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Approaches to Nuclear Cooperation: A Review of the U.S.-ROK Agreement

Philip Baxter

ON April 22, 2015, the United States and the Republic of Korea (ROK, also known as South Korea) signed a new bilateral civilian nuclear agreement known as a 123 Agreement, a prerequisite for cooperation and trade in nuclear technologies and resources, after previously being unable to reach an agreement in 2014. With the new agreement, the United States has opened, however slightly, the door to allowing South Korea to expand its nuclear operations, with implications for future nonproliferation efforts. This paper reviews why this has been a point of contention, the technical issues at stake, the implications for U.S. approaches to 123 Agreements, and the potential strategic consequences for the Korean Peninsula.

Energy and South Korea

Nuclear energy has become an important component of South Korea's energy security, as well as being a particular area of focus for the country's international commercial activities. It has been argued by representatives of South Korea that to advance the country's energy security and commercial interests, enrichment and reprocessing (ENR) of nuclear material is critical. This has been a consistent sticking point between the United States and South Korea.

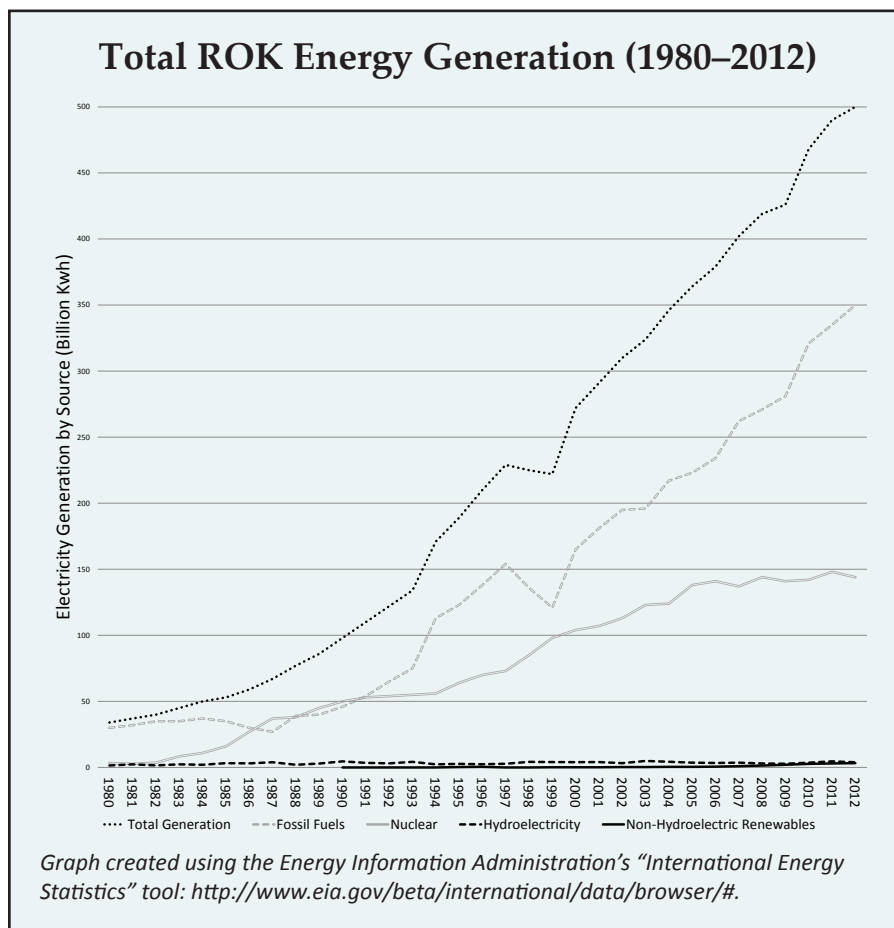
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With limited indigenous energy resources, South Korea depends on the importation of most of its energy portfolio, including for the electricity and transportation sectors. In 2011, South Korea was the world's second largest importer of liquefied natural gas (LNG), third largest of coal, and fifth largest of oil. The country lacks international pipelines and thus relies on tanker shipments of oil and LNG. This heavy dependence on external energy sources has focused South Korea's efforts toward energy innovation. In particular, South Korea is a leader in research and development, pushing for innovation in renewable energy technologies and mandating higher efficiency standards, as well as being a global leader in technologies for nuclear energy production.

South Korea manages a moderate level of insecurity with regard to its energy portfolio. Because of its heavy dependence on imported fossil fuels, South Korea is perpetually at risk of facing external restrictions on energy imports, although such restrictions are unlikely. Additionally, as an importer the country is at the mercy of the high cost of foreign fuel. Finally, generation is overwhelmingly concentrated in two fuel sources—oil and coal—making energy diversification a major priority.

That said, South Korea is a global leader in energy research with ambitious goals to increase efficiencies, decrease import dependence, and decrease greenhouse gas emissions by 30 percent by 2020, as compared to the 2009 business-as-usual output levels. Nuclear energy plays an important role in this strategic outlook, functioning as a stable base-load power source while South Korea reduces fossil fuel consumption, doubles renewable output, and improves efficiencies in its electric grid. While some nations, including Germany and Japan, have decided to dramatically decrease reliance on or cut altogether nuclear energy in their energy profiles, South Korea will maintain its current schedule for constructing new reactors. Nevertheless, South Korea has decided to scale back its original goal of 41 percent electrical generation from nuclear power to 29 percent. This is largely a result of public perception of nuclear energy following Japan's Fukushima disaster and domestic scandals involving the bribing of safety officials and the use of questionable components. While this has stalled the ambitious plan for domestic use of nuclear power, it has not stopped construction of sited plants under development. In addition to its existing 24 operational nuclear reactors, South Korea has four under construction and eight more in the planning stage, which would result in a significant increase to its nuclear power generation capability. This would also have meaningful consequences for future waste storage.

Broadly speaking, nuclear power has been identified as a major international arena in which South Korea can advance its commercial interests. At the peak of the "nuclear renaissance," from 2009 to 2010, South Korea had high aspirations for expanding its market share in nuclear energy services. South Korea has outlined the goal of capturing 20 percent of the international market for nuclear energy by 2030. As the global market for nuclear energy is estimated between \$500 and \$740 billion, this would equate to a significant boost to the country's GDP. However, in the wake of the Fukushima disaster, the renaissance has been largely stalled



globally and these figures may be optimistic. Still, nuclear servicing remains critical to the daily operations of nuclear power plants. The Korean Ministry of Knowledge Economy's stated objective is to provide operational and maintenance services for nuclear facilities on the international market of roughly \$78 billion. To facilitate this market capture, a movement toward offering "full-cycle fuel services" is a potential game changer for South Korea. A full-cycle service offers a number of economic efficiencies: potential purchasers of nuclear energy can buy the reactors, the maintenance, the operations, the fuel, and the repatriation of fuel to the servicer, significantly reducing costs and environmental concerns for the purchasing country.

With this expansion in production, South Korea's management of a rapidly increasing amount of spent nuclear fuel has elevated concerns. A 2012 estimate put waste storage at ROK nuclear power plants at roughly 70 percent full. This figure has decreased as South Korea has worked to expand storage capacity at its nuclear sites. However, storage remains a concern, particularly if normal operations continue and the number of plants increases as planned. An analysis by Chaim Braun and Robert Forrest found that even if operators were able to shift material freely to optimize storage, no space would be left by 2029. Further, South Korea has argued that it lacks space and the appropriate geological conditions within

its territory to safely store spent nuclear material long-term, raising the desire for alternative means to address long-term waste issues.

Nonproliferation, 123 Agreements, and Nuclear Enrichment and Reprocessing

The term “123 Agreement” references Section 123 of the U.S. 1954 Atomic Energy Act, which requires a specific agreement between the United States and another country in order for nuclear material, equipment, components, or technology to be transferred. These agreements require congressional approval and must meet nine detailed nonproliferation criteria before nuclear cooperation can occur. More broadly, the agreements are critical to the nonproliferation of nuclear weapons because they require safeguards to ensure material is not diverted for illicit purposes, restrict how the material will be used, and ensure material and equipment are secured. These requirements reduce a partner state’s capability and likelihood of proliferating or transferring material or technology to a third party. Working in conjunction with other international treaties, 123 Agreements serve as a cornerstone of the global nonproliferation regime. To continue to engage in nuclear cooperation, renewing the 123 Agreement between the United States and South Korea was therefore imperative.

South Korea’s increasing domestic usage of nuclear power, its desire to play a larger role internationally with nuclear power servicing and plant construction, and the limited space available for long-term spent fuel storage have all been employed in arguments to promote South Korea’s case for enriching or reprocessing domestically. This has been a continuous point of contention in U.S.-ROK negotiations and torpedoed the ability of negotiations in 2013 and 2014 to lead to a new agreement. Fundamentally, the 123 Agreement between the United States and South Korea denies all ENR activities by South Korea. Yet South Korea perceives ENR as critical to meeting its strategic objectives and energy security needs. Further, the country’s desire to become a major international producer and service provider in nuclear energy is a critical issue and elevates the importance of acquiring a capacity to enrich, fabricate, and reprocess nuclear fuel. In particular, South Korea desires the ability to use a reprocessing technique called pyroprocessing because it can reduce waste volume and allow for fuel to be recycled.

South Korea wants to expand its ability to conduct operations within the full spectrum of the fuel cycle, necessitating preapproval, or advance consent, from the United States under the 123 Agreement. This desire for expansion has been routinely counter to the United States’ desire to promote a global “gold standard” embodied in enrichment- and reprocessing-prohibition terms built into 123 Agreements. While the objective has been to move toward formalized gold-standard text, the United States has more practically fallen back on the position of case-by-case approval with regard to ENR. This debate encompassing gold

standard, case-by-case, and advance consent has been a major point of contention for South Korea, which believes domestic access to the entire fuel cycle is necessary for meeting its strategic objectives.

The recent U.S. immovability on ENR issues with regard to South Korea might have been viewed as reflecting a lack of trust between the United States and South Korea, or even a decline in the perceived value of the relationship to the United States. South Korea has seen the United States bestow 123 Agreements on a number of other countries without caveats on ENR-technology-related issues. The U.S. promotion of the gold standard or case-by-case approval is seen as a weak argument from South Korea perspective, given that other countries with similar relationships with the United States (e.g., Japan or the European Union more broadly) are not subjected to the same level of scrutiny. Additionally, the United States has broken nonproliferation norms in the past and allowed clauses for maneuvering out of the harsh ENR restrictions. India was particularly motivating as a comparative case for South Korea, given that India disregarded international norms and developed nuclear weapons but was still granted a nuclear cooperative agreement. Vietnam is another example in which the agreement took on the case-by-case ENR clause; because Vietnam is a new nuclear state that does not have a history of nonproliferation or a historically strong relationship with the United States, this is viewed as indicating another contradiction in U.S. policy. The new ROK agreement starts to address this disconnect by opening the door to expanded ROK activities in nuclear fuel, although reprocessing and in particular the desired pyroprocessing technique are still prohibited.

Pyroprocessing: A Technical Review

A major, continuous sticking point in the negotiations was South Korea's desire for advanced approval of future introduction of commercial-scale ENR capabilities. The pathway advocated by South Korea has been through pyroprocessing, an electrolytic reduction method that reduces the volume of radioactive waste to be stored and provides fuel for fast reactors. This process, it is argued, would reduce waste, ensure a supply of nuclear fuel, and provide a formal recognition of South Korea as a leader in nuclear energy. While the updated agreement does enable some enrichment following vice ministerial-level consultations between the two countries and, more important, institutionalizes a mechanism for consultations, the ban on reprocessing remains intact. However, the United States and South Korea will continue their ten-year study (to conclude in 2021) on the viability of the pyroprocessing option.

South Korea has consistently advocated for pyroprocessing—a technique it argues is proliferation resistant—for managing its ever increasing backlog of spent fuel. Pyroprocessing in this context is a nuclear reprocessing technique that utilizes an electrolytic reduction rather than an aqueous process to separate isotopes after

nuclear fuel is irradiated in a nuclear reactor. The general process is for the spent fuel rods to be cut into small pieces and run through a process of oxide reduction utilizing a lithium chloride–lithium oxide electrolyte. The resulting molten salt is then electrorefined in a lithium chloride–potassium chloride eutectic salt, with an electrolytic reduction cathode removing residual salts in the metal products of the electrolytic reduction process, resulting in uranium deposited on a solid cathode in pure dendritic form. This process allows for the extraction of uranium from the spent fuel but leaves plutonium and other transuranics combined as one output. This also allows the high-heat fission products to dissolve, thus decreasing the overall heat load of spent fuel. This heat reduction is key to the long-term storage options for spent fuel. While further reprocessing is possible following this step, this output does allow for direct fabrication of the uranium into metallic fuel for use in a fast reactor without further purification.

The major benefit of this process is that it significantly reduces the volume and heat output of the high-level waste, as well as allowing for greater utilization of fuel that South Korea has in its fuel cycle, as opposed to the conventional once-through process. This is attractive for South Korea given its argument that it lacks the geographic space for a high-volume storage facility. Additionally, reducing the time line of heat output from the decay of the nuclear fuel enables South Korea to handle the material sooner, rather than having significant material amounts cooling in ponds or casks. Further, proponents of the method argue that during the process plutonium is never separated from other transuranics—a major concern for those worried about nuclear proliferation—making it more difficult to manipulate and to extract, and thus making this process more proliferation resistant.

However, concerns with pyroprocessing remain, as this method makes further purification much more straightforward, which could ease plutonium extraction. Another difficulty is that the other fission products that are a proliferation concern—neptunium, americium, and curium—are extractable during the process. Lastly, two political arguments against pyroprocessing in South Korea persist: the potential long-term effects for the continued viability of the Nuclear Non-Proliferation Treaty (NPT) if further proliferation of ENR expertise occurs, and the potential impact on relations between South Korea and the United States, on the one hand, and South Korea and the Democratic People's Republic of Korea (also known as North Korea), on the other.

While the United States has conceded on enrichment, reprocessing remains in large part off-limits under the 123 Agreement with South Korea. As mentioned previously, the United States and South Korea will continue their ten-year study on the viability and safeguarding of industrial-scale pyroprocessing. However, it is unlikely that the United States will approve pyroprocessing, or reprocessing more broadly, at a scale meaningful to South Korea in the near term because of technical and policy questions that remain: How does one make the process proliferation resistant? What signals does this send North Korea regarding South

Korea's intentions? What are the legal implications for the 1992 Joint Declaration of South and North Korea on the Denuclearization of the Korean Peninsula? While technical hurdles still need to be resolved, principally over safeguards, the debate over pyroprocessing is more of a policy issue. The United States and South Korea will need to continue to discuss this process, possibly establishing a framework for implementation based on the outcome of the ten-year study.

123 Agreement's Strategic Importance to the United States

Three main drivers are influencing the U.S. perspective on the 123 Agreement with South Korea: nonproliferation concerns, commercial motivators, and the U.S.-ROK strategic relationship. Nonproliferation concerns are not primarily founded on the premise of South Korea's proliferation of nuclear weapons, but rather on the larger nonproliferation agenda and security on the Korean Peninsula. The policy of the United States has been to advocate against states taking on ENR capabilities, given the concern that the infrastructure, even if built initially for civilian purposes, can potentially be retasked to enable the production of material for nuclear weapons. As discussed, South Korea would like advance consent for its ENR endeavors. According to the United States, this advance consent could undermine nonproliferation policy by encouraging other countries to advance their own domestic programs and to request similar advance-consent arrangements. Another concern is that if the United States were to allow ENR in South Korea, this could complicate efforts to convince North Korea to adhere to the Korean Peninsula denuclearization agreement and to disarm. Further, introducing ENR capability into South Korea may be perceived by North Korea as a provocative action, hurting progress in the normalization of relations or destabilizing the peninsula.

The significant trade between the United States and South Korea in nuclear materials, amounting to millions of dollars in equipment and expertise annually, gives the 123 Agreement great commercial implications for the United States. This extends beyond bilateral trade flows and includes the associated services that U.S. companies could provide on ROK contracts, such as in the case of the purchase by the United Arab Emirates (UAE) of four nuclear reactors from South Korea in 2009. While a U.S. company was not a finalist on the bid, the resulting deal and close commercial relationship between nuclear companies in the United States and South Korea will provide U.S. companies opportunities to supply material, engineering, and equipment. This close commercial relationship between U.S. and ROK companies has also allowed for efficiencies in the supplying of particular components and services, which have created an integral link between the two countries in maintaining and operating each country's nuclear infrastructure. Cuts to these relationships and trade could have dramatic energy-security consequences for the United States.

As for the third influencing factor, the larger strategic relationship between the United States and South Korea, the current bilateral relationship is often argued by South Korea as being outdated, in particular when considering South Korea's advanced technological standing with regard to nuclear expertise. When the initial U.S.-ROK 123 Agreement went into effect in 1974, South Korea was reliant on external partners for turn-key systems. Having now established itself as a world leader in the engineering, technology, and servicing of nuclear energy, South Korea's status has grown beyond the initial needs of the agreement between the two parties. If insistence by the United States on a stringent ENR policy were to continue, this could strain the U.S.-ROK relationship to a point similar to the 1970s, when the United States was viewed as not dedicated to the security of South Korea and, as a result, then President Park Chung-hee explored a nuclear weapons program. That program was scrapped after U.S. recommitments to the security of South Korea. Maintaining a strong security partnership with South Korea has been a continuous objective of U.S. policy, one reiterated in President Obama's desire for an "Asian pivot," which would bolster the security of U.S. partners in the region.

The New Deal

The new bilateral nuclear deal, which was sent to the U.S. Senate for approval in June 2015, allows for more leeway in nuclear energy for South Korea, attempting to accommodate South Korea's demands for greater freedom in nuclear energy while still meeting the strategic necessities for the United States. Key expansions in the nuclear agreement include the addition of a mechanism to enable South Korea to enrich uranium, use spent fuel for research purposes, and take advantage of additional disposal options, along with leaving the door open to research on pyroprocessing.

On uranium enrichment, the new deal establishes a mechanism by which South Korea can enrich for nuclear power purposes and research to less than 20 percent. According to South Korea's Ministry of Foreign Affairs, a bilateral commission of ministerial-level officials will convene and review petitions for enrichment programs as they arise. The consent of this commission will be needed before any programs move forward. This is a critical step because it institutionalizes a mechanism by which the case-by-case review can now occur. This also bridges the gap for both parties by creating a more open dialogue. South Korea doesn't quite receive the desired advance consent, but this change does move in the direction of allowing for reduced restrictions. The United States, for its part, meets the demands of South Korea while still maintaining an element of review.

An additional step forward in the agreement is that it allows South Korea to now move spent nuclear fuel to a third country for disposal purposes. As previously outlined, waste disposal and a secure fuel supply are key issues for South Korea. This helps address both. South Korea could ship fuel to Europe for reprocessing

and utilize the separated plutonium in mixed-oxide fuel, thus helping relieve the amount of waste as well as increase the diversity in fuel supply. Or South Korea could ship the waste for long-term disposal. With the rise of Russian full-cycle fuel services, this may be an option given proximity and costs. The United States maintains an element of control, though, with this fuel removal also requiring consent.

These front- and back-end expansions of capabilities will aid South Korea's efforts to expand its nuclear energy business abroad as well, an economic necessity as South Korea attempts to establish itself as a leader in providing complete fuel-cycle services. More important, though, this sends two signals to South Korea. First, it starts to rebuild trust between the two nations with regard to mutual commitment. Second, it demonstrates U.S. recognition that South Korea is a technical peer in nuclear energy and that it should not be fully constrained in its nuclear energy operations, given the economic harm this would cause. This strengthening of the relationship is more than evident in South Korea's Ministry of Foreign Affairs press release on the agreement, which emphasizes trust, mutual concern, and mutual benefit.

Implications of the New Agreement

One of the more significant implications of the new agreement is its potential impact on the U.S. commitment to advocating a gold standard globally, a policy position that has been strongly advocated by the Obama administration following the UAE 123 Agreement, and the impact this move will have on the NPT. The components of this new agreement that allow for some flexibility signal that the United States is committed to responsible actors in nonproliferation, rather than a dogmatic principle that is nearly impossible to contractually obligate. South Korea has been a steadfast party in nonproliferation for more than thirty years; this new agreement treats the country as such.

In comparison to its implied recognition of responsible nonproliferation actors, the deal holds relatively minor implications for the NPT. Most debates today regarding the NPT's continued viability focus on the nuclear weapons states' commitment, or lack thereof, to Article VI of the treaty, which calls for disarmament. The new structure of the U.S.-ROK 123 Agreement appears to have built-in mechanisms for review to prevent quick escalation to nuclear weapons, ensuring that the commitment to the peaceful use of nuclear material in South Korea continues. By not allowing for domestic reprocessing during the tenure of an agreement, a framework is now taking shape that signals to the international community that the NPT and a corresponding obligation to nonproliferation are critical to both the United States and South Korea.

Conclusion

Nuclear energy is a key component for South Korea's energy security. The country's strategy for its domestic use, and goal of becoming a proprietor of nuclear energy on the global market, will be a substantial driver for South Korea's economy. The full-scale development of enrichment and reprocessing, in particular pyroprocessing, in South Korea would have significant impacts, and would not have been appropriate in the near term. Minor expansions to the 123 Agreement allow both countries to move forward with wins. While the United States walks back its global desire for gold standards, relying rather on a formalized case-by-case position with some compromises, this new approach may be more sustainable in the long run. However, this will require more formalization to ensure equitable application in future agreements. South Korea moves slightly forward in its objectives for increasing its nuclear energy capabilities, both domestically and abroad. More important, though, South Korea wins in strengthening and securing its relationship with the United States, while building prestige at home through U.S. recognition that South Korea is an "advanced stage" nuclear power. This new agreement also strengthens U.S. nonproliferation policy by ensuring South Korean commitment, building protection mechanisms, and signaling to the global community that the United States is prepared to work constructively with strong advocates and proponents of nonproliferation. **SD**

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