hurdles remain to be solved, and there are rival technologies among the so-called ‘Gen IV’ reactors that may yet win out. If commercial scale thorium reactors *are* developed in the coming years, we can expect to see. That would come with advantages, including the excision of Russian companies from western states’ energy policies, but would also bring new and perhaps unforeseen challenges, including around nuclear security and safeguards. For the time being, however, the messier dynamics of uranium remain dominant.

Find out more

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