Federal Ministry
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Climate Action, Environment,
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Can nuclear power deliver security of supply and energy independence?

Nuclear power is held to be a guarantee of energy security and energy independence, and statements like these are readily repeated by the people who back it. However, a closer look reveals that these claims do not hold water and that the use of nuclear power reinforces existing dependencies, creates new ones, and is incapable of ensuring security of supply in any case.

Even as early as during the large-scale programs to expand nuclear power in the 1970s, the technology was being promoted in a similar way to how it is today. In the wake of the various oil crises, several countries saw nuclear power as a way of reducing their dependence on oil-exporting states, prompting a significant expansion of nuclear power at the time.[1,2] Most of the nuclear power plants in the European Union (EU) date from this period and are now beginning to show their age. However, the trend of the time – namely continuous further expansion – came to an end as new projects became less profitable in the face of sharp falls in energy prices and the high cost of technology, itself caused primarily by stricter safety and security requirements.[3]

Energy security

Nuclear power plants run on fuel produced from uranium ore that is extracted from naturally occurring deposits. Uranium is therefore an essential resource in the operation of nuclear power plants and was still being mined in significant quantities in Europe –

[1] Hatch, Michael T., "Politics and Nuclear Power: Energy Policy in Western Europe", 2014.
[2] Graf, Rüdiger, "Oil and Sovereignty: Petro-Knowledge and Energy Policy in the United States and Western Europe in the 1970s", 2018.
[3] Muellner, Nikolaus, et al., "Nuclear energy – The solution to climate change?", "Energy Policy 155", 2021.

including some current EU member states – during the 1970s. France, East Germany, and Czechoslovakia were home to some large uranium mines at the time.[4] As of 2024, there are no more uranium mines in Europe engaged in commercial operations, requiring all the natural uranium needed to be imported. Four countries – Kazakhstan, Niger, Canada, and Russia – provided 91 per cent of uranium imports in 2022, meaning that those EU member states that generate nuclear power are dependent on these very countries. The remaining natural uranium is brought in from Uzbekistan, Australia, and Namibia. With commercially viable deposits of natural uranium concentrated in a handful of countries, it is not only the EU member states with nuclear power plants that are reliant on them – other users of nuclear power such as the US, China, Japan, and India are too. Aside from Canada and Russia, the countries that use nuclear power are not those home to significant deposits of natural uranium. The Russian invasion of Ukraine, uncertainties surrounding mining and exporting uranium following the military coup in Niger, and Kazakhstan's current geo-political stance highlight the vulnerability and dependence issues affecting the security of supply of uranium to fuel nuclear power plants in EU countries.[5, 6, 7, 8]

Besides natural uranium, some EU members and other European countries also import enriched uranium from Russia because Europe lacks the capacity to enrich enough of the material to meet its own needs. This is also due partly to deliveries that it makes under contract to the US, amongst other places.[9, 10]

Producing nuclear fuel necessitates a large number of upstream steps that also require significant resources as well as complex technical processes. The failure of just one of these process steps can be enough to disrupt the nuclear fuel supply chain.[11] When reactor types are chosen, it sets in stone a series of supply chains and dependencies that will offer very few, if any, alternatives over the long term. This holds true for all nuclear

[4] OECD NEA, "Forty Years of Uranium Resources, Production and Demand in Perspective", "The Red Book Retrospective", 2006.
[5] Muellner, Nikolaus, et al., "Nuclear energy – The solution to climate change?", "Energy Policy 155", 2021.
[6] Euratom Supply Agency, "Euratom Supply Agency Annual Report 2022", Luxembourg, 2024.
[7] Euratom Supply Agency, "Euratom Supply Agency Annual Report 2021", Luxembourg, 2022.
[8] Gufler, K., Meister, F., "Analyse der Rosatom-Aktivitäten bzw. Rosatom-Verflechtungen mit der EU", 2022.
[9] Muellner, Nikolaus, et al., "Nuclear energy – The solution to climate change?", "Energy Policy 155", 2021.
[10] Gufler, K., Meister, F., "Analyse der Rosatom-Aktivitäten bzw. Rosatom-Verflechtungen mit der EU", 2022.
[11] Wilson, P. D., "The Nuclear Fuel Cycle: From Ore to Wastes," United Kingdom: N. p., 1996. Online.

power plants and all manufacturers and is being highlighted particularly clearly at the moment in the dependence on Russian nuclear fuel, components, and services.[12, 13]

Dependence on Russia

There are various ways in which EU member states that produce nuclear power and other European countries that operate nuclear power plants cooperate with Rosatom, Russia's state-owned nuclear energy corporation. For instance, some might import Russian natural uranium, uranium products, and fuel assemblies, while others might buy in Russian services to build, run, maintain, decommission, and modernise their nuclear power plants.[14]

Even as recently as 2023, fuel assemblies for Soviet-era reactors, which can be found in Bulgaria, Hungary, Slovakia, Czechia, and Finland among other places, were still entirely dependent on Russian fuel. Following Russia's invasion of Ukraine in 2022, attempts were launched to reduce this level of dependence on Russia, and all European countries that operate Soviet-era reactors have now signed contracts with alternative manufacturers. As of April 2024, the relevant EU member states had only signed supply agreements. Nuclear fuel from the US manufacturer Westinghouse is already being used in Ukraine with a view to making a complete switch at some point in the future.[15,16] Besides Westinghouse, the other alternative manufacturer that could supply the Soviet-era reactors in the future is France's state-owned Framatome. Although Westinghouse has produced fuel assemblies for Soviet-era reactors in the past, it stopped making them in 2014 due to technical difficulties, high costs, and low demand, while Framatome does not yet have any experience in manufacturing assemblies for these kinds of reactor. From 2022 onwards, Framatome signed contracts to supply fuel assemblies to the relevant countries, engaging in a joint venture with the Russian monopoly-holder Rosatom in order to be able to use the necessary manufacturing techniques and certifications.[17, 18]

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[12] Muellner, Nikolaus, et al., "Nuclear energy – The solution to climate change?", "Energy Policy 155", 2021.
[13] Gufler, K., Meister, F., "Analyse der Rosatom-Aktivitäten bzw. Rosatom-Verflechtungen mit der EU", 2022.
[14] Ibid.
[15] world-nuclear-news.org/Articles/Westinghouse-VVER-440-fuel-loaded-into-reactor.
[16] westinghousenuclear.com/media/i5pjkvtk/westinghouse-reprint-vver-fuel-nei.pdf.
[17] Gufler, K., Meister, F., "Analyse der Rosatom-Aktivitäten bzw. Rosatom-Verflechtungen mit der EU", 2022.
[18] bloomberg.com/news/articles/2024-03-16/putin-s-french-venture-shows-russian-atomic-power-still-growing?embedded-checkout=true.

Long-term dependencies and supply security

Building and operating nuclear power plants is a long-term undertaking. Reactors take between 10 and 20 years (or even longer) to plan and construct. With plants designed to stay in operation for 40 to 80 years and needing decades to decommission, long-term cooperation between the manufacturer (country) and the operator (country) is essential. Many bilateral agreements cover the supply of nuclear fuel, spare parts, retrofits, maintenance, training and qualification of personnel.[19, 20]

The long-term nature of the collaboration required between the signatories of these agreements creates a number of mutual dependencies, albeit not ones "between equals". Whilst the manufacturer (country) mainly has a financial interest in the deal, the operator (country) is reliant on the manufacturer (country) delivering on time to avoid jeopardising its energy supply.[21]

Building nuclear power stations calls for a significant outlay of capital, which in turn requires long-term operation and stable supply and sales conditions for refinancing. Financing arrangements can result in long-term dependencies in an economic and political context that harbour complex financial risks. These dependencies will be particularly severe if the country in question is a newcomer to the use of nuclear power, as there will be a very uneven distribution of expertise between manufacturer and operator. Examples include the Russian nuclear power plants built in Belarus, Türkiye, Egypt, Bangladesh, and, to an extent, Iran.[22, 23]

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[19] Muellner, Nikolaus, et al., "Nuclear energy – The solution to climate change?", "Energy Policy 155", 2021.
[20] Gufler, K., Meister, F., "Analyse der Rosatom-Aktivitäten bzw. Rosatom-Verflechtungen mit der EU", 2022.
[21] Szulecki, K., Overland, I., "Russian nuclear energy diplomacy and its implications for energy security in the context of the war in Ukraine", "Nat Energy 8", pp. 413–421, 2023.
[22] Hatch, Michael T., "Politics and Nuclear Power: Energy Policy in Western Europe", 2014.
[23] Graf, Rüdiger, "Oil and Sovereignty: Petro-Knowledge and Energy Policy in the United States and Western Europe in the 1970s", 2018.