The Case for Nuclear Energy in the Philippines and the Experience of the Republic of Korea

Joint Forum of the Senate of the Philippines and the Ateneo School of Government
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I. **Background**

On 24 July 2020, President Rodrigo Duterte issued Executive Order 116 (E.O. 116) directing a study for the adoption of a national position on a nuclear energy program. The EO created the Nuclear Energy Program Inter-Agency Committee (NEP-IAC) composed of 17 agencies studying the potential of nuclear power in the country.

Based on the recommendation of this committee, President Duterte issued E.O. 164 on 28 February 2022 which formally includes nuclear power in the country's energy mix. The new policy states that the country "shall ensure the peaceful use of nuclear technology anchored on critical tenets of public safety, national security, energy self-sufficiency, and environmental sustainability".

Through EO 164, the Chief Executive has recognized that nuclear power has the potential to be a reliable, cost-competitive, and environment-friendly source of energy based on the experience of highly developed countries. Thus, the issuance of EO 164 requires a deeper, more nuanced discussion on the viability of nuclear energy in the Philippines. A useful source of information would be the experience of the Republic of Korea (ROK) in this area.

ROK is one of the closest economic and national security partners of the Philippines with extensive experience in nuclear energy. Currently, nuclear power makes up roughly 27% of the country's power mix, with 35% coal and 29% liquefied natural gas. President Yoon Suk-yeol has promised to raise nuclear power's contribution to 30% by restarting construction and extending reactors' lives, and also by exporting 10 nuclear power plants by 2030.

The discussion in this policy brief revolves around the advantages and disadvantages of nuclear energy which are summarized in the Box below. The next section is a synopsis of the Korean experience based on the inputs of three Korean experts who participated in the forum. Reactions of Filipino thought leaders are presented in Section III focusing on aspects of ROK's experience that are viable for the Philippines. Areas of concern are

highlighted in Section IV. Responses to these concerns is the topic of Section V. A possible way forward concludes this policy brief.

II. A Brief Description of the Korean Experience

In 2019, ROK ranked sixth in the world in terms of total energy consumption; in 2020 it ranked 10th in terms of per capita primary energy consumption. The configuration of energy supply since 1990 has changed with the following major shifts (Figure 1): 1) a significant increase in the share of natural gas; 2) a steady rise in the share of coal; and 3) the rise in the shares in both sources being offset mainly by the fall in the consumption of oil. During this period, however, the share of nuclear energy has been fairly steady.

ROK's strategy on nuclear power can be described as pragmatic and deliberate. ROK began its nuclear program just after the Korea-US Nuclear Cooperation Agreement in 1956. In 1957, the Korean government developed a 5-year plan that included nuclear power. Meanwhile, beginning in 1958, universities introduced nuclear engineering departments and the Korea Atomic Energy Research Institute was established in 1959. Experimental reactors were introduced at that time. The Kori Unit 1, which was the first nuclear power plant in ROK was planned in 1968 and construction began in 1971. The nuclear power plant began operation in 1978. Thus, it took ROK 22 years to establish a full-fledged nuclear program.

At present ROK is operating 25 nuclear reactors with 3 more under construction. Two reactors have been shut down. The country experienced what could be described as a flip-flop in terms of policy. During the administration of President Moon Jae-in which began in May, 2017, he implemented a Nuclear-Zero policy. The "net zero scenario" announced during President Moon's administration projected nuclear power in 2050 electricity demand at 6.1-7.2%; renewable energy at 60.9-70.8%. However, as indicated in the earlier section, President Yoon reversed this policy.

Under the new administration, the nuclear program in ROK is expected to be strengthened in several areas:

- Secure next-generation nuclear power plant technology such as small modular reactors (SMR)
- Promote competitiveness in the nuclear power plant ecosystem

- Create nuclear power plant export capability through the establishment of a government-wide export system
- Promoting seamless implementation of high-level radioactive waste management policies
- Secure the expertise and independence of the Nuclear Safety and Security Commission at the level recommended by the International Atomic Energy Agency (IAEA)

Of particular importance is the development of SMRs, which are nuclear reactors whose capacity to generate electricity is less than 300 MW per module. They are very useful in the process of distributed generation, particularly for countries or regions with relatively large chunks of off-grid areas. SMRs can also power large industrial complexes. They have several other advantages:

- Smaller initial investment and shorter gestation period
- Easy to implement; higher safety factor
- Existing transmission lines can be used
- Multiple Applications: Desalination, District Heat, Industrial Process Heat, Hydrogen Production, etc.
- Big potential market in other countries

At present, the main disadvantage of SMRs is the technology is not yet commercialized. In other words, they have not yet been mainstreamed in the global energy market. However, they are already on the radar of the Department of Energy of the Philippines.

III. The Case of the Philippines: views from local experts

The energy gap between ROK and the Philippines is epitomized by per capita electricity consumption in 2020: 9,900 kWh versus 897 kWh. This huge gap encapsulates the problem of energy security in the Philippines. One way to frame the issue currently under consideration is a series of questions related to energy security. First, would the adoption of nuclear power—primarily for generating electricity—help the Philippines address the issue of energy security? In other words, can nuclear power become a "reliable, cost-competitive, and environment-friendly source of energy"? This is related to the advantages associated with nuclear energy (see Box). Second, are there better options to achieve energy security? Third, if adopting nuclear power is the best option or equally as good as other options, can the Philippines build the necessary capabilities to harness

nuclear energy in terms of manpower, infrastructure and institutions? Lastly, how can ROK help in this process?

The experience in ROK highlights the need for a deliberate and pragmatic process in adopting nuclear power in the energy mix. This includes the need to overcome negative perceptions about nuclear energy that were spawned by the controversy surrounding the Bataan Nuclear Power Plant (BNPP). Market analysis of the viability of nuclear power in the Philippines will be useful in this regard, including a comparison between SMR technology and construction of a new nuclear power plant. Ten years may be a reasonable timeline to consider for the development phase but SMR technology may shorten the process. But even then, the Philippines will likely rely heavily on ROK for operations, monitoring & maintenance for a significant period of time. Another consideration is how nuclear power will be incorporated effectively in the energy market in order to maintain a competitive environment. The aforementioned market analysis will also be helpful in this aspect.

Meanwhile, as a further response to the last query, the panelists noted that ROK has a standing offer to rehabilitate the BNPP. In addition, there is a proposition from ROK to share its SMR technology, an area where it is well-positioned because of the working license for the SMART100 model. At present, the Philippine Nuclear Research Institute has a memorandum of understanding with the Korea Institute for Energy Research (KIER). Meanwhile, the Department of Science and Technology (DOST) recently completed the nuclear commissioning of a long-mothballed research reactor in the DOST-PNRI complex in Quezon City, signaling the start of research and training of nuclear engineers and scientists as well as potential nuclear power plant operators in the Philippines. As part of this program, fuel loading of the TRIGA (Training, Research, Isotopes, General Atomics) subcritical reactor was completed. This development aligns with the need to build capabilities necessary to adopt nuclear power in the energy mix.

The role of nuclear power can be fine-tuned by examining the various aspects of energy security, particularly adequate and reliable supply, affordability, and environmental impact. This allows for a more holistic medium-term strategy in the energy sector. The strategy can encompass other development aspects like economic growth, foreign policy, and the role of the private sector.

IV. Concerns about Nuclear Power

Reluctance to adopt nuclear power in the energy mix stems from its well-known disadvantages (see Box). Many of these were expressed in the forum. First and foremost is the management of nuclear waste. Second, is the risk of accidents. Third, is the lack of adequate manpower. Fourth is the matter of security. And lastly, a cross-cutting issue is the issue of a poor regulatory environment which roughly translates to corruption. A panelist even inquired as to an example of a country which has a successful nuclear program and is considered corrupt. Another panelist mentioned Russia.

In terms of energy security, the more relevant issue is the optimal and efficient fuel mix. Being a developing country, nuclear power may not yet be an appropriate technology to consider. The gestation period may be too long in terms of developing the manpower, infrastructure and institutional capabilities. There may be better options to address the more important components of affordability and accessibility. Nevertheless, if nuclear power is to be considered, SMR technology is likely the more feasible option.

The affordability of nuclear energy can also be questioned since in Slovenia, for example, the LCOE is four pesos per kWh. This is not much different from the average that businesses pay in the Philippines which is 6 pesos per kWh. It was clarified, however, that in Korea, nuclear energy is priced at 60 won per kWh and four pesos is approximately 100 won. Hence, nuclear energy hast the potential of being much cheaper than conventional sources. And it should be emphasized that nuclear power has a much higher capacity factor than renewable energy sources (see Box).

V. Addressing the Concerns

ROK's experience in overcoming obstacles to its nuclear program can be useful to address the concerns laid out in the previous section. The general philosophy of Korean nuclear experts was not to allow obstacles to overwhelm the program. Effort was exerted to directly address the issues. For example, one of the more important obstacles is acceptance by society at large. It is quite ironic that acceptance of nuclear energy by Koreans jumped from 40% to 70% during the administration of President Moon. This was a result of an information campaign.

With regard to the issue of the possibility of a poor regulatory environment, it should be emphasized that countries with active nuclear programs are under the jurisdiction of the International Atomic Energy Agency (IAEA). This body functions as an international watchdog. Meanwhile, there is a move through legislation to revive the Philippine Atomic

Regulatory Commission and restore its independence. And even if the energy sector is deregulated there are rules and policies that act as guardrails. For example, many energy projects are bound by the Foreign Corrupt Practices Act since foreign investors are usually involved.

Managing nuclear waste is a bit more complicated. Most nuclear waste of the 450 nuclear plants in the world are stored temporarily beside the plants because they have to cool off. There is still a debate about the nature of the final repository since nuclear waste will be radioactive for 10,000 years. Only Finland is currently building a repository. The Philippines and ROK have a joint research program on how to deal with nuclear waste. One important aspect from the perspective of Philippine experts is that the issue of managing nuclear waste must be addressed at the beginning of the program.

With regard to assembling a team of experts to manage the nuclear program in the Philippines, one initial source would be the 80 persons who were trained abroad in relation to the BNPP. Those who are still active have expressed interest in helping jumpstart the proposed nuclear program. Some Filipino engineers have also been involved in the construction of nuclear power plants in ROK and other countries. ROK also trains engineers from countries which purchase its technology. For example, as part of its project with Saudi Arabia, there were 40-50 Saudi engineers who trained and studied in ROK.

VI. The Way Forward

Underlying E.O. 164 is the Net Zero Emissions by 2050 Scenario (NZE). This is a normative International Energy Agency scenario that shows a narrow but achievable pathway for the global energy sector to achieve net zero CO_2 emissions by 2050, with advanced economies reaching net zero emissions in advance of others. NZE is consistent with the concerted action aimed at holding the global average temperature increase to "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels". This is referred to as the 1.5°C Paris Agreement goal.

In other words, one cannot isolate the discussion of nuclear power from the topic of NZE. In this context, it is welcome news that Filipino political leaders, including those in the Senate, are open to considering nuclear power as part of the Philippine energy mix. The best way to approach this is through the scientific method which involves extensive research and consultations with nuclear experts. The Senate has been providing funds

for these types of activities. And to address concerns about a poor regulatory environment, it is important that the entire process be transparent.

Box: Advantages and Disadvantages of Nuclear Power

Advantages

Low Cost of Operation. Constructing a nuclear power plant is very costly resulting in nuclear energy having the highest levelized cost of electricity (LCOE). However, after this large initial outlay, nuclear energy becomes relatively cost-effective in terms of operation and maintenance. Producing electricity from nuclear energy is considerably less costly compared with producing it from gas, coal, or oil. Nuclear energy also has the benefit of greater stability in terms of fluctuation in cost—unlike traditional fossil fuels that experience greater price volatility.

Dependable Source of Energy. Certain energy sources, like solar and wind power, are dependent upon weather conditions, However, nuclear energy does not have to deal with this constraint. Nuclear power plants are, therefore, essentially impervious to external climatic factors resulting in reliable energy output. The result is a higher capacity factor. The figures imply that nuclear power plants are generating peak power more than 93% of the time during the year, which is higher than all other sources.

Stable Base Load Energy. This is related to the feature of dispatchability: output can be transmitted to the system as and when required. For example, under ideal conditions wind turbines generate significant amounts of power. Therefore, when the wind is blowing, nuclear plants can adjust their output downward. Conversely, when the wind is not blowing or the sun is not shining, nuclear energy can be adjusted to compensate for the drop in generated power from VRE.

Low Pollution Output. Abstracting from the issue of nuclear waste (see below), nuclear energy produces much less pollution compared with fossil fuels. Throughout its life cycle, nuclear produces about the same amount of carbon dioxide-equivalent emissions per unit of electricity as wind, and one-third of the emissions per unit of electricity when compared with solar. At current levels of consumption of nuclear energy, the emission of greenhouse gases is reduced by over 555 million metric tons annually.

Adequate Fuel Availability. Both fossil fuels and the uranium used to operate nuclear power plants have finite supply. However, fossil fuels have much lower lifespan than uranium, whose reserves are estimated to last another 80 years. Switching to nuclear energy might provide the Philippines the added time it needs to develop more reliable

and cleaner renewable energy resources. Meanwhile, some countries like Russia, India, and China are already making progress toward using the more abundant and environment-friendly thorium as fuel for nuclear reactors. Another area of interest is turning nuclear fusion into a reality. In order to classify nuclear energy as sustainable, the use of breeder reactors and nuclear fusion is required.

High Energy Density. Compared with fossil fuels, nuclear fission is approximately 8,000 times more efficient at generating energy. This results in a substantial amount of energy density. Greater efficiency leads to less waste and makes existing fuel resources available for a larger segment of the population.

Disadvantages

Expensive to Build. As indicated in the previous list, nuclear power plants are cost-effective to operate but very expensive to construct. In addition, the cost has risen sharply. From 2002 to 2008, the cost to build a nuclear plant grew from an estimated US$2– US$4 billion to US$9 billion, and these cost estimates are usually surpassed during construction. A more recent example is the 1.63 GW European Pressurized Reactor being built by Électricité de France in Flamanville. The cost of this Generation III project has ballooned to over US$ 12 billion (IEA 2019). In addition to the cost of construction, nuclear energy projects must also budget funds to safeguard the waste that is produced. This normally entails keeping the waste in cooled structures and implementing appropriate security procedures. All of these factors make the cost of nuclear power prohibitive.

Accidents. The three major disasters mentioned earlier—Three Mile Island, Chernobyl, and Fukushima—have created doubt and suspicion among many people about the safety of nuclear power. In particular, the Fukushima crisis in 2011 demonstrated that despite extensive safety measures built into nuclear power plants, accidents can and do happen.

Produces Radioactive Waste. While the use of nuclear energy does not generate any GHG emissions, it does produce radioactive waste that has to be securely stockpiled in order not to pollute the environment. Exposure to small quantities of radiation—such as radioactivity from cosmic rays or radon in the air—is not harmful. However, exposure to radioactive waste from nuclear energy production is quite hazardous.

Nuclear power plants have been contending with the challenge to store radioactive waste. Because it cannot be destroyed, the solution at present is to seal the nuclear waste securely in containers and stockpile these deep underground. This minimizes

the chances of the nuclear waste to contaminate the environment. As technology progresses, more suitable ways of stockpiling radioactive waste will be available.

Environmental Impact. Apart from the issue of radioactive waste, nuclear power plants have other adverse impacts on the environment. The mining and enrichment of uranium also has harmful effects. While open-pit mining for uranium has enough safety features to protect miners, the process leaves behind radioactive particles, causes erosion, and even pollutes nearby water sources. Underground mining is not much different as it exposes miners to high levels of radiation during the process of extraction and processing. Radioactive waste rock is also produced.

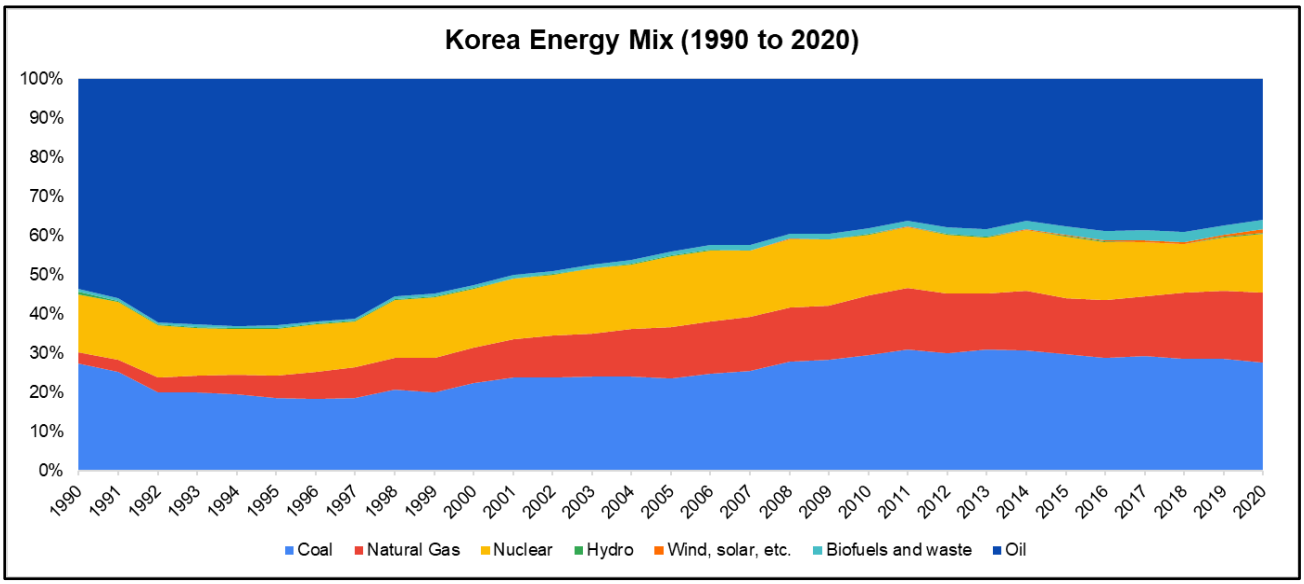
Security Threat. By its nature, nuclear power poses a distinctive threat to national security. Nuclear power plants are an obvious target for terrorists because of the potential disaster that they could cause. Meanwhile, the uranium used to operate the power plant can be enriched to produce nuclear weapons and the situation can be disastrous if the weapons end up with lawless elements. For these reasons, security related to nuclear materials and nuclear power plants has to be prioritized.

Limited Fuel Supply. If nuclear fusion does not become a reality and/or better breeder reactors are not built, nuclear energy will not be sustainable. The supplies of uranium and thorium will eventually be depleted. In this scenario, nuclear power will only be a temporary source of clean energy, and a very expensive one. Extensive and detailed cost-benefit analysis has to be applied before embarking on a nuclear program.

Source: Yap, J. T. 2021. "Towards a Balanced Assessment of the Viability of Nuclear Energy in the Philippines." *Journal of Environmental Science and Management* 24 (2): 17–29.

https://doi.org/10.47125/jesam/2021_2/03.

Figure 1: Structure of energy supply in ROK



Source: https://www.iea.org/countries/korea