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REVISITING REPROCESSING IN SOUTH KOREA

JOEL PETERSSON-IVRE



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Please direct inquiries to:
Asia-Pacific Leadership Network
APLN Secretariat
4th floor., 116, Pirundae-ro
Jongno-gu, Seoul, ROK, 03035
Tel. +82-2-2135-2170
Fax. +82-70-4015-0708
Email. apln@apln.network

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Image, page 6: South Korean designed Barakah nuclear power plant in the United Arab Emirates, under construction, 2017. Wikimedia.

REVISITING REPROCESSING IN SOUTH KOREA¹

The domestic debate about South Korea acquiring nuclear weapons continues. Recent surveys show that a majority of the population wants them, not just to balance North Korea's nuclear threats, but also to counter perceived encroachment from China.² They ask: If Russia could prey on its smaller neighbor under the shield of its nuclear weapons, what stops China or North Korea from doing the same? The Russian invasion raises an important question about South Korea's energy security as well.³ Rising gas prices and inflation already threaten to dissatisfy the voters whom President-elect Yoon Suk-yeol won by only a razor-thin margin. South Korea imports 98 per cent of its energy, and the South Korean port of Yeosu is the fourth largest recipient of Russian fossil fuel shipments since the start of the war.⁴ The question is, how can South Korea wean itself off this dependency on foreign fuel?

The president-elect has nuclear answers to both questions. He has said that he would secure South Korea from surrounding nuclear powers by asking the United States to once again station nuclear weapons on the Korean Peninsula. Failing that, some more fringe – but increasingly vocal – members of his party have called for South Korea to make its own nuclear weapons, at whatever the cost. This thinking is not new and South Korea's desire to proliferate even under

the US alliance commitments has been an issue since the 1970s, when South Korea briefly considered a nuclear weapons program.

Yoon's answer to the second question is to reverse the outgoing Moon administration's decision to phase out nuclear power. This reversal won't immediately push down gas prices, but in the long run – likely beyond Yoon's single five-year term – South Korea's energy security would become more solid. But a renewed focus on civilian nuclear power also holds more subtle, yet important implications for South Korea's ability to acquire the bomb.

REPROCESSING

Yoon's plan to re-expand the domestic nuclear power industry is a timely move. With demand for nuclear power suddenly surging in Europe as it seeks to wean itself off Russian gas, South Korea might find an export market for its domestic nuclear reactor industry. With Russia hobbled by sanctions, the competition might not be quite as fierce in other parts of the world either. However, South Korea lacks a competitive advantage in the reactor export market: unlike some competitor countries, it cannot offer full fuel-cycle services. It could, however, be a big marketing advantage for South Korea, if it were to take back spent fuel and reprocess it, or recycle it in the country.⁵

In addition to enhancing its export competitiveness, South Korean officials have argued that reprocessing would allow the country to recycle fuel for its own reactors, become an important part of the nation's energy security, and reduce the radioactivity of spent fuel, which makes storage easier. As the country turns back to nuclear power and as current nuclear fuel storage fills up, these arguments will likely grow stronger. However, reprocessing – the chemical process that separates

¹ Acknowledgements: The author wants to thank John Carlson and Dr. Tanya Ogilvie-White for helpful comments. Any remaining mistakes are the responsibility of the author.

² Toby Dalton, Karl Friedhoff, and Lami Kim, "Thinking Nuclear: South Korean Attitudes on Nuclear Weapons," Research (The Chicago Council on Global Affairs, February 21, 2022), <https://www.thechicago-council.org/research/public-opinion-survey/thinking-nuclear-south-korean-attitudes-nuclear-weapons/>.

³ Troy Stangarone, "How South Korea Can Wean Itself off Russian Fossil Fuels," *The Diplomat*, March 31, 2022, <https://thediplomat.com/2022/04/how-south-korea-can-wean-itself-off-russian-fossil-fuels/>.

⁴ "Financing Putin's War on Europe: Fossil Fuel Imports from Russia in the First Two Months of the Invasion" (Centre for Research on Energy and Clean Air, April 28, 2022), <https://energyandcleanair.org/wp/wp-content/uploads/2022/04/Fossil-fuel-imports-from-Russia-first-two-months-of-invasion.pdf>.

⁵ Ferenc Dalnoki-Veress et al., *The Bigger Picture: Rethinking Spent Fuel Management in South Korea*, 2013, 23, http://cns.miis.edu/opapers/pdfs/130301_korean_alternatives_report.pdf.

uranium and plutonium isotopes from spent reactor fuel – is a contentious issue for the global non-proliferation regime as it is a crucial step towards obtaining plutonium for a nuclear bomb.

DISAGREEMENTS

While South Korea's construction of a reprocessing facility would not violate the Non-Proliferation Treaty (NPT), it would violate the 1992 Inter-Korean Agreement, as well as the 2015 Agreement on peaceful uses of nuclear energy with the United States.⁶ Today, Japan is the only non-nuclear weapons state that owns a plutonium reprocessing facility, having received permission to construct it by the United States. This irks many Korean policymakers, who believe that they are treated as a minor ally in nuclear matters. The AUKUS deal that will provide Australia with nuclear-powered submarines adds to this perception; the United States has long denied South Korea a similar deal. An infected dispute between US reactor manufacturer Westinghouse and South Korea's KEPCO, over the intellectual property rights to components of the APR1400 reactors that South Korea wants to export to Saudi Arabia, has certainly contributed further to Korean policymakers' frustrations.⁷

To convince the United States that it can be trusted to handle reprocessing responsibly, South Korea has carried out research on a form of reprocessing called pyroprocessing since 1997. South Korean officials, backed by scientists at the Korea Atomic Energy Research Institute (KAERI), have argued that, when compared to other forms of reprocessing, pyroprocessing "enhances the proliferation resistance significantly, as separation

of sole plutonium is impossible."⁸ But pyroprocessing could in fact help a proliferation program: if a country established a covert PUREX (plutonium uranium reduction extraction) plant, materials could be diverted during the pyroprocess to the covert plant, and substantially reduce the volume of material to be reprocessed in that plant. It has been argued that doing so would be a complicated process in itself, and that there are measures that can be taken to avoid such diversion.⁹ However, as former Clinton-official Frank von Hippel has argued, the best way to avoid the proliferation risks of pyroprocessing is to not do it at all.¹⁰

In spite of the risks, the South Korean push for reprocessing capabilities did strike a chord with the Bush administration, which allowed the Argonne and Idaho national laboratories to run a joint R&D program with South Korea's KAERI on pyroprocessing. The Obama administration maintained a more cautious attitude towards South Korean pyroprocessing ambitions, but agreed to "kick the problem down the road" by initiating a Joint Fuel Cycle Study between the two countries in 2011.¹¹ The purpose of that study was to explore the method's economic and technological feasibility.

In 2021, Yonhap News reported that the results of the Joint Fuel Cycle Study "were approved by authorities in both

⁶ "Agreement for Cooperation Between the Government of the Republic of Korea and the Government of the United States of America Concerning Peaceful Uses of Nuclear Energy," 2015, <https://fissilematerials.org/library/kr123.pdf>.

⁷ "Newbuild: US-Kepeco Clash Over IP Rights in Saudi Bidding," Energy Intelligence Group, April 24, 2019, <https://www.energyintel.com/0000017b-a7d7-de4c-a17b-e7d7a0160000>.

⁸ "Korea Bets on Pyroprocessing Technology," KAERI, March 9, 2010, <https://www.kaeri.re.kr/eng/board/view?linkId=4719&menuId=MENU00718>.

⁹ Seung Min Woo, Sunil S. Chirayath, and Matthew Fuhrmann, "Nuclear Fuel Reprocessing: Can Pyro-Processing Reduce Nuclear Proliferation Risk?," *Energy Policy* 144 (September 2020): 111601, <https://doi.org/10.1016/j.enpol.2020.111601>.

¹⁰ Frank von Hippel, "South Korean Reprocessing: An Unnecessary Threat to the Nonproliferation Regime | Arms Control Association," *Arms Control Today*, March 2010, https://www.armscontrol.org/act/2010_03/VonHippel.

¹¹ Frank von Hippel and Jungmin Kang, "Why Joint US-South Korean Research on Plutonium Separation Raises Nuclear Proliferation Danger," *Bulletin of the Atomic Scientists* (blog), January 13, 2022, <https://thebulletin.org/2022/01/why-joint-us-south-korean-research-on-plutonium-separation-raises-nuclear-proliferation-danger/>.

countries.”¹² The full report was not released, but according to von Hippel and colleague Jungmin Kang, leaked sections of the report indicate that it exaggerates the economic feasibility of pyroprocessing and does not draw conclusions regarding nuclear security and proliferation concerns on the basis of adequate data. Von Hippel and Kang write:

With regard to costs, the enthusiasts who authored the report ignored the lessons of decades of failed efforts to commercialize these dangerous technologies. Their strategy appears to keep their collaboration alive until new administrations come into power in South Korea and the United States, which they hope will allow the Korea Atomic Energy Research [sic] Institute to actually build a prototype pyroprocessing plant and a plutonium-fueled reactor.¹³

And now, a new administration *will* soon come to power. It remains to be seen how the Yoon administration will handle the reprocessing issue, but considering President-elect Yoon’s nuclear-friendly energy policy, he is likely to pursue it further. The change of power in Seoul therefore seems to be one of many political trends that are converging to lead South Korea another step closer to nuclear proliferation.

CHALLENGES AHEAD

To be sure, President-elect Yoon’s first challenge will be to simply restore the industry to the state it was in when the Moon administration decided to phase out nuclear power in 2017. His new minister of trade, industry and energy, Lee Chang-yang, will have his hands full increasing the size of the nuclear workforce and gaining the confidence of

investors that the next administration will not simply undo his efforts. One way to gain such confidence is to make credible investments in South Korea’s ability to export reactors. The construction of ambitious nuclear infrastructure – such as a prototype pyroprocessing plant – might also seem attractive in this regard.

Should Yoon’s nuclear policy succeed over the next five years, the industry’s importance in South Korea’s national energy policy will grow. But it must be recognized that, depending on the technologies involved, the new policy also risks giving South Korea the latent capacity to produce nuclear weapons, at the same time as public and political pressures for acquiring them grow stronger.

This convergence of technological and domestic political trends in South Korea – coupled with the perceived threat from not only North Korea but also China – is a fundamentally new challenge for the non-proliferation regime on the Korean Peninsula and beyond. A nuclear breakout decision by South Korea would have disastrous consequences for the country, the region, and for the global non-proliferation regime. The risk of a nuclear exchange on the Korean Peninsula (or between South Korea and China) would rise; Japan and even Taiwan might attempt nuclear breakout themselves; and the NPT would tither on the edge of collapse, with states in other regions – such as Iran – likely to abandon the treaty entirely.¹⁴

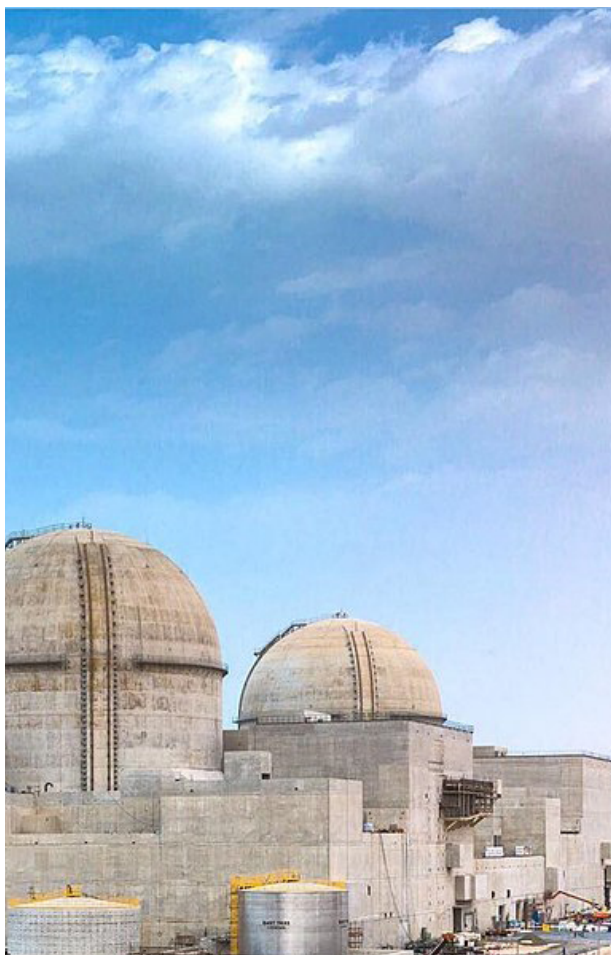
The United States’ provision of extended deterrence, and the 2015 Agreement on peaceful nuclear use still act as constraints on South Korea’s nuclear proliferation. Extended deterrence weakens the rationale for South Korean nuclear weapons; the Agreement curbs South Korea’s ability to manufacture them.

¹² Hae-sung Lee, “US, Korea Approve Nuclear Fuel Recycle Technology,” The Korea Economic Daily Global Edition, September 2, 2021, [https://www.kedglobal.com/\[exclusive\]-energy/newsView/ked202109020004](https://www.kedglobal.com/[exclusive]-energy/newsView/ked202109020004).

¹³ von Hippel and Kang, “Why Joint US-South Korean Research on Plutonium Separation Raises Nuclear Proliferation Danger.”

¹⁴ For more on the “nuclear domino effect” in Northeast Asia, see: Chung-in Moon, “Is Nuclear Domino in Northeast Asia Real and Inevitable?” (Asia-Pacific Leadership Network, October 1, 2021), <https://www.apln.network/projects/wmd-project/is-nuclear-domino-in-northeast-asia-real-and-inevitable>.

But it is worth noting that it was only two decades ago that South Korean enrichment and reprocessing practices were last put under scrutiny.¹⁵ As for the influence of the United States, the 2024 US elections are not far off. If another Republican – Trump, or someone who shares his disdain for American allies – becomes president, the South Korean belief in US alliance commitments might waver again, as it did under Trump. A Republican President may even be willing to encourage South Korean proliferation activities, such as granting Seoul’s long-standing request for nuclear submarines. 2024 is also the year of the South Korean National Assembly elections, which might bring into power even more pro-nuke politicians.



¹⁵ Fortunately, these activities did not seem to be approved by policymakers or under any military direction: Jungmin Kang et al., “South Korea’s Nuclear Surprise,” *Bulletin of the Atomic Scientists* 61, no. 1 (January 1, 2005): 40–49, <https://doi.org/10.2968/061001011>.

RECOMMENDATIONS

What should the new South Korean president do?

For reactor exports, South Korea does not need to offer reprocessing services to be competitive – most customers do not ask for the service (and only Russia provides it). Moreover, most states with nuclear power programs have already decided that a once-through cycle, where spent fuel is stored rather than reprocessed, is a more economical way to manage spent fuel.¹⁶ Neither would reprocessing-acquired plutonium be necessary for South Korea’s energy security. The APR1400 reactors that South Korea is set to restart constructing all use low-enriched uranium, not plutonium, which South Korea already receives from a diverse set of suppliers.

President Yoon thus has little reason to pursue reprocessing; for transparency, he should make efforts towards releasing more data from the US-ROK Joint Fuel Cycle Study for independent (though not necessarily public) peer review. The United States need to agree – and should agree – on this course of action. An ideal time to do so would be the summit between the two presidents in Seoul at the end of May.

There is also an urgent need for South Korea to find storage for its spent nuclear waste. Rising fuel prices should give Yoon the opportunity to seek further public approval for nuclear power and impress on it both the need to construct dry-cask storage sites for spent fuel, and the safety of such methods.

¹⁶ John Carlson, “The Nuclear Fuel Cycle and Horizontal Proliferation in the Asia-Pacific Region” (Asia-Pacific Leadership Network, 2021), 20.

Nuclear energy works on long time-scales. South Korea will continue to struggle with the thorny question of energy security, and it will not become a world-leading exporter of nuclear reactors within a single five-year presidential term; commercial-scale pyroprocessing is decades away. Neither is South Korea likely to acquire nuclear weapons under President Yoon.

But one only has to look to North Korea to consider what might happen in the longer-term. Technology facilitates proliferation, but the decision to acquire nuclear weapons is political. It depends on domestic, as well as the international political factors – factors that are growing more concerning by the year. As the war in Ukraine splits the UN Security Council, North Korea will be given looser reins to advance its

nuclear and missile program unpunished. The immediate question is how to prevent South Korea from edging closer to the nuclear threshold in the face of such an urgent security threat. But in the longer term, we must ask: If South Korea lays the groundwork for nuclear weapons today, can the fractured global community even stop it from nuclear breakout in the future? It is not in South Korea's interest to embark down a path that will have the global community confronting this question.

ABOUT THE AUTHOR

Joel Petersson Ivre is a Policy Fellow at the APLN. He received his Master's degree from Yonsei University's Graduate School of International Studies for East Asian Studies and International Security and Foreign Policy, and his Bachelor's degree in Chinese Language and Culture from Stockholm University.

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