Nuclear vs. Renewable Energy and the Alternatives: Conundrum of the ROK's Main Energy Policy

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Abstract

This paper deals with energy policy for carbon neutrality and stable energy supply from 2017 to the present. In the case of the Republic of Korea, there is a tendency for major energy policy to swing sharply between nuclear power and renewable energy whenever the ruling party changes. This study will examine South Korea's chronic energy policy dilemma and explore policy alternatives to overcome it.

Keywords:

ROK energy policy, nuclear phase-out, renewable energy, crowd-out, green hydrogen

Introduction

The Republic of Korea (ROK) is continuously driving innovation through its energy policies in order to fulfil its goal of carbon neutrality by 2030. This is mainly because global standards for carbon neutrality function as trade barriers, putting significant pressure on export-oriented companies, which are the driving force of the Korean economy. With the increasing importance of Environmental, Social, and Governance (ESG), companies are in a situation where they must take proactive measures to address climate change, resulting in a policy area that requires government support. During the Moon Jae-in administration from May 2017 to May 2022 (Democratic Party), the goal of net-zero emissions was pursued through an energy supply strategy centred on renewable sources such as solar and wind power. The next government, led by Yoon Suk-yeol of the conservative People Power Party, who was inaugurated in May 2022 and impeached in April 2025, aimed to achieve this goal by focusing on non-carbon and clean energy, especially nuclear power. And the current Lee Jae-myung administration (May 2025–present) is once again emphasizing renewable energy.

In short, over the past decade, spanning three different administrations, the South Korean government has swung between prioritizing renewable energy and nuclear energy in its policies. As a result, it has struggled to achieve its two major goals: carbon neutrality and a stable energy supply. South Korea's economy, centred on industries such as AI and semiconductors that require massive amounts of electricity, continues to drive up energy consumption even as the country faces mounting pressure to achieve carbon neutrality. The ongoing policy competition between renewables and nuclear energy has disrupted the establishment of long-term energy supply plans, which in conjunction with fast economic growth and increasing energy supply costs has led to rapidly rising carbon emissions. Meanwhile, key measures for carbon neutrality—such as mandatory corporate carbon emission disclosures—have been persistently delayed, further slowing progress toward these targets.[1] [2]

There was a belief during the Yoon Suk-yeol administration that achieving high-intensity carbon neutrality goals solely through renewable energy would be difficult. Moreover, the rapid implementation of renewable energy policies during the previous administration led to confusion in the energy strategy. During the Moon administration, the core of the net-zero strategy, which was support for solar and wind power, faced criticism due to subsidy problems and efficiency concerns, among other things. The Yoon administration moved towards abolishing or reducing subsidies for solar power, while wind energy was also deprioritized.[3] Meanwhile, they initiated a process to return nuclear power generation to the centre of energy policy, including the resumption of construction on the suspended Shin Hanul nuclear power plant. Ultimately, the Yoon administration concluded that pursuing both nuclear phase-out and net-zero simultaneously was impossible and thus moved towards abandoning the nuclear phase-out policy.

However, despite the above-mentioned advantages of nuclear energy, it too has failed to achieve social consensus. Although there was a heavy emphasis on nuclear energy in the Yoon administration, it was doubtful whether this leads to a reduction in carbon emissions in the ROK. There are significant limitations to the use of nuclear energy due to its low public acceptance and strong opposition from urban areas, which are the main centres of energy consumption.[4] In fact, due to continual

1 ROK Ministry of Environment, "2024 National Greenhouse Gas Inventory," *Greenhouse Gas Comprehensive Information Center,* 2024, https://www.index.go.kr/unify/idx-info.do?idxCd=4288.

2 Hyoji Lee, "Wholesale Electricity Price Hits 4-Month High, Adding to KEPCO's Financial Burden," *Yonhap Infomax*, August 9, 2024, https://news.einfomax.co.kr/news/articleView.html?idxno=4320672.

3 Seong Hwan Kim, "Yun Chŏngbu Chaesaengyŏnŏji Yesan 43%...Han Kiŏm-dŭl Haeoe-ro" [Yoon Government Reduces Budget for Renewable Energy by 43% ... Korean Companies Move Abroad], Newsis, October 10, 2023, https://mobile.newsis.com/view.html?ar_id=NISX20231010_0002477150

4 Doo Hwan Won, "A Comparative Study on NIMBY to Nuclear Power Plants," *Environmental and Resource Economics Review* 28, no. 4 (2019): 560–61

postponements of the timeline for net-zero emissions by the government, public scepticism has grown regarding the feasibility of rapidly achieving this goal through a nuclear-centred policy.

Then what alternatives are there? Government officials have also explored various alternatives to address both challenges: the low thermal efficiency of renewable energy and social constraints surrounding nuclear energy. One such alternative is hydrogen, with a particular emphasis on green and blue hydrogen energy. While nuclear power already contributes significantly to the ROK's carbon neutrality efforts on a maintenance level thanks to its high technological standards and established infrastructure, it is difficult to expect significant effects beyond a certain point due to limitations that will be explained later. Hydrogen energy, however, while still requiring further technological advancements, is anticipated to exert a faster reduction in carbon emissions compared to renewable energies while partially replacing the current role of nuclear power.

It is also necessary to keep supporting the development of renewable energies while addressing hydrogen energy. There are many challenges and constraints in the development of renewable energy, but it should not be completely abandoned. The international community continues to demand carbon neutrality through renewable energy. In this context, policies that indiscriminately reduce budgets for technological development or impose restrictions on technological advancement should be avoided. However, as mentioned earlier, the adoption and advancement of renewable energy require considerable time and costs, and so far, few countries have been able to fully adopt it as a main energy source. The ROK is a major emitter of carbon, with significant industrial output relative to its physical size. Sudden energy transitions pose serious difficulties for the country, as does maintaining its existing nuclear-centred policy. To overcome this energy transition period, it is essential to rapidly develop energy technologies that are efficient, such as hydrogen power, and to build upon expertise gained from existing energy industries such as nuclear power. It is imperative to accelerate the development of hydrogen energy technology until renewable energy matures, so that it can contribute as much as possible to shortening the timeline for carbon neutrality.

This article will explain why the ROK government is putting considerable effort into hydrogen energy development and what outcomes these efforts are likely to yield. Specifically, this study will explain why the Korean government has found itself in the dilemma of having to choose between renewable energy and nuclear energy, and why it is focusing on the development of hydrogen energy as a way to overcome this dilemma. To this end, the study will conduct a comparative analysis of the characteristics and relevant policies of various energy sources—renewable energy, nuclear energy, and hydrogen energy—based on information provided by the Korean government. This study will thus contribute to the study of the ROK's energy policy by identifying the political reasons behind the dilemma faced in this arena.

Theoretical framework

Before presenting answers to the research questions, it is necessary to review the existing literature. Sovacool et al. argue that while nuclear energy and renewable energy are the most mainstream solutions for achieving carbon neutrality, they are characterized by a mutually competitive ("crowd out") relationship. According to

their study, most countries are faced with the dilemma of having to choose between nuclear energy and renewable energy.[5] Sovacool et al. argue that, depending on its scientific and technological capabilities and industrial characteristics, each country tends to focus on the type of energy—either nuclear or renewable—that is more suitable for its own context.[6]

While South Korea is not the only country faced with having to choose between energy sources, its unique governmental structure exacerbates this dilemma, making it particularly difficult to focus on either nuclear or renewable energy in the long term compared to other countries. South Korea operates under a single-term presidential system, with two major parties alternating in power. The presidential term is five years, and since 1992 the two major parties have taken turns holding the presidency. Notably, since 2012, neither of the two major parties has won two consecutive presidential elections. Furthermore, in both 2017 and 2024, the presidents were impeached and power changed hands early, leading to abrupt shifts in energy policy each time. As a result, it has been particularly difficult to maintain consistent, long-term energy policies in the ROK.[7]

In the South Korean presidential system, the president holds absolute power within the executive branch during their term. While most major policies pursued by the president require approval from the legislature (the National Assembly), the president still has considerable autonomy and exclusive power to advance policies during their term and to instruct bureaucrats within the administration to implement these policies. Because of the concentration of power in the presidency, it is typical for one of the two major parties to dominate both the legislative and executive branches in a given term.[8] When this happens, it is common for whichever party is in power to oppose policies introduced by the other party in order to gain support from their electorate. The current ROK government's emphasis on a nuclear-centric policy and clean energy sources such as hydrogen, in contrast to the previous government's anti-nuclear and pro-renewable energy policies, can also be attributed to these political dynamics, stemming from the backlash against the policies pursued by the previous administration.

Furthermore, while the president may be an expert in a specific field, they cannot be proficient in all areas. Because of this issue, in addition to the tendency to serve only one five-year term, it is practically impossible for any president to fulfil their campaign promises in full. Therefore, there is a need for mechanisms at the national level to prevent policies from being implemented without professional knowledge and long-term planning. Bureaucratic groups, especially technocratic groups consisting of skilled experts, can complement the shortcomings of political leaders in terms of tenure and technical expertise by executing policies or even proposing new ones in response. In other words, the pledges and plans of political leaders, constrained as they are by limited tenure and a lack of specialized expertise, could be transformed into refined and actualized goals through the decision-making process of bureaucratic groups with long-term tenure and expertise. This decision-making model has already been well articulated by scholars such as G. T. Allison and Zelikow.[9]

However, the government still has an impetus to adhere to international standards. Its technocratic groups display functionalist characteristics from an international political perspective, interacting with the international community in their respective fields to formulate policies. As argued by the Neo-functionalists, interaction and network-building among technocrats lead to supranational cooperation.[10] ROK

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Benjamin K. Sovacool et al., "Differences in Carbon Emissions Reduction between Countries Pursuing Renewable Electricity versus Nuclear Power," *Nature Energy* 5, no. 11 (2020): 928–35.

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Sovacool et al., "Differences," 929–31

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Sung-Young Kim and John Byrne, "South Korea's Green Growth Strategy: The Role of the State and the Politics of Energy Transition," *Energy Policy* 54 (2013): 293–95.

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W. P. Shively, *Power & Choice: An Introduction to Political Science*, 16th ed. (McGraw-Hill, 2022), 339–42.

9
G. T. Allison and P. Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis*, 2nd ed. (Longman, 1999).

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Ernst B. Haas, ed., *The Uniting of Europe: Political, Social, and Economic Forces, 1950–1957*, 3rd ed. (University of Notre Dame Press, 2004).

government bureaucrats are well aware of the potential damage that could arise from delays in implementing the net-zero strategy. Through constant exchange and dialogue with international regulatory bodies and foreign officials, they recognize that while there may be delays in achieving the ROK's carbon neutrality goals, the goals themselves will not be abandoned. In other words, while there may be disagreements regarding the method and timing for achieving carbon neutrality, there is no opposition to the objective itself.

The ROK's energy landscape and the issue of nuclear phase-out through a top-down approach

The competition between renewable energy and nuclear energy in Korea began in earnest in 2017, when the Moon Jae-in administration was inaugurated and declared the nuclear phase-out policy, which was one of its presidential campaign pledges. This was because following the Fukushima nuclear disaster in neighbouring Japan in the early 2010s, the Korean public began to question the safety of nuclear power. The Moon administration announced a phase-out of nuclear power, reducing its share of the national energy supply while at the same time shifting the focus to renewable energy such as solar and wind power. Consequently, from 2017 on, the share of nuclear power in Korea began to decrease and the share of renewable energy began to increase.[11] However, due to the economic difficulties caused by COVID-19 in 2020, the share of nuclear power increased again as a result of rising energy costs. Nevertheless, even during this period, the policy of gradually phasing out nuclear power plants and focusing on renewable energy remained unchanged.

The conservative party, which had utilized nuclear power as the main source of national energy until 2017, strongly criticized this nuclear phase-out policy and the renewable energy-centred energy strategy. As a result, the competition between nuclear and renewable energy became not just a technical issue but a central topic of political conflict.[12] In the 2022 presidential election, Yoon Suk-yeol, the candidate from the conservative People Power Party, pledged to halt the nuclear phase-out and adopt a nuclear-centred energy policy. After Yoon was elected president, the Moon Jae-in administration's nuclear phase-out and renewable energy-focused policies were scrapped. Yoon's government resumed construction of nuclear reactors that had been suspended, set ambitious targets for increasing the share of nuclear power in the energy mix, and positioned nuclear energy as a core driver of the country's energy policy.[13]

Before Yoon's impeachment, his administration pursued a nuclear-friendly policy, for example by increasing the nuclear-related policy budget by 1,498 per cent in 2023. In contrast, the budget for renewable energy sources such as solar and wind power, which were focal points of the previous administration's energy strategy, was reduced by about 43 per cent.[14] Replacing fossil fuel–based sources while maintaining existing levels of power generation is not easy through renewable energy methods. Moreover, there are challenges associated with renewable energy sources. Solar energy faces issues such as the disposal of panels, while wind power encounters problems related to environmental degradation in installation areas such as mountainous regions as well as relatively low energy efficiency.[15] Against this backdrop, nuclear power quickly re-emerged as a cornerstone of the ROK's energy industry.

However, the nuclear focus from 2022 through early 2025 still failed to resolve

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World Nuclear Association, "Country Profiles: Nuclear Power in South Korea," accessed June 22, 2025, https://world-nuclear.org/information-library/country-profiles/countries-o-s/south-korea.

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Lyong Choi and Yejun Kim, "Comparative Research on Nuclear Energy Policies in the Republic of Korea and Germany: The Influence of Demographic Factors, Local Acceptance, and Geopolitical Factors," *Gukje Gwangye Yeongu* 29, no. 2 (2024): 172.

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Han Kyu Joo, "Tasks for the Yoon Suk-yeol Administration's Energy Policy," Sejong Institute, June 19, 2023, https://sejong.org/web/boad/1/egoread.php?bd=2&itm=&txt=&pg=1&seq=6494.

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Kim, "Yun Chŏngbu," 2023.

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ROK Government Agencies, "New Government's Energy Policy Direction (Draft)," 2022, 3–5, https://www.kier.re.kr/resources/download/tpp/policy_220705_data.pdf.

South Korea's energy dilemma and remains part of the Yoon Administration and his party's political agenda. Even the South Korean citizens who chose Yoon as their president do not welcome nuclear facilities to be constructed in their towns. Korean citizens continue to raise concerns about the structural problems of nuclear energy, and even in regions that support the conservative party, scepticism toward nuclear power is common. Two main reasons have deepened this public scepticism toward nuclear energy in South Korea. First, conflicts have arisen between regions over the construction of nuclear power plants. Second, interest groups associated with nuclear power tend to tend to lobby for it in order to obtain more resources.

Nuclear plants are located in the ROK's southeastern and southwestern coastal regions, serving as a factor of inter-regional conflict. They are concentrated in areas far from the densely populated and industrialized capital region. In other words, the major energy consumption areas are at significant distances from the energy production areas. Areas hosting nuclear power plants have a markedly negative perception of them due to concerns about the disposal of radioactive waste generated from nuclear fuel after use. Such concerns have been exacerbated by incidents such as the Chernobyl and Fukushima meltdowns.[16] The strategy of maintaining nuclear power production at 30 per cent of total energy, as advocated by the Yoon administration, fundamentally relies on the construction of new nuclear plants and the decommissioning and remodelling of aging plants. However, due to strong opposition from local residents, these plans for physical additions and replacements of nuclear plants are challenging to implement on schedule. These residents are no longer willing to bear the risks of living near a nuclear power plant, even if some compensation is offered. The majority of residents show strong opposition or high scepticism toward nuclear power.[17]

The divide between energy demand and production areas remains a source of conflict among supporters of the conservative party. Even during Yoon's candidacy, many voters in the capital region, especially those residing near proposed plant construction sites, showed little willingness to accept the installation of nuclear power plants. These voters in major power consumption areas argue that locating high-risk facilities like nuclear power plants in densely populated areas is hazardous.[18] This logic applies equally to technologies such as SMRs (small modular reactors), which are considered suitable for addressing the issue of separate demand and production areas. Ultimately, apart from the Shin Hanul nuclear power plant, for which construction plans were already established in 2005 but which has faced prolonged delays in breaking ground, there are very few additional construction projects underway.

Next, there is an issue of interest group formation among the leaders in the nuclear industry, which has negatively influenced the perception of nuclear safety. As mentioned earlier, nuclear power has been at the core of the ROK's national energy industry for a long time. As a result, the influence and number of elites in the nuclear field has grown. However, the technical complexity of nuclear technology and its inaccessibility to the general public pose challenges for political oversight and supervision. Consequently, in the 2010s, amid growing doubts about nuclear safety following the Fukushima disaster, several scandals emerged in the ROK, strongly reinforcing the perception that Korean nuclear power plants were not safe. The aforementioned consolidation of interests within the nuclear industry had led to problems of lax oversight and inadequate safety assessments.[19] In response, the denuclearization policy of the Moon Jae-in administration in the late 2010s aimed

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P. A. Speed, "South Korea's Nuclear Power Industry: Recovering from Scandal," *The Journal of World Energy Law & Business* 13, no. 1 (2020): 51, https://doi.org/10.1093/jwelb/jwaa010.

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Speed, "South Korea's Nuclear Power," 52–54.

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Kyeonggi Ilbo, "4Myŏng Chung 3Myŏng 'Wŏnjaryŏkpaljŏn P'ilyo'... Kŏjuji Sŏlch'inŭn 'Pandae'" [Three out of Four People Believe "Nuclear Power Generation Is Necessary" ... Opposition to Installation Near Residential Areas], *Kyeonggi Ilbo*, November 7, 2023, https://www.kyeonggi.com/article/20231107580018.

19
Speed, "South Korea's Nuclear Power," 53–54.

to reduce reliance on nuclear power, which was perceived as being of questionable stability in the energy sector.

However, entrenched interest groups have consistently lobbied in favour of nuclear power, and despite a situation where nobody welcomed the installation of nuclear power plants near their homes, the president-elect campaigned successfully on a pro-nuclear policy platform. This paradox originates from the ROK's political system. The ROK operates under a presidential system in which the executive shares power with the legislature, the latter being elected by plurality vote in single-member districts. Such government and electoral systems, which produce a single president and members of the National Assembly representing individual constituencies, naturally result in only two parties effectively wielding power. Furthermore, because the ruling party frequently changes, this often leads to abrupt shifts in policy direction in certain fields. The characteristics of this dominant two-party system and presidential system have ultimately led to a top-down framing of major energy policies by the president and an elite minority group. As a result, regardless of public perception or necessity, nuclear power was promoted again by the Yoon government until his impeachment. Currently, nuclear power does not contribute to reducing the reduction of carbon emissions. While expanding nuclear power plants could potentially achieve this, the reality is that the construction or remodelling of nuclear power plants is practically impossible due to regional conflicts. Due to population decline, many regions oppose the extension of nuclear power plant operations or the construction of additional plants, except for Uljin, which is actively seeking to host the aforementioned Shin Hanul Nuclear Power Plant. As Choi and Kim (2024) demonstrate with data, Unit 1 of the Kori Nuclear Power Plant in Busan, a densely populated industrial area, has already ceased operation, and public opposition to building additional nuclear plants is even stronger than the opposition in less populated areas.[20] As a result, the Yoon Suk-yeol administration's plan to increase the share of nuclear power to over 40% was seen as unlikely to materialize, and with President Yoon's impeachment in 2025 and the subsequent change of government following the presidential election, its implementation became even more improbable.

In June 2025, with the inauguration of the new Lee Jae-myung administration, the emphasis was once again placed on the use of renewable energy. At the same time, it was anticipated that this would lead to a reduction in the share of nuclear power.[21] However, just as support for nuclear power was not responsible for the election of Yoon, support for renewable energy itself was not the reason for the election of a progressive government under President Lee Jae-myung. Given soaring energy demands and cost issues, it is also questionable whether the Lee administration's renewable energy-centred policy can be sustained in the long term. If the political focus continues to alternate between renewable energy and nuclear energy, it could pose significant problems for Korea's long-term energy goal of net-zero emissions. As mentioned, Korea has yet to succeed in reducing its carbon emissions, largely because whenever a new party comes into power—which has been the case after every presidential election since 2012—they fundamentally redesign energy policy and thereby increase the surrounding confusion. Ultimately, there is a need to explore other energy sources, which are not being which have not entered the political discussion. For this purpose, greater emphasis should be placed on bottom-up decision-making involving policy practitioners and stakeholders, including citizens and businesses. Additionally, evidence-based decision-making

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Choi and Kim, "Comparative Research on Nuclear Energy Policies," 187.

21
JoongAng Ilbo, "With Lee Jae-myung's 'Energy Highway' in Full Swing, the Power Cable Industry Thrives While Nuclear Power Remains on Edge," June 8, 2025, https://www.joongang.co.kr/article/25342087.

should be prioritized in energy production methods, while efforts should be made to prevent specific sectors from becoming a political agenda.

Exploring solutions: A bottom-up approach to clean hydrogen production plans and green technologies

Despite the top-down approach to policymaking within the government, agencies responsible for climate change and energy policies in the ROK such as the Ministry of Trade, Industry, and Energy (MOTIE), the Ministry of Environment, and the Ministry of Foreign Affairs are actively engaging with businesses to steer the country towards meeting international standards. MOTIE, for instance, is promoting the development of green technology talent through initiatives aimed at developing expertise to achieve carbon neutrality. Additionally, the Ministry of Environment and the Ministry of Foreign Affairs are collaborating with like-minded nations to advocate for the inclusion of high-efficiency energy sources such as nuclear power and hydrogen, which emit no carbon, into international standards.

With the recent outcome of COP-28 leading to an increased emphasis on nuclear power and hydrogen in international energy dialogues related to climate change, South Korean government agencies are receiving further support for their efforts in the hydrogen energy initiative.[22] In turn, these agencies are actively encouraging institutes and companies to develop green technologies and file patents through proactive communication. They provide financial support for such technological advancements to assist companies in their operations. Government officials are promoting collaboration between the public, private, and academic sectors through these green technology support programmes to drive progress toward net-zero emissions. In the next chapter, this study will introduce the reasons and process behind the government's selection of hydrogen, particularly clean hydrogen, as a future energy source, and outline the policies being pursued for this purpose. It will also describe the direction in which hydrogen energy development is progressing.

The rise of hydrogen energy: The role of technocrats

As neofunctionalists argue, governments do not consist solely of policymakers; technocrats, through their expertise, propose alternatives to overcome the difficulties of policy decision-making.[23] Korean government technocrats are proposing a third type of energy source—distinct from renewables and nuclear power, both of which have become political agenda, such as a lobby activities of interest groups—and are gradually developing this third energy source before it, too, becomes a political agenda. From this perspective, technocrats are pursuing various policies aimed at commercializing hydrogen energy, expanding the energy supply through hydrogen, and reducing carbon emissions. Like nuclear power, hydrogen is not classified as a renewable energy source, but it is considered a green energy source because it emits less carbon than fossil fuels. Furthermore, based on green hydrogen standards, it emits even less carbon than nuclear or renewable energy sources.[24]

The ROK government's plans for hydrogen energy development have been actively pursued since the early 2010s. Through the Hydrogen Economy Achievement and Vision Report (October 2021), the government announced that as of 2020, approximately 220,000 tonnes of hydrogen were being produced.[25] This accounted for only about 1 per cent of total power generation, with approximately

22
World Nuclear News, "COP28 Agreement Recognises Nuclear's Role," *World Nuclear News*, December 13, 2023, https://www.world-nuclear-news.org/articles/cop28-agreement-recognises-nuclear-s-role.

23
Haas, *The Uniting of Europe.*

24
Michael Pehl et al., "Understanding Future Emissions from Low-Carbon Power Systems by Integration of Life-Cycle Assessment and Integrated Energy Modelling," *Nature Energy* 2 (2017): 939–45.

25
Ministry of Trade, Industry, and Energy, "Achievements and Vision of Korea's Hydrogen Economy Policy," May 2022, 6–7.

20 refuelling stations in operation. It was also reported that the production method relied entirely on fossil fuel-based generation and extraction. In summary, the ROK was producing hydrogen through the grey hydrogen method, which involves carbon emissions, and the amount produced was relatively low, making it insufficient as a means to achieve carbon neutrality at present. The self-sufficiency rate was also limited, standing at 13.2 per cent. However, the ROK government aims to transition gradually to supplying hydrogen exclusively through green and blue hydrogen methods by 2050, with a self-sufficiency rate target of 50 per cent. Additionally, the goal is to achieve over 20 per cent of power generation from hydrogen by that time.[26]

The ROK government's emphasis on hydrogen energy is becoming stronger over time. Since the adoption of CF100 in 2022, which includes nuclear power and hydrogen, essentially phasing out RE 100, hydrogen supply has become not just a choice but a necessity. While RE 100 allows states and companies to use renewable energies, CF 100 allows other green energies. With nuclear power facing significant challenges even in maintaining its current status, achieving carbon neutrality through hydrogen appears to be the most realistic alternative. Moreover, for energy independence, hydrogen is a notable energy source for the ROK. As a major energy-importing country (ranked fourth globally), the ROK heavily relies on imported fossil fuels, which constitute the largest share of the energy supply since domestic extraction is not feasible. Additionally, for another key energy source—nuclear power—the ROK relies entirely on imported enriched uranium fuel for its main reactor, the pressurized heavy water reactor (PHWR), due to the US-ROK nuclear cooperation agreement.[27] Currently, hydrogen production relies on fossil fuels such as oil and natural gas, leading to a dependence on imports. However, it is anticipated that if the production of green hydrogen—which uses renewable energy for the electrolysis of water—becomes mainstream, it could dramatically reduce the heavy dependence on foreign energy sources.

The transition to green hydrogen as part of the country's energy policy was not solely driven by the government. As mentioned, technocrats from government agencies have close relationships with Korean companies and research institutes. Policymakers in the government refer to research and prediction reports from research institutes and actively gather opinions from business executives to formulate national energy policies. Moreover, companies willing to acquire or develop relevant technologies for green hydrogen are encouraged to bid for government funding to achieve the policy goals set by the government. Future funding is sustained based on achieving these goals. Beneficiary or potential beneficiary companies provide feedback on these support policies to enhance efficiency in achieving the government's long-term objectives. Furthermore, companies aiming to generate profits through these support programmes can strive for innovation through R&D efforts. Like other technologies, if innovation occurs in green tech, carbon neutrality goals can be achieved faster than anticipated.

The ROK government, with the MOTIE at the forefront, has pledged to gather opinions from the private sector, including businesses, on how to boost green hydrogen production. MOTIE has set the goal of producing 1,000 tonnes of green hydrogen annually by 2050, having focused on research and development funding for universities and businesses since 2022.[28] In September 2023, the Korean government declared regulatory innovations related to green hydrogen and planned to establish a public-private consultative body to facilitate mass

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Ibid.

27
Due to the US-ROK nuclear agreement, the ROK cannot enrich uranium without US approval. In the 1970s, there were diplomatic tensions between the ROK and the US due to suspicions of a nuclear weapons programme. To ensure that the ROK does not pursue nuclear weapons, a prohibition on uranium enrichment was included in the US-ROK nuclear agreement.

28
Ministry of Trade, Industry, and Energy, "Support for Demonstrating Annual Production of 1,000 Tons of Green Hydrogen for 26 Years," press release of April 6, 2022.

production of green hydrogen.[29] In 2024, the Korean government established the Clean Hydrogen Portfolio Standards, a clean hydrogen auction market, to create an ecosystem for hydrogen energy supply and trading. Additionally, in 2024, Korea began constructing large-scale fuel cell power plants. For example, the Shinincheon Bitdream fuel cell power plant, with a capacity of 78.96 MW, is being built with the goal of starting operations in 2028.[30] Moreover, a 3,000 GWh–scale clean hydrogen power generation tender is scheduled in 2025, aiming to achieve both a stable electricity supply and carbon neutrality through hydrogen-based power generation.[31]

The Korean government also supports workforce development programmes for nurturing green technology in universities and other educational institutions. Universities not only provide technological research similar to businesses but also foster and supply the manpower necessary for such research. Since 2022, the MOTIE has initiated the Energy Manpower Development Programme, providing research funding to graduate schools to cultivate energy-related technological talent, with a focus on hydrogen and renewable energy.[32] Many universities in Korea have actively pursued institutional development through government research funding, given the persistently low birth rate and prolonged stagnation of tuition increases.

The Korean government recognizes the efficiency of hydrogen, especially green hydrogen, in achieving carbon neutrality, and is actively supporting the development of green hydrogen through assistance to businesses, research institutes, and universities. However, the Yoon government allocated significantly more funding to maintaining existing nuclear power projects while reducing support for renewable energy sources such as solar and wind power. Considering the limitations of nuclear power and the approaching deadline for carbon neutrality, it has become increasingly necessary to raise investment in the field of green hydrogen. However, merely increasing funding may not be sufficient; there is a need to introduce efficient support measures and focus investment more intensively. The next section will propose necessary measures for Korea to rapidly achieve carbon neutrality through the supply of green hydrogen.

Policy proposal: Restructuring human resource development programmes and optimizing green hydrogen technology acquisition through international collaboration

Despite the contribution of MOTIE's human resource development programmes to the training of energy technology and policy-related personnel, it is anticipated that there will still be a shortage of university-trained personnel at the level demanded by businesses. While many of Korea's major engineering universities have shown interest in energy human resource development programmes, only a few universities have been selected although these universities are not far better than their competitor in terms of technologies and expertise. The unfortunate result is that the competition between universities is more pronounced than their concentration on achieving human resource development goals. MOTIE already supported projects across three phases until 2025, and plans to continue supporting such initiatives in the future. However, the current system, which has repeatedly selected one or two applicants from multiple universities with similar competitiveness, wastes a significant amount of time and effort in the selection process. Moreover, crucially, if previously selected universities fail in their operations and are unable to generate

29 Ministry of Trade, Industry, and Energy, "Supporting Domestic Production of Green Hydrogen through Regulatory Innovation—Promotion of Regulatory Improvement in Hydrogen Production Field including Standardization of High-pressure Electrolysis Facility Safety Standards," press release of September 19, 2023.

30 CMS, "Hydrogen Law, Regulations & Strategy in South Korea," CMS Expert Guide to Hydrogen, accessed June 21, 2025, https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/south-korea.

31 Park Yoon Seok, "Discussing the Present and Future of Low-Carbon Power Supply Systems: Sharing Energy Storage Technology and Clean Hydrogen Power Bidding Market," *Electric Power Journal*, May 15, 2024, https://www.epj.co.kr/news/articleView.html?idxno=36273.

32 Korea Institute of Energy Technology Evaluation and Planning, "2024 Energy Technology Development Project Planning Report: Energy Workforce Development—Nuclear Energy Sector New Program," 2024, https://grant-documents.thevc.kr/200277_2024%EB%85%84%EB%8F%84+%EC%97%90%EB%84%88%EC%A7%80%EC%9D%B8%EB%A0%A5%EC%96%91%EC%84%B1+%EA%B8%B0%ED%9A%8D%EB%B3%B4%EA%B3%A0%EC%84%9C_%EC%9B%90%EC%9E%90%EB%A0%A5.pdf.

results, it may be difficult for the projects to continue. This could create the results, these human resource development projects face the risk of becoming no more than a costly dead-end. To address these issues, a post-evaluation method that aims to achieve mid-term goals and encourages competition by simultaneously selecting multiple universities that meet certain criteria could be more rational.

Furthermore, considering the current situation in Korea, there is a need to further encourage cooperation projects with countries that have successfully implemented green hydrogen supply in similar circumstances or comparable locations. Analyzing the trial-and-error experiences and know-how of these countries and accepting advanced technologies for green or blue hydrogen production through technology transfer or partnerships could lead to a more efficient pursuit of clean hydrogen goals. For example, the Netherlands, with its high proportion of maritime territory and favourable conditions for wind energy utilization, is making attempts (such as the PosHYdon project) to utilize wind energy in offshore plants to decompose seawater and produce green hydrogen.[33] Of course, these endeavours may not necessarily achieve the expected level of efficiency due to various factors such as cross-national environmental and economic conditions. However, by analyzing multiple cases, it would be possible to introduce or adapt technologies optimized for Korea. Moreover, for projects with a high potential for success, participating in funding or development can accelerate the adoption of technology or reduce the costs associated with its implementation.

Conclusion

As we have seen, the ROK's energy sector is undergoing rapid transformation. Since the 2010s, the ROK has introduced policies focused on renewable energy, such as solar and wind power, as concerns over the risks and environmental issues associated with nuclear power have escalated. However, due to efficiency concerns in light of carbon neutrality goals, the nuclear phase-out policy began to be reversed, and support for renewable energy policies has somewhat faltered. Nonetheless, negative opinions and perceptions about nuclear power still dominate Korean society, making it very challenging to achieve net-zero emissions through the nuclear policies of Yoon administration, for example by refurbishing aging nuclear plants or securing new nuclear sites. The ROK's limited land area and waste disposal issues also contribute to the inefficiency of renewable energy sources such as solar and wind power. Moreover, renewable energy sources have significantly lower thermal efficiency than nuclear power.

As a result, the ROK is now in a situation where it needs to focus on hydrogen, particularly green hydrogen that does not emit carbon. The ROK government agencies, primarily led by technical bureaucrats, make energy policy decisions. These technical bureaucrats complement and optimize policies planned by elected policy decision-makers such as the president. They actively engage in exchanges with the private sector, including companies and universities, sharing knowledge and improving accessibility to science and technology. Through such exchanges, government agencies establish detailed strategies for achieving energy policy goals such as net-zero and supplying the necessary workforce.

However, considering the rapidly changing international energy supply network and environment, there is a need to pursue new strategies for technology acquisition/development and workforce supply. Currently, approaches to green hydrogen or

33 For more information see the website of PosHYdon: https://poshydon.com/en/home-en/about-poshydon/.

blue hydrogen–related technologies are diverse, and it is difficult to determine the most effective approach. In this regard, it is recommended to collaborate with research institutions in multiple countries for technology transfer and development, and to utilize the ROK's the placement of talent to acquire technology

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