Coal-to-Nuclear Transition Policy and Research in the Republic of Korea

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1. Introduction

A recent discussion on converting aging coal-fired power plants to nuclear power plants (NPPs) is gaining momentum across the world. This approach enables the efficient utilization of stranded asset sites that would otherwise be abandoned due to early retirement. For instance, the U.S. Department of Energy has released research results [1] indicating that approximately 80% of its domestic coal-fired power plants are suitable for the construction of advanced reactors. Additionally, it has published information guides [2, 3] for communities considering coal-to-nuclear transition, which encompass economic impacts, workforce transition considerations, and policy and funding information.

In this paper, the recent policy on transitioning aging coal-fired power plant to NPPs in the Republic of Korea will be examined, followed by a brief overview of recent research activities.

2. Coal-to-Nuclear Transition Policy

In this section, the policy of the Republic of Korea concerning the transition from coal-fired power plants to NPPs is examined. To date, the government has not officially announced plans to transition coal-fired power plants to NPPs. Instead, it prioritizes the conversion of coal-fired power plants to LNG and intends to transition to carbon-free energy sources in the future. Examples of these carbon-free energy sources include pumped storage and hydrogen-ammonia co-firing, but there is no mention of nuclear energy, specifically small modular reactors (SMRs).

2.1 Policy Direction for Coal-Fired Power Plants Phase-Out or Reduction

The Ministry of Trade, Industry and Energy announced the "Policy Direction for Coal-Fired Power Plant Phase-out or Reduction" in December 2021 to accelerate the transition of coal-fired power plants to clean energy while ensuring a stable electricity supply. The plan involves replacing coal-fired power plants with LNG or carbon-free energy sources like hydrogen-ammonia co-firing under the assumption that those technology development and demonstration are well achieved.

2.2 National Framework Plan for Carbon Neutrality and Green Growth

The government established the "National Framework Plan for Carbon Neutrality and Green Growth" in April 2023 to achieve a carbon-neutral society by 2050 and promote harmonious development of the environment and economy. According to the plan, coal-fired power plants that have been in operation for 30 years or more will be phased out (28 units by 2036), and hydrogen-ammonia co-firing power plants will be promoted subject to the development of environmentally friendly technology.

2.3 Formation of the Coal-Fired Power Plant Transition Council

In December 2024, the government formed the "Coal-Fired Power Plant Transition Council" to minimize the adverse impact of domestic coal-fired power plant shutdowns on regional economies and employment and to reuse existing infrastructure such as power generation facilities, transmission lines, and sites after shutdown. The plan developed through this council will be promoted smoothly through the concerted efforts of multiple government departments, including the Presidential Commission on Carbon Neutrality and Green Growth, the Ministry of Employment and Labor, the Ministry of Trade, Industry and Energy, and the Ministry of Economy and Finance. The "Coal-Fired Power Plant Transition Roadmap" is expected to be published in the first half of 2025.

2.4 Basic Plan on Electricity Supply and Demand

The government has been establishing the "Basic Plan on Electricity Supply and Demand" every two or three years to foresee mid-to-long term electricity demand and secure necessary power facilities for a stable electricity supply. A total of 11 plans have been established since the first plan in 2002. The 8th plan (2017) was the first one to include the plan to convert coal-fired power plants to LNG power plants. According to the plan, 6 units will be converted to LNG by 2030. The 9th plan (2020) increased this to 24 units, and the 10th plan (2023) further expanded it to 28 units.

The 11th plan (2025) added 12 more units, but instead of converting them to LNG, they will be converted to carbon-free energy sources such as pumped storage or hydrogen-ammonia co-firing to avoid increased dependence on LNG. Table I summarizes these transition plans.

Table I: Coal-Fired Power Plants Transition Plans

Plans	Date	Coal-Fired Power Plants to be Replaced	Alternatives
The 8th	Dec. 2017	6	LNG
The 9th	Dec. 2020	24	LNG
The 10th	Jan. 2023	28	LNG
The 11th	Feb. 2025	28	LNG
		12	Carbon-Free

A notable aspect of the 11th plan is that it included SMR power generation plans for the first time, with a planned capacity of 700 MW, although a specific domestic site has not been determined. It is also noteworthy that the 11th plan included carbon-free energy sources as alternatives to coal-fired power plants, whereas previous plans were limited to LNG only.

3. Coal-to-Nuclear Transition Research

Research on the just transition of the coal-fired power generation sector in Korea is being actively pursued. A study by Lee et al. [4] compared and analyzed the just transition policies of major countries and proposed that for the Republic of Korea, a long-term roadmap for decarbonization should be established, a dedicated organization should be set up, and comprehensive worker support measures should be prepared.

Additionally, feasibility of implementing international strategies to support the closure of domestic coal-fired power plants was explored [5] and financing measures for decarbonization of power generation industry were reported [6].

Kwon [7] analyzed the changes in employment resulting from the closure of coal-fired power plants and identified key challenges to be addressed for a just transition, including expanding the scope of stakeholder participation, establishing a just transition fund, and conducting comprehensive surveys and analyses to develop job transition strategies.

Researches on converting domestic coal-fired power plants to carbon-free energy sources as well as SMRs are also underway. Kim and Cho [8] conducted a study on the impact of carbon-free energy sources, such as hydrogen-ammonia co-firing power plants that can be introduced to replace domestic coal-fired power plants, on the domestic electricity market.

In the report "A Study on the Implementation of Carbon Neutrality Policy in Power Generation Sector" [9], SMRs were proposed as an alternative to coal-fired power generation. Since SMRs share similarities in terms of generation principles, facilities, and infrastructure, construction costs can be saved by up to 33% compared to new constructions, and employment can be doubled, which are cited as advantages.

The study by Hwang [10] analyzed the current status of domestic and foreign coal-fired power plants to establish a Korean coal-to-nuclear policy and assessed the required capacity of nuclear power or SMR to replace coal-fired power plants. According to the assessment, the United States would need 1,967 units of 100 MW SMRs, while Korea would need 423 units.

Kim et al. [11] proposed a hybrid system combining SMR and solar power as an alternative to coal-fired power plants and evaluated its economic feasibility. They found that combining the two power sources is more economical than building them separately.

Shin and Kim [12] investigated the potential for replacing aging coal-fired power plants and decommissioned nuclear power plant sites with i-SMR, currently under development for overseas export. The study estimated the optimal units of i-SMR deployable in each country under their power generation plans, targeting Indonesia, Poland, and Saudi Arabia. According to the results, 85 units can be deployed in Indonesia, 11 units in Poland, but no demand is expected in Saudi Arabia. Although this study has the limitation that it was not conducted specifically on Korea's coal-fired power plants, its results are expected to provide basic data for Korea's future coal-to-nuclear policy.

The Korean Nuclear Society released the results of a feasibility study on using Korean SMRs to replace a coal-fired power plant in the Philippines [13]. The study evaluated whether SMR models currently being developed in Korea can be used to replace coal-fired power plants in the Philippines. According to the findings, it was considered appropriate to replace 28 coal-fired power plants in the Philippines with Korea’s PGSFR (Prototype Gen-IV Sodium-cooled Fast Reactor).

At the 170th Forum hosted by KISTEP (Korea Institute of Science and Technology Evaluation and Planning), it was proposed that SMRs could be installed on smaller sites compared to coal-fired power plants, making it possible to reuse existing coal-fired power plant sites [14]. This would be a good option for reducing coal power generation and achieving carbon neutrality.

A newspaper column [15] was published, suggesting the replacement of domestic aging coal-fired power plants with SMRs. The column proposed promoting coal-to-nuclear policy at existing coal-fired power plant

sites while obtaining the understanding of local residents. The advantages of coal-to-nuclear policy were presented as follows: (1) the reuse of existing sites and facilities can reduce SMR construction costs, (2) existing employment can be maintained or even increased, (3) increased regional support funds can contribute to regional economic revitalization, (4) energy security will be enhanced, and (5) the track record of SMRs in Korea can be utilized to promote SMR exports.

4. Conclusions

In the Republic of Korea, efforts are already underway to convert aging coal-fired power plants to LNG power plants, and concrete plans for the transition to carbon-free energy sources have also been recently announced. However, no specific plans for transitioning to nuclear energy have been established yet, and the focus thus far has been on feasibility studies at the basic research level.

However, SMRs are now included in the national plans, discussions on converting Korea's aging coal-fired power plants to SMRs are expected to gain momentum. According to the results of a recent study [9], the stranded assets of the 28 aging coal-fired power plants scheduled to be phased out by 2036 are estimated to be around 3 billion USD. To minimize losses and maximize efficiency, coal-to-nuclear transition policy is likely to gain significant attention.

Moreover, it is essential to gather policy implementation cases from other countries regarding coal-to-nuclear transition policy. This will provide valuable insights and support for Korea's decision-making processes in coal-to-nuclear transition policy in the future.

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