



# Nuclear energy and international relations: the external strategy of Russia's Rosatom

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## Abstract

This article analyses the role of nuclear energy in global politics today through the perspective of three International Relations theories: realism, liberalism and dependency theory. It contends that concepts developed to investigate oil and gas geopolitics do not always apply to the nuclear sector due to its greater complexity. The supply chain for nuclear power involves different, interrelated stages—notably the provision of natural uranium, of enriched uranium, and the construction and servicing of nuclear reactors—which have distinct leading suppliers and relationships of dependence. We illustrate this through a case study of Russia's state nuclear company Rosatom. Rosatom leads in the provision of enriched uranium and reactor construction. This enables Russia to deepen economic and political relations with Rosatom's clients. Even after its attack on Ukraine, Russia has not 'weaponized' Rosatom's international business. Its strategy focuses on consolidating its reputation as a trustworthy partner, especially in the Global South and China.

**Keywords** Nuclear energy · Russia · Rosatom · International relations · Dependence

## Introduction

Access to energy sources and control of energy supply chains have become the subject of renewed attention in both media and scholarly debates. Russia's invasion of Ukraine and the subsequent Western sanctions and embargoes have provoked major shifts in the trade and geopolitics of oil and gas (Zhang et al. 2024). Due to rising tensions between the US and China, debates concerning energy security have extended to renewable energy technologies and the critical minerals that are essential to their production (Kalantzakos et al. 2023). The nuclear energy sector has also

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become the focus of greater attention. Media and expert analyses have examined the potential benefits of nuclear energy in a decarbonizing world, as well as the numerous economic and technical challenges that the nuclear sector faces especially in Western countries (Hernandez et al. 2023; Millard and Tauschinski 2024).

In the discipline of International Relations (IR), the international politics of nuclear energy is an understudied field, particularly if compared to oil and gas geopolitics. While nuclear is by no means a ‘new’ energy source, dating back to the 1950s, it has received more attention in IR scholarly debates only recently, due to the growing politicization of energy supply chains and the role that nuclear energy may play in the context of low-carbon transitions (World Nuclear Industry Status Report 2023: 58–61). In their analyses of the international politics of nuclear energy, both academic and think tank studies tend to apply concepts developed to analyse the geopolitics of oil and gas, such as ‘dependence’ and ‘weaponization of energy’ (see for instance Laryš 2023 and Saha 2017).

Some scholars have expressed concerns about Western countries’ dependence on supply chains that they do not control, as well as about the declining competitiveness of US and EU technologies vis-à-vis those developed by Russia and China (Miller and Volpe 2022; Rothwell 2022; Vlcek 2016). Some have highlighted that the success of the nuclear sector in Russia and China is linked to state type and governance; most notably, statist models including strong public support appear as the key to success (Brutschin 2023). Conversely, the transformation of Western energy markets over the last three decades, driven by the principles of liberalisation, limited state intervention and competition, has led to suboptimal outcomes for the nuclear sector. The private sector in the West appears unable or uninterested in investing in nuclear power and competing on the global arena with its state-owned counterparts in Russia and China. This is the result of delays and large overruns of ongoing projects in the West, as well as of complex safety standards and growing competition from other energy sources, including increasingly cheaper renewable energy generation. In Europe, Finland’s Olkiluoto 3 reactor became operational in 2023, with a 14-year delay and costs that nearly quadrupled compared to initial plans (from 3 to 11 billion Euros); the Hinkley Point C reactor in the United Kingdom, the Flamanville 3 reactor in France and Slovakia’s Mochovce 3 reactor have also had a decade-long delays (Hernandez et al. 2023). Nuclear disasters at Three Mile Island (1979), Chernobyl (1986) and Fukushima (2011) weakened public support for nuclear energy in the West and beyond, leading also to more stringent safety requirements and higher costs (Markard et al. 2020).

Arguably, the Western loss of competitiveness in the nuclear sector could have consequences in the broader context of rising geopolitical competition. While, demand for nuclear power is stagnant or even decreasing in the West, it is increasing in China and the Global South, where energy consumption is growing rapidly and nuclear is seen as a reliable source for low-carbon transitions. In these contexts, non-Western actors are already offering and implementing a variety of attractive deals. Russian state company Rosatom is the best example in this regard, as it currently holds the largest portfolio of international orders (Schepers 2019; Szulecki and Overland 2023). Rosatom has retained its leading position despite Russia’s attack on Ukraine and Western sanctions on Russia. In



fact, Western sanctions largely spared the Russian nuclear sector (except, most notably, Rosatom subsidiaries developing dual-use and military applicable equipment and components), not least because some Western countries also depend on Russian supplies of nuclear fuel and services (Jewell et al. 2019; Szulecki and Overland 2023).

After briefly reviewing how IR theories have approached international energy politics, this article investigates the applicability of concepts developed by IR scholarship in the study of oil and gas geopolitics to the nuclear sector. Russia's Rosatom and its international activities are examined as an empirical case study. Specifically, this study assesses the applicability of the concept of dependence to the relationship between Russia's Rosatom and its current clients, as well as the related issues of vulnerability of supplies and their potential weaponization for political goals. In order to do this, the article identifies three main stages of dependency in the nuclear sector: for raw materials (uranium), for enriched uranium, and for reactor construction and other services (from fuel production to handling spent fuel). These stages are interconnected and each of them sometimes involves several actors; while analysing them distinctly somewhat oversimplifies the technical complexities, it is functional to understanding the different layers of dependence. The goal is to provide a more nuanced analytical framework to assess the international politics of nuclear energy, as well as to explore an example of growing political, trade and technological links between a non-Western actor such as Russia and states in the Global South. The analysis reviews recent academic literature on these topics, drawing also on the extensive data that it has generated. It complements these works with more recent empirical material (for instance, through a discussion of Rosatom's projects in the Global South) sourced from the websites of the World Nuclear Association and World Nuclear News. The goal is to provide an informed discussion that combines both the findings of recent literature and latest developments; empirical data are related to theoretical perspectives in IR—a task that most recent publications have neglected.

The article argues that concepts developed by IR scholarship to explain the geopolitics of oil and gas need further elaboration to aptly illustrate the international politics of nuclear energy. Most notably, dependence is more complex in the nuclear sector as it involves different stages of the supply chain, with different leading providers and market concentration for each stage. The article contends that Russia's Rosatom enjoys a prominent position at two stages of the supply chain, the provision of enriched uranium and reactor construction and operational services. This enables Russia to deepen both economic and political relations with Rosatom's clients. However, 'weaponizing' this position for geopolitical advantage—to use a term dear to realist approaches to energy politics (see Labelle 2023)—is far from easy and would swiftly undermine the credibility of Rosatom as a reliable provider. In some cases, as in Rosatom's projects in China and India, the potential for weaponizing exports in the nuclear sector is very limited, as the impact would be minor and the Russian company would be replaced with alternative suppliers. The fact that Moscow refrained from weaponizing nuclear energy supply chains to the West even in the extremely tense post-2022 context reflects this. Russia's main strategy appears to be that of consolidating Rosatom's reputation as a reliable supplier and



constructor, most notably in non-Western countries, where it can conduct lucrative business, while simultaneously contributing to the Kremlin's soft power.

## International relations theories and energy politics

Energy politics has been at the core of many scholarly debates in the discipline of IR (Prontera 2019, 36–37). Realist and liberal scholars conceptualise energy in very different ways, in accordance with their contrasting emphasis on conflict and cooperation in international politics. Realists view energy as a strategic tool in the competition among great powers. Following realist logic, international energy politics is a zero-sum game among states that seek to secure the control of finite resources (Kuzemko et al. 2015: 9–10). States that control significant energy resources can use them as a lever in political deliberations with other countries that lack such resources and depend on imports from abroad. From this perspective, for instance, the EU's reliance on Russian gas is a source of weakness because Russia can use gas for political influence or to extract concessions. Hence, a country's dependence on external energy suppliers is seen as a security issue because it increases its vulnerability to geopolitical fluctuations. Conversely, large exporting countries possess an 'energy weapon' that can be deployed strategically to coerce energy-poor countries (LaBelle 2023).

In order to apply realist logic and concepts to nuclear energy, an important distinction must be made between fossil fuels and the nuclear sector. While resource endowments (of oil, gas, coal) and export infrastructure are the main determinants of power in fossil fuel geopolitics, long-term technological know-how and capacity are the most important factors in the nuclear sector. In other words, rather than just the possession of natural uranium, it is the capacity to enrich it, produce nuclear fuel, build nuclear reactors and service them that matters most in the nuclear sector (Minin and Vlcek 2017). From this, it follows that applying the concept of dependence (and its potential weaponisation) is more complex in the nuclear sector than in the oil and gas sectors: relationships of dependence develop not only for the supply of the energy source (uranium), but also and most significantly for the capability to enrich it, fabricate fuel, build nuclear power plants and service them.

Following a realist approach, states are the only actors that matter in energy politics. States define energy security, the goals of national energy policy and the strategies and means to achieve them. State control of the energy sector is thus assumed and seen as a necessary prerequisite for successful energy policy (Siddi 2023, 15–18). On the other hand, liberal IR scholars see states as key actors in energy politics, but also highlight the role of international, substate and private actors, such as companies and transnational corporations, as well as international organisations that support energy cooperation and trade. Contrary to realists, liberals argue that states can agree on a shared set of norms and cooperate both bilaterally and in multilateral frameworks. This cooperation facilitates energy trade, which is thus framed as a positive-sum game, where both exporters and importers benefit.

The concept of interdependence is particularly important for liberals. Energy producing states and energy consuming states have mutual and compatible interests: the



former make profits from selling their surplus production in international markets, whereas the latter will benefit from having peaceful, commercial access to energy resources (Kuzemko et al. 2015: 10–12). While importers depend on exporters for energy supplies, exporters also rely on importing countries for financial revenue from energy trade. Moreover, energy exporters often depend on trade with importing countries in other areas, such as manufactured and high-tech goods. They cannot interrupt their energy sales without risking retaliations in other areas, or the loss of vital income for their societal welfare. Hence, a situation of complex interdependence arises, where neither side has a rational interest in suspending trade. Commercial links create path dependencies that perpetuate themselves, encourage further cooperation and the crafting of shared norms and institutions. According to liberal theory, interdependence and commercial relations have a pacifying effect on international relations because they reduce the incentives for conflict (Gökçe et al. 2021).

Liberal approaches largely shaped international energy politics for over two decades after the end of the Cold War. The EU-Russia relationship, with its strong energy component, was arguably a case of deep interdependence. However, the Russian invasion of Ukraine in 2022 and the ensuing Western sanctions posed a serious challenge to liberal thinking. Several policymakers and scholars had already criticised the EU's trade-focused approach to Moscow following Russia's annexation of Crimea and the destabilisation of Donbas in 2014 (see for instance Vihma and Wigell 2016). A few East Central European countries including Poland and Lithuania started to diversify their energy supply, which had been overly reliant on Russia; others, such as Germany, maintained and even expanded energy trade with Moscow. These different approaches generated considerable controversy within the EU (for a summary, see Siddi 2020). Overall, while after 2014 the EU focused on integrating its energy market and limiting its exposure to external supply shocks, volumes of gas and oil trade with Russia remained largely unchanged. Ultimately, the multibillion energy trade between Russia and the EU proved insufficient to avert conflict; indeed, both sides weaponized oil and gas trade through sanctions, embargoes and supply cut-offs and restrictions (Siddi 2023, 99–117).

Trade and services in the nuclear sector constitute an exception for the time being. While being much smaller in terms of financial flows than oil and gas trade, EU-Russia trade and cooperation in the nuclear sector has continued in several areas (for example the supply of nuclear fuel) and has not been affected significantly by sanctions. This may suggest that the liberal logic of trade and interdependence has been more resilient in the nuclear sector than in the gas and oil business. However, this is only partly true. The economic significance of the nuclear sector is relatively small, and this likely allowed leaving the sector out of the ongoing EU-Russia economic confrontation. At the same time, its small economic significance constrains any 'pacifying effect' that, following liberal logic, nuclear energy trade would have on the broader EU-Russia relationship. In other words, the concept of interdependence has limited applicability to the nuclear sector in EU-Russia relations. The revenues from this sector for Russia's federal budget are small (even if they are significant for specific cities and regions within Russia), whereas EU dependence on Russia's exports can be circumscribed to the provision of enriched uranium and to operating a few reactors in Eastern Europe. Indeed, it may be only a matter of time



until decoupling does happen. The EU is trying to secure alternative suppliers of nuclear fuel for its Russia-built reactors, and member states—with the exception of Hungary—have halted plans to construct new plants or reactors with Rosatom. However, it remains true that so far, contrary to the oil and gas sectors, the nuclear sector has not been weaponized.

Beyond the ‘mainstream’ realist and liberal approaches, critical theories offer a useful perspective on international energy politics by focusing especially on the position of the Global South in energy trade. Most notably, dependency theory argues that a country’s potential in terms of economic development is determined by its relative position within the economic structure of a world system. The world system is characterised by a ‘core’ of rich, developed countries and a periphery of poorer states (Wallerstein 2004). The core controls finance and advanced technology, whereas the periphery mostly provides raw materials and cheap labour to the core. These patterns can be traced easily in the global energy system, where peripheral continents (Asia, Africa) have traditionally played the role of fossil fuel providers to the Global North and may find themselves in a similar position in a post-transition context, as suppliers of critical minerals and rare earths. Moreover, due to limited financial resources in the Global South, investments in new energy technologies there are likely to remain a function of the economic cycles in the Global North (Goldthau et al. 2020).

Dependency theory can explain important aspects of the nuclear sector, for instance the subaltern position of countries such as Kazakhstan and Niger as providers of natural uranium to a few states in the Global North that possess the technological know-how and human capital to enrich uranium, produce nuclear fuel and build reactors.<sup>1</sup> Countries in the Global South remain dependent on a few providers located in the Global North to develop and maintain a nuclear industry. At the same time, states in the Global South account for a substantial part of world demand for new nuclear reactors, as their overall energy demand is rising quickly (as opposed to generally stagnant demand in the North) (World Nuclear Industry Status Report 2023, 61). Hence, they also play the role of significant buyers and markets for which reactor builders and service providers must compete. It follows that the categories of dependency theory, which apply in a straightforward manner to North–South gas and oil trade, need some adaptation when applied to the nuclear sector: the Global South is both a ‘periphery’ subject to neocolonial extractivist exploitation and—at least the countries that chose to invest in nuclear energy—a prime market for technology exports from the ‘core’. To an extent, this reflects shifting global power dynamics: many states in the Global South are no longer just territories for postcolonial resource extractivism, but also play a role as important economic and political partners with independent and influential actorness. The nuclear industries of the West, Russia and China compete to secure shares in the markets and nuclear energy projects of the Global South. Therefore, they need to

<sup>1</sup> However, Kazakhstan has attempted to diversify and advance its role in the supply chain by producing nuclear fuel at its Ulba plant (Siddi and Silvan 2023, 5).



offer economically attractive deals, while simultaneously avoiding political conflicts that could lead partner countries to turn to a competitor.

## The nuclear sector: key aspects and stages of dependency

Nuclear power technology involves a complex supply chain including uranium mining; uranium conversion and enrichment; fuel fabrication; construction, operation, maintenance and decommissioning of plants and reactors; and storage, processing and disposal of nuclear waste. It requires large upfront investments and long lead times: planning, licensing and construction can take more than ten years, and plants are then operational for at least three decades. Nuclear technology requires skilled labour and specific competences that are particularly difficult and expensive to acquire for incomers in the nuclear sector. Environmental challenges include the risk of accidents and of proliferation of nuclear material, the unresolved question of safe disposal of radioactive waste and the thermal pollution of water used to cool reactors. As the cost of renewable energy installations has decreased considerably in recent years, and renewables can be deployed much faster in numerous locations, the rationale for investing in new nuclear power plants has been questioned from a low-carbon perspective too (Markard et al. 2020, 3–4).

Nuclear technology creates dependencies all along the supply chain. It is necessary to examine the main ones in order to relate them to realist and liberal conceptualizations of dependence. Drawing on Brutschin (2023: 375–378), we identify three main stages of the nuclear supply chain, which have different providers and hence different constellations of inter-state dependencies. The first stage concerns the recovery of natural uranium through mining and other methods. Kazakhstan is by far the largest producer, accounting for 43% of global supply. Other major producers are Canada, Namibia and Australia, followed by Uzbekistan, Russia and Niger. The largest identified resources recoverable are in Australia (28% of global resources), Kazakhstan (13%), Canada (10%), Russia and Namibia (8% each) (World Nuclear Association 2023). During the 1990s and 2000s, the uranium production industry was characterized by takeovers, mergers and closures; major international companies acquired stakes in mines in the largest producing countries, notably Kazakhstan. However, state actors retain a central role in the sector. Over half of uranium mine production is from state-owned mining companies, some of which prioritize secure supply over market considerations. In 2022, the top ten companies by production contributed over 90% of the world's uranium production; the largest is by far Kazakhstan's Kazatomprom, which accounts for 22% of global production (World Nuclear Association 2023).

Despite this market concentration, international dependencies on natural uranium supplies appear less controversial than in the next two stages identified in this article. This is partly because large importers such as the United States receive a substantial share of their supplies from allies or politically close countries—Canada being the main US supplier (EIA 2023). Imports from Kazakhstan are a partial exception in this regard. While a substantial share of Kazakh exports goes to Russia and especially China—countries with which Kazakhstan enjoys good



relations— considerable volumes of Kazakh uranium are exported to France, Canada, the United States and India. Kazakhstan has been keen to diversify its international clients and to appear as a reliable supplier on the world market. Following Russia's invasion of Ukraine in 2022 and Moscow's subsequent confrontation with the West, Kazatomprom has cooperated with its Western suppliers in the exploration of new exports routes bypassing Russia (and China), notably the Trans-Caspian International Transport Route via Azerbaijan, Georgia and Turkey (Siddi and Silvan 2023, 5). However, a scenario in which Kazakh supplies to international markets are disrupted cannot be excluded completely, not least due to domestic instability and potential interference by external powers. Niger, another important natural uranium producer (accounting for approximately 5% of global output) and a key supplier to the EU, no longer seems a fully reliable provider to the West following a coup d'état in July 2023. The new military junta has taken an anti-Western, and particularly anti-French attitude (France is the former colonial power and preserved an important and controversial economic presence in Niger after its independence), notably by severing security cooperation and asking French troops to leave the country (Yabi 2023).

The second stage of activities in the supply chain concerns uranium conversion and then enrichment. Before being enriched, mined uranium needs to be converted to uranium hexafluoride. Conversion plants are operating commercially in a few countries: Canada, France, Russia, China and the United States. The Russian plant at Seversk accounted for the largest share of converted uranium in the recent past; however, facilities in France and the United States had very limited capacity utilization (World Nuclear Association 2022a). Following Russia's attack on Ukraine and the rebound in prices of uranium hexafluoride, US company Converdyn is reopening its mothballed conversion facility, while simultaneously seeking long-term guarantees from potential customers aimed at keeping out competitive Russian supplies (Bloomberg 2023).

Most of the approximately 500 commercial nuclear power reactors operating or under construction require uranium enriched in the U-235 isotope. Natural uranium contains 0.7% of the U-235 isotope, while the remaining 99.3% is mostly the U-238 isotope. Most reactors are light water reactors that require uranium to be enriched from 0.7 to 3–5% U-235 in their fuel (World Nuclear Association 2022a, b). While there has been a significant oversupply of enrichment capacity worldwide in recent years, uranium enrichment is strategically sensitive and capital intensive, which hinders market entry for new suppliers. As nuclear enrichment capacity is closely linked to the production of nuclear weapons (for nuclear bombs, however, enrichment to at least 90% of U-235 is necessary), a country that wants to develop such capacity must accept rigorous international scrutiny, otherwise it will fail to get essential technological support and face sanctions (Brutschin 2023, 377).

For these reasons, there are few commercial enrichment suppliers that operate a limited number of facilities worldwide. Currently, the three major producers are Russia's Rosatom (with nearly half of global capacity), Urenco (with production in Germany, the Netherlands, the United Kingdom and the United States) and French Areva. China's CNNC is a major domestic supplier and is pursuing export sales. In Japan and Brazil, domestic companies have modest supply capability. A few



other small non-safeguarded facilities in other countries are subject to international opposition (World Nuclear Association 2022a, b). This strong market concentration is partly alleviated by two international enrichment centres, or Low Enriched Uranium Banks, that act as fuel sources of last resort for any country upon request of the Director General of the International Atomic Energy Agency (IAEA). The first one was opened in 2006 in Angarsk, Russia, while a second centre was initiated in 2019 in Kazakhstan (Brutschin 2023, 378). With the expected rise in demand of enriched uranium in the next years, consumption could surpass supply if no new production capacity is created. At the same time, capacity can be scaled up, hence current major producers such as Rosatom would risk losing international clients (which have become essential to its business strategy) if they were to restrict supplies or manipulate prices (Meyer 2023, 4–5).

The third stage concerns the supply of nuclear reactors and plant construction, including the provision of adequate fuel rods, the servicing of the infrastructure and the disposal of spent fuel. Today there are about 440 nuclear power reactors operating in 33 countries and generating approximately 10% of the world's electricity. In addition, 60 reactors are under construction, most of which are in Asia (World Nuclear Association 2024a, b). Suppliers of nuclear reactors and power plants are very few, with six countries (Russia, US, France, China, Korea and Japan) accounting for 94% of supply (Jewell et al. 2019, 843). As we shall see more in detail below, Rosatom is the company with the largest portfolio of foreign orders. Most reactors are pressurised water reactors installed at large plants. Since the early 2010s, the implementation of small modular reactors (SMRs, usually with one third of the capacity of a regular reactor) has been discussed based on some of their advantages: easier siting, affordability and flexibility of use. However, SMR technology is still in the early stages and presents many of the same safety, political and environmental issues as larger reactors. Hence, it has not been implemented on a commercial scale (Rothwell 2022, 6; Markard et al. 2020, 13).

The construction of a reactor, especially in a country that does not yet have a nuclear industry, involves several types of dependence, starting from the provision of the required technology and the training of personnel to operate the plant (unless the provider operates the plant). Moreover, some nuclear reactors (for example, Rosatom's VVER reactors) require specific materials and types of fuel rods that are only or mostly produced by the manufacturer of the reactor. Different companies are now developing the capacity to produce fuel for these reactors, but their production remains limited for now. The treatment of nuclear waste is another major issue. As a long-term geological storage facility does not exist anywhere, most states store their waste in wet pools and in dry casks on site. Rosatom is the only company that offers the processing and storage of spent fuel in its contracts. Capacity for reprocessing and reuse of fuel has only been developed in few countries and is still very limited (Brutschin 2023, 378–379).

Therefore, acquiring foreign nuclear technology leads to several layers of long-term dependencies that cannot easily be overcome due to the technological complexity of nuclear power. Market concentration theoretically puts the limited number of providing countries in the position of exploiting nuclear trade for political purposes or, to use realist terminology, to weaponize dependence. However, the



generally fragile economic situation of the global nuclear sector (see Markard et al. 2020) and the presence of current and prospective providers across geopolitical dividing lines raises the cost of political manipulations and of weaponizing nuclear energy trade. At the same time, the liberal concept of interdependence does not apply to the nuclear sector in the same way as it did, for example, to the gas and oil sectors in EU-Russia relations. This is because nuclear energy trade only produces very limited revenues for providers if related to total trade or GDP (it can, however, be economically significant for the cities and regions, where the nuclear industry is located). On the other hand, we should note that some providers consider their nuclear industry as strategic for security and status or prestige reasons. Moreover, international trade allows alleviating the domestic costs of the nuclear energy industry, which otherwise tends to be a significantly loss-making business in the domestic market. Furthermore, while uranium extraction or foreign technology supply can put importing countries in the Global South in a subaltern position, as conceptualized by dependency theory, the increasing share of demand from these regions—combined with providers' competition and need of foreign markets—means that importers can sometimes negotiate advantageous deals and limit the negative effects of dependencies.

## Russia's Rosatom: domestic set-up and international strategy

### A statist paradigm for the nuclear sector

As a leading actor in the global nuclear sector, Russia's state company Rosatom offers a highly relevant case study to analyse dependencies in civilian nuclear power and the evolving nature of the international nuclear sector. Rosatom is a vertically integrated corporation controlling either directly or via subsidiaries the full cycle of competences in the Russian nuclear industry, from uranium mining to the construction and operation of nuclear power plants, including processing and storage of spent fuel.<sup>2</sup> Following its establishment in 2007, Rosatom has enjoyed a unique revival and expansion thanks to domestic political choices and economic support, a growing number of international clients and decreasing competition from the Western nuclear industry. Financial and diplomatic support from the Russian state, together with flexible and comprehensive business offers to customers, have enabled the company to acquire a large foreign portfolio (Szulecki and Overland 2023).

The institutional set-up of Rosatom and the strong financial support it has received from the state thus far make it a textbook case of the realist understanding of energy politics. The Russian state retains control of the strategic nuclear sector and can potentially exploit its international ramifications to pursue foreign policy goals. Rosatom's foreign activities receive full support by the Russian government, including during bilateral meetings between representatives of the partner country

<sup>2</sup> Rosatom is also responsible for Russia's nuclear weapon division, nuclear-powered icebreaker fleet and nuclear research institutions, and for ensuring nuclear and radiation safety.



and the Russian president or senior members of government. Cooperation on the peaceful use of nuclear energy is included in the agenda of such meetings, mentioned in public speeches and sometimes codified in memoranda of understanding. When cooperation is at an advanced stage, the Russian president or senior Russian government members attend official ceremonies with their foreign counterparts and celebrate landmarks in the construction of new projects (Schepers 2019, 4–5).

Moreover, Rosatom plays an important role for Russia's international prestige and status, notably its claim to be a great power, beyond the domains of military force and fossil fuel geopolitics. Nuclear technology is one of the few high-tech sectors, where Russia is a world leader. Rosatom is investing in the development of new reactor technologies, most notably safe plants using fast neutron reactors, MOX (a blend of oxides of plutonium and uranium) and a closed fuel cycle, which would allow eliminating the production of radioactive waste from power generation. Currently, Russia is the main viable commercial supplier of high-assay, low-enriched uranium (with 5–20% concentration of the isotope U-235, instead of the 3–5% concentration that fuels the existing fleet of light water reactors), which will be needed to power the new generation of advanced reactors (Lorenzini and Giovannini 2022). Besides Russia, only China has the infrastructure to produce HALEU at scale, whereas in the United States production started with a pilot project in November 2023 (US Department of Energy 2023).

Hence, following a realist approach, Rosatom is an important element of Russia's great power status and international influence. Considerations concerning financial profits seem to play a secondary role in its functioning, as highlighted by the fact that the company receives considerable state subsidies. Moreover, plans to increase electricity generation from nuclear massively—as specified in Russia's Energy Strategy to 2035—are unlikely to be achieved without substantial government intervention (IAEA 2021; Mitrova and Yermakov 2019, 37).<sup>3</sup>

At the same time, keeping to a realist reading, the Russian nuclear sector has an important vulnerability: it needs to import natural uranium from abroad. Russia uses approximately 5,500 tons of natural uranium per year, but its domestic production has oscillated between 2870 and 3560 tons since 2004 (World Nuclear Association 2021). Moreover, domestic production is only a fifth of Rosatom's needs if its requirements to fulfil export contracts of enriched uranium are considered (Meyer 2023, 5). While, Russia has substantial resources of natural uranium, extraction from remote locations make imports from abroad cheaper. Therefore, Rosatom has chosen to import part of its requirements from abroad, mostly from Kazakhstan, where its subsidiary Uranium One set up joint ventures with or acquired stakes from its Kazakh counterparts (Siddi and Silvan 2023). If Russia were to act fully in accordance with a realist script, it would prioritise domestic sourcing of natural uranium despite higher costs in order to avoid vulnerability to external supply shocks. Russian imports of Kazakh uranium show that Russia is in the position of leading global

<sup>3</sup> Russia's Federal Target Programme envisages a 25–30% nuclear share in electricity supply by 2030, 45–50% by 2050 and 70–80% by the end of the century, see <https://cnpp.iaea.org/countryprofiles/Russia/Russia.htm>.



supplier only in two of the three identified main stages of the nuclear supply chain, namely uranium enrichment (and conversion) and the export of reactors and related services. We now turn to these two stages more in detail to assess whether and how Rosatom's actorness reflects realist or liberal paradigms.

### **Various shades of dependence and cooperation: enriched uranium and nuclear power plants**

Rosatom's portfolio of foreign orders includes reactor construction, enriched uranium and fuel provisions and other services, and spans 54 countries. Rosatom's projects are at very different stages of development: plants in operation; ongoing, contracted or planned construction of reactors; invitations to partnerships; memoranda of understanding for services and general development of nuclear energy. Between 2009 and 2018, the company received 23 of 31 global orders and was responsible for half of the reactors under construction worldwide (Szulecki and Overland 2023).

The strength of Rosatom's export strategy for reactors and whole NPPs lies in its ability to provide all-inclusive packages comprising plant construction know-how, training, support related to safety, non-proliferation regime requirements, flexible financing options (including Russian government loans) and handling of spent nuclear fuel (Schepers 2019, 3). This makes it particularly attractive to newcomers in the civilian nuclear power sector, which explains Rosatom's surging business in Africa, the Middle East, Asia and South America. Its business model enabled it to outclass Western competitors such as Framatome, Mitsubishi, Siemens and Westinghouse, which normally require robust financial guarantees and partnership arrangements with clients as part of their corporate business standards. Currently, Rosatom is building reactors in China, India, Bangladesh, Iran, Belarus, Turkey and, most recently, Egypt (World Nuclear News 2023a, b).

Moreover, through its subsidiary TVEL, Rosatom controls 38% of global uranium conversion and 46% of uranium enrichment capacity (Szulecki and Overland 2023, 413–414). Many Western and Asian states, including the United States, the United Kingdom, France, Japan and South Korea, have contracts with Rosatom for enrichment services. Western production capacity is limited in the short term. The United States relies on Rosatom and Russian-controlled supply chains for nearly half its enriched uranium supply, whereas 40% of the EU's imports come from Russia (Szulecki and Overland 2023, 416).

Russia's key role in the Western nuclear fuel markets is the result of two main factors. Firstly, Russian engineers developed a system to enrich uranium that is significantly less energy-intensive and thus much cheaper than the method used by French and American engineers (Blas 2023). Secondly, in 1993 Russia and the United States agreed to the so-called 'megatons to megawatts' program, in which the highly enriched uranium from former Soviet nuclear warheads was transformed into low-enriched uranium and shipped to the US for civilian nuclear plants. As a result, the US industry could not compete against Russian fuel (Minin and Vlcek 2017, 39).



Much of the relevant Western IR literature frames Russia's role as key exporter of enriched uranium and nuclear reactors in terms of dangerous dependence and vulnerability to economic and political pressure, thus adopting a realist perspective. Laryš (2023) argued that Rosatom is more likely to succeed in tenders and progress to the implementation phase of new projects in states that experience democratic backsliding, or where civil society, press and political freedoms are weaker. Thomas (2018) highlighted technical, political and security issues in partner countries that have little experience of nuclear power. He also called into question Rosatom's capabilities to implement its large foreign portfolio, thus implying that its current size is due more to the Kremlin's external power projection strategies than to economic rationale. Examining the specific case of Rosatom's Akkuyu project in Turkey, Kyriakides (2023) claimed that the project reflects Ankara's drift away from NATO and involves important security and nuclear safety issues.

Furthermore, Szulecki and Overland (2023) attempted to measure current and projected dependence on Russian nuclear reactors and related services, arguing that high levels of dependence may pose a threat to the energy security of Rosatom's customers. Based on their analysis, dependence varies substantially in Rosatom's partner states. Estimates based on prognosed national electricity supply coming from Rosatom reactors operating or planned by 2040 show that dependence will be high in Armenia (100%), Hungary (42%), Bulgaria (37%), Belarus (34%) and Uzbekistan (20%), and larger than 10% also in Bangladesh. Reliance on Russian reactors is particularly significant in countries that base their decarbonisation efforts primarily on nuclear energy (i.e. Hungary and Slovakia) and where the power system is inflexible and overreliant on a single large nuclear power plant. Conversely, dependence on Rosatom appears marginal in China and India, which already have domestic nuclear industries and expect to receive only a small share of their electricity from Rosatom-built reactors.

While these analyses illustrate very clearly the potential risks for Rosatom's client countries, they do not delve into the consequences that the weaponization of civilian nuclear energy trade may have for the Russian company, as well as its incentives to follow a business-oriented approach (as opposed to confrontational power politics). Teva Meyer's (2023) and Minin and Vlcek (2017) presented a nuanced approach to these issues. While acknowledging that Rosatom's share of the enriched uranium market has increased since the early 2010s, Meyer showed that its capacity to weaponize enriched uranium exports is low. The Russian company controls 43% of production capacity, followed by German-Anglo-Dutch Urenco (32%), French Orano (12%) and China's CNNC (12%). However, global enrichment capacity currently exceeds demand by approximately 20%. Transport infrastructure for enriched uranium is less rigid than that used for hydrocarbons, gas in particular, which makes rerouting easy and hinders potential attempts by Russia or others to weaponize chokepoints. Moreover, earlier research has found no evidence of price manipulation for political purposes in Rosatom's behaviour; as Vlcek (2016, 80) and Meyer (2023, 9) note, fluctuations in uranium enrichment price would have little effect on the final cost of power generation. Likewise, disruptions in the supply of nuclear fuel would have limited impact on nuclear power plant operations because



operators usually stockpile fuel assemblies that are sufficient to keep the plant working for at least one year (Vlcek 2016, 78).

Most EU countries that rely on nuclear power have diversified their sources of enriched uranium, and Rosatom is only one of several suppliers. Among the countries where nuclear plays an important role in the energy supply mix, Sweden ended its contract with Rosatom in 2022, while Finland started diversifying away from Russian supplies the same year. The Czech Republic signed new contracts with Westinghouse and Framatome in 2022, while Slovakia followed suit in 2023. Bulgaria and especially Hungary are the EU members with the largest reliance on Russia's enriched uranium and nuclear fuel. Bulgaria pursued no diversification strategy until 2023, whereas Hungary continues to have none and is installing two new Rosatom-supplied reactors of a type (VVER-1200) for which no other fuel supplier than TVEL exists (NS Energy 2024; Vlcek 2016, 80). Except for this specific case, however, Rosatom no longer holds a technological monopoly on fuel assemblage for Soviet designed reactors; capacity for producing such fuel is now also available in Sweden, Germany and Spain (Meyer 2023, 8). While such capacity currently remains limited compared to the requirements of Soviet and Russia-built reactors in East-Central Europe, diversification has begun and will progressively decrease vulnerability to potential supply disruptions. In January 2023, the EU started co-funding the Accelerated Program for Implementation of Secure VVER Fuel Supply (APIS), which should develop and deliver a fully European nuclear fuel supply for Russian-designed VVER reactors (World Nuclear News 2023a).

Most notably, Rosatom showed no sign of changing its market-oriented strategy towards EU countries even after Russia's aggression of Ukraine in 2022. Air transport of nuclear fuel to Hungary, Slovakia and the Czech Republic in early 2023 was heavily publicised by the communication division of Rosatom to highlight its commitment to cooperation and reliability (Yle 2023; Meyer 2023, 9). This may be part of a 'normalisation strategy' of Rosatom to convey the impression that it remains a reliable supplier, both to the West and to other parts of the world (Szulecki and Overland 2023). It may also reflect the fact that Rosatom has become more economically dependent on the international market. Export contracts helped save the Russian nuclear industry in the 1990s and have generally remained more profitable than national contracts; Rosatom's expected profitability rate for projects is 2.3% in Russia and 6.1% abroad (Minin and Vlcek 2017, 39). The yearly reports of Rosatom consistently stress the importance of its foreign activities and their financial significance (see Rosatom 2022 for latest available data). In 2011, Rosatom's supervisory board approved a strongly export-oriented, long-term strategy that is valid until 2030. A key target in the strategy is that revenues from foreign operations should reach 50% of total company revenues (Minin and Vlcek 2017, 37). In the light of Rosatom's ambitious economic targets, its acquisition of a large portfolio of new plant projects abroad can be seen as an attempt to create economies of scale, rather than as a *Realpolitik* attempt to monopolize the market for geopolitical advantage.

The foreign strategy and behaviour of Rosatom suggests that a trade-oriented and cooperative rationale has not disappeared in the company. This is particularly significant given the context of geopolitical crisis in which it is operating. Hence, liberal thinking arguably continues to play a significant role in the international strategies



of the Russian nuclear industry, next to a realist approach driven by the Russian government that uses nuclear energy for status-seeking purposes and geopolitical influence. Analyses that see Rosatom merely as a weaponized arm of the Kremlin appear as reductionist and have not been confirmed by empirical developments so far. Minin and Vlcek (2017, 37) went as far as to argue that Rosatom's 'interests are economic, and it is economic logic that prompts the company to focus on projects abroad'; according to them, 'fears of the Russian nuclear giant and politicization are unwarranted'. On the other hand, the argument that Russia and its clients are interdependent in the nuclear sector seems far-fetched. While international activities are important for Rosatom's income, the company only accounts for 0.6% of Russia's federal budget—far less than its counterparts in the oil and gas sector (Meyer 2023, 9). Therefore, Russia's finances are not dependent on the foreign activities of its nuclear sector; this, in turn, could contribute to explaining why the West did not sanction this sector: the effects of such sanctions on the Russian war machine would be very limited.

### **Generating new North–South dependencies?**

A swift look at Rosatom's ongoing nuclear power plant projects abroad is sufficient to understand the importance of the Global South and China for the Russian nuclear company (Rosatom 2024). While the Soviet and then Russian industry used to build most of its new reactors in the former Soviet Union and in East-Central Europe, today (outside Russia) the two planned Paks-2 reactors in Hungary are the only project in this area (following the completion of the two Astravets reactors in Belarus in 2023 and the cancellation of the planned Hanhikivi reactor in Finland in 2022). This is the result of changing geopolitical circumstances and, most significantly, of the saturation of the former client markets in East-Central Europe, where the growth of energy demand (including nuclear energy) is either negative or negligible.

The situation is very different in the Global South and China, where energy demand is increasing and nuclear energy is often seen as a low-carbon source to meet growing needs, while relying less on fossil fuels. Between 2012 and 2022, over 83% of the growth in nuclear power capacity occurred in Asia; out of the ten countries that are currently building their first nuclear power plants or have signed contracts to do so, six are in Asia, three in Africa and only one in Europe (IAEA 2023, 13). Besides the Paks-2 project in Hungary, Rosatom's contracts include a new plant with two reactors in Bangladesh, two reactors in China (Tianwan), two four-reactor plants in Egypt (El Dabaa) and Turkey (Akkuyu) and four new reactors in India (Kudankulam). Overall, Rosatom is building 16 new reactors in Asia and two in Europe (Rosatom 2024), as opposed to six in Russia (IAEA 2021).

The partnerships between the Russian nuclear industry and its Global South clients partly correspond to the asymmetrical relationships theorised by dependency theory. Russia can be seen as a country of the Global North and, particularly in the nuclear sector, as part of the highly developed industrial core that negotiates with peripheral countries in the Global South from a position of strength, keeping them in a condition of subordinate dependency. The various layers of dependence in



the nuclear sector, in this case reliance on Rosatom's high-tech plant construction and operation services, corroborate this reading. Poorer countries do not have the enormous resources that are necessary to develop a domestic nuclear industry and keep it afloat. This is certainly the case of Bangladesh and, to a certain extent, Egypt and Turkey—even if Rosatom's large investments in these countries also involve considerable financial risk for the company and the Russian government. China and India, however, are in no such position of asymmetrical dependence on Rosatom, as they have a well-developed and diversified national nuclear industry. Moreover, the share of Rosatom's projects in the electricity supply of China and India will be marginal, below 1% and 3%, respectively (Szulecki and Overland 2023: 415).

The new nuclear partnership between Russia and Turkey, and specifically the Akkuyu project, has been the subject of studies that frame it as a security risk for the West and for Turkey itself (see Kyriakides 2023). The four reactors of the plant are expected to provide 10% of Turkey's electricity needs, generating a new layer of energy dependence that adds up to Ankara's significant reliance on gas imports from Russia. Moreover, the plant will be operated directly by Rosatom based on a build-own-operate model, under which the Russian company retains majority ownership and has a guaranteed price on electricity sales. While this framework puts Turkey in a position of dependence and potential vulnerability, Rosatom and Russia are also taking considerable risks and costs. The Russian company bears all the financial, construction and operational risks. Construction costs are estimated at \$22 billion; the high cost of the project led Russian experts to argue that the model on which it is based cannot be replicated elsewhere (Schepers 2019, 4). Both Russia and Turkey recognise the high stakes involved in the project and have sheltered it from the turbulence that occasionally characterised their political relationship, such as the serious bilateral crisis in 2015–2016 following the downing of a Russian bomber by the Turkish air defence near the Syrian-Turkish border. As a result, the Akkuyu project appears to be cementing a strategic partnership between Russia and Turkey in which, considering their broader economic and political relationship,<sup>4</sup> the two countries are mutually reliant rather than in undesired asymmetric dependences (Al Jazeera 2023).

In Egypt Rosatom signed an intergovernmental agreement in 2015 to build and operate four reactors, including fuel supply, processing of used fuel, training and development of regulatory infrastructure. This included a financing agreement for a Russian state export loan of \$25 billion, covering 85% of the cost and repayable over 22 years at a favourable 3% interest rate. Construction of all four reactors began between July 2022 and January 2024 (World Nuclear Association 2024a). The plant will produce electricity and have the capacity to desalinate seawater. Critics argue that the project could put Egypt in a position of risky dependence in various ways: the country may be unable to operate the plant independently also in the long run, or it may fail to repay its loan and be forced to make concessions to Russia in other

<sup>4</sup> Most notably, Russia's deep crisis with the West, Turkey's help to Moscow in bypassing Western sanctions and Russian-Turkish economic interdependence in various fields, from tourism to the construction industry.



areas. Egypt's large debts and its inability to restructure them leaves the country vulnerable to potential Russian pressure (Lorenzini 2023).

Nonetheless, risks for Egypt are alleviated by the availability of other energy sources such as gas –of which the country recently became an exporter, following the discovery of significant domestic resources- and plans to increase drastically generation from renewable sources (EIA 2022). At a political level, the partnership with Russia allows Egypt to diversify its foreign relations, while keeping strong economic ties with its traditional partners in the West, the Gulf States and China. For Moscow, the relationship with Cairo is important at a time when Russia is losing its Western markets and may offer a springboard for further projects in Arab countries and Africa. Russian leaders view Egypt as a mid-sized, regional power and as one of the 'poles' in a multipolar world order (which they prefer to a West-dominated one), as witnessed by the fact that Moscow warmly welcomed Cairo's membership of the BRICS in 2023 (cf. Seric 2023). Their nuclear partnership should be assessed within this broader context, rather than just as an attempt of Russia to create energy dependencies and asymmetries to extract political concessions.

## Conclusion

The aim of this article was to show that the geopolitics of nuclear energy is highly complex due to the existence of different stages of dependence in the supply chain, which also have distinct leading suppliers and dependence relationships between states. While natural uranium production is concentrated in a group of countries, global supply chains are relatively flexible and diversified. However, uranium enrichment and the construction and servicing of nuclear reactors require much greater technological know-how, which only few countries possess. Even so, the market and geopolitical influence of these countries should not be exaggerated, and neither should their potential and interest in weaponizing supply chains of nuclear energy. The capability to enrich uranium and the know-how to build and operate nuclear power plants exist across current geopolitical dividing lines.

The article also aimed to relate empirical developments in the nuclear sector to IR theory. New, excellent studies have provided useful insights into Russia's nuclear energy diplomacy and the dependencies and vulnerabilities that it has created for partner countries (see most notably Szulecki and Overland 2023). However, this literature does not engage with IR theories; this article intended to address this gap. Its findings suggest that, due to the technical and geopolitical complexity of nuclear energy, no individual theory of IR provides an exhaustive explanation of nuclear energy politics. A realist approach sheds light on how states can use (enriched) uranium supplies and technological know-how to create long-term dependencies and acquire political leverage in client states. However, it cannot explain why nuclear energy supply chains have not been weaponized even in the current context of high geopolitical tensions between Russia and the West. A liberal approach highlights how nuclear energy can be a springboard for cooperation between states, and how this cooperation can be based on economic logic and mutual gains for providers and buyers. Yet, it underestimates the strategic nature and long-term security implications of nuclear partnerships. As argued, both the realist



focus on ‘weaponised’ dependence and the liberal emphasis on interdependence need qualifying when applied to the nuclear sector, which has distinct features from oil and gas trade (such as complex and multiple supply chains, high technological requirements but more limited economic significance than oil and gas trade). Dependency theory aptly illustrates how unequal relationships of dependence between technologically advanced states and peripheral countries are perpetuated also through trade patterns in the nuclear energy sector. However, it does not account for the rising influence of several importers of nuclear technology in the Global South and the relative fragility of the nuclear industry in the Global North, which needs clients overseas to sustain itself economically.

These arguments were shown through a case study of Russia’s state company Rosatom, a leading provider of enriched uranium and reactor technology. In line with realist tenets, Rosatom epitomises a statist approach to energy policy and is an important factor of Russia’s great power status. However, while the company can act as a tool of Russian political influence in client states, its activities have followed mostly a business logic and have not been weaponised—not even in countries that have imposed sweeping sanctions on Russia. Rosatom has attempted to build a reputation as a reliable partner. It has expanded its foreign portfolio also to maximise profits and build economies of scale by meeting the growing energy demand in the Global South and China. Among its nuclear partnerships, those with Bangladesh and, to a certain extent, Egypt, Hungary and Turkey produce asymmetrical dependence of the client states on Russia. However, in the Turkish and Egyptian cases dependence appears less asymmetric if the broader bilateral relationship and the national energy mix are considered. Meanwhile, Rosatom’s projects in India and China do not generate significant levels of dependence.

Finally, the article advocates a nuanced approach to nuclear energy politics that combines applicable insights from different theoretical schools and takes into account the complexity of the nuclear sector. It cautions against analyses that portray the nuclear energy industry exclusively as a weaponised ‘arm’ of the state, and that neglect the evolving dynamics in North–South relations.

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## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

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