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France's History as a Nuclear Powerhouse and a Wake-up Call to the Nuclear Fuel Cycle

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The French government's announcement in June 2018 to freeze plans for the ASTRID fast reactor was a major blow to Japan's nuclear policy. France, one of the world's leading nuclear powers, built a close partnership with Japan in terms of research and development of fast reactors with the aim of bringing the nuclear fuel cycle to fruition. After the decision to decommission Monju, the Japanese government looked to ASTRID as its successor and sought a solution to its spent nuclear fuel problem. However, with France's nuclear industry in financial trouble, the ASTRID program frozen, and the French government looking to reduce its dependence on nuclear power, Japan's nuclear fuel cycle is at a greater impasse than ever before. With increasing criticism over Japan's plutonium surplus from a proliferation perspective, the issue of nuclear fuel cycle policy is not limited to France and Japan, but has rather brought the entire international community to a crossroads.

France: A Nuclear Powerhouse

France is the most nuclear dependent country in the world. Currently, there are 58 reactors in operation domestically, and nuclear power accounts for about 70 percent of the country's energy production. The oil crisis in the 1970s prompted France, which has limited energy resources such as oil and natural gas, to develop nuclear power on a large scale to secure a limited source of energy and maintain its position in Europe. As a result, nuclear research and development conducted primarily at the French Alternative Energies and Atomic Energy Commission (CEA) has made significant progress, and has been applied to a wide range of fields other than nuclear energy, such as medical technology and astrophysics.

The French government has established close communication channels with the public in order to gain strong support for nuclear power. After the Chernobyl disaster in 1986, there were concerns about the safety of nuclear power plants, and nuclear power was subjected to worldwide criticism. Even in France, there was no shortage of skepticism about nuclear power. Meanwhile, the French government actively disseminated information about energy security and the risks associated with nuclear energy to the public.

The government successfully manipulated public opinion, and before the Fukushima nuclear accident in 2011, two-thirds of the population was in favor of nuclear power.

French nuclear companies have also supported the country's competitiveness in the international nuclear market. AREVA, a major French nuclear power company (renamed ORANO in January 2018), suffered from management difficulties due to the effects of the Fukushima Daiichi nuclear accident in 2011 and delays in the construction of a new nuclear reactor in Finland. Consequently, in 2014, the company recorded a net loss of €4.8 billion. Later, the French government forged ahead with restructuring the nuclear industry, and AREVA was given a fresh start as ORANO, the world's largest nuclear conglomerate. As part of the restructuring, AREVA's reactor and service division was transferred to the state-owned electric company, Électricité de France (EDF). The Energy Transition Law of 2015, enacted under Hollande's Socialist Party government, stipulates a nuclear power capacity of 63.2 million kW, which will allow for the construction of new nuclear power plants if the closure of existing reactors frees up capacity. For that reason, the EDF has begun designing a new European Pressure Reactor (EPR) and has announced that it will rebuild nuclear reactors that have reached the end of their lifespans. EDF, which is also involved in the design and construction of nuclear reactors, is expanding overseas, including sales to China and India.

Japan and France Working Together Toward a Nuclear Fantasy

Many countries using nuclear power once envisioned a nuclear fuel cycle, including nuclear powerhouses America and France, as well as Germany, Switzerland and Belgium. However, the key to the cycle, fast breeder reactors, was not economical and had many technical issues. Moreover, fast breeder reactors that produce high-purity plutonium have been viewed as a problem from a non-proliferation perspective, and many countries have given up on developing breeder reactors.

In spite of these issues, France has continued to actively pursue pluthermal (recycling plutonium in existing light water reactors) policy and plans for fast breeder reactors. Currently, there are about 1,200 tons of spent nuclear fuel generated in France annually, of which about 1,000 tons are reprocessed at the La Hague Reprocessing Plant operated by AREVA and then turned into MOX fuel. In turn, about 120 tons of MOX fuel is produced annually, generating 10% of France's domestic electricity. Spent nuclear fuel that is not immediately reprocessed is held in wet storage pools at the La Hague Reprocessing Plant and other power plants around the country. About 65 tons of plutonium owned by France will eventually be processed into MOX fuel, and it has sought to establish a nuclear fuel cycle to prevent the accumulation of spent nuclear fuel.

As for fast breeder reactors, France built and operated the Rapsodie (experimental reactor with 40 MW of thermal power) in 1967, the Phoenix (prototype reactor with 250 MW of electric power) in 1973, and the Superphoenix (demonstration reactor with 1,240 MW of electric power) in 1985. However, all of them suffered from sodium leaks and generator failures, were not profitable, and were decommissioned.

Subsequently, France turned to the development of fast reactors, which were intended to burn waste rather than breed plutonium like their fast breeder reactors counterparts. The French government requested that the CEA develop a new demonstration reactor, which led to the creation of the ASTRID program. At the beginning of 2010, when the national project was launched, the new fast reactor ASTRID was expected to produce 600,000 kilowatts of power, and it was announced that construction costs would total 6 billion euros (about 780 billion yen). At the same time, the French nuclear industry was suffering from financial difficulties and the development of fast reactors was at a standstill. In order to proceed with its plan, France requested that the Monju operation, which was suspended at the time, be resumed and joint research be established. In 2014, agreements on the development of a fast reactor were made between Japanese and French government agencies (CEA, Ministry of Economy, Trade and Industry, and Ministry of Education, Culture, Sports, Science and Technology) and implementing agencies (CEA, AREVA, Japan Atomic Energy Agency [JAEA], Mitsubishi Heavy Industries, Ltd., Mitsubishi FBR Systems [MFBR]).

On the other hand, after the Monju project was abandoned in 2016, Japan expected ASTRID to become its successor. In fact, even the burden of the ASTRID joint-development costs were mentioned in the Basic Energy Plan. By 2019, the French government had invested as much as 1 billion euros (about 120 billion yen) in developing a new fast reactor. In addition to Japan, Russia, China, and the United States were candidates for joint research, but in terms of funding, France was particularly keen on Japan's support. Japan, which had been relying on ASTRID, was willing to provide assistance, and bore the project cost of about 20 billion yen. In this way, France and Japan established a flexible cooperation system toward the realization of a fast breeder reactor, or the so-called dream reactor, and its replacement, the fast reactor.

Freezing the ASTRID Project

Contrary to Japan’s expectations, at the Conference on Fast Reactor Development held by the Japanese Ministry of Economy, Trade and Industry (METI) in June 2018, a CEA official announced that the ASTRID program had been frozen. Judgment on the feasibility of the construction will be postponed until 2024, and even if it is built, the planned electric power output of the fast reactor will be greatly reduced from 200,000 to 100,000 kilowatts, with practical application expected to last until 2080.

The plan was downsized due to the pressing financial situation surrounding the development of the fast reactor. Nicolas Devictor, a senior official at the French Alternative Energies and Atomic Energy Commission, said, "the need for commercial deployment of fast neutron reactors is much less urgent, due to the current context of the uranium market," later adding that, "France is seeking an economical reactor." In addition, Jacques Percebois, Professor Emeritus at the University of Montpellier specializing in energy policy, explained that he has seen a tightening of safety regulations following the Fukushima Daiichi nuclear accident, which has tripled the construction cost of the nuclear power plant, resulting in a shortage of funds for fast reactor development. ORANO, which is leading the ASTRID project, continues to underperform and EDF, which was planning to build a large fast reactor for commercialization, has other priorities, such as rebuilding existing nuclear power plants and developing a new EPR. From the beginning, France was in such financial difficulty that it had to rely on funds from its development partners for ASTRID. It raises the question of whether the French government should continue to spend its limited funds on the development of fast reactors in the midst of growing concerns about nuclear proliferation around the world. France's nuclear fuel cycle policy, which has led the nuclear industry for decades, is in dire straits.

The Nuclear Fuel Cycle Coming to an End

After the Fukushima Daiichi nuclear accident, the myth of nuclear safety collapsed, and the French government decided to switch to renewable energy. The rise in nuclear-related costs can also be said to have accelerated policies to eliminate nuclear power. The aforementioned Energy Transition Law promoted not only the development of renewable energy, but also the closure of nuclear power plants in France with the aim of reducing the ratio of nuclear power generation. Despite the fact that a certain amount of nuclear power generation capacity is being maintained, President Macron, who took office in 2017, has advocated for a policy to eliminate nuclear power and has announced a policy to reduce the ratio of nuclear power to 50% of the country's overall power generation by 2035.

Setbacks to the ASTRID program have cast a shadow over Japan's development of the nuclear fuel cycle. The Monju project was decommissioned in 2016, but Japan has continued research and development of fast reactors in order to efficiently process surplus plutonium, which has been the target of international criticism. METI had planned to proceed with the fast reactor project mainly under the auspices of ASTRID, but the suspension of the ASTRID project in France has thrown off the original plan. In December 2018, METI announced a "Strategic Roadmap" policy that outlined research and development of fast reactors. Although it mentions the possibility of various technological developments in the future, there is no mention of ASTRID. The question of whether small-scale fast reactors, smaller than Monju, can produce any results at all remains unanswered, even among those involved.

The operation of the reprocessing plant in Rokkasho, Aomori Prefecture, which is undergoing a safety review, remains unclear. Furthermore, there is a move to build dry storage facilities in nuclear power plants such as Genkai and Hamaoka. Now that the ASTRID program, Japan's only glimmer of hope, has been frozen, the significance of the country's nuclear fuel cycle is being questioned.

Many countries that have introduced nuclear power plants once feared that fuel and uranium for nuclear power would become depleted, and, thereby, aimed to implement a nuclear fuel cycle as a solution. However, in the 21st century, uranium resources are not scarce and the nuclear industry has declined, so fast breeder reactors are not considered to be economically competitive technology. Although plans for the development of fast breeder reactors themselves are being pursued in some countries (Russia, China, and India), the prospects for practical application are unclear. On the other hand, Japan and France, which have been conducting research and development on the nuclear fuel cycle, have also been forced to change paths due to the cancellation of the ASTRID program.

The "Memorandum of Cooperation on Innovation for Energy Transition" signed by the Japanese Ministry of Economy, Trade and Industry and the French Ministry for Ecological and Inclusive Transition on 26 June 2019, stipulates a roadmap for launching a cooperation framework between Japan and France for the development of fast reactors starting in 2020. However, the memorandum only states that the framework will "focus on R&D based on simulation and experimental work", with no concrete developments in sight. The continued development of Monju and ASTRID as a countermeasure to excess plutonium has been used to challenge some of the critics of Japan's massive plutonium stockpile and nuclear weapons potential. This is no longer an effective counter-argument, and as the international community's concerns about nuclear proliferation are becoming more serious, a new direction must be considered.