December 13, 2022

The Russian Risk in the Supply of Enriched Uranium

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What is uranium enrichment?

Natural uranium that exists in the natural world contains uranium-235, which undergoes nuclear fission to release an immense amount of heat energy, and uranium-238, which is non-fissile. Uranium-235 can be used as fuel at existing nuclear power plants, but natural uranium contains only about 0.7% of it. For this reason, it is necessary to carry out work to increase the concentration of uranium-235 to about 3 – 5% to make it suitable for use in nuclear power plants. This work is known as "uranium enrichment." The uranium enrichment methods that are currently carried out commercially are gaseous diffusion and centrifuge separation. Although the gaseous diffusion method used to be the mainstream method, the pivot has now shifted to centrifuge separation.

Trends in enriched uranium production capacity worldwide

Looking at the trends in enriched uranium production capacity worldwide in recent years, we can see that Russia accounts more than 40%. Furthermore, this exceeds 60% when combined with China, which has shown a remarkable increase in its production capacity for enriched uranium. This shows clearly how great our reliance is on specific countries in the field of uranium enrichment, and how this reliance is continuing to grow.

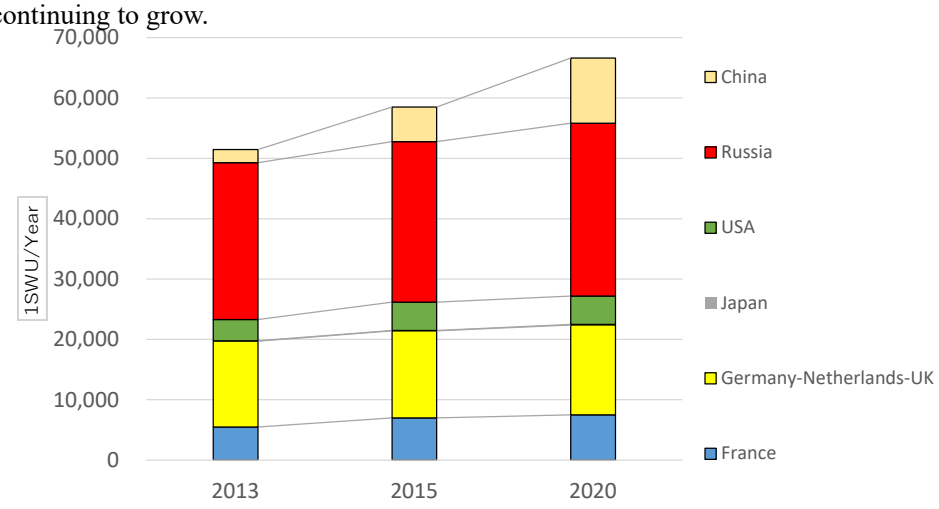

Figure 1 Trends in enriched uranium production capacity worldwide

Source: Prepared based on "Uranium Enrichment," WNA (September 2022)

Next, looking at the future demand-supply balance for enriched uranium (Figure 2), we can see that it is currently possible to meet global demand as long as demand does not increase rapidly. However, if we were to consider the fact that the world relies on Russia for more than 40% of its enriched uranium supply, as explained above, it may not be possible to meet demand if its supply volume were to fall significantly in situations where the United States or other countries prohibit the import of Russia-produced uranium, or where Russia prohibits the export of uranium.

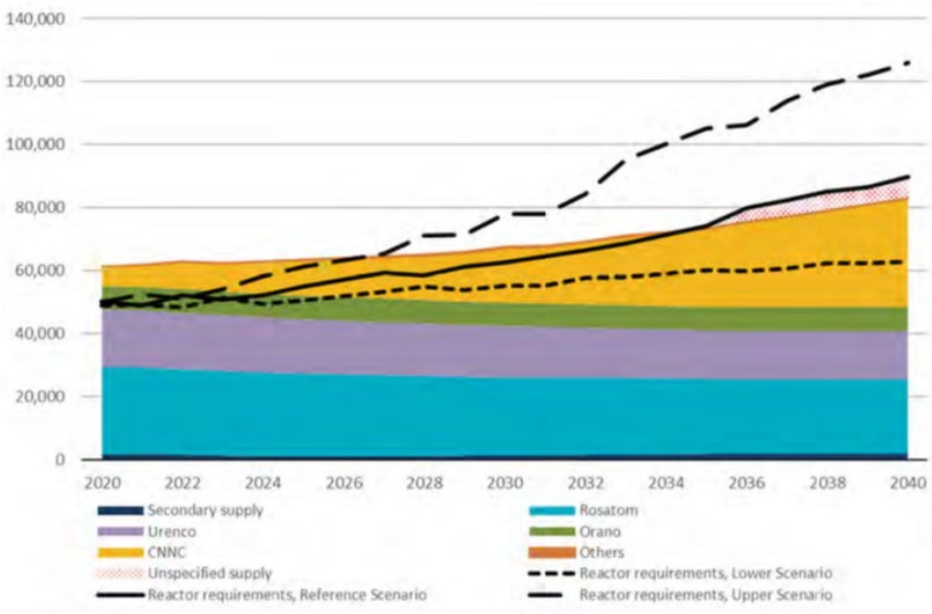

Figure 2　Forecast of global enriched uranium demand and supply

Source: “The Nuclear Fuel Report: Expanded Summary Global Scenarios for Demand and Supply Availability 2021-2040,” World Nuclear Association (April 2022)

This problem is especially prominent in the United States. Russia accounted for 14% of all uranium products imported by the country in 2021, but if we were to look only at enriched uranium, its reliance on Russia exceeds 30% (Figure 3, approximately 4,000tSWU).

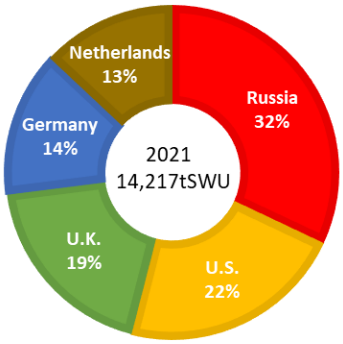

Figure 3　Structure of enriched uranium supply in the United States

Source: Prepared based on the 2021 Uranium Marketing Annual Report (May 2022)

Currently, there is only one enriched uranium production plant (production capacity of 4,700tSWU) operating within the United States, which belongs to Louisiana Energy Services (LES), a subsidiary of the British-German-Dutch multinational, the Urenco Group[1]. Although USEC Inc. (now Centrus Energy Corp.) under the U.S. Department of Energy (DOE) is developing a centrifuge separation plant (American Centrifuge Plant or ACP), the start of its operation has been postponed time and time again, and it is unclear when it will commence full-scale operation.

It is likely that the export agreement for highly enriched uranium (HEU) from dismantled nuclear weapons, concluded between the United States and Russian governments in 1993[2], is the reason behind the fact that only one enriched uranium production plant is operating in the United States today.

Lingering impact of the Russia-U.S. highly enriched uranium (HEU) export agreement on the United States

After the collapse of the former Soviet Union, the international community was faced with the pressing issue of safely managing or disposing of Russia's nuclear weapons that were out of use due to nuclear disarmament. To address this problem, the United States and Russia concluded an agreement concerning the disposition of highly enriched uranium extracted from nuclear weapons (Russia-U.S. HEU Agreement dated February 17, 1993)[3]. Under this agreement, the "Megatons to Megawatts" Program was established to divert the uranium used in nuclear weapons to peaceful uses[4]. Over 20 years from 1993 to 2013, this program diluted 500 tons of highly enriched uranium (HEU) recovered from dismantled Russian nuclear weapons, and exported it to the United States as low enriched uranium (LEU) for use in its commercial nuclear reactors. The former Soviet Union had possessed more than 40,000 nuclear warheads at its peak in 1986, but it is said that approximately 20,000 of these have been disposed of through this program. Hence, this program has contributed to the peaceful use of nuclear energy by diluting about half of the nuclear warheads held by the former Soviet Union.

Looking now at the background to the establishment of this program from the viewpoint of the enriched uranium market, the United States had dominated this market until the mid-1970s. However, coupled with the promotion of nuclear power development triggered by the first oil crisis that hit in 1973, enrichment plants alone were unable to keep up with supply to meet the ever-growing demand through the use of the gaseous diffusion method, which was the mainstream method used in the enriched uranium market at the time. In view of this, countries such as the former West Germany, the Netherlands, and the United Kingdom developed uranium enrichment technology that uses the centrifuge separation method, which consumes less electricity than the gaseous diffusion method, and entered the market. These European countries contracted a part of the uranium enrichment business to

[1] https://www.urenco.com/global-operations/uusa
[2] https://fissilematerials.org/library/heu93.pdf
[3] https://fissilematerials.org/library/heu93.pdf
[4] https://americancenterjapan.com/aboutusa/translations/2734/

the former Soviet Union even though the Cold War was still ongoing.

The United States had been importing very small amounts of enriched uranium from the former Soviet Union at the time. On the other hand, the inflow of cheap enriched uranium from the former Soviet Union led to the fall of enriched uranium prices in Europe, so electric power companies in the United States also began to purchase enriched uranium from Russia via Europe. As a result, the spot price for natural uranium which had been US$40/lbU3O8 in the latter half of the 1970s, began to drop at the start of the 1980s and plunged to around US$10/lbU3O8 by 1990.

To address this situation, in November 1991, an interim committee of domestic uranium producers in the United States petitioned the DOE and others on the former Soviet Union's dumping practices through the exporting of enriched uranium. Subsequently, an anti-dumping agreement was concluded in 1992. As a result, a tariff of 115% was imposed on the import of all uranium produced by the former Soviet Union into the United States.

At the time, there was growing risk in the former Soviet Union of nuclear substances being taken out of the country illegally amidst the social turmoil after the collapse of the Soviet regime. However, there were insufficient funds for managing nuclear substances safely. Hence, for the former Soviet Union, which had been effectively squeezed out of the U.S. market by the anti-dumping tariff, it was crucial to obtain cash by selling HEU.

In the United States as well, the DOE expected that the use of cheap Russian HEU would help to reduce the cost of enriching uranium domestically and secure supply commitments to electric power companies in the United States.

Against this backdrop, the U.S. Department of Commerce (DOC) decided to impose restrictions on the amount of uranium exported from the former Soviet Union to the United States in exchange for suspending further anti-dumping tariff investigations. A new agreement was ultimately concluded between the United States and Russia in 2008, making it possible for Russia to export up to 20% of the LEU needed for commercial reactors in the United States every year since 2014. In 2020, before Russia launched its military operation in Ukraine, it was decided that this agreement would be extended till 2040[5].

On the other hand, the strong reliance on Russia-produced enriched Uranium has long been perceived as a problem within the United States. As a countermeasure, the United States decided that it would gradually reduce this dependency over the next 20 years, bringing it to below 15% from 2028 onwards.

Hence, although dependence on Russian uranium has been an issue in the United States since before Russia's military operation in Ukraine and measures to reduce this dependence had been reviewed, no concrete solutions have been presented.

[5] https://www.jaif.or.jp/journal/oversea/4888.html

In March 2022 after Russia launched its military operation in Ukraine, a number of Congress members submitted a bill to the U.S. Congress to prohibit the importation of uranium from the Russian Federation, but no conclusion has been reached even now. This suggests the difficulty of securing a substitute source for Russian enriched uranium, which accounts for more than 30% (approximately 4,000tSWU) of the annual demand volume in the United States.

Future issues for the United States and other countries

After the bill to prohibit Russian uranium imports was submitted to the U.S. Congress, it was reported in June 2022 that a US$4.3-billion plan on directly purchasing uranium from uranium enrichment plants within the United States, had been formulated and submitted to the Congress[6]. As there was only one enriched uranium production plant in operation within the United States, it was presumed that this plan was targeted at the LES enrichment plant. In response, Urenco, the parent company of LES, stated in an address delivered at the Bank of America in October 2022, that it was prepared to consider expanding production capacity at all four plants owned by the Urenco Group worldwide if there were prospects of securing long-term customers[7]. However, in view that a certain amount of lead time is needed to expand production capacity in reality, there remains the issue of how to secure supply to meet current demand levels if the United States were to decide to ban Russian uranium imports.

Another issue is the supply of HALEU fuel (low enriched uranium with a maximum concentration of 20%) for next-generation nuclear reactors known as small modular reactors (SMR), for which research and development is currently being conducted by various countries.

For major countries, SMR is anticipated to fulfill an important role in their goal toward decarbonization. Among the advanced nuclear reactor designs selected by the DOE for support under its Advanced Reactor Demonstration Program (ARDP), many include plans to use HALEU fuel. This underscores the need to secure HALEU fuel for the introduction of next-generation reactors.

In the United States, the U.S. Nuclear Regulatory Commission (NRC) approved the production of HALEU fuel by ACP under Centrus Energy Corp in 2021[8]. Furthermore, in November 2022, DOE and Centrus Energy Corp. announced that they have concluded an agreement to commence production of HALEU fuel[9].

However, as explained previously, the start date of ACP's operation has been postponed time and

[6] https://www.bloomberg.co.jp/news/articles/2022-06-07/RD4GVQDWX2PU01
[7] https://www.urenco.com/news/global/2022/urenco-presents-to-the-bank-of-america
[8] https://www.centrusenergy.com/news/nrc-approves-centrus-energys-license-amendment-for-haleu-production/
[9] https://www.energy.gov/articles/doe-announces-cost-shared-award-first-ever-domestic-production-haleu-advanced-nuclear

again, and many uncertainties remain with regard to whether or not production will proceed as planned.

Currently, Russian company TENEX is the only one engaged in the production and sale of HALEU fuel to commercial nuclear reactors. Given the confrontational structure between Russia and Japan, the United States, and Europe, how the latter three can build a future supply chain for enriched uranium, including HALEU fuel supply for next-generation nuclear reactors, as well as for existing nuclear reactors, is a key question that will affect not only the stable operation of existing nuclear reactors, but also the timing for the commercialization of next-generation reactors.

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