A Comparative Study of Power Mixes for Green Growth: How South Korea and Japan See Nuclear Energy Differently

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Abstract: South Korea and Japan are two large contributors to global greenhouse gas emissions. In October 2020, President Moon Jae-in and Prime Minister Suga Yoshihide declared that their countries would aim for carbon neutrality by 2050. The Moon administration presented the Korean version of the New Deal that includes its Green New Deal, whereas the Suga administration completed its strategy aiming for green growth. Both countries emphasize the importance of energy transition through the expansion of green energy in power generation. However, they show some significant differences in dealing with nuclear energy. The purpose of this article is to compare the two countries’ energy policies and analyze the rationales and political dynamics behind their different approaches to nuclear energy. The study reveals that the contrast between the two political systems has resulted in differences between their policies. This study depends on comparative methods that use primary sources, such as governmental documents and reports by local news media.

Keywords: South Korea; Japan; energy policy; energy security; nuclear energy; carbon neutrality; green growth

1. Introduction

South Korea and Japan, two economic powerhouses in East Asia, had used very similar energy mixes until the Fukushima Nuclear accident occurred in 2011 [1]. Their greenhouse gas (GHG) emissions had been enormous; South Korea’s GHG emission recorded 694,066 tons of CO$_2$ equivalent in 2016 when the Paris Agreement entered into force, while Japan’s GHG emissions were 1,302,842 tons of CO$_2$ equivalent in the same year [2]. In 2020, the two countries announced their goal of achieving carbon neutrality by 2050. Almost simultaneously, on 26 October, Japan’s Prime Minister Suga Yoshihide declared that Japan would aim to create a carbon-neutral society by 2050 [3], and on 28 October, South Korea’s President Moon Jae-in declared the same goal [4].

Considering the commonalities between the two economies, such as a heavy dependence on imported fossil fuels for power generation, a manufacturing-oriented industrial structure, and the absence of energy infrastructure connectivity to neighboring countries, some might have expected that there would have been more similarities than differences between the two countries’ energy policies. While displaying similarities, however, the two countries have also shown significant differences in their approach to the de-carbonization of the power generation sector, particularly in their approach to nuclear energy.

This study aims to comparatively analyze the two countries’ current approaches to achieving the challenging goal of carbon neutrality by 2050 in the power generation sector. The article illuminates the similarities and differences between the two countries, and explains the political dynamics behind them. The layout of this article is as follows: the first section explains the theoretical framework and research methodology used, and provides a conceptual overview of the two countries’ energy policy-making processes and green growth. The second section presents a brief comparison between the two countries in terms of their economic and environmental performances. The third section comparatively
reviews how South Korea and Japan have internalized the trends of carbon neutrality and green growth within their own contexts and how their conceptualizations have been reflected in their approaches to the de-carbonization of the power generation sector. The fourth section analyzes the similar challenges faced by the two countries and their different views on nuclear energy. The fifth section discusses the structural differences between their decision-making processes and who the key players are in each system. The final section summarizes the findings of the study and presents its academic contributions and limitations.

2. Theoretical Framework and Conceptual Overview

2.1. Mill’s Canon and Nuclear

This study adopts John Stuart Mill’s method of “difference”. According to Mill, “if an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring only in the former; the circumstance in which alone the two instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon”. In other words, difference is established by comparing an instance of the occurrence of a phenomenon with an instance of its non-occurrence, instead of comparing different instances of the occurrence of the same phenomenon in order to discover how they agree [5].

As mentioned in the Introduction, South Korea and Japan share similarities. First, both are highly industrialized and open market economies. Second, neither of the two countries has natural resources to support their energy-intensive industries within their territories, which has made them prioritize energy security above anything else when designing their energy policies. The traditional meaning of “energy security” is “securing access to oil and other fossil fuels” [6]. Nuclear energy had been regarded as an energy source that can contribute to the self-sufficiency of the two countries, which both lack natural resources within their territories.

Nuclear energy was promoted and developed as a national project in both South Korea and Japan after the two countries decided to bring the relevant technologies from the United States in the early 1950s. South Korea’s first president, Rhee Syngman, and Japan’s Nakasone Yasuhiro, were well known as politicians who eagerly wanted to develop nuclear technologies in order to ensure their countries’ energy security. Especially in the wake of the two oil crises in the 1970s, nuclear energy received wide public support due its potential role in energy security. In addition, as the response to climate change became an important agenda for the two countries, the use of nuclear energy was increasingly legitimized because it is almost carbon-free.

More recently, however, the two countries’ approaches have diverged. Regardless of the Fukushima accident, Japan made a U-turn to its pre-Fukushima nuclear policy [7]. By contrast, the Moon Jae-in administration of South Korea decided to reduce its nuclear dependence, which is known as the “nuclear phase-out” policy. After his inauguration in 2017, President Moon announced that South Korea “would halt plans to build new nuclear power plants and would not extend the lifespans of existing ones” at a ceremony commemorating the permanent closure of Kori 1, the country’s first nuclear reactor, which had operated since 1978 [8].

Jasanoff and Kim suggested that nuclear energy policies represent the dynamics of conflict and compromise among civil society, governments, industry, and epistemic communities in national energy governance [9]. Chung and Kim also highlighted that nuclear energy policy is a product of the political process [10]. I hypothesize that differences in the decision-making structures and political systems of the two countries are the variable that made political views on nuclear energy diverge between South Korea and Japan. By using Mill’s comparative methods and carefully reviewing governmental documents and local news media reports as primary sources, I will verify the hypothesis above.
2.2. Who Are the Architects of Energy Policy in South Korea and Japan?

Both South Korea and Japan have been regarded as “developmental states” by many political scientists. Johnson highlighted the interventionist role of the Ministry of International Trade and Industry (MITI) that led Japan’s industrialization, and described Japan as a “developmental state” [11]. Woo-Cummings saw South Korea as a late follower of the developmental state model [12]. When analyzing the energy policy-making processes of the two countries, scholars have tried to verify the existing theory of the developmental state. For example, Samuels argued that the Japanese government functions as a “guarantor” that helps the market and minimizes conflicts in the process of energy policy-making [13]. Vivoda and Graetz described Japan as a “coordinated market economy” and highlighted that the energy policy-making process remains very centralized in Japan [14]. Kucharski and Unesaki emphasized the role of the Japanese government as a coordinator that adjusts conflicting interests in the market through using policy tools, such as regulations and advisory committees, when designing the country’s energy policies [15]. The Ministry of Economy, Trade, and Industry (METI) that replaced MITI in 2001 is the main institution that performs the role described above.

South Korea seems to be similar to Japan in terms of its strong government leadership; however, the process is more top-down. Under Park Jung-hee’s developmental dictatorship, the country’s energy policy is designed and implemented to support rapid industrialization by a strong central government. As the South Korean economy entered into a more mature stage, its energy policy turned in a new direction, that of green growth, which is to be discussed more deeply later in this study. According to Ha and Byrne, the then-President Lee Myung-bak was the architect of this new energy policy approach [16]. Lee compared the Lee Myung-bak (February 2008–February 2013) and Park Geun-hye (February 2013–March 2017) administrations and the Moon Jae-in administration (May 2017–), and analyzed how the different political coalitions impacted on the country’s energy policy-making [17]. In South Korea’s presidential system, the president and the president’s political coalition groups have more influence over the government’s energy policy-making process.

2.3. The Green Economy, Green Growth, and the Green New Deal

The United Nations Environment Program (UNEP) defines a “green economy” as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcity [18]. Meanwhile, the Organisation for Economic Co-operation and Development (OECD) conceptualizes “green growth” as economic growth and development, which ensures that natural assets continue to provide the resources and environmental services upon which our well-being rely [19], and outlined strategies for green growth in Towards Green Growth in 2011 [20]. The OECD distinguishes “green growth” from the “sustainable development” suggested by the United Nations by defining green growth as providing “a practical and flexible approach for achieving concrete, measurable progress across its economic and environmental pillars, while taking full account of the social consequences of greening the growth dynamic of economies” [19].

The term “Green New Deal” was first used by Thomas Friedman, a famous columnist for The New York Times, in 2007 [21]. Chomsky and Pollin define the “Green New Deal” as a bold vision of environmental economics, inspired by Franklin Roosevelt’s New Deal and guided largely by the logic of Keynesian economic approaches to growth, and highlight that there are different versions of a “Green New Deal”. They highlight that the question of how to overcome existing political, economic, and even cultural resistance to a “green economy” is a critical in order to achieve a zero-emission society by 2050 [22]. Meanwhile, Rifkin argues, “the transformation from a dying fossil-fuel-weighted Second Industrial Revolution to a smart green zero-emission Third Industrial Revolution is the very nucleus of the Green New Deal” [23]. Major economies, such as the US and European Union, now promote their own Green New Deal policies to achieve the goal of carbon neutrality and green growth.
3. South Korea vs. Japan at a Glance

3.1. South Korea

South Korea’s total Gross Domestic Product (GDP) was USD 1.647 trillion in 2019, which put it as the twelfth largest economy in the world [24]. The South Korean economy is heavily dependent on exports. At its highest, exports of goods and services were responsible for 54% of the country’s total GDP in 2012. The share of exports in the country’s total GDP has declined gradually as South Korea’s economic growth rate has slowed down; the share of exports was approximately 40% in 2019, which is still higher than that of other industrialized economies, such as Japan [25]. In addition, a substantial portion of South Korea’s total exports is from the steel and petrochemical industries, which require fossils as input sources and are at the same time intensively energy consuming. However, South Korea is inherently resource-poor, which makes it one of the world’s largest importers of raw materials, including petroleum, natural gas, and coal. In 2019, South Korea ranked as the ninth largest energy consumer in the world; 43% of its primary energy consumption was from petroleum and other liquids, 28% was from coal, and 16% was from natural gas [26]. Furthermore, South Korea has been dependent on fossil fuel-fired power plants; coal-fired power is still the dominant source of electricity generation (almost 40%), and natural gas-fired capacity is the second-largest source (26%) of the country’s electricity supply [26]. The industrial structure and its power mix contribute to the high figure of CO₂ emissions per capita in South Korea, which was 12.7 tons in 2019, an increase from 1.95 tons in 1970 at an average annual rate of 4.05% [27]. South Korea’s total GHG emissions reached 727.6 MtCO₂eq in 2018, and while its emission growth rates have slowed down since 2010, they were still recorded at 2.52% in 2018 [28].

In its first Nationally Determined Contribution (NDC) submitted to the United Nations Framework Convention on Climate Change (UNFCCC)’s 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (hereafter COP21), South Korea planned to lower its GHG emissions by 37% from the business-as-usual (BAU) level by 2030, across all economic sectors, i.e., from 850.6 MtCO₂eq (excluding Land Use-Land Use Change and Forestry (LULUCF)) to 535 MtCO₂eq, which earned wide criticism both domestically and internationally. After President Moon’s declaration of “2050 carbon neutrality”, South Korea announced its updated NDC on 30 December 2020; the updated target was to reduce the total national GHG emissions from their 2017 level (709.1 MtCO₂eq) by 24.4% by 2030, i.e., limiting national GHG emissions to 536 MtCO₂eq by 2030. Furthermore, South Korea would use its Emissions Trading Scheme (ETS), which covers 73.5% of the national GHG emissions, to meet its target [29].

The Climate Action Tracker (hereafter CAT), an independent scientific analysis that tracks government climate action and measures it against the globally agreed Paris Agreement aim of keeping global warming well below 2 °C, and pursuing efforts to limit warming to 1.5 °C, evaluated South Korea’s 2030 target as well as its existing climate measures as “Highly Insufficient” [30]. Al Gore, a former US presidential candidate, and now a globally known environmentalist, sent out his letter concerning South Korea’s newly updated NDC to President Moon. Gore observed that South Korea’s NDC of 24.4% below 2017 levels is only consistent with a warming scenario of 3–4 °C, and argued that it should be upgraded [31].

3.2. Japan

Japan used to be the world’s second largest economy, just behind the US, until its economic position was surpassed by China in 2010 [32]. However, Japan remains the third largest economy of a single country. With the size of USD 5.082 trillion in 2019, Japan’s economy is almost three times larger than South Korea’s economy [33]. Compared to South Korea, Japan’s economy is relatively less dependent on its exports, mainly because of its bigger domestic market. In 2018, 18.525% of Japan’s total GDP was from its exports, which was, historically, its highest-ever export share [34]. Iron-related products account for a bigger portion of its export total compared to those of South Korea, but the share
of petrochemical products is relatively smaller than South Korea’s [35]. Just like South Korea, however, Japan does not have natural resources to sustain its massive and highly industrialized economy, which makes it one of the largest importers of fossil fuels as well. Japan was ranked the world’s fifth-largest oil consumer and fourth-largest crude oil importer in 2019 [36]. In addition, Japan consumes enormous fossil fuels for power generation. Accordingly, Japan’s total level of GHG emissions is massive; Japan recorded about 1212 MtCO$_2$eq in 2019 [37], which made it the fifth highest single country behind China, the US, India, and Russia.

Even though Japan is also a highly industrialized economy and manufacturing is significant to the country’s economy, its CO$_2$ emissions per capita are much lower than South Korea’s; CO$_2$ emissions per capita in Japan were 9.09 tons in 2019 [38]. The low level of CO$_2$ emissions per capita in Japan is closely related to its energy efficiency level. Japan has continuously worked hard on improving Shō Enerugi (translated into “energy conservation”, meaning energy efficiency). Japan adopted its “Comprehensive Management under the Act on the Rational Use of Energy (hereafter in short, the Energy Conservation Act)” in 1979, right after the second oil crisis, in order to make its energy use more efficient. Aimura and Iwata explain that the Energy Conservation Act has been amended many times and it has evolved to address climate change [39]. According to the Agency for Natural Resources and Energy (ANRE) under METI, Japan’s energy efficiency level is one of the highest in the world; Japan’s score in 2013 was 1.0, which means it was much more efficient than the US (1.6), South Korea (2.3), China (6.2), and Russia (7.8) [40].

Although Japan’s total GHG emissions have been steadily decreasing, its high dependence on fossil fuels is still projected into massive GHG emissions. According to statistics from Japan’s Ministry of the Environment, the country’s total GHG emissions in 2019 were 1.21 billion tons, a 2.9% reduction from the 1.242 billion tons recorded in 2018, and a 14% reduction from the 1.48 billion tons recorded in 2013. Japan’s total GHG emissions have declined for six consecutive years since 2014, and if calculated as total GHG emissions per real GDP, they have been decreasing for seven consecutive years since 2013, which was the lowest level since 1990, when the country started collecting relevant statistics [37].

Japan’s original NDC at COP21 was a reduction of 26.0% by 2030 compared to the 2013 level (a 25.4% reduction compared to 2005). Although Japan’s long-term goal has become increasingly ambitious], its 2020 NDC did not show significant changes from its 2015 NDC. The Fifth Basic Plans for Energy adopted in 2018 set up the target of an 80% reduction of GHG emissions by 2050, and Prime Minister Suga declared carbon neutrality by 2050 in October 2020. Japan’s 2020 NDC emphasizes that the country has reduced its GHG emissions by over 8% between 2014 and 2017, and that it will continue to aim for a reduction of 26% by 2030 compared to 2013 (a 25.4% reduction compared to 2005) [41]. CAT rates Japan’s current NDC target under the Paris Agreement as “Highly Insufficient” [42]. Table 1 is a summary of comparison between South Korea and Japan in terms of its economic and environmental performances.

Table 1. Comparison between South Korea and Japan.

|               | GDP                        | Total GHG Emission | GHG Emission per Capita | Energy Efficiency | Original NDC | Updated NDC                  |
|---------------|----------------------------|--------------------|-------------------------|------------------|---------------|------------------------------|
| South Korea   | USD 1.647 trillion in 2019 | 727.6 MtCO$_2$eq in 2018 | 12.7 tons in 2019 | 2.3              | 37% from the business-as-usual (BAU) level by 2030 | 26.0% by 2030 compared to 2013 level (25.4% reduction compared to 2005) |
| Japan         | USD 5.082 trillion in 2019 | 1212 MtCO$_2$eq in 2019 | 9.09 tons in 2019 | 1.0              | 24.4% by 2030, from the 2017 level (▼709.1 MtCO$_2$eq) | 26% by 2030 compared to 2013 (25.4% reduction compared to 2005) |
4. Green Growth and the De-Carbonization of Electricity
4.1. South Korea’s Power Mix Outlook under Its Green New Deal

The Moon Jae-in administration recently presented its Green New Deal policies as a part of the Korean New Deal (KND), having suffered an economic crisis caused by the 2020 COVID-19 pandemic. For KND, the Korean government created the Council of Strategy for the Korean New Deal, which is chaired by the President. Under this council, there is the Government-Ruling Party Headquarters for Promoting the Korean New Deal. The heads of these headquarters are the minister of Trade, Industry and Energy, and the chief policymakers of the ruling party. The headquarters are composed of related ministries, such as the Ministry of Trade, Industry and Energy, the Ministry of the Environment, the Ministry of Employment and Labor, and the Ministry of Science and ICT. The Korean government explains that the KND has a two-plus-one approach; the Digital New Deal and the Green New Deal are two pillars in the plan to strengthen the Social Safety Network. In total, the Korean government plans to spend approximately USD 142 billion and aims to create 1.9 million jobs in the context of the KND. For the Green New Deal alone, the Korean government is planning to spend the largest portion, USD 65.21 billion out of the total USD 142 billion [43].

For the Green New Deal, the Korean government suggests three major goals: first, a transition to green infrastructure; second, the expansion of low-carbon Distributed Energy Sources (DER); and third, the creation of an ecosystem for green industrial innovation [44]. The second goal in particular is more directly related to the country’s energy policies, especially in the field of power mixes. Under the goal of the expansion of low-carbon DER, the Korean government plans to spend USD 31.8 billion while aiming to build a smart-grid system for the more efficient management of electricity distribution, to support the fair and green transition of conventional energy to renewable energy, and to expand forms of green mobility, such as Electric Vehicles (EVs) and Hydrogen Vehicles (HVs) [44].

Arguably, the most important question arising from these three goals is how rapidly and extensively South Korea can expand low-carbon DER and phase out the use of fossil fuels for power generation. South Korea’s total electricity consumption went down as its economic growth slowed down; it recorded 520.5 TWh in 2019, which was composed of 279.8 TWh for industrial purposes, 170.3 TWh for commercial purposes, and 70.5 TWh for residential purposes [45]. Considering the fact that South Korea’s domestic population hit its peak in 2020 [46], some might argue that the country’s total electricity consumption will keep going down. However, electrification is likely to be accelerated by the Digital New Deal, which aims at digital transformations amid the trend of the Fourth Industrial Revolution. Furthermore, green mobility also needs more electricity. Therefore, one can expect that the total level of electricity consumption will be maintained or even expanded. The share of electricity in the total energy consumption in South Korea has been around 19% over the last decade [45].

Reflecting these new realities, the Korean Ministry of Trade, Industry and Energy (MOTIE) completed The Ninth Basic Plan for Electricity Supply and Demand in December 2020. According to this plan, the Korean government estimated that the country’s total electricity consumption will be 620.2 TWh in 2030, and that the annual average growth rate will be 1.6% between 2020 and 2034 [45]. Addressing this growing demand, the Korean government plans to reduce the installed capacity of coal-fired power generation from the current level of 35.8 GW to 32.6 GW by 2030, while expanding the installed capacity of renewable energy from the current level of 20.1 GW to 58.0 GW by 2030. In addition, it plans to reduce nuclear capacity slowly, from the current level of 23.3 GW to 20.4 GW by 2030, by shutting down aged reactors and stopping new construction. It also aims at increasing the installed capacity of natural gas-fired power plants from the current 41.3 GW to 54.5 GW by 2030 by transforming selected coal-fired power plants into natural gas-fired ones [45]. However, because of the unpredictable nature of renewable energy, the Korean government expects that renewable energy’s share in the real power mix will only be
8.4 GW, which is equivalent to 6.9% of the total power generation in 2030, whereas coal’s share will be 26.1%, natural gas will account for 45.3%, and nuclear will provide 16.7% [45].

4.2. Japan’s Power Mix Outlook under Its Green Growth Strategy

Japan’s energy policy has maintained the three E principles: Energy security, Economic efficiency, and Environmental sustainability. Safety was added to the three Es after the Fukushima accident. Japan’s principles for energy policy formation are now known as “Three Es plus S”. Japan’s Fifth Basic Plan for Energy, adopted in 2018, aims to achieve a more diversified power mix by 2030 by thoroughly working on Sho Enerugi: according to the plan, renewable energy will be expanded and nuclear power plants restarted in order to enhance the efficiency of fossil fuel use and reduce energy demand. Renewable energy is a power source that generally matches the principles of 3E+S. Nuclear power, another low-carbon energy source, has been more controversial in Japan than in any other country considering the ongoing problems caused by the Fukushima accident. However, the Japanese government has gradually justified the reoperation of halted nuclear reactors based on the 3E+S principles. Despite the damaged reputation and reduced trust of Japan’s nuclear industry because of the Fukushima accident and its aftermath, the Japanese government sees both renewable and nuclear energy as sources that can contribute to de-carbonization and energy security. The Japanese government plans to increase power generation by low-carbon and self-sufficient energy sources, i.e., renewable and nuclear, from the 2013 level of 12% (11% from renewable and 1% from nuclear) up to 44% by 2030 [47].

After Prime Minister Suga’s declaration of the aim of carbon neutrality by 2050, METI presented an important document, Strategies for Green Growth together with 2050 Carbon Neutrality (SGG), in December 2020. The SGG document includes general plans for the following industries: (1) offshore wind power, (2) ammonia as a green/carbon-free fuel, (3) hydrogen, (4) nuclear power, (5) automobile/storage battery, (6) semiconductor and Information and Communications Technology (ICT), (7) shipping, (8) logistics, traffic, and civil engineering, (9) food, agriculture, forestry and fisheries, (10) aircraft, (11) carbon recycling, (12) housing/building and next-generation solar power, (13) resource recycling, (14) lifestyle-related businesses. The above 14 industries were selected as important fields for the green growth of the Japanese economy, and implementation plans for each field are outlined in SGG [48].

Among the 14 industries above, offshore wind power and nuclear power are the two that are directly related to the future of Japan’s power mix. Japan began supporting the introduction of wind power generation facilities in 1997. In 1998, the guidelines for grid-linked technology requirements related to the securing of power quality were rearranged, and the Renewable Portfolio Standards (RPS) Act was enforced in 2003. Since RPS was implemented, the capacity of wind power generation facilities has steadily increased, and there is an expectation that it will continue to increase in the future based on the Feed-In-Tariff (FIT) system, which was initiated in 2012 [49]. In fact, the capacity of wind power generation facilities in Japan steadily increased from 140,000 kW in 2000 to a cumulative total of about 3.63 million kW at the end of 2017. Although it is not in operation yet, the combined capacity of the approved facilities exceeds 9 million kW, and METI estimates the capacity will reach approximately 10 million kW by 2030 [50]. However, onshore wind farms face increasing challenges and limitations, such as local opposition, their compatibility with natural views, and their cost efficiency. That is why SGG emphasizes the potential of offshore wind power over that of onshore wind farms. The Japanese government plans to designate a zone of about 1 million kW consecutively over the next 10 years, setting a goal of introducing 10 million kW in total by 2030 and 30 to 45 million kW, including floating wind turbines, by 2040 [51].

Just like the Fifth Basic Plan, SGG also highlights that nuclear power is a proven and established low-carbon technology that can contribute to the de-carbonization of the power generation sector, and that it is necessary to utilize nuclear power as much as possible while
improving technological stability while gradually reducing the dependence on nuclear power in the longer term. In addition, SGG is calling for the continuation of innovation in nuclear technologies, as it is necessary for Japan to pursue all options, including nuclear power, while pursuing the aim of carbon neutrality by 2050 [48].

5. Comparison between South Korea and Japan

5.1. Similarities

Both South Korea and Japan seem to have taken the trend of carbon neutrality and green growth as an opportunity to transform and innovate in their economies, which had successfully developed only to have slowed down. Regardless of their deep interests in transformation and innovation, especially in the power generation sector, however, it is tremendously challenging for both South Korea and Japan to overcome their realities, such as their heavy dependence on fossil fuels for power generation, the limitations of their existing power grid systems, and market structures.

A quick overview on the two countries’ electricity industry might help to clarify these challenges. South Korea and Japan showed similarities in terms of deregulation; both accepted the trend of globalization with neo-liberalism and started liberalization efforts in the late 1990s, although South Korea’s actual policy program was implemented later than Japan, in the early 2000s [1]. In April 2001, South Korea carried restructured its power industry, which included the division of its power generation sector and the establishment of a competitive system. After the South Korean government announced the basic plan for restructuring of the power industry in 1999, the restructuring bill was passed in December 2000. Accordingly, in April 2001, the power generation division of the Korean Electric Power Corporation (KEPCO) (Naju, Korea) was spun out to six companies. Six companies are (1) Korea Hydro & Nuclear Power Co., Ltd. (KHNP) (Gyeongju, Korea), (2) Korea South-East Power Co., Ltd. (Jinju, Korea), (3) Korea Midland Power Co., Ltd. (Boryeong, Korea), (4) Korea Western Power Co., Ltd. (Taean, Korea), (5) Korea Southern Power Co., Ltd. (Busan, Korea), and (6) Korea East-West Power Co., Ltd. (Ulsan, Korea), and the Korea Power Exchange was launched. This completed the first stage of the restructuring policy. However, the transmission and distribution sector remained vertically integrated and KEPCO kept its monopoly.

The Japanese electricity market became fully liberalized through market reforms that started earlier than in South Korea, in April 1996. Through the first stage, independent power producers (IPPs), which supplied power to electric power companies, participated in the retail market. The second reform, conducted in March 2003, partially opened the retail market to “special high voltage users” that consumed more than 20 kV or 2000 kW of electricity, such as factories, department stores, and office buildings. The electricity grid that used to be monopolized by General Electric Utilities (GEU) was opened to Power Producers and Suppliers (PPS). In April 2003, the Electricity Enterprises Act was revised, and the Japan Electricity Power Exchange (JEPX) was established in April 2004, which was followed by the opening of the electricity grid to high voltage users consuming as little as 500 kW. The figure was further reduced to 50 kW in April 2005. Invigorating the wholesale market and improving the conditions of competition were goals of the fourth round of reform, undertaken in April 2008. Finally, in April 2017, the Electricity Business Act was amended to complete the full liberalization of the electricity market, which resulted in a completely competitive market [7]. However, the maintenance and management of the power grid are still operated by GEUs, such as Tokyo Electric Power Company (TEPCO) (Tokyo, Japan), Hokkaido Electric Power Company (Sapporo, Japan), Tohoku Electric Power Company (Sendai, Japan), Kansai Electric Power Company (Osaka, Japan), and Kyushu Electric Power Company (Fukuoka, Japan), which used to be regional monopolies. Utility companies that need to use the existing power grid to sell their electricity are required to pay a charge for the use of the power grid to GEUs. The electricity market in Japan is now overly competitive, with an increasing number of new entries, the so-called Shin Denryoku, and electricity charges are comparatively higher than in South Korea [52].
As analyzed above, South Korea and Japan have similarities in terms of the energy and electricity structures they have implemented while aiming for 2050 carbon neutrality. Given similar challenges, the two countries need to expand low-carbon energy sources for power generation as rapidly and extensively as possible. However, the key challenge facing DER, which for now mainly comprises renewable energy sources, is unpredictability. Renewable energy is intermittent, so the amount of supply varies depending on the time and weather conditions, and the demand for power changes. When Bulk Energy Sources (BER), such as existing nuclear power plants, continue to produce a certain amount of electricity and, at the same time, DER produces more electricity than is needed and/or calculated, problems can arise within the system. Power outages can occur if power is produced in excess of what can be received from the power grid. Without innovation and the distribution of Energy Storage Systems (ESS) and reforms of the existing power grid system, the expansion of DER per se can add some risks to the electricity market.

In South Korea, for example, Jeju Island, which is the largest island in the country and is listed as part of UNESCO’s world natural heritage, faces challenges caused by the problems mentioned above. Wind power companies operating large-scale power generation complexes in Jeju Island are suffering losses due to forced output restrictions. Because excessive electricity generation can overload the power grid and lead, in extreme cases, to massive power outages, wind turbines on Jeju Island have been shut down. The forced shutdown of wind turbines has increased every year on Jeju Island, from 14 times in 2017 to 16 times in 2018, 46 times in 2019, and 77 times in 2020. In 2021, by March, more than 30 restrictions over wind power output were made. The Korea Institute of Energy Technology Evaluation and Planning predicted that the number of times that the output of wind power on Jeju Island would be limited would reach 201 by the end of 2021 and 240 in 2022, taking into account the electricity supply and demand situation. As of 31 March 2021, the loss of operators due to the restrictions on wind power output was estimated to have been about KRW 6.5 billion over the previous seven years [53].

Japan has experienced similar problems. As the FIT price was cut from April 2014, the number of operators who wanted to be connected to the existing grid exploded in March of that year. In particular, applications in the Kyushu area, which is suitable for solar power generation, greatly increased. It was found that the amount of power generation would exceed total consumption if all requests were accepted. Therefore, on September 24, Kyushu Electric Power Co., Ltd. announced that all existing and new requests for grid connection would be suspended (except for residential solar power generation of less than 10 kW). Similar decisions were made in other regions, and this series of events was called the “first Kyushu Electric Power Shock”. In October 2018, Kyushu Electric Power applied further restrictions on the output of solar and wind power, which became known as the “second Kyushu Electric Power Shock” [52].

The expansion of renewable energy for power generation is not a simple task either for South Korea or for Japan, where transmission and distribution are vertically integrated and monopolized by giant-size firm(s). Therefore, it is important for both countries to design a balanced and strategic power mix between BER and DER until technological conditions are improved.

5.2. Divergence in Nuclear Energy

Because of the problems explained above, it is a very challenging but important task for both South Korea and Japan to maintain a good balance between BER and DER in the short- and medium-term, until infrastructural reforms can be implemented. Nuclear power is a baseload BER that can produce electricity stably without massive GHG emissions. The difficult question to answer is how large the nuclear portion should be in the two countries’ power mix while both are trying to expand their production of renewable energy.

The Moon administration (May 2017–) that replaced the Park Geun-hye administration, and the Suga administration (September 2020–) that succeeded the Abe Shinzo administration, have very different views on this question. However, the two countries used to show
a similar view on nuclear power, as explained in Introduction. Valentine and Sovacool categorized South Korea and Japan as nations that had staunchly supported nuclear power and highlighted the following six factors as common socio-political backgrounds of support for nuclear power between the two countries: (1) strong state involvement in guiding economic development; (2) the centralization of national energy policymaking and planning; (3) campaigns to link technological progress with national revitalization; (4) the influence of technocratic ideology on policy decisions; (5) the suppression of challenges to political authority; and (6) low levels of civic activism [54]. With this developmental state mindset, the two countries emphasized the contribution of nuclear power to energy security.

As climate change emerged as an internationally important topic, nuclear power earned another justification, as a carbon-free energy source, both in South Korea and Japan. Nuclear power used to be promoted as a “green energy”, especially during the years of President Lee Myung-bak. Lee argues that the Lee (February 2008–February 2013) and Park (February 2013–March 2017) administrations, from the perspective of the developmental state, supported nuclear power with a strong coalition between politicians, bureaucrats, the nuclear industry, and the nuclear energy epistemic community. However, the Moon Jae-in administration, which previously advocated “nuclear phase-out” as a political slogan and election pledge, propelled energy transition from nuclear energy to a decentralized renewable energy system [17]. The Moon administration decided to shut down permanently the two oldest reactors, Kori 1 and Wolsong 1, in June 2017 and in June 2018, respectively. At the end of 2020, a review report on the Energy Transition Assistance Act was released at the Trade, Industry, Energy, SMEs, and Startups Committee; according to this report, six new nuclear reactors, including Shin Hanul Units 3 and 4, and Cheonji Units 1 and 2, and 14 obsolete nuclear reactors were subject to major reductions [55].

Yoon Sun-jin, who is a professor at Seoul National University and the newly appointed chair for the Presidential Advisory Committee for 2050 Carbon Neutrality, shared the following view in her interview with a domestic newspaper in January 2021. While highlighting that it is not impossible to phase out both coal and nuclear energy, she emphasized the importance of technological developments, such as weather forecasting technology, methods to calculate electricity demand and supply, and energy storage systems (ESSs). She pointed out that maintaining a rigid power source, such as nuclear power, puts a huge burden on the system’s operation as renewable energy increases. She concluded that less nuclear power and slower renewable energy put less strain on the grid connection [56]. Yoon’s view can be understood as characteristic of the Moon administration.

By contrast, in Japan, where the Fukushima accident took place, and there are still ongoing problems, including radioactive wastewater and the restoration of local communities, nuclear power has been reevaluated as a low-carbon and self-sufficient energy source. When the Fukushima accident occurred, the ruling party of Japan was the Democratic Party of Japan (DPJ). The DPJ and then-Prime-Minister Kan Naoto (June 2010–September 2011) were widely criticized for mismanagement of the disaster, and the DPJ failed to maintain power [57]. The Liberal Democratic Party (LDP)’s Abe Shinzo came back to kantei (the Prime Minister’s office) in December 2012, and Japan conducted the full liberalization of the electricity market during his term (December 2012–September 2020).

Along with market liberalization, nuclear energy gradually restored its legitimacy, which resulted in the slow restarting of halted nuclear power plants. It is intriguing to look into the discussions at the Combined Committee for the Expansion of Renewable Energy, Next-Generation Power Grids, and Systematic Reform for Renewable Energy under METI, held seven times between July 2020 and February 2021. The Combined Committee critically evaluated the status of solar power, which has been rapidly expanded through the provision of government subsidies. The Combined Committee evaluated that FIT for solar power has added financial burdens and solar power facilities were vulnerable to natural disasters, such as typhoons, earthquakes, and landslides [58]. Instead, the Combined Committee emphasized the potential of offshore wind power. In addition, the Committee
for Nuclear Power under METI, which was held twenty-three times between June 2014 and April 2021, evaluated the contribution of nuclear power positively.

Sueyoshi, Ryu, and Goto observed that South Korea’s electricity industry outperformed Japan’s between 2014 and 2018, but pointed out that the difference in performance between the two countries has gradually diminished. The narrowing performance gap was partly due to the fact that Japan has been slowly recovering from the Fukushima accident and resuming its operation of nuclear power plants, while South Korea’s technological innovation activities have been inconsistent, which has resulted in the latter’s technical regression [1].

6. Discussion

It is academically intriguing to think about the reason why this difference came about. Facing very similar challenges, South Korea sees nuclear power as a risk that adds burdens to the country’s energy transition, whereas Japan sees renewable, especially solar power, as a risk. To understand Japan’s approach to nuclear power after the Fukushima accident, Calder’s analytical framework, “circles of compensation”, can be helpful. Calder previously proposed his analysis of how Japan’s policymakers used their institutional tools, such as income compensation, entitlements, and subsidies, to stabilize their society when crises occurred [59]. Calder enriched this earlier analysis, and explained that “circles of compensation” typically internalize benefits and externalize costs. According to Calder, the short-term benefits of nuclear power have been extensive and widely distributed among the parties involved, such as METI, host communities, supportive politicians, and related industries, whereas the long-term costs are less visible in normal circumstances and are externalized those lying outside the circle, such as accident victims and fishery communities [60].

Furthermore, we need to pay attention to Keidanren, the largest business association in Japan, and its influence. Aimura et al. discuss how Japan’s environmental policy has been undertaken by voluntary approaches; they highlight that voluntary approaches are conducted through negotiations with polluters and led by Keidanren [61]. It can be argued that interests and voices within the nuclear circle of compensation have been continuously reflected in Japan’s energy policies, including SGG, through negotiations among METI, the main policy-making institution for energy policies, and Japanese business.

In theory, South Korea’s situation is not fundamentally different from Japan’s situation. Like Japan, nuclear energy has been promoted and protected as a national project for many decades, which has created a similar circle of compensation composed of the nuclear industry, nuclear engineers/scientists, politicians promoting nuclear energy, and the government. However, since Moon, who pledged to clean up “deep rooted irregularities” during the 2017 presidential campaign after Park Geun-hye’s impeachment won him the election [62], nuclear power became regarded as a historically corrupt industry, or “jeokpye”, meaning “deep-rooted evils”. Nuclear power is not fully considered as an option for Korea’s Green New Deal by Moon’s political coalition groups, which include like-minded politicians, civil society activist groups, and the post-nuclear energy epistemic community [17], and the country’s current energy policy reflects their view.

The difference between the two leaderships’ views on nuclear power is related to the decision-making structures and political systems of the two countries. South Korea, as a strong presidential system, has a very top-down and centralized decision-making structure. How the presidential office, the Blue House, sees the situation penetrates into decision-making, and any decision made by an incumbent government can be dramatically reversed when a new leadership comes in. By contrast, Japan is a parliamentary cabinet system. Van Wolferen described Japan’s decision-making structure as a “truncated pyramid”, meaning that Japan’s political system lacks a peak governing body and a supreme institution with ultimate policymaking jurisdiction [63]. The Japanese government functions as a coordinator that narrows gaps between different industries and tries to avoid conflicts, which often results in incrementalism.
Furthermore, it is interesting to see the gap between public opinion and leadership in both South Korea and Japan. In South Korea, according to a recent survey about the image of Korea Hydro & Nuclear Power Co., Ltd. (KHNP) and nuclear power conducted at the end of 2020, more than 64% of the respondents answered that South Korea needs nuclear power, and the support rate has increased consecutively for the last four years. However, the majority (42.4%) answered that South Korea should reduce nuclear dependence in the longer-term, whereas 32% answered no [64]. On the other hand, the Japanese are more critical of nuclear energy. According to a recent survey performed by NHK to commemorate the 10th anniversary of the Fukushima accident, 50% of the respondents said that Japan should reduce its nuclear power plants, 29% said that Japan should maintain them, 17% said that Japan should phase out nuclear energy, and only 3% said that Japan should increase nuclear power. Meanwhile, 39% of the respondents were negative towards the reoperation of nuclear power plants, 16% were positive, and 44% said, “can’t pick either side” [65].

Regardless of the differences between their policy-making structures, there are gaps between public opinion and the leadership’s view on nuclear power both in South Korea and in Japan. This situation indicates that neither South Korea nor Japan has institutional mechanisms to fully reflect public opinion in their energy policy formation. In South Korea, the political will of the leadership and its political patrons’ works as the determining factor, whereas the interests of powerful businesses are carefully coordinated by the government and reflected in the government’s energy policy in Japan. Table 2 gives a comparative snapshot of nuclear power in South Korea and Japan.

Table 2. Comparison on Nuclear Power’s Position in South Korea and Japan.

|                | Seen as Green? | Seen as Risk? | Key Players                                                                 | Decide How?                      | Future Prospect                                                                 |
|----------------|----------------|---------------|----------------------------------------------------------------------------|----------------------------------|--------------------------------------------------------------------------------|
| South Korea    | Not necessarily| Yes           | Civil activist groups and “post-nuclear epistemic community (under the Moon administration)” | Top-down                         | Planned to be reduced but cannot be guaranteed because of the political system |
| Japan          | Yes            | Not necessarily| Related businesses, Keidanren, and METI                                   | Incrementalism and “Circles of Compensation” | Likely to increase                                                             |

7. Conclusions

This article comparatively analyzes how South Korea and Japan have internalized green growth under the pressure of aiming at carbon neutrality by 2050, which challenges they have encountered, and how they have been trying to overcome them. The study reveals that both countries need to create a balanced and strategic power mix that can contribute to the de-carbonization of the power generation sector. South Korea prioritizes energy transition, tries to substitute coal with natural gas, and plans to expand renewable energy while maintaining stability by reducing nuclear capacity. On the other hand, Japan tries to expand both renewable and nuclear energy in order to de-carbonize power generation. The main difference is in how the two countries’ leaderships see nuclear energy; the Japanese leadership sees it as a “green” one, whereas the current South Korean leadership sees it more negatively.

This study adds some value to the existing literature by comparatively analyzing the two countries’ decision-making structures and who the key players in them are. It is not a subject of this study to answer which system is better, and it is beyond the scope of this study to judge which country’s policies are more appropriate to achieve the goal of 2050 carbon neutrality. Of course, it is necessary to investigate how the key players in each system interact, and this requires a deeper analysis. These remaining questions should be the subject of future research.
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