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Can Privatization Solve the Spent Nuclear Fuel Issue in South Korea?

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Abstract

The Republic of Korea (ROK) faces many challenges in the development of its energy policy. Solving the spent nuclear fuel (SNF) problem remains a divisive and complex issue for both technical experts and policy makers. The future of the nuclear industry is dependent on effectively managing spent nuclear fuel, and handling its relationship with the public opinion. This paper will evaluate ROK domestic policies and strategies needed to achieve these goals. In addition, it will address various policies such as the privatization of the ROK's nuclear energy industry. Recommendations for public engagement and stakeholder management will also be discussed.

Introduction

The Republic of Korea currently draws more than 29% of its electricity from nuclear power plants (Lim 2019). However, the country is estimated to run out of on-site storage space for its spent nuclear fuel by 2030 (Braun & Forrest 2013). Considering the small territory of South Korea, its high population density, and past public opposition to geological repository that escalated to a riot (Park et al. 2010), the direct disposal of SNF is both technically and politically salient. Therefore, South Korea has considered pyroprocessing as a possible solution to reducing the waste volume, radiotoxicity, and heat load.

However, the ROK is bound by a 123 Agreement with the United States of America (US), renewed in 2015, which prohibits any reprocessing of US-derived fuel in the Korean Peninsula (Baxter 2015). To the US, pyroprocessing is a form of reprocessing, which directly defies this agreement, as well as the 1992 Joint Declaration for Denuclearization of the Korean Peninsula.

In 2011, the ROK and the US agreed to conduct a 10-year joint study to assess pyroprocessing for South Korean spent nuclear fuel management. Meanwhile, the Moon Jae-in government is committed to its gradual nuclear phaseout policy (Lim 2019). The upcoming 2021 renegotiation of the 123 Agreement is going to be Moon's legacy, whose term ends in 2022, although it is highly unlikely that The United States will allow South Korea to pyroprocess. Whether future governments pursue Moon's energy policy shift is questionable. However, nuclear energy is still an important element of the South Korean energy portfolio, which is not expected to change in the foreseeable future.

Considering the tangled structure of the South Korean public opinion and the uncertain feasibility of the technology, the government needs to find a short-term solution for the accumulated stockpiles of spent nuclear fuel. Further, South Korea needs to prioritize domestic policies by targeting public opinion and shifting rhetoric regarding nuclear energy issues. Regardless of the outcome of the joint study and the negotiations, the government needs to address a public opinion turmoil that has contradicting views and goals.

Overview on Public Opinion

When it comes to the implementation of nuclear energy policies, the general public is a powerful stakeholder. After the Fukushima-Daiichi nuclear accident in 2011, public outcry forced Japan to initiate a gradual decrease of its dependence on nuclear energy (Suzuki 2018). Due to the 2015 earthquake in Gyeongju, the host city of a low and intermediate level waste (LILW) disposal facility and a neighbor to other cities hosting nuclear power plants such as Ulsan and Busan, the public feared a fate similar to Japan. Accordingly, President Moon prioritized gradual nuclear phaseout in its energy policy agenda (Lim 2019).

Safety-related issues in South Korean-built power plants also highlighted that fear. In 2012, KHNP inspectors found cracks in the control rod tunnels of the nuclear power plant (NPP) in Yeonggwang, in addition to components with forged quality certificates, which led to the shutdown of two of the reactors of the plant (Kwon 2012). According to South Korean officials, in the last decade, 60 quality certificates were forged on more than 7,600 components. However, the officials stressed that these items were "noncore" parts and imposed no risk of

radiation exposure (Dalnoki-Veress et al. 2013). And in December 2018, grease was found on the wall of the containment building of the third unit of the South Korean-built Barakah NPP at the United Arab Emirates (UAE), and a crack in the containment is the suspected cause. A similar issue was detected in August at unit four of the Hanbit NPP in Yeonggwang (Choi 2018). These incidents raise concerns about the safety and reliability of nuclear energy in South Korea, and particularly its SNF management options.

Expanding onto this perspective, the South Korean public opinion has a complex network of stakeholders. Among them, four stand out as particularly relevant: host communities and local governments, conservatives represented by the Liberty Korea Party (LKP), civil non-governmental organizations (NGOs), and the nuclear establishment.

To begin with, host communities are hereby defined as those communities who receive SNF for reprocessing, storage, or disposal options. In the late 1980s, the Korea Atomic Energy Research Institute (KAERI) conducted a geological survey and chose three potential sites for LILW storage, and interim SNF storage. Local residents, however, opposed the plan, so the government built the facilities on Anmyeon Island instead. They also tried to win the local community over by proposing to locate another KAERI headquarters there. Press leakage of the plan sparked a riot and the ministry responsible for the project resigned (Park et al. 2010). Local governments and host communities are also very interested in economic incentives, increasing their tax revenue, and the jobs they acquire in newly built facilities. In 2005, in order to secure a site for LILW facility in Gyeongju, Seoul pursued a new consultative strategy and provided economic incentives to the local government that costed \$1.5 billion and were subject to increase if the central government expanded the facility's capacity (Park et al. 2010).

Host communities, in turn, are often intimately related with civil NGOs. This group of stakeholders has the additional characteristic of being able to lobby the government efficiently. When KAERI initiated a pyroprocessing experiment with actual nuclear fuel, the civil society in Daejeon raised oppositions and formed a coalition of 24 NGOs. They succeeded with the help of some lawmakers to lobby the Ministry of Science and ICT to cut down KAERI's budget by 30% and review its R&D program (Lim 2019). This halted the Sodium Integral Effect Test Loop for Safety Simulation and Assessment: Phase 2 (STELLA-2) program that was supposed to evaluate the effectiveness of safety systems of sodium-cooled fast reactors (SFR), an integral part of pyroprocessing technology (Personal Communication 2019). However, such NGOs, and other organized public movements, do not appear to have massive support among ordinary South Koreans. They acquire their influence from connections with people in power and actively lobby their interests to the media to achieve political gain.

Another important aspect of public opinion on SNF management is how groups perceive nuclear energy and, collaterally, nuclear security. When it comes to conservatives, nuclear energy is a matter of national security, not just a public service. Hong Joon-pyo, the leader of the LKP, suggested South Korea may need to develop its own nuclear arsenal (Song 2017). Due to the recent polarization of South Korean politics, this position is increasingly seen by sections of the public as a viable option. (Kirk 2018). Conservatives tend to support direct disposal because of material retrievability. This position is rising in popularity among conservatives after the September 2017 North Korean sixth nuclear test and stagnant negotiations following the Hanoi meeting. Liberals, on the other hand, see electricity as a commodity and are more concerned about energy efficiency. However, they are also less nuclear-friendly and have a strong preference for renewables, which leads to support for Moon's energy policy shift (Lim 2019).

The nuclear establishment occupies the last pivotal role in composing public opinion. It strongly supports pyroprocessing and sees it as the only option to solve the problem of SNF accumulation. Nuclear professionals acknowledge that the technical, economic, and safeguard feasibility is still debatable. They argue, however, that proving the technology is only a matter of more research. This acclaimed research however conveys a different message. For instance, if an educated non-specialist examined the articles/studies of SNF management options written by South Korean scholars, they might appear to be short-sighted, delivering contradictory conclusions, depending heavily on assumptions rather than real-time market data, and only driven by the need to publish (Kim et al. 2013, Kim et. al 2017, Khan et al. 2017). These features compiled with others, we argue, give rise to confusion and deepens people's distrust in the nuclear establishment.

Analysis and Policy Recommendation

The ways in which the ROK government has treated the SNF issue resulted in public distrust. Host communities only knew about the chosen sites after the choice had already been made, triggering negative reactions even

from citizens supporting nuclear energy. The main government approach relied on the promise of economic incentives and local development, which are not enough to convince local governments to host disposal related facilities. This is partly due to the lack of knowledge by people and NGOs about the benefits offered by interim storage. Most are also unaware of the management timescale and fear that storage will be indefinite. Friction is amplified by safety concerns: the public is suspicious about the government's ability to build safe and reliable disposal facilities. In addition, the relation between the public and the nuclear establishment has deteriorated, with the former perceiving the latter as biased and driven by vested interests.

The lack of trust between the several stakeholders, in turn, prevents the society from taking significant steps toward a long-term and comprehensive solution to the matter. Take the pyroprocessing option as an example. Assuming it has been chosen as the long-term waste management strategy in South Korea, the government needs to take immediate action in order to prepare the ground for its implementation and make sure it is economically feasible. One study estimates that economic feasibility depends on the construction of 14 to 34 SFRs in order to utilize the reprocessed fuel (Khan et al. 2017). This would necessarily require government efforts dedicated to educating the public and easing the resistance to building these reactors and reprocessing facilities. Instead, the current government has promised to phase out nuclear power and prioritize renewables (Normile 2017). The continuous changes in administrations, coupled with a highly polarized public opinion, prevent the government from taking these necessary measures because they jeopardize popular support.

From the perspective of the current government, there is no guarantee that its policies will be maintained or respected after the political cycle transitions in 2022. In the past, cabinets struggled to commit to a long term policy because of a lack of consistent leadership in energy policy. Political motivations in energy reform instead of economic approaches will only lead to short term results because cabinet members are unable to carry out their long term plans. The Korean government must adopt an attitude that energy is a tradable commodity instead of a government service (Tsai 2019). The state controlled energy enterprise is victim to political shifts and will struggle to develop a comprehensive, competitive strategy to support nuclear energy.

For these problems, privatization of nuclear energy is a practical solution. In almost all cases, new development and investment in nuclear energy are pursued by governments following their energy security strategies (Howes 2013). Without state support and incentives, it is likely that the South Korean energy industry will have to shift away from the nuclear business. On the other hand, privatization is a tested and approved method for shielding strategic sectors from bureaucratic moods and government changes (Pettinger 2017). Given the need for the current administration to protect its power while maintaining a healthy national industry, partial privatization is the most suitable answer.

The push for privatization has been supported by multiple administrations in the past (Tsai 2019), although it has never had enough political momentum to be concluded (see Appendix). For this case, the government can give up some shares from a 51% majority share in the Korean Electric Power Company (KEPCO) to empower the private industry. The shift will grant industry experts more control in decision making and allow nuclear energy to have a commercial association. The government can assume the role of a regulator instead of exerting complete control. Further privatization through selling state assets and shares can give the ROK government a short term influx of cash and the increased efficiency of the nuclear energy industry will allow for economic growth. More importantly, reducing shares will also affirm a market based attitude in nuclear energy and protect its interests from future phase out policies or political pressures. In order to better assess the effects of such measures, this work will focus on two case studies. Chile and the United Kingdom (UK) launched privatizations of their energy sector with mixed results, summarized in Table 1.

Country	Chile	UK	South Korea
Privatization Motivation	<ul style="list-style-type: none"> - Stabilizing the country after a military coup - Attracting foreign investments 	<ul style="list-style-type: none"> - Tax revenue - Economic reform - Weakening the political power of trade unions 	Condition by the International Monetary Fund for loan after the Asian financial crisis
Electricity Generation	Privatized	Privatized	51% Public-owned
Electricity Distribution	Public-owned	Privatized	51% Public-owned

Electricity Price	Went high due to external effects unrelated to privatization	Went down by 35% for wholesale, 22% for large consumers, and 5% for small consumers	Marginally above the generation cost
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Table 1: A comparison of the privatization schemes of Chile, UK and South Korea (*data are compiled from Lim 2011, and Newberry & Pollitt 1997*)

Chile

Privatization of the Chilean energy sector, done in 1986, was the first case of a country privatizing its state-owned electricity utilities. Therefore, Chile has always provided important information on the effects of privatization for both researchers and policy makers. The idea of privatization in Chile started by the advent of the Pinochet military regime in 1973. It was inspired by neoliberal ideas borrowed from Chicago economists and by Pinochet's desire to undo the nationalization movement of the withdrawn regime (Lim 2011). Pinochet calculated that a quick economical reform would suppress the after-coup disturbances.

The privatization scheme considered electricity generation as a competitive market, while the government operated transmission, distribution, and retail as a natural monopoly, thereby acting as a coordinator. The General Law of Electric Services, the privatization regulatory law, established two types of consumers: free and regulated consumers. Free customers, whose consumption exceeds 2MW, purchase electricity directly from generators with agreed-upon prices, while regulated consumers, whose maximum consumption does not exceed 2MW, must purchase electricity from the government (Lim 2011). This strategy was aimed at encouraging foreign investments.

Broadly speaking, Chilean privatization was successful because of the increase in operational efficiency, service quality, and power capacity. In addition, the competitive energy sector attracted many domestic and foreign investors which led to fast economic growth. Private generation companies increased from 11 in 1996 to 26 in 2000 (Lim 2011). On the other hand, high prices were a remarkable feature of the Chilean electricity sector. Usually, they are incorrectly correlated to privatization while they are caused by other external factors. For example, hydropower, a major power source in Chile, experienced high prices when due to droughts occurring after the privatization. Natural gas, another major power source, has experienced high prices because Argentina reduced its gas exports to Chile in the 2000s (Lim 2011).

United Kingdom

The English and Welsh energy generation sector was owned by the government from 1948 to 1990 and was operated by a single company, the Central Electricity Generation Board (CEGB), while regional monopolies controlled electricity distribution. The reasons for privatization are argued to be CEGB's low growth and low return on assets (Newberry & Pollitt 1997), need for cash influx and tax revenue, and weakening the political power of trade unions (Lim 2011).

On March 31, 1990, CEGB was divided into four smaller entities: a transmission entity, National Grid, and three generation entities: National Power, PowerGen, and Nuclear Electric, which was responsible for nuclear power plants (Newberry & Pollitt 1997). Except Nuclear Electric, those entities were subsequently divided into smaller companies and sold to private parties. The UK government could gain £15 billion by selling and £5 billion per year as tax revenue. The generation market later expanded to include external suppliers, e.g., Électricité de France, Scottish and Southern Electricity Networks, and plants owned by banks. The British energy market is currently very competitive (Lim 2011).

In the first six years after privatization, labor productivity in the newly created companies nearly doubled. There has been a marked shift away from coal and toward natural gas, which considerably reduced sulfur and carbon emissions. This market shift was also encouraged by European Union regulations against sulfur emission. The coal price declined by 20% and the British coal market nearly collapsed which called for a Parliamentary inquiry. The coal industry was finally privatized by 1994. As a side effect of this Parliamentary inquiry, the government's policy toward nuclear energy was also reviewed. In 1996, it was finally decided to privatize the new nuclear power plant and leave the old plants in the public's ownership. As a result, plans to expand the nuclear program and build two new NPPs were stalled (Newberry & Pollitt 1997). Regarding cost, the wholesale electricity price went down by 35% percent, and retail prices for large consumers went down by 22%.

However, the price for small consumers went down only by 5%, which made many critics argue that privatization fostered inequality (Lim 2019).

Roadmap, Challenges, and Benefits

Since the late 1980s, South Korea was not able to find a sustainable solution to SNF accumulation (Park et al. 2010) due to fluctuations in the consecutive governments' policy towards the issue, and the governments' inability to take daring decisions in fear of public opposition. Instead, they resorted to short-term actions delaying the problem and unconsciously treated the public as an adversary.

The goal of suggesting privatization is threefold: isolating the decision-making process from the continuous government and policy shifts, enabling a long-term market-oriented plan, and relieving public tensions by emphasizing economic value of energy-related issues. Privatization as a strategy to ease public opinion polarization certainly seems counterintuitive. However, we are not proposing a complete instant privatization of the whole energy sector, but a slow gradual privatization of the government-owned entities whose mission is directly related to matters that are vulnerable to public opposition. When it comes to SNF management, the main players are Korea Nuclear and Hydro Power (KHNP), and Korea Radioactive Waste Agency (KORAD), both belonging to the Ministry of Trade, Industry and Energy (MOTIE) (Park 2015).

On one hand, the private sector is capable of taking long-term decisions without being pressured by the public or the party's desire to be re-elected. Those decisions tend to be more efficient because they are based on real-market data rather than estimates, driven by economic incentives, and are dependent on policy design and analysis machinery that is characteristic of large industries, e.g., system dynamics, which has been used for decades to design and analyze strategies for industrial processes and proved very successful (Woo & Kim 2012).

On the other hand, the public is likely to oppose privatizing entities that affect direct service cost, e.g., electricity, water, and gas prices (Hall et al. 2005). Even though the two case studies suggest that privatization is not necessarily correlated with price increases, an eventual price increase will remain a public concern. South Korea was required by the International Monetary Fund (IMF) to carry on privatizations after receiving financial support during the Asian financial crisis in the late 1990s. In response, the ROK has privatized 5 (out of 11) public-owned large enterprises, and 61 (out of the 108) public-owned companies from 1998 to 2000 (Lim 2011).

During this massive movement, there have been two records of public opposition to privatization. First, South Korean unions have pursued a campaign against the privatization of electricity, gas and other utilities. However, no party supported this campaign (Hall et al. 2005) and it soon lost momentum when the South Korean economy had quickly recovered and the gains of privatization were sensed by ordinary people. Second, citizens from a provincial city interrupted a seminar about KEPCO privatization, because they feared that a subsidiary of KEPCO would not be built at their hometown if the company was privatized (Lim 2011). These incentives conform to our previously explained model of the South Korean public opinion.

Public opinion stakeholders have fragmented motives toward energy policy. South Koreans, however, are quite open to privatization provided that sufficient assurances are granted: price stability for the general public, tax revenue for host communities, and equity and reliability for civil NGOs. Based on our understanding of public opinion's anatomy, we propose a number of strategies aimed at integrating the public as part of the process rather than treating it as a permanent adversary. Such strategies act as a preventive measure against organized movements of opposition.

1. Public engagement from the early stages, e.g., choosing investors. People are more likely to have a positive attitude toward a process if they feel that their opinion matters.
2. The public is likely to respond positively when there is an obvious comprehensive plan that addresses their concerns and argues for the benefits.
3. The government should act as a regulator to enhance market competitiveness and formulate a legal framework that ensures equity and prevents monopoly.
4. Slow gradual privatization and government control of the electricity distribution act as a price regulator. The US privatized the energy sector on a state-by-state basis. It was observed that states like Idaho and Kentucky which pursued slower privatization of the distribution utility had lower electricity prices (Lim 2011).

5. Due to the recent safety concerns about South Korea's built NNPs and the doubts that arose regarding its ability to undertake a nuclear-related project, we suggest that a scheme for a multilateral administration of KORAD should be formulated. For instance, the French company Orano, which is seeking huge investments (Orano 2019), is a good candidate for cooperation. Another good option is a comprehensive cooperation agreement with Finland, the country who has recently succeeded in constructing a geological repository (Feiveson et al. 2011).

One issue for workers at KEPCO is the uncertainty privatization brings for job security. KEPCO has over 35,000 workers that may be affected by a privatization shift. Labor unions have expressed strong opposition to job losses resulting from privatization (Tsai 2016). While full privatization can lead to job loss, a slow and minor restructuring may ease tensions with labor unions. A policy that pushes further privatization over time with government involvement can reduce uncertainty and create stability throughout the restructuring process. Labor benefits from gradual privatization come in addition to the price control argument previously mentioned.

In case of successful further privatization, the nuclear industry will need compensation for negative market externalities associated with fossil fuel and natural gas industry. The government can remain loyal to its green energy stance while minimizing the impact of interfering with the energy market by adopting market solutions to the energy demand, such as a carbon tax, in order to help nuclear energy. However, this approach may be insufficient to guarantee nuclear energy will prosper in the long run. In the United Kingdom, the energy market gradually transitioned away from nuclear even in the presence of a carbon tax. It's the job of the government-owned KAERI and other entities to keep nuclear energy a viable option for the industry by constantly analyzing alternative intervention measures if it need be.

Conclusion

In order to have a resolution for the SNF accumulation in the near future, South Korea needs to be creative in addressing the complex public opinion issue. Privatization could be a promising option to raise the economic value of the matter at the expense of the political debate. Privatization of the energy sector offers many short-term direct benefits, according to the case studies presented. It may also lay the road for a long-term strategy for SNF management issue by isolating it from government turnover. Job security and nuclear energy survival are challenges that need to be addressed. However, privatization gains should motivate the government to formulate a legal framework and a policy that prioritizes people's interest.

Appendix: Brief History of the Privatization of KEPCO

To solve issues of inefficiency under the state owned energy industry, KEPCO sold 21% of its shares to the public in 1989. Shortly after KEPCO was listed on the New York Stock Exchange and more government stocks were sold to handle the 1998 financial crisis. The Kim Young-Sam administration attempted a four stage project to completely privatize the electricity industry by 2010, but was later suspended from political and campaigning pressures. Further reorganization was also attempted under the Kim Dae-Jung administration as the "Basic Plan" featuring competition, new generation facilities, and consumer benefits (Tsai 2016). Selling a subsidiary of KEPCO was attempted however, the large size of the organization, small profits, and a bias against privatization among policy makers and the administration increased (Lim 2011). Under Roh Moo-Hyun, power reform was not pursued despite having party similarities with the Kim Dae-Jung administration. Policy reform had a close affiliation with executive leadership rather than party loyalty. Several factors explain the failure of power reform such as the ROK's frequent political turnover. Between 1993 to 2008, the ROK government had a total of fourteen prime ministers and ten acting prime ministers with little time in office (Tsai 2016).

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