Issue Brief
May 23, 2024

South Korea's Road to Carbon Neutrality: Solutions and Obstacles

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Globally, energy security policies are gaining prominence as geopolitical tensions and climate concerns intersect. The escalating impacts of climate change, evident through extreme weather events like heatwaves, heavy snowfall, typhoons, and forest fires, underscore the urgency for action. In response, major developed countries are hastening their transitions towards a green economy to mitigate climate-related disasters and their socioeconomic fallout. Carbon neutrality has emerged as an irreversible international imperative, symbolizing a shift towards "low carbon, green growth" as a strategy for environmental conservation—addressing climate issues and transitioning to a low-carbon society—and a catalyst for economic growth, fostering the renewable energy industry and generating employment opportunities. South Korea has emerged as a pivotal player in the global transition towards carbon neutrality, driven by its strategic adoption of state-of-the-art green technologies and evolving policy frameworks aimed at reducing greenhouse gas emissions and promoting renewable energy sources.

Introduction

The Republic of Korea (ROK) has been at the forefront of carbon neutrality efforts for multiple reasons. According to the United Nations Framework Convention on Climate Change (UNFCCC), the ROK, between 1999 and 2011, witnessed the highest increase in greenhouse gas (GHG) emissions per capita globally due to the country's dependency on fossil fuels.[1] Therefore, the ROK has been pursuing state-of-the-art green technologies and has been adjusting its policy targets since 2008, under various administrations, in order to minimize GHGs and pollutant emissions and to substantially increase the share of renewable energy sources in its energy mix. While each administration had its own policies and vision vis-à-vis green technology and green transition, all strategies, despite various conceptual reshuffles, served to set the foundations of today's focus on carbon neutrality.

As of 2022, the ROK recorded an annual electricity

consumption of 12 exajoules, a 2.7 percent increase from 2021, in part driven by South Korea's emission-intensive industrial sector.[2] The ROK's energy mix is mainly composed of fossil fuels and nuclear energy, with over 90 percent of the overall energy consumed being imported.[3] In 2022, the ROK imported over one billion barrels of crude oil.[4] Despite this high degree of dependency on energy imports, domestic energy production has steadily increased over the last decade, with wind and solar power sources reaching 6 percent and nuclear energy 68 percent of the energy mix.[5] Furthermore, advancements in fuel cell technology have enabled the ROK to enhance its power generation efficiency using hydrogen and other fuel sources.[6] These alternatives offer a diverse and more sustainable approach to meeting the nation's future energy needs. The Korean government aims to raise the proportion of renewable electricity to 20 percent by 2030 and further to 30-35 percent by 2040.[7] This commitment involves a gradual phase-out of coal from the energy mix, accompanied by significant improvements in energy efficiency and fostering the growth of South Korea's emerging hydrogen industry.

The Foundations of Carbon Neutrality: From Lee Myung-bak to Moon Jae-in

The ROK has been engaged in environmental conservation and sustainable development efforts since the 1990s, with the UNFCCC in 1992 and later through the Kyoto Protocol in 2002. While efforts before the Lee Myung-bak administration might not have been labeled under the unitary overarching terminology of green growth, green transition, or even carbon neutrality, the ROK's early administrations implemented environmental policies and programs aimed at addressing pollution, natural resources conservation, and various initiatives to reduce air and water pollution and encourage energy efficiency. All these efforts laid the groundwork for the ROK's focus on green transition and carbon neutrality.

Starting with the Lee Myung-bak administration's inaugural Low Carbon Green Growth policy and the National Strategy for Green Growth, between 2008 and 2012, the ROK mainly focused on the research and development (R&D) of technologies

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specialized in gas emissions and pollution reduction. The Lee administration, on top of R&D investments, introduced tax incentives for eco-friendly industries, subsidies for projects focused on renewables, and various regulatory frameworks to encourage the adoption of green technologies across sectors.[8] However, there were limited penalties for industries that continued to rely on polluting practices and general overreliance on fossil fuels.

Under the two subsequent administrations, there was a major reshuffle of the government's conceptual understanding of green technologies. Under the Park Geun-hye administration, among 27 key technologies, the government identified six core technologies in three priority areas to combat climate change. These included solar cells, fuel cells, and bioenergy as alternatives to fossil fuel energy production. Additionally, efforts were made to advance rechargeable battery technology, IT applications for energy efficiency, and the implementation of carbon capture and storage (CCS) technology to reduce GHG emissions directly.[9] The Park administration maintained the previous administration's approach to incentives, with a specific focus on solar and fuel cells and penalties—or their lack thereof—for practices that furthered environmental degradation.

There were also several significant developments under the following Moon administration. In 2019, the government announced its 3rd Five-Year Green Growth Plan, and by the end of 2020, it finalized the Long-term Low Carbon Emission Development Strategies (LEDS). Furthermore, by May 2021, the Moon administration established the Presidential Commission on Carbon Neutrality and Green Growth and, through the National Assembly, spearheaded the Framework Act on Carbon Neutrality and Green Growth. By October 2021, green technology definitions were once again overhauled by a report published by the Ministry of Science and ICT, wherein the government identified 10 core carbon-neutral technologies.[10]

The Moon administration stood out for introducing a somewhat stricter mix of incentives and penalties to promote green technologies and transition. His administration increased funding for renewable energy projects, tax breaks for eco-friendly businesses, and subsidies for energy-efficient practices. Under the Moon Jae-in administration, penalties for discouraging polluting practices included increased fines, legal actions, license revocations, and public disclosure of violations, serving as deterrents and promoting environmental accountability. However, while the Moon administration pledged to phase out nuclear power, this commitment lacked broader collective support from other political forces or institutions, resulting in a mismatch between GHG emission reduction efforts and nuclear power production reduction, as well as inconsistencies in nuclear waste disposal policies and nuclear power plant exports.[11] Consequently, this lack of coherence led to a complete reversal of nuclear policies under the subsequent Yoon administration.

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The Yoon Administration's Course Correction

The Yoon Suk-yeol administration, once sworn into power in March 2022, presented a panoply of new priorities for energy and climate policy. Beyond reversing the nuclear power phase-out and re-establishing the ROK nuclear power plant ecosystem, Yoon has sought to scale up investments in renewable energies, the hydrogen industry, and carbon capture, utilization, and storage (CCUS) technologies.[12] The Yoon administration established the Presidential Commission on Carbon Neutrality and Green Growth in October 2022 and released its work plan in March of the subsequent year, presenting annual and sector-specific reduction targets.[13]

The government's objectives have been formalized in the 10th Basic Plan on Electricity Demand and Supply, which was concluded in January 2023, and the work of the Commission culminated in the drafting of the 1st National Basic Plan for Carbon Neutrality and Green

Growth, published in April 2023. The plan sets targets for an energy mix consisting of 32.4 percent nuclear, 19.7 percent coal, 22.9 percent LNG, and 21.6 percent new and renewable energy by 2030.[14] Proposed investment strategies include strengthening the emissions trading system and encouraging private investment through the completion of the "K-Taxonomy." While maintaining a high degree of focus on technological advancement, the Yoon administration, unlike its predecessors, focuses on a practical approach to energy and climate policy. The Yoon administration's energy policy direction has led to a decrease in the proportion of renewable energy compared to the 9th Basic Plan to set reasonable goals and balance energy sources. This approach, enshrined in the 1st Basic plan, outlines 37 mid- to long-term objectives for reducing GHG emissions across various sectors, alongside 45 policy objectives spanning six major sectors.[15]

Notably, the 10th Electricity Plan and the 1st Basic Plan expand the use of nuclear energy and clean energy, such as solar, offshore wind, and hydrogen power, and plan for reduced coal power generation. The government's plan is to retire 30 coal-fired power plants by 2034, out of the 59 currently operational.[16] Seven coal-fired power plants under construction will be completed as they were previously approved.[17] Meanwhile, the reversal of the nuclear phase-out entailed the pledge to spend 4 trillion won (USD3 billion) on nuclear energy research and the promise to extend loans to 1 trillion won and revised tax benefit-related laws. However, the Yoon administration has yet to assuage the concerns of residents close to nuclear power plants or anti-nuclear environmental groups regarding the management of nuclear waste, which is set to increase due to life extension and construction of nuclear power plants and given the country's lack of spent fuel storage or nuclear waste disposal sites.[18]

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The administration intends to reorganize decision-making processes to be more efficient, emphasizing expert involvement and consolidation of sub-committees. The policy direction includes harmonizing nuclear power with renewable energy, optimizing energy efficiency with ICT, establishing community-led carbon neutrality strategies, and resolving challenges through a pan-government support system.

The Future of Green Technology in ROK

Several challenges persist in South Korea's pursuit of carbon neutrality. The backsliding on renewable energy targets and the adequacy of the current GHG reduction targets remains contentious. The ROK's continued reliance on coal power will impact its ability to meet its carbon neutrality goals.[19] The ROK will "need to retire its operating power plants much earlier than the currently proposed age of 30 years and/or dramatically reduce their utilization rate."[20] Additionally, the submitted Nationally Determined Contributions (NDC) have been criticized by civil society groups as highly insufficient.[21] Several pending lawsuits from civil society and individuals concerning the NDC targets until 2030 further compound this issue.[22] Despite Yoon's party's loss at the National Assembly elections in April 2024, the ROK's nuclear strategy is poised to continue, albeit with hardships, given the opposition's favor toward renewable energies. The 2024 financial budget has seen a reduction in the prioritization of the ROK's net zero goals, and Seoul has been strengthening its ties with its

Middle East energy-producing partners since its phase-out of Russian energy, signaling a continued reliance on fossil fuels.[23]

From a technical and economic perspective, the feasibility of Yoon's commitment to nuclear power plants and other green technologies, such as hydrogen and CCUS, has been under scrutiny at all levels of interest groups, from civil society to academia.[24] Additionally, Yoon's objective to re-establish the country's nuclear power ecosystem is highly dependent on its ability to expand its exports of nuclear technology. An uptake in the ROK's efforts to boost its exports should be expected, especially in the context of its Carbon Free Energy initiative. Lastly, the ROK's energy rates and taxation need an overhaul to offer companies a clear direction in their contribution to carbon neutrality.

Moving forward, the Yoon administration will also continue international cooperation efforts devoted to climate and environmental conservation. However, the ROK's commitment to the reduction of GHG emissions seems to be mainly focused overseas, hence risking stifling domestic actions, as Seoul could purchase carbon offset credits to achieve its NDC emissions reductions.

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