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# Nuclear Power in South Korea's Green Growth Strategy

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## Introduction

Nuclear power has been an important, if understated, aspect of South Korea's National Strategy for Green Growth, a set of policies reflecting the idea that economic growth and environmental protection can be compatible activities rather than conflicting. Former president Lee Myung-bak did not mention nuclear power when he announced his administration's national vision for green growth in a 2008 speech, although nuclear power later made an appearance as one of ten major green growth policy objectives.<sup>1</sup> Arguing that nuclear energy use improves energy independence while mitigating carbon emissions, Lee championed a green growth framework that provided a new justification for South Korea to expand nuclear power at home and promote it abroad.<sup>2</sup> Plans are under way to increase nuclear power's share of the country's electricity generation from 33 percent to 59 percent by 2030.<sup>3</sup> In addition to the twenty-three reactors currently operating, five new reactors are under construction and eight more are planned.<sup>4</sup>

However, recent reports of safety and quality-control problems at nuclear power plants in South Korea have undermined public trust in the safety and reliability of the country's cheapest source of electricity.<sup>5</sup> Although South Korea has experienced no major nuclear accidents since its first reactor began commercial operations in 1978, the nuclear power rethink in many countries resulting from the March 2011 nuclear accident in Fukushima, Japan, has created an atmosphere that only heightens these concerns.<sup>6</sup> At the same time, the government must also secure public acceptance of new storage sites for radioactive waste from spent nuclear fuel—an issue that highlights how doubts about nuclear power's green credentials can clash with the desire to meet rising electricity demand with low-carbon sources. Complicating this situation is the new South Korean president Park Geun-hye, who must decide how to put her stamp on green growth.

## Linking Nuclear Power and Green Growth

South Korea's 1970s-era decision to adopt and expand nuclear power long predates the green growth initiative, although the two efforts share a common motivator: the quest for energy security in a country that is poor in energy resources and relies on imports to meet almost all its high energy demand. Currently, South Korea consumes more energy than all but ten other countries.<sup>7</sup> Added to the country's long struggle with energy security are the global economic slowdown of 2008–2009, a growing consensus about the need to tackle climate change, and the concomitant inability of global climate talks to achieve meaningful action on emissions reduction. These dynamics have recently given rise to the concept of green growth, which, under Lee's rubric, aims to curb carbon emissions while improving energy independence, create new engines of economic growth, and enhance South Korea's international standing. Although nuclear power—already firmly entrenched in South Korea's energy mix—seems tailor-made for achieving all three of these overarching goals, its broader impact on South Korea's energy landscape renders its use much more complex.

In an era of widespread concern about climate change, the emissions mitigation potential of nuclear power generation, which emits no carbon, provides a new leg on which South Korea's nuclear expansion ambitions can stand. According to a recent report by the International Energy Agency (IEA), South Korea's per capita CO<sub>2</sub> emissions increased 115.4 percent between 1990 and 2010.<sup>8</sup> The same report noted that electricity demand from all sectors “has grown significantly since 2000,” while “production of nuclear electricity increased by almost 50 percent over the same period.”<sup>9</sup> In 2009, the government of South Korea announced a voluntary target to reduce greenhouse gas emissions by 30 percent below the expected level by 2020.<sup>10</sup> The challenge of following through on this commitment while meeting increasing electricity demand provides double justification for South Korea's plans to expand nuclear power.

Expanding nuclear power is not the only way South Korea is attempting to reign in its carbon emissions. There is already a program in place that requires the country's top emitters to meet designated emissions reduction targets or face a financial penalty. An emissions trading scheme (ETS) is expected to take effect in 2015 and the government is aggressively pursuing a smart-grid strategy aimed at reducing demand by providing real-time consumption and pricing information to consumers. But these efforts remain works in progress, whereas nuclear power is longstanding and proven.

Determining the relationship between improved energy independence and nuclear power in South Korea requires an assessment of the country's electricity sources. Together, coal and natural gas account for two-thirds of electricity production in South Korea and nuclear energy accounts for most of the remaining third.<sup>11</sup> Coal—the majority of which is imported—is the largest single source of electricity, making up 45 percent of total electricity production.<sup>12</sup> Nuclear power expansion can

offset the need for additional imports of coal and natural gas, diversifying the energy mix and improving energy independence. Moreover, indigenous technology is now used in critical systems in new reactors; at a groundbreaking ceremony for two new reactors last year, President Lee noted that South Korea had “achieved the dream of independent nuclear technology.”<sup>13</sup> However, South Korea is wholly reliant on imported uranium and uranium conversion services to fuel its reactors.<sup>14</sup> This means nuclear energy is not entirely an autonomous power source for the country.

There is evidence that nuclear power expansion can create new engines of economic growth. A 2009 paper published by the Korea Atomic Energy Research Institute found that “the total net contribution of nuclear technologies as a percentage share of GDP amounted to 2.38 percent in 2005.”<sup>15</sup> This amount includes economic activity generated from the construction and operation of nuclear power plants as well as industrial output stimulated by the electricity produced from nuclear power. Furthermore, South Korea’s aggressive pursuit of new export opportunities for its nuclear expertise has already boosted economic growth. In 2009, a South Korean consortium won a bid to build four nuclear reactors in the United Arab Emirates (UAE), prevailing over competitors from Japan and France. According to projections by the International Atomic Energy Agency (IAEA), global demand growth for nuclear power is expected to continue, although at rates lower than predicted prior to the Fukushima accident.<sup>16</sup> Strategic marketing of nuclear power as a zero-carbon alternative to fossil fuels may enhance the country’s efforts to capture more of this market. In 2010, President Lee wrote in the journal *Global Asia*, “Nuclear is one of the most efficient power generation methods that will lead us to a low-carbon society, and I intend to make sure that [South] Korea keeps up with its role as one of the major suppliers of these zero-carbon power plants.”<sup>17</sup> He went on to say the nuclear reactors South Korea is building in the UAE would equal “40 million tons of carbon mitigation.”<sup>18</sup>

This UAE deal was a critical initial win in the country’s quest to export eighty nuclear reactors by 2030, which could reportedly total \$300 billion in sales for South Korea.<sup>19</sup> However, experts question the feasibility of this goal, noting it would require a significant uptick in production of nuclear reactors at a time of diminishing human resource capacity in South Korea’s nuclear industry.<sup>20</sup> Therefore, nuclear power’s future contribution as a green growth export engine is questionable.

Finally, nuclear power can serve the third pillar of the green growth strategy—enhancing international standing—in three ways. First, South Korea’s contract to build four nuclear reactors in the UAE is a major opportunity for South Korea to show it can deliver a nuclear power plant export on time and on budget while building safety credentials. One executive who was involved in the UAE contract decision cited “world-class safety performance” of South Korean plants as one reason for the win.<sup>21</sup> Other sources have emphasized the South Korean project’s smaller budget relative to those of other proposals.<sup>22</sup> Second, whereas some countries, such as Germany, responded to the Fukushima accident by retreating from nuclear power production, South Korea is taking the opportunity to promote nuclear safety, beginning at home. Following Fukushima, President Lee emphasized, “We must learn from the Fukushima accident and redouble our efforts to enhance nuclear safety in keeping up with new technology and demands of the times, and to restore public confidence.”<sup>23</sup> South Korea already houses the world’s first International Nuclear Safety School to train safety experts from other countries. This can be a basis for bolstering international collaborative

efforts on nuclear safety. Finally, nuclear power could also strengthen South Korea's international standing in an indirect fashion by serving as an important means for the country to deliver on its voluntary emissions reduction target. A report released by South Korea's Ministry of Knowledge Economy projecting electricity supply and demand indicates the country may overshoot the target by 10 percent in 2020.<sup>24</sup> In any case, if South Korea can meet its target, or make significant emissions reductions in later years, nuclear power will surely have played a role.

Nuclear power has an important role to play in South Korean green growth, especially as a near-term tactic for meeting rising electricity demand without increasing emissions. Its future as a green growth engine is buttressed by the cost advantage it enjoys over other forms of electricity generation. However, this potential is complicated by the task of regaining public trust in the safety of nuclear power and the debate over nuclear power's green credentials at a time when the government must secure public acquiescence to new storage sites for nuclear waste.

## Bolstering Public Trust in Nuclear Safety

Public confidence in the safety of nuclear power plummeted in South Korea after the March 2011 nuclear accident at Fukushima, Japan.<sup>25</sup> The monumental accident ultimately resulted in the idling of almost all of Japan's nuclear power plants. Promoting the expansion of nuclear power in South Korea might have been difficult enough in such an environment, but domestic safety problems and a quality control scandal that unfolded during the closing months of 2012 have further hampered these efforts. In February 2012, a power loss at a South Korean nuclear plant went unreported until authorities discovered it.<sup>26</sup> The revelation that falsified quality-control documents had been used to certify more than seven-thousand reactor parts led to the temporary closure of two reactors in November of that year, sparking fears of power shortages at a time of unusually cold temperature forecasts and record-high levels of electricity consumption.<sup>27</sup> One month later, hundreds of falsely certified parts were discovered in two other reactors, as well as in their water-cooling systems.<sup>28</sup> These reactors have remained online during replacement work.

Discerning the implications of these events on public opinion was made more difficult after Fukushima, when the Korean Nuclear Energy Promotion Agency (KONEPA) declined to publish its regular polls on the public opinion of nuclear safety in South Korea.<sup>29</sup> According to a report by Reuters, South Korean opposition lawmaker Woo Yoon-guen has called on KONEPA to resume publishing the polls and has also revealed some of the agency's data himself.<sup>30</sup> A September 2012 KONEPA poll indicated that public confidence may have begun to regain its footing, showing that 53.3 percent of respondents viewed nuclear power plants as safe compared with 41.5 percent who did not.<sup>31</sup> However, public confidence dipped to 34.8 percent by the end of 2012 as the quality control scandal was unfolding.<sup>32</sup> The Fukushima accident galvanized existing antinuclear movements and gave rise to new ones in South Korea, but these do not appear to have gained widespread traction.

The situation in the east-coast town of Samcheok, where there are plans to build a nuclear power plant, may illustrate a measure of ambivalence about nuclear power among some citizens in South Korea. According to a March 2011 survey of residents taken before the Fukushima accident, 75 percent of respondents favored locating the new plant in their town.<sup>33</sup> Seven months later, following the accident, support dropped to 50 percent.<sup>34</sup> A local group tried to recall the pronuclear mayor, though the effort failed.<sup>35</sup> By contrast, some residents seemed to value the need for economic resurgence over safety concerns. According to a report by Reuters, even after the Fukushima accident, local pronuclear activists based their support for building a nuclear plant in their town on the estimation that the construction and operation of the plant would pump 6.2 trillion won (\$5.7 billion) into Samcheok's economy.<sup>36</sup> Public opinion of nuclear power expansion seems to result in part from a complicated mix of safety perceptions and self-interest; the citizens were conflicted

between concerns about the government response to the recent scandals and the recognition that nuclear power is, for now at least, a low-cost electricity source that can bestow economic benefits on the communities where plants are located.

Nuclear power may be the one piece of the green growth strategy most vulnerable to changes in public perception, especially because its expansion requires some level of public acceptance to manage the tangible problem of storing spent nuclear fuel. There was no broad public debate over the ETS, which passed the National Assembly with little fanfare. Investments in smart-grid technology and new forms of renewable energy, including wind and solar power, do not attract as much opposition due to safety concerns as nuclear power does. In January, the government announced new measures responding to the quality control scandal and safety problems. These include new procedures for procuring reactor parts and dealing with mechanical problems.<sup>37</sup> However, any indication that the government is suppressing data that reflects negatively on nuclear power—such as the refusal to publish KONEPA polls—could undermine public trust and ultimately backfire.



## Cost Advantages of Nuclear Power

Nuclear power has one advantage that would make it difficult to dislodge from South Korea's energy mix: it is the cheapest source of electricity in the country.<sup>38</sup> The IEA report notes that "while the Korean consumer price index increased by 254 percent from 1982 to 2011, electricity prices increased by 29.9 percent in the same period."<sup>39</sup> Although the initial investments and operations and maintenance costs are higher for nuclear power plants than coal or gas plants, the cost advantage of generating electricity with nuclear power instead of using imported fossil fuels outweighs the start-up costs of a nuclear power plant in South Korea.<sup>40</sup> When a carbon price is added to the cost of fossil fuel electricity generation, nuclear power's cost advantage becomes even starker.<sup>41</sup> South Korea's ETS may eventually result in a carbon price, making nuclear power even more affordable relative to fossil fuels than it already is. The country also seems to be well positioned to build new nuclear power plants at a lower cost than many other developed countries, due to its recent experience and lower construction costs.<sup>42</sup>

Nuclear power's cost advantage is even clearer when compared with renewable forms of energy such as wind, solar, and tidal power. According to one researcher at the Korea Energy Economics Institute, the wholesale cost of power from alternative sources in South Korea is six times higher than that of nuclear power.<sup>43</sup> The green growth strategy sets out a goal of increasing the share of renewables to 11 percent of total primary energy supply by 2030 (though it is unclear how much of that share is intended for the electricity sector versus other sectors, such as transportation).<sup>44</sup> South Korea has a long way to go on this score. Renewable energy sources currently make up a meager 1.5 percent of the country's electricity generation, with the bulk of that supply coming from biofuels and renewable waste.<sup>45</sup> Although solar and wind power are growing in South Korea, they still account for only a tiny share of renewable energy.<sup>46</sup> Moreover, as is widely noted, "their intermittent and variable supply make them poorly suited for large-scale use in the absence of an affordable way to store electricity."<sup>47</sup> In addition, as the IEA has noted, South Korea's climate and geography present a steeper challenge for the development of renewable energy compared with other IEA countries.<sup>48</sup> Nuclear power is the only major energy source that South Korea can rely on for wide-scale, zero-carbon electricity in the near term as more costly renewable energy sources struggle to gain a foothold. Han Seung-soo, former prime minister of South Korea and then chairman of the Seoul-based Global Green Growth Institute, acknowledged this in 2011 when he said, "If we pursue clean energy, we need to accept nuclear power as a reality until we have better options readily available."<sup>49</sup>

## Is Nuclear Power Really “Green”?

Although nuclear power can help meet energy needs without emitting carbon, there is disagreement over whether it truly serves the purpose of green growth. The Lee administration emphasized nuclear power as a “clean” source of energy, focusing on its zero-carbon characteristics, but some environmental groups, such as Green Korea United, reject its no-carbon credentials, arguing that emissions from the mining and refining of the uranium fuel source must be taken into account.<sup>50</sup> In addition, the problem of finding new storage sites for high-level radioactive waste from spent nuclear fuel further tarnishes nuclear power’s “green” image and is likely to be a pressing challenge for the government in the coming years as it runs up against storage limits at current sites amid “not in my backyard” opposition to new sites. The three reactor sites where spent nuclear fuel is currently stored in South Korea are projected to reach capacity in 2016.<sup>51</sup> Reprocessing spent fuel is a strategy for managing nuclear waste, but South Korea does not have this option. A longstanding agreement with the United States that was recently extended for two more years prohibits this practice over concerns about nuclear weapons proliferation. Although the South Korean government is pressing for the right to reprocess spent nuclear fuel, in part to help manage the storage problem, the United States remains reluctant to agree to this.

Nuclear power expansion will create more nuclear waste that must be handled without reprocessing spent fuel. The real challenge for the near term may be overcoming public opposition to new storage sites for spent nuclear fuel. The government already spent 300 million won (\$247 million) in cash and other benefits to tamp down local opposition to a low- and intermediate-level radioactive waste storage site at Gyeongju.<sup>52</sup> Construction of this repository was twice prolonged due to “weak bedrock and groundwater problems,” a situation that does not bode well for public acceptance of new storage spaces for high-level radioactive waste.<sup>53</sup> Government-sponsored public discussions to help determine new locations for storing high-level waste from spent nuclear fuel are expected to begin in the coming weeks. If these talks are a true give-and-take between citizens and government, they could help build the “culture of transparency” in the nuclear power industry that President Lee called for.<sup>54</sup> Regardless, the challenge of managing nuclear waste that remains radioactive for centuries is a powerful argument against labeling nuclear power as “green.” However, the need for a zero-carbon electricity source to meet rising demand is likely to win out, as long as the government can gain enough public acceptance to new storage sites.

## Conclusion

When it comes to nuclear power in South Korea, green growth is a new banner for an old strategy. South Korea's long experience with nuclear power, its reliance on this form of energy to meet rising demand, and its recognition of nuclear power's carbon mitigation potential together render a natural and convenient relationship between nuclear power and South Korea's green growth strategy. Public trust in nuclear safety has faltered but can recover, as polls have shown. Going forward, President Park is likely to continue the aggressive nuclear agenda she inherited from President Lee. She has indicated that she does not support closing all of the country's aging nuclear plants.<sup>55</sup> However, working with the public to find new storage sites for nuclear waste from spent fuel will be an important task during her tenure—one that complicates the challenge of selling nuclear power as "green." In an early signal that she may decouple nuclear power from green growth, her newly appointed environment minister, Yoon Seong-kyu, publicly questioned nuclear power's relevance to green growth in a recent hearing.<sup>56</sup> In any case, Fukushima did not stop South Korea from breaking ground for two new reactors a little more than one year after the accident, a signal of how important nuclear power is to meeting the country's electricity demand. Nuclear power expansion is likely to continue in South Korea. It is less certain whether President Park is as eager as her predecessor to embrace green growth as a justification for it.

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