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Working Paper

The Implications of Developing a Philippine Nuclear Energy Program

PIDS Discussion Paper Series, No. 2022-61

Provided in Cooperation with:

Philippine Institute for Development Studies (PIDS), Philippines

Suggested Citation: Navarro, Adoracion M. (2022) : The Implications of Developing a Philippine Nuclear Energy Program, PIDS Discussion Paper Series, No. 2022-61, Philippine Institute for Development Studies (PIDS), Quezon City

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DISCUSSION PAPER SERIES NO. 2022-61

The Implications of Developing a Philippine Nuclear Energy Program

Adoracion M. Navarro



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The Implications of Developing a Philippine Nuclear Energy Program

Adoracion M. Navarro

PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES

December 2022

Abstract

Nuclear energy remains a promising option for the Philippines. But as the International Atomic Energy Agency (IAEA) has reiterated, deciding to use nuclear energy is a long-term commitment and one that should consider a time frame of 100 years from construction to decommissioning and waste disposal or storage. Thus, it would do well for the Philippines to follow the IAEA's Milestones Approach and for every government administration to be consistent in seeking progress through this approach. As a demonstration of understanding the commitment involved in nuclear energy development, the positive national position adopted by the Duterte administration may have to be confirmed and reinforced by the Marcos Jr. administration by issuing a fresh mandate to the inter-agency committee for the nuclear energy program and by setting new targets and timetable for the requirements that remain unaddressed. The Philippines also needs to ratify the international legal instruments that it signed in the past. The existing legal framework in the Philippines for nuclear energy development and regulation also needs to be updated. On the Bataan Nuclear Power Plant (BNPP), the decision whether to rehabilitate it must be guided by project economics. Aside from the huge cost, the biggest hurdle in rehabilitating the BNPP is the fact that the government is no longer allowed under the Electric Power Industry Reform Act to engage in power generation except for missionary electrification. If the project economics of BNPP rehabilitation, or a new nuclear power plant at the same site with flexible dispatchability, would prove that this is worth undertaking, it is better to attract the private sector to the project economics of it through incentives rather than the government directly making the investments and competing in the generation sector. Lastly, the prospects for nuclear energy development in the Philippines must not only be well argued before policy makers but be convincingly communicated as well to the general public.

Keywords: nuclear energy, nuclear power, Bataan Nuclear Power Plant, nuclear safety, generation mix, clean energy, energy transition

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The Implications of Developing a Philippine Nuclear Energy Program

*Adoracion M. Navarro**

1. Introduction

The Philippine Energy Plan 2020-2040 recognizes the role of nuclear energy in the clean energy transition as it indicates that it could replace coal as fuel in baseload generation (DOE 2020). The new Philippine Development Plan 2023-2028 also mentions that the inclusion of nuclear energy in the electricity generation mix will be explored (NEDA 2022). Against the backdrop of the country's nuclear energy development ambition and global developments on growing nuclear energy use, it is opportune to study the possible implications of committing to a nuclear energy development program. Standards on nuclear safety and security have also evolved since the construction of the Bataan Nuclear Power Plant in 1976-1985, the country's first attempt at nuclear energy development. The International Atomic Energy Agency (IAEA), an independent intergovernmental organization for nuclear cooperation, safety standards, and inspection system for non-proliferation agreements, has also provided updated guidelines for countries wanting to develop their first nuclear power plant or expand their nuclear power plant portfolio after many years of non-expansion.

This study is thus relevant to policy makers and implementing agencies considering that the history of pursuing nuclear energy development in the Philippines has been a complex journey that is deficient in long-term commitment and practical milestones. It may help to generate commitment if there can be an updated assessment of the prospects given recent technological advances and political environment changes. For instance, dealing with radioactive waste and safeguards against catastrophic accidents continue to be the deal-breakers for those opposed to nuclear power development in the Philippines. Moreover, considerations for safety, security and safeguards come at a high cost and the cost-effectiveness of investing in a nuclear power plant versus investing in renewable energy, the cost of which is on a downtrend, are always being raised.

The study is also expected to have a policy impact in terms of clarifying the needed legislative measures to ensure long-term commitment to nuclear energy development for peaceful uses, whether for electric power generation or other productivity benefits. Note that based on the IAEA's assessment, ensuring that a nuclear power program would be successful "requires commitment of at least 100 years" considering the life cycle of the nuclear power infrastructure from development to decommissioning (International Atomic Energy Agency, n.d.).

The general objective of the study is to provide an updated assessment of the prospects for developing a Philippine nuclear energy program. The specific objectives are:

- To review the experiences of other countries in pursuing a nuclear energy development program

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- To conduct a case study of the Bataan Nuclear Power Plant and assess how it fits with the existing realities and future energy development prospects
- To understand the opposing views on nuclear energy development and review how other countries are managing the risks and dealing with the opposing views
- To assess the requirements and implications of a Philippine nuclear energy development program
- To assess the shortcomings of the existing legal framework in addressing the modern requirements of nuclear energy development
- To assess where the Philippines is now with respect to the IAEA Milestones Approach
- To formulate policy recommendations.

This study employed a combination of systematic literature review, desk research on other countries' experiences and the Philippines' efforts in nuclear energy development, and key informant interviews with government officials. The systematic literature review covered recent literature and guidelines on nuclear power development, that is, published between 2010 to 2022, and an exhaustive set of literature related to the historical events surrounding the Bataan Nuclear Power Plant development. It also covered thematic analysis, involving such themes as nuclear safety, security, clean energy, and alternative technologies. The study collected secondary data on global nuclear energy developments from international organizations and other countries' nuclear agencies. Recent developments on domestic efforts to pursue nuclear energy development were gathered through direct information and data gathering from concerned government agencies.

2. International experience in nuclear energy development

The International Atomic Energy Agency (IAEA), an independent intergovernmental organization for the peaceful use of nuclear technology, monitors the countries' experiences in nuclear energy development. Most of the data used in the analysis below are from IAEA sources and augmented by other international sources and recent reports.

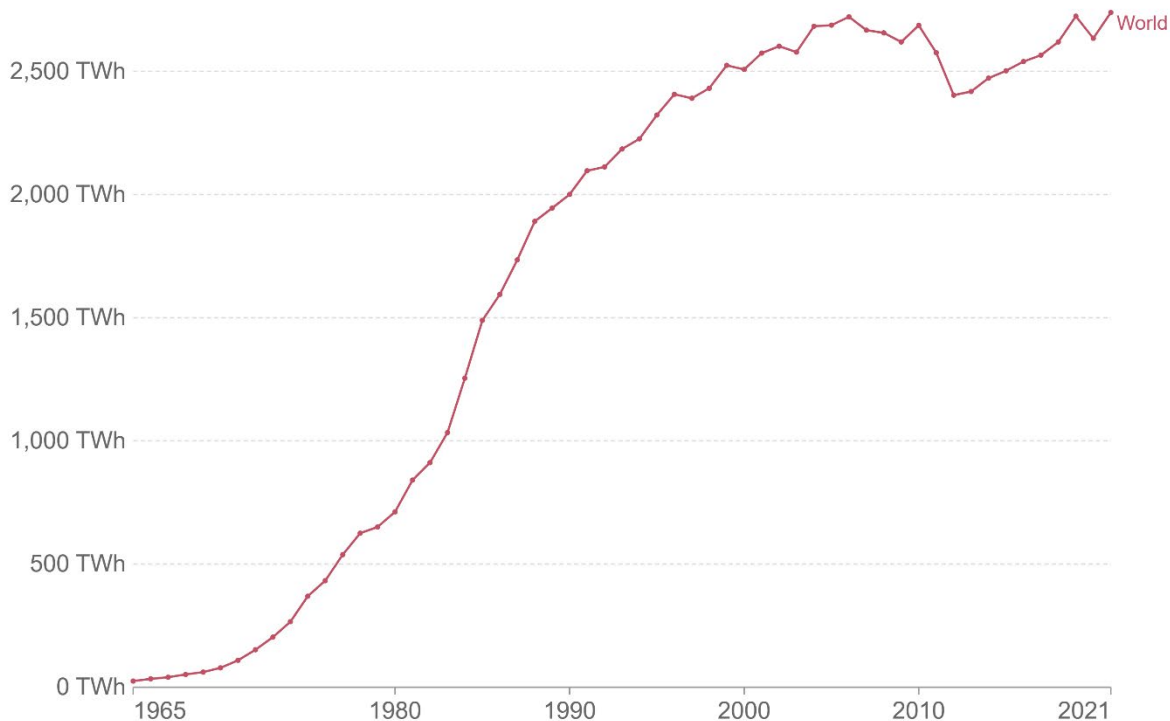
2.1 Nuclear power generation worldwide

Electric power generation through nuclear fission (the split of an atom into two or more smaller nuclei) in a reactor started in 1948 when the X-10 Graphite Reactor in Tennessee, United States (US) produced electricity for the first time. A bigger experiment successfully occurred in 1951 through the EBR-I experimental station in Idaho, US. In 1954, the world's first nuclear power plant for electricity generation at the grid level started operating in the former Union of Soviet Socialist Republic city of Obninsk. This was followed by the operation of the world's first full-scale power station, the Calder Hall Nuclear Power Station, in 1956 in England, United Kingdom (UK). The world's first full-scale PWR power station (i.e., with a pressurized water reactor (PWR) where

water acts as the primary coolant when pumped under high pressure into the reactor), the Shippingport Atomic Power Station in Pennsylvania, US was commissioned in 1958 (Nuclear Power for Everybody n.d.).

Since then, nuclear power plants continued to be built and nuclear power generation grew massively in the 1970s to 1980s (Figure 1). Nuclear power generation growth slowed down in the latter part of the 1990s to the 2000s owing to a number of factors, including the political turbulence in existing and prospective nuclear countries, failure of the nuclear industry to achieve scale economies in construction, the stiffening of regulatory regimes (in part due to previous nuclear accidents and as a way to promote public acceptance of nuclear) that led to cost escalations, the rise of other fuel sources as additional oil reserves and gas reserves were discovered, and the rise of renewable energy technologies (Kidd 2013).

Figure 1. Nuclear power generation in the world, 1965-2021 (in TWh)



Note: Chart generated by ourworldindata.org based on BP Statistical Statistical Review of World Energy & Ember.

Source: Our World in Data (2022).

Nuclear power generation suffered a sharp dip in 2011 (Figure 1) after the nuclear accident in Fukushima Daiichi Nuclear Power Plant in Fukushima, Japan, following the 2011 Tohoku earthquake and tsunami. Stricter regulations and procedures for safety improvements and the decommissioning of old power plants contributed further to the decline. As safety-related technologies improve and as the recognition of the important role of nuclear energy in accelerating

carbon emissions reduction (as it emits zero carbon) grows, nuclear energy generation is seeing a resurgence. Although there were declines in 2019 and 2020 due to decommissioning, new construction are ongoing and the trend in nuclear power generation is generally increasing. More recently, Russia's invasion of Ukraine¹ and the resulting energy crisis led to a growing desire, especially in Europe, to lessen dependence on fossil fuels and accentuates the need to extend the life of operational nuclear power plants and build new ones.

2.1.1 Current nuclear power generation

At present, 32 countries operate nuclear power plants (Table 1), with the US having the largest nuclear energy production (771.64 terrawatt-hours (TWh)) (Figure 2) and France having the largest share of nuclear in the country's energy mix (69%) (Figure 3). There are 431 operational nuclear power reactors in the world delivering a total of 382,818 MW of net electrical capacity, with the US operating the most number of reactors (94 reactors) and having the largest generation capacity (96,553 MW) (Table 1).

Table 1. Nuclear Electricity Generation in the World in 2021

Country	Total Net Electrical Capacity (MW)	Number of Operated Reactors	Nuclear Electricity Supplied (GWh)	Nuclear Share (%)
Argentina	1641	3	10169.72	7.2
Armenia	448	1	1850.04	25.3
Belarus	1110	1	5422.11	14.1
Belgium	5942	7	47962.47	50.8
Brazil	1884	2	13858.44	2.4
Bulgaria	2006	2	15798.89	34.6
Canada	13624	19	86780.11	14.3
China	50034	53	383205.32	5
Czech Republic	3934	6	29043.75	36.6
Finland	2794	4	22645.97	32.8
France	61370	56	363394.15	69
Germany	8113	6	65444.27	11.9
Hungary	1916	4	15121.12	46.8
India	6795	22	39757.85	3.2
Iran, Islamic Republic of	915	1	3235.97	0.1
Japan	16321	17	61304.12	7.2
Korea, Republic of	23091	24	150456.38	28
Mexico	1552	2	11605.54	5.3
Netherlands	482	1	3614.16	3.1
Pakistan	2332	6	15832.34	10.6
Romania	1300	2	10401.16	18.5

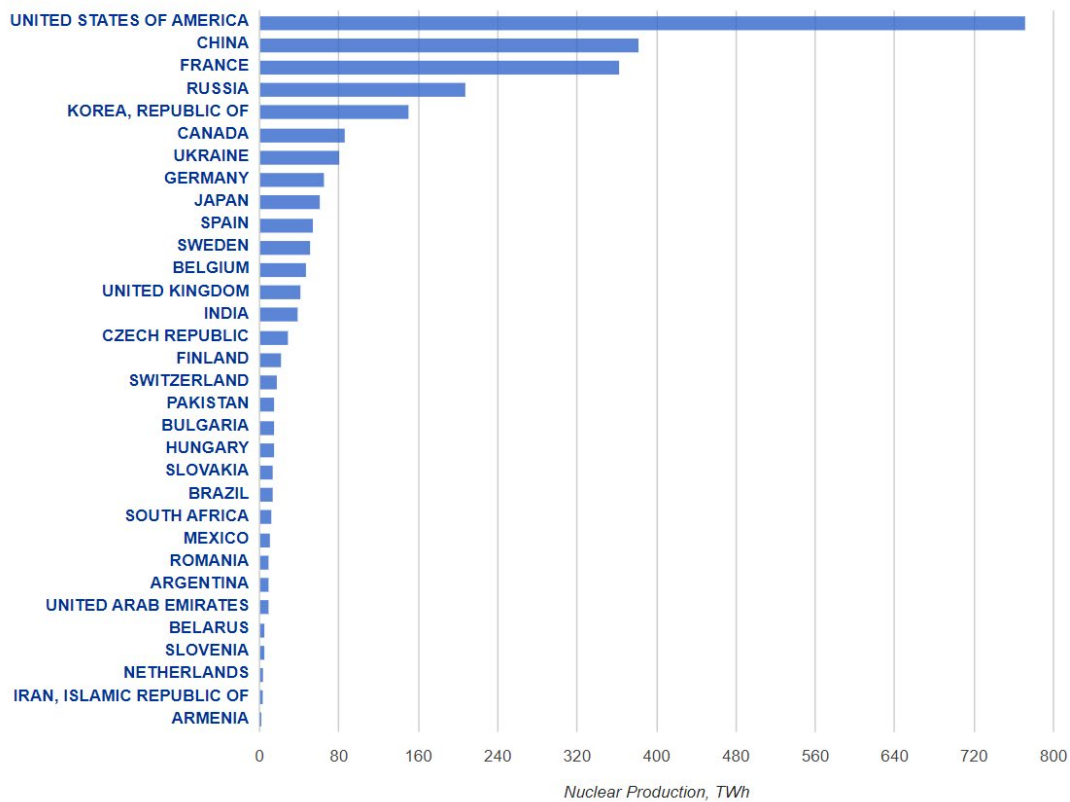
¹ Russia's invasion of Ukraine started on February 24, 2022 and was still ongoing at the time of writing. In 2021, natural gas from Russia accounted for 45 percent of the European Union's gas imports (IAEA 2022a).

Country	Total Net Electrical Capacity (MW)	Number of Operated Reactors	Nuclear Electricity Supplied (GWh)	Nuclear Share (%)
Russia	28652	38	208442.8	20
Slovakia	1868	4	14645.84	52.3
Slovenia	688	1	5418.64	36.9
South Africa	1854	2	12198.9	6
Spain	7121	7	54218.18	20.8
Sweden	6882	6	51426.36	30.8
Switzerland	2960	4	18593.2	28.8
Ukraine	13107	15	81125.58	55
United Arab Emirates	2762	2	10126.28	1.3
United Kingdom	8923	15	41788.5	14.8
United States of America	96553	94	771637.57	19.6
Total	382818	431	2653344.19	NA
<i>The following information is included in the totals:</i>				
Taiwan, China	3844	4	26818.46	10.8

Notes: Above data generated by the Power Reactor Information System (PRIS) database. Last update on December 16, 2022.
In all presentations in the PRIS database, the IAEA includes Taiwan data under China country data and at the same time, for certain indicators, shows Taiwan in a separate row.

Source: International Atomic Energy Agency (2022b).

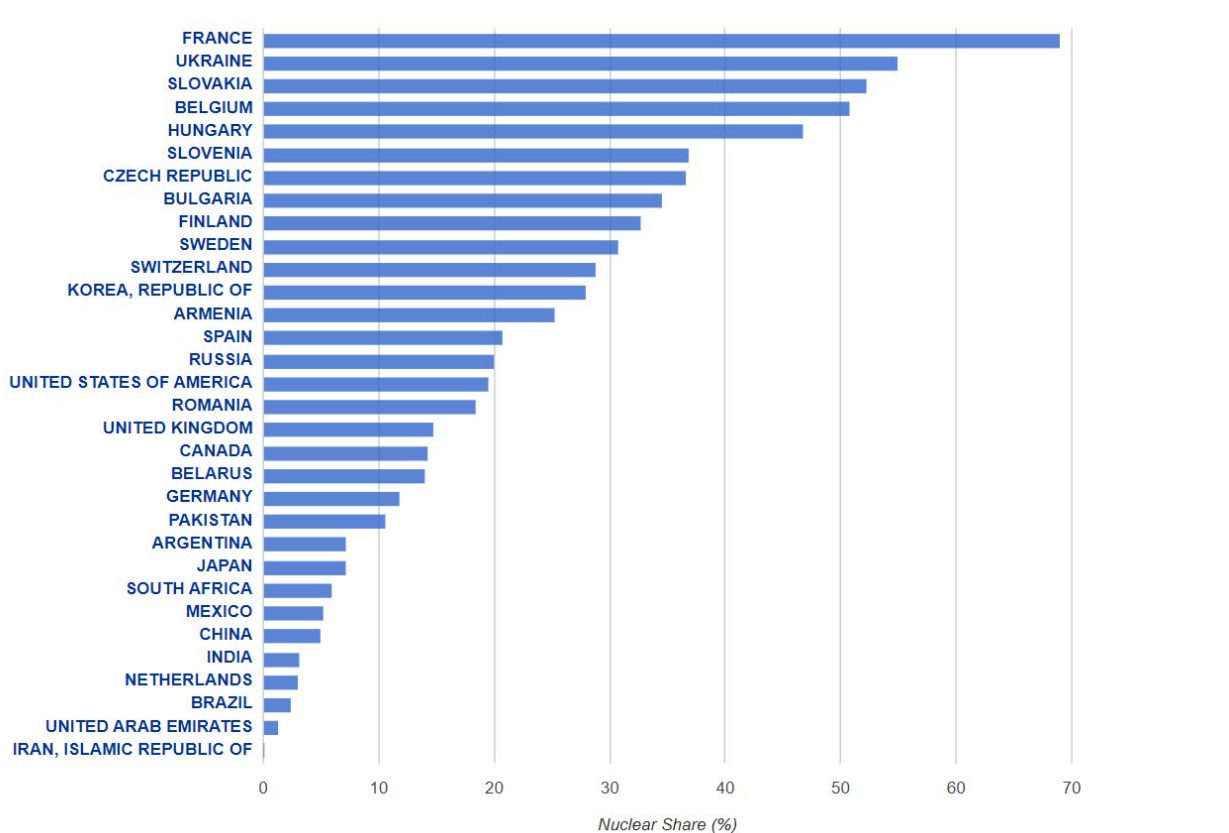
Figure 2. Nuclear Energy Generation in 2021 (in TWh produced)



Note: Above figure and data generated by the Power Reactor Information System (PRIS) database. Last update on December 15, 2022.

Source: International Atomic Energy Agency (2022b).

Figure 3. Share of Nuclear Power in the Electricity Generation Mix in 2021 (in percentage)



Note: Above figure and data generated by the Power Reactor Information System (PRIS) database. Last update on December 16, 2022.

Source: International Atomic Energy Agency (2022b).

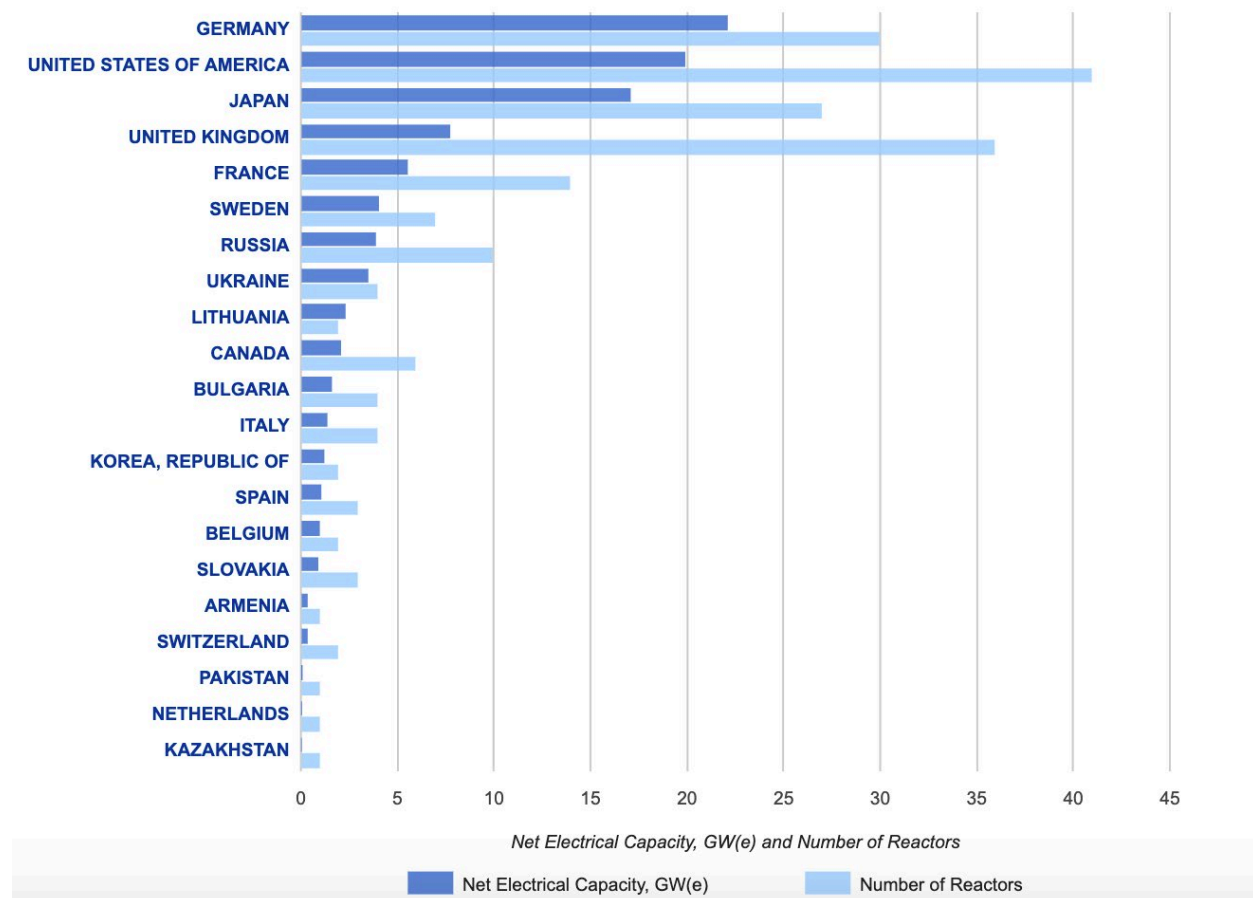
The number of operational reactors and capacity are largest in the North America, East Asia, and Western Europe regions. The following are considered as the six major nuclear states: US, France, China, Japan, Russia, and Republic of Korea. In Asia, China leads the pack in having the greatest number of nuclear power reactors. It started operating one reactor in 1991 and now it has 53 reactors. Russia has 38 reactors. Japan, an earthquake-prone country, has 17 reactors. The Republic of Korea, which first used nuclear energy for electric power generation in 1978, has 24 reactors. India, which initially operated a nuclear power plant in 1972, has 22 reactors. Pakistan operates 6 reactors, the United Arab Emirates 2 reactors and Iran 1 reactor (Table 1).

2.1.2 Decommissioning activities

Commercial nuclear power generation is entering its seventh decade. Most nuclear power plants have life spans of between 20 to 40 years and experts projected that with ageing reactor fleets, the world will see a doubling of phaseout within the next 20 years (Robertson 2017). The US is leading in the decommissioning activities in terms of number of reactors and Germany is leading in terms

of net electrical capacity to be withdrawn with the permanent shutdown of its nuclear power plants (Figure 4).

Figure 4. Permanent Shutdown Reactors – by Country, 2022



Note: Above figure and data generated by the Power Reactor Information System (PRIS) database. Last update on December 16, 2022.

GW(e) means gigawatts of electricity.

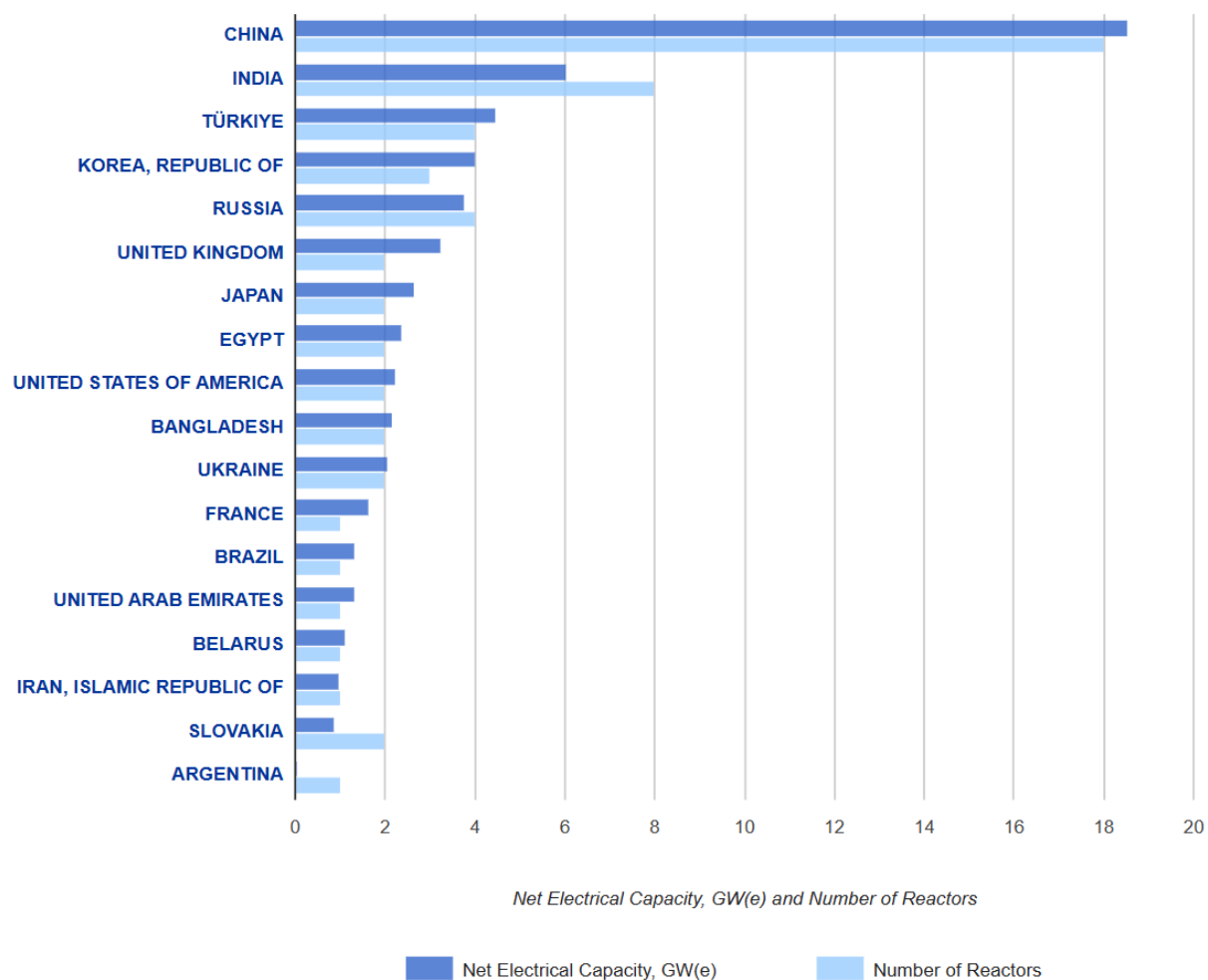
Source: International Atomic Energy Agency (2022b).

Given the safety risks such as radioactive contamination, human resources and technology development for decommissioning should be highly prioritized by any nuclear-powered country regardless of the future of nuclear energy. Decommissioning also involves communicating well to the public information about risks. The US encourages nuclear decommissioning licensees to create citizen advisory panels to improve public participation in aspects of decommissioning (Robertson 2017).

2.1.3 Construction activities

Nuclear reactor construction continues and as of 2022, there are 57 under construction reactors with a total net electrical capacity of 58,858 MW (Figure 5). China's buildup is accelerating and its pace in nuclear power development is leading globally. Its nuclear power development is associated with a long-term plan for nuclear energy and backed by five-year development plans, namely, five-year national economic and social development plan, five-year national energy science and technology plan, five-year plan and vision for nuclear safety and radioactive pollution and control, and five-year energy development plan (Mu et al. 2015, p. 164).

Figure 5. Under Construction Reactors (by country) in 2022



Note: GW(e) means gigawatts of electricity.

Source: International Atomic Energy Agency (2022b).

2.1.4 Other interesting cases

Phaseout then turnaround in Germany, France and Japan

Germany initially decided to completely phase out nuclear energy by 2022 but decided recently to turn around. Many international observers portrayed the phaseout as a panic reaction to the Fukushima disaster because the decision was announced in 2011 (Sonnberger et al. 2021). But this actually has a long history and is deeply rooted in German society, beginning with anti-nuclear movements in the 1970s (Appunn 2021). The complete phaseout, however, is unlikely to happen soon given the unprecedented energy crisis in Europe caused by Russia's invasion of Ukraine. German Chancellor Scholz announced in October 2022 that the operation of three nuclear power plants supposedly scheduled for decommissioning will be extended to reduce the country's dependence on Russian gas (Euronews 2022).

France legislated in 2015 a nuclear energy share reduction when it passed an energy transition bill. The legislation specified, among others, that France will reduce the nuclear energy share from 75% to 50% by 2025. Then the government announced in 2017 that this target was not realistic and would endanger the country's security of supply (Appunn 2021). Among nuclear-powered countries, France currently has the highest share of nuclear energy in the energy mix at 69 percent (Table 1 and Figure 3).

After the Fukushima accident, Japan switched off its 50 nuclear power reactors. But after security checks, it decided in 2014 to start operating the reactors again (Appunn 2021). At present, Japan is constructing two additional reactors with a combined 653 MW of net capacity (IAEA 2022).

Nuclear energy ambition in Indonesia and Vietnam

Indonesia's nuclear ambition suffered from policy reversals and the recent announcement is it the nuclear plan is on again. In 1997, a nuclear energy law provided guidance on nuclear power development from construction to operation and decommissioning. But in December 2015, the government decided to stop all nuclear plans, even long-term plans, and issued a policy that nuclear will be considered only when the 23 percent renewable energy target by 2025 would not be achieved (Schneider and Froggatt 2020). In November 2021, however, the Minister of Energy and Mineral Resources announced the possibility of deploying nuclear power by 2045 (World Nuclear Association 2022a).

Vietnam came close to developing its first nuclear power plant project until it abandoned its plan in 2016 because electric power demand projection turned out to be lower than the previously projected 17-20 percent annual growth (Nguyen and Binh Minh 2016). Nevertheless, experts say that nuclear energy is still an option for Vietnam given its 100 million people and growing power demand over the long term (Anh 2021).

Decades-old nuclear power plant program in Bangladesh and recent progress

In 1961, before the independence of Bangladesh, a plan was crafted to build a nuclear power plant in Roopur in the Pabna district of former East Pakistan. Although there were discussions with the

governments of Canada, Sweden and Norway, no progress was achieved, and the plan was scrapped in 1970. After the independence of Bangladesh, the nuclear power program with the same site selection was revived in 1974. The years that followed also showed little progress as feasibility studies were conducted and discussions with the governments of the former Soviet Union, France, and China were held in various instances with insignificant results. In 2011, the plan became more concrete as the IAEA rendered technical assistance for the Roopur nuclear power plant project, which was eventually contracted to the Russian state company Rosatom. The World Nuclear Association (2022b) reports that Bangladesh now has two nuclear power plants under construction, Roopur 1 and Roopur 2 with a gross capacity of 1200 MWe each. Roopur 1 started construction in November 2017 and is expected to be operational by 2023 or 2024. Roopur 2 started construction in July 2018 and may be operational by 2024 or 2025.

2.2 The continuing debate on nuclear energy development

Nuclear power plants are considered the most reliable energy source of an electric power system because they can run 24 hours a day in all days of the year and are designed to refuel only every 1.5 to 2 years (US Office of Nuclear Energy 2021). Moreover, even though capital cost is initially high, the operating cost per kWh is very small given the low fuel cost. Given this reliability and low operating cost, nuclear energy has fueled the prosperity of many countries since the 1960s.

Following the Three Mile Island accident in 1979 and the Chernobyl accident in 1986, there was a slowdown in the construction of nuclear power plants. In the late 2000s, there was renewed global interest in nuclear power as its advantages are highlighted by the following considerations: the technological advances in the performance and safety of nuclear power plants; the need to use lower-cost sources of electricity given the dramatic increases in fossil fuel prices at the time; the desire to reduce carbon emissions in response to the climate change challenge and given that electricity generation from nuclear power plants does not produce carbon dioxide; and the promotion of energy security given that some oil imports come from conflict-affected areas of the world (Joskow and Parsons 2009).

A development that tempers environmentalists' opposition to nuclear energy is the increasing recognition that it can play a large role in quickly achieving climate targets. The IAEA reported that nuclear energy has a large potential future contribution to climate change mitigation across 400 recently published scenarios of climate change, including those from the International Panel on Climate Change Special Report (IAEA 2020a). Even the United Nations Economic Commission for Europe recognizes the potential of nuclear energy in achieving sustainable development goals. It recognizes that nuclear energy plays a role not only in decarbonizing the energy sector but also in providing needed affordable energy to help eliminate poverty, achieve zero hunger, provide clean water, fuel economic growth and promote industry innovation. It also expressed optimism for current technology that offers high levels of safety and operating performance and the technological progress in small modular reactor and advanced reactor designs. It also recognizes various ways that nuclear and renewable energy technologies complement each other in delivering clean, affordable and reliable energy (United Nations Economic Commission for Europe 2021).

But issues in the utilization of nuclear energy remain, such as safety, economics, radioactive waste disposal, and nuclear weapons proliferation (Martin n.d.). Safety is a prominent concern and acutely affects public perception given the three global nuclear accidents in the past (viz., Three Mile Island, Chernobyl, and Fukushima accidents). Project economics also continues to be a concern, especially for developing countries, given that capital costs remain high and sensitive to interest and foreign exchange fluctuations. There is still no permanent disposal site anywhere in the world for the highly radioactive nuclear waste and current waste are only temporarily stored in secure repositories. Although the world's first permanent nuclear waste disposal site is being built under the bedrock of Olkiluto Island in Finland, operation will still be in 2024 or 2025, that is, if everything goes smoothly (El-Showk 2022). There also remains the public fear that commercial nuclear power can also lead to nuclear weapons proliferation because uranium enrichment and reprocessed spent fuel can be used for weapons development.

The pros and cons of nuclear energy development is neatly summarized in Yap (2021) based on various sources (see Box 1). Not highlighted in Yap (2021) but worth adding to the summary of the continuing debate is the issue of hidden subsidies. For less developed countries, the hidden subsidies in nuclear energy development is a large concern. Historically, there is heavy government involvement in many parts of the nuclear fuel cycle. Subsidies can take the form of explicit purchase mandates for nuclear power but there are also subsidies along the supply chain, from subsidies to various primary factors of production to intermediate inputs and security and risk management during operation. Decommissioning in some cases also involve subsidies. However, data on subsidies to the nuclear fuel cycle are weak, or subsidies are hidden. These subsidies promote the expansion of nuclear even when other alternatives could provide the same energy services more quickly, more cheaply, and at lower risk (Koplow 2011).

Box 1. Summary of pros and cons of nuclear energy development

Although the following advantages and disadvantages are discussed in Yap (2021) in relation to the Bataan Nuclear Power Plant, they are applicable to nuclear energy in general.

Pros

1. Low cost of operation - after the initial cost of construction, the cost to produce electricity is much lower than the cost in gas, coal or oil
2. Reliable source of energy - unaffected by external climatic factors, can produce energy non-stop
3. Stable base load energy - output can be dispatched to the system as and when required
4. Low pollution output - quite low compared with pollution from fossil fuels; current fleet already reduces over 555 million metric tons of emissions yearly
5. Sufficient fuel availability - current uranium reserves are estimated to last another 80 years
6. Higher energy density - nearly 8,000 times more efficient at producing energy than traditional fossil fuels

Cons

1. Expensive to build
2. Accidents can and do happen
3. Produces radioactive waste - current solutions are sealing and storing deep underground
4. Impact on the environment of mining and enrichment of uranium

- 5. Security threat - used uranium can be turned into nuclear weapons
- 6. Limited fuel supply - uranium will eventually run out

Source: Yap (2021, p. 22-26).

3. The implications of developing a Philippine nuclear energy program

3.1 Contextualizing through history

3.1.2 Key points in the history of the Philippines' nuclear energy ambition

The administration of former President Carlos P. Garcia in 1958 introduced the possibility of utilizing nuclear energy in the Philippines through the creation of the Philippine Atomic Energy Commission (PAEC) by virtue of Republic Act 2067 or the Science Act of 1958. The first nuclear reactor for research purposes was then built by the PAEC in the early 1960s (NEDA 2015).

When the global oil crisis hit in the early 1970s, the country's overdependence on imported oil became a growing concern. Former President Ferdinand E. Marcos, Sr. (Marcos Sr.) announced in 1973 that a nuclear power plant will be built to reduce the country's dependence on imported oil. The construction of the Bataan Nuclear Power Plant (BNPP) started in 1976, with Westinghouse Electric bagging the contract at USD500 million. There were vocal anti-nuclear protests then, especially in the community where the plant is located. Construction was put on hold in 1979 following the Three Mile Island Accident in the US. After an inquiry on the safety of the BNPP and assurances on safeguards had been made, construction restarted. By 1984, the cost had ballooned to USD2.3 billion (IAEA 2016a).

In 1986, the year Marcos Sr. was overthrown by people power revolution, the Chernobyl Disaster occurred in the former Soviet Union. The administration of former President Corazon C. Aquino (Aquino I) decided not to operate the BNPP due to safety concerns, public opposition, and corruption allegations. It then reorganized the PAEC into the Philippine Nuclear Research Institute (PNRI) in 1987. It also sued Westinghouse for alleged overpricing and bribery (IAEA 2016a). By March 1992, negotiations with Westinghouse reached a compromise agreement which involved a plan for the firm's payment of USD100 million to the government and for the government to borrow USD400 million to pay Westinghouse for the repair and eventual operation of the BNPP (Branigin 1992). In the meantime, no new generation capacity that would replace what was expected from the BNPP came in, resulting in a crippling power crisis that would be acutely felt in the 1990s.

Under the term of former President Fidel V. Ramos, the government found the terms in the compromise agreement unacceptable and decided to continue the lawsuit against Westinghouse, but the government eventually lost the case. To cope with the electric power crisis at the time, Ramos entered into costly deals with independent power producers (IPPs). The Department of Energy (DOE) under the Ramos administration incorporated nuclear power as a long-term option

in the Philippine Energy Plan 1998-2035, with 2025 as target operation year of a 600 MW nuclear power plant (IAEA 2016a). This set the target for having a nuclear power plant far in the future, that is, 27 years after 1998, which is appropriate as nuclear energy development is a long-term commitment that requires adequate preparation. However, in the meantime, no decision was made about the BNPP and the National Power Corporation (NPC) continued to preserve the power plant. In the aftermath of the 1998 East Asian Financial Crisis, slower economic activities tempered the demand for electricity and left the country with excess electric power supply, which eventually burdened consumers due to take-or-pay provisions in the IPP contracts.

During the administration of former President Gloria M. Arroyo, international interest in 2007 in the so-called “nuclear renaissance” influenced Philippine policymaking. In 2008, the government sought for a mission review by the IAEA and commissioned the Korea Electric Power Corporation (KEPCO) to conduct a feasibility study on the possible rehabilitation of the BNPP. The study established the technical feasibility of rehabilitating BNPP at a cost of USD1 billion, as disclosed in KEPCO’s study submitted to the NPC in 2010 (Murakami 2013).

In 2011, the Fukushima incident happened, which sparked renewed fears about the safety of nuclear power plants. Nevertheless, the inclusion of nuclear energy in the power mix remained as one of the energy sector development objectives during the administration of former President Benigno C. Aquino III (Aquino II). Considering that public acceptance is one of the requisites, the DOE and the NPC conducted in 2014 a public forum for the people of Bataan. The social acceptability survey revealed that majority of the respondents favor the possible rehabilitation of the BNPP. Considering also that regulation is a vital component of nuclear power development, two bills on nuclear and radiation safety regulation (House Bills 147 and 4930) were filed during the 16th Congress (Murakami 2015). Moreover, in the preparation of the long-term vision *Ambisyon Natin 2040* under the Aquino II administration, the inclusion of nuclear energy in the generation mix was among the recommendations. The long-term vision document was first released in 2015.

The administration of former President Rodrigo R. Duterte, as early as 2016, expressed interest in nuclear energy and the DOE reached out to the IAEA for review missions on the prospect of developing a nuclear energy program. In addition, the DOE created the Philippine Nuclear Energy Program Implementing Organization (NEPIO) through Department Order 2016-10-0013. Duterte also issued in July 2020 Executive Order No. 116 series of 2020 (EO 116, s. 2020) “Directing a Study for the Adoption of a National Position on Nuclear Energy Program, Constituting a Nuclear Energy Program Inter-Agency Committee, and for Other Purposes”.² In February 2022, Duterte issued EO 164, s. 2022 “Adopting a National Position for a Nuclear Energy Program, and for Other Purposes”. It declared, among others, that “nuclear power shall be tapped as a viable alternative baseload power source along with alternative energy sources” (EO 164, s. 2022, Section 1).

A nuclear energy roadmap is already discussed in the Philippine Energy Plan (PEP) 2020-2040. The PEP 2020-2040 has a long-term scenario building that includes the clean energy scenario wherein renewable energy-based generation capacity is 50 percent of the total capacity by 2040. The PEP states that the clean energy transition does not discount the entry of alternative and

² It is not clear if a written study was produced by the inter-agency committee as it has not yet released a study at the time of writing.

emerging technologies such as nuclear, hydrogen and ocean thermal energy conversion. However, the projected figures do not yet include a target contribution of nuclear energy to the generation mix.

Under the current administration of President Ferdinand R. Marcos, Jr. (Marcos Jr.), the new Philippine Development Plan (PDP) 2023-2028³ articulates that: (1) the government will explore the inclusion of nuclear energy in the power generation mix; (2) any decision by the government to allow investment in nuclear power plants will have to be backed by rigorous scientific studies that are consistent with IAEA guidelines and acceptable to the public; and (3) the legal and regulatory framework for nuclear energy will be crafted (NEDA 2022). The DOE Secretary has also made announcements that the government will not discriminate against any technology in meeting the country's energy security objectives and will study the use of nuclear energy, including the potential small modular reactors to power off-grid areas and even the future of nuclear fusion (Flores 2022).

3.1.2 The Bataan Nuclear Power Plant case

The primary motivation for the Philippines embarking on nuclear power plant development in the 1970s was its high dependence on imported oil. When the 1973 embargo by the Organization of Petroleum Exporting Countries happened, the country was importing 93 percent of its oil demand. At the time, the estimate was that as much as 6 million barrels of crude oil per year could be saved through one nuclear power plant alone (Beaver 1994). In 1973, Marcos Sr. directed NPC to negotiate a deal for two 600-MW nuclear power plants (Dumaine 1986). General Electric (G.E.) and Westinghouse Electric Corporation (Westinghouse) were the two serious contenders in the negotiations. In 1974, G.E. proposed to build two 600-MW reactors for around USD700 million but Marcos Sr. eventually entertained Westinghouse's letter of intent to build the two reactors for USD500 million. Negotiations with Westinghouse took two years but the final agreement was for one reactor only. Thus, the BNPP was supposed to have been called PNPP-I or Philippine Nuclear Power Plant I and a separate project for PNPP-II was supposed to be pursued. (be arranged) The final contract, with an escalated cost of USD1.1 billion, was signed in 1976 (Beaver 1994).

As the Philippine Supreme Court would later declare in 2021, the Westinghouse contract was marred by corruption right from the start. In *G.R. No. 205172, Herminio T. Disini v. Republic of the Philippines*, the Supreme Court affirmed the 2012 *Sandiganbayan* ruling that Disini unduly enriched himself at the expense of the Filipino people and the Republic of the Philippines by exerting undue influence, through his close association with Marcos Sr., in the awarding of the BNPP project to Westinghouse in 1976 and receiving commissions of about USD50 million in the process. The Court also directed Disini to pay the Republic PHP1 billion in temperate damages and PHP1 million in exemplary damages. But the Court upheld the *Sandiganbayan*'s finding of no direct evidence that Marcos Sr. and his wife Imelda benefited from Disini's dealings (Supreme Court 2021).

On doubts about safety of the BNPP, a primer by Gonzales (1979) archived by the IAEA showed that these doubts started in 1978 when an IAEA team visited the BNPP site and gave a stricter

³ The new PDP was approved by the President on December 16, 2022.

recommendation afterwards. The 1978 IAEA team compared the final site, Morong, Bataan, with the previously selected site, Bagac, also in Bataan. The previous site selection was based on recommendations made after the 1963, 1966 and 1972 visits by IAEA consultants upon the invitation of the Philippine government. Between 1972 and 1974, technical experts from the NPC and Ebasco Services⁴ assessed candidate sites for the power plant and they eventually recommended the current site, Napot Point in Morong. This is because: (1) the Bagac site is near two rivers and flooding risk makes the site unsuitable; (2) Napot Point is higher at 18 meters above sea level whereas the Bagac site is only 3 meters above sea level and the higher elevation will protect the power plant from possible huge tidal waves; (3) the foundation in Napot Point is firmer than that in Bagac. The Westinghouse design for the power plant is supposed to withstand a 7.9 magnitude earthquake. But the 1978 IAEA team, noticing the change in site selection and alarmed by the existence of a dormant volcano near Napot Point and some inactive faults farther away, recommended that the design consider a higher earthquake magnitude and sent such finding to the IAEA headquarters in Vienna. The primer begrudged that the 1978 IAEA team, which did not have a volcanology or seismology expert, examined in just a few days the volumes of two-year studies prepared by experts consisting mostly of Filipinos and made adverse conclusions. It averred further that the location choice should be respected “unless it can be claimed that the Filipinos do not know what they are doing” (Gonzales 1979, p. 8). As the Philippine Institute of Volcanology and Seismology (PhilVolcs) would declare later, the site is far from any fault lines, and the proximate volcano, Mount Natib, is no longer active (Cheng 2018). The PhilVolcs assessment on the safety of the BNPP location is echoed by the Philippine Nuclear Research Institute (PNRI).⁵

Cardenas (1987) recounted that the executive director of the US' Union of Concerned Scientists wrote Marcos Sr. and told him about the safety problems in the Westinghouse design and the cost of the Philippine project, which reached USD1.9 billion at the time, that was far higher than any equivalent nuclear power project in the world. Marcos Sr. created the Puno Commission (headed by then Assemblyman Ricardo Puno) to investigate the safety of the project. Then the 1979 Three Mile Island (TMI) nuclear accident happened in Pennsylvania, US and it sparked safety discussions everywhere. Marcos Sr. ordered the temporary suspension of project construction even before the Puno Commission had finished its hearings. The Commission submitted its report in September 1980, which found inadequacies in safeguards and in standards for dealing with nuclear contamination, among other findings. Ten months later, Marcos Sr. announced the resumption of construction supposedly on the strength of a renegotiated contract with Westinghouse, which incorporated 102 safety requirements.

As Abadilla (1985) noted, there were constraints to the free flow of information and the press was "timid" during the 1972-1981 martial law years. It was only when martial law was lifted in 1981 that fuller discussions on the BNPP ensued and opposition to the BNPP escalated in public. This belies the common claim that the opposition to the BNPP was mounted only in the waning years of the Marcos Sr. regime up to the Aquino I administration.

⁴ The firm was referred to in the 1979 primer as IBASCO Corporation and at times as EBASCO Corporation but it is actually Ebasco Services, which was hired by the NPC to assess the safety of candidate sites for the plant. Ebasco Services is a subsidiary of Enserch Corp. of Dallas (Dumaine 1986).

⁵ In discussion with Dr. Carlo A. Arcilla, Executive Director of the Philippine Nuclear Research Institute, on October 21, 2021.

As criticisms continued, construction proceeded. By January 1985, Westinghouse announced that the 620-MW power plant is complete and ready for loading with fuel. The final cost reached USD2.2 billion (Beaver 1994). The planned start of commercial operation was December 1985 after completion of various tests and after the NPC had secured a license to operate from the PAEC. But in September 1985, the Supreme Court issued an injunction restraining the PAEC to decide on the NPC's application for license and ordered the reconstitution of the PAEC, which had only one single commissioner and one deputy commissioner at the time. On February 11, 1986, the Supreme Court ordered the PAEC to re-open the hearings on the power plant project once it has been reconstituted, which the latter did by forming a collegial body with one commissioner and four associate commissioners (Venida and Reyes 2011). But activities related to the BNPP were overtaken by political events leading to the ouster of Marcos Sr. and the start of the Aquino I administration on February 25, 1986.

Safety concerns were discussed anew within the Aquino I government as two conflicting IAEA reports delivered only months apart made the cabinet more cautious. In June 1984, visiting IAEA inspectors raised questions on safety as they noted problems in welding, plumbing, and electrical wiring. In February 1985, a second inspection team from the IAEA visited and concluded that the plant was ready for operation. The question then was how the two IAEA teams could have arrived at diverging conclusions only eight months apart (Dumaine 1986). An IAEA advisor suggested that the second team specialized in training and radiation exposure rather than in construction and thus lacked the expertise to properly inspect the previous problems (Beaver 1994), but he argued that the problems could be fixed (Dumaine 1986). Then the Chernobyl nuclear accident occurred on April 24, 1986. On April 30, 1986, the Aquino I cabinet voted to mothball the BNPP (Beaver 1994). Most accounts highlight this decision as the sole reason why the BNPP was not able to operate, but as history shows, there were attempts to make the plant operational during the Aquino I and Ramos administrations.

When the economic realities of costly maintenance and need for electric power set in, the Aquino I government attempted to negotiate with Westinghouse to address the safety concerns so that the BNPP could be put in operation. Westinghouse resisted and the government sued Westinghouse in the US federal court in December 1988. Westinghouse filed for arbitration before the International Chamber of Commerce in Switzerland, and the latter issued a favorable ruling. But the federal court ruled that "the arbitration panel held the Philippine government to a more rigorous standard of proof than would a federal jury" (Beaver 1994, p. 277). Before the trial before a federal jury could begin, a compromise agreement was worked out in March 1992. The compromise with the Aquino I government was described as complex—Westinghouse would pay the Philippines USD100 million in cash, goods and services, the Philippines would shell out USD400 million to upgrade the power plant to 1992 safety standards, USD300 million of that amount would come from the plant's to-be-generated revenues as Westinghouse operates the plant for 30 years, and Westinghouse would receive USD40 million per year from the plant's revenues for its services in operating the plant (Beaver 1994).

The Ramos administration decided to renegotiate for better terms in the compromise agreement but negotiations broke down. The Presidential statement back then indicated that it planned to find other foreign companies which could repair and operate the BNPP. (Branigin 1992). The Philippine government then resumed the legal action before the US federal court, but the jury

acquitted Westinghouse in May 1993. Then the government filed an appeal, which was ultimately turned down by the court (Albor 1993). The BNPP has not been operated since and the uranium fuel was sold to Siemens and shipped out on December 15, 1997 (Venida and Reyes 2011). The NPC continued to preserve the power plant assets, spending an average of PHP51.34 million in nominal terms per year (Table 2) or PHP43.93 million in real terms (Table 3) from 2012 to 2022.

Since the time that the government decided to sell the fuel for the BNPP, the preservation and maintenance activities of the NPC "was reduced to the general upkeep of the whole reservation area and the maintenance of the major equipment like the turbine."⁶ In addition, during the Arroyo administration, there was explicit instruction for the NPC to wind down its maintenance and operating activities for the BNPP to its barest essentials, as seen in the special provisions of the 2012 GAA and the 2014 GAA (DBM n.d.). But there were huge increases in the 2020 and 2021 budget because of capital expenditures such as repair of the turbine roofing, administration building, perimeter fence, and lights.⁷

Table 2. BNPP preservation budget (nominal prices) in the GAA, 2012-2022 (in thousand pesos)

Year	Current Operating Expenditures			Total
	PS	MOOE	CO	
2012	0	23,000	0	23,000
2013	6,832	41,484	0	48,316
2014	6,284	20,780	0	27,064
2015	11,746	20,780	0	32,526
2016	11,955	34,483	0	46,438
2017	15,904	35,521	0	51,425
2018	14,481	32,630	0	47,111
2019	15,742	39,878	180	55,800
2020	25,281	40,850	6,317	72,448
2021	27,254	30,507	34,773	92,534
2022	33,908	28,246	5,965	68,119
Average				51,344

Note: GAA - General Appropriations Act; PS - Personnel Services; MOOE - Maintenance and Other Operating Expenses; CO - Capital Outlays.

Source: DBM (n.d.)

⁶ In discussion with Atty. Manuel Luis B. Plofino, Senior Department Manager of the NPC-Resource Management Service (the unit in charge of maintaining the BNPP), on October 14, 2021.

⁷ *Ibid.*

Table 3. BNPP preservation budget (real prices, 2012 base year) in the GAA, 2012-2022 (in thousand pesos)

Year	Current Operating Expenditures			Total
	PS	MOOE	CO	
2012	0	23,000	0	23,000
2013	6,659	40,433	0	47,092
2014	5,912	19,548	0	25,460
2015	10,978	19,421	0	30,398
2016	11,029	31,811	0	42,839
2017	14,264	31,857	0	46,121
2018	12,345	27,818	0	40,163
2019	13,097	33,176	150	46,423
2020	20,504	33,131	5,123	58,758
2021	21,160	23,686	26,998	71,843
2022	25,465	21,213	4,480	51,158
Average				43,932

Note: PS - Personnel Services; MOOE - Maintenance and Other Operating Expenses; CO - Capital Outlays. In converting the expenditures above to 2012 prices, the historical Consumer Price Index (CPI) dataset (2012-2021) from the BSP (2022) was used. For 2022, the average of January to November 2022 inflation figures from the PSA (2022) was used to approximate the 2022 CPI.

Source: DBM (n.d.)

As the possibility of reviving the BNPP was still on the table, the government in previous administrations sought technical experts' opinions on the feasibility and cost of doing such. As mentioned in Section 3.1.2, a 2010 KEPCO study conducted during the Arroyo administration placed the cost at USD1 billion. In 2017, during the Duterte administration, the Philippine government sought Korean assistance again in assessing the feasibility of rehabilitating the BNPP. The state-owned Korea Hydro & Nuclear Power (KHNP) conducted a pre-feasibility study through a cooperation agreement with the DOE (Ronda 2022) but the results of the study, including the needed rehabilitation cost, have not yet been released by the DOE.

On November 13, 2017, the DOE signed with the Russian Federation State Atomic Energy Corporation (Rosatom) a five-year Memorandum of Cooperation that includes the audit and assessment of the BNPP as one of the areas of cooperation (DOE 2017). The DOE has not yet made public the results of the audit and assessment. But in 2018, the Rosatom Vice President remarked that their technical experts, who accordingly made a thorough inspection of the BNPP, believe that the power plant can still be revived if that is the desire of the Philippine government. However, the rehabilitation option may not prove cost-effective and that the Philippine government has to consider whether it will be beneficial for the country to choose that option given that other options include exploiting the existing infrastructure and synergies in the Bataan site to build a new nuclear power plant or pursuing the use of small modular reactor technology (Cordero

2018). In 2020, an Asia financial news report quoted the Rosatom estimate for BNPP rehabilitation as USD3 billion to USD4 billion (Maulia and Venzon 2020).

The decision to rehabilitate and put into operation the BNPP has long hounded the Philippine government. But regardless of the outcome in this decision-making, embarking on a nuclear energy development program can be pursued by the government if it could make a long-term commitment to it. New and more advantageous technologies for tapping nuclear energy have emerged and just as other countries are benefiting from these, the Philippines also could, provided the international and domestic prerequisites are understood and complied with.

3.2 Assessing the requirements

The long-term commitment of any country to pursue a nuclear energy development program revolves around nuclear safety, nuclear security and safeguards. The IAEA (2015) emphasizes the following with respect to these three considerations: On nuclear safety, the government, including the regulatory body, and the operator need to ensure that the people and the environment are protected from harm due to nuclear radiation and that a culture of safety is in place in all stages of the nuclear program. On nuclear security, they need to ensure that people, property, the environment, and the next generation are protected from the damaging effects of a nuclear security event. On safeguards, the country needs to assure the rest of the world that in its pursuit of the nuclear power program, there is no risk at all of proliferation of nuclear weapons and it adequately accounts for and protects all nuclear material in accordance with international treaties. Given these considerations, the IAEA prescribes a milestones approach that demonstrates how long-term the commitment should be.

The needed long-term commitment is best described by the IAEA assertion that "Each nuclear power plant involves a commitment in the order of 100 years, through construction, operation, decommissioning and waste disposal" (IAEA 2015, pp. 1–2). The IAEA estimates that, based on experience, the pre-operation stage would take 10 to 15 years. This duration is from the country's initial consideration to embark on a nuclear power development program up to commissioning and operation of the first nuclear power plant. It also assumes that the political, economic and social environment in the country is stable.

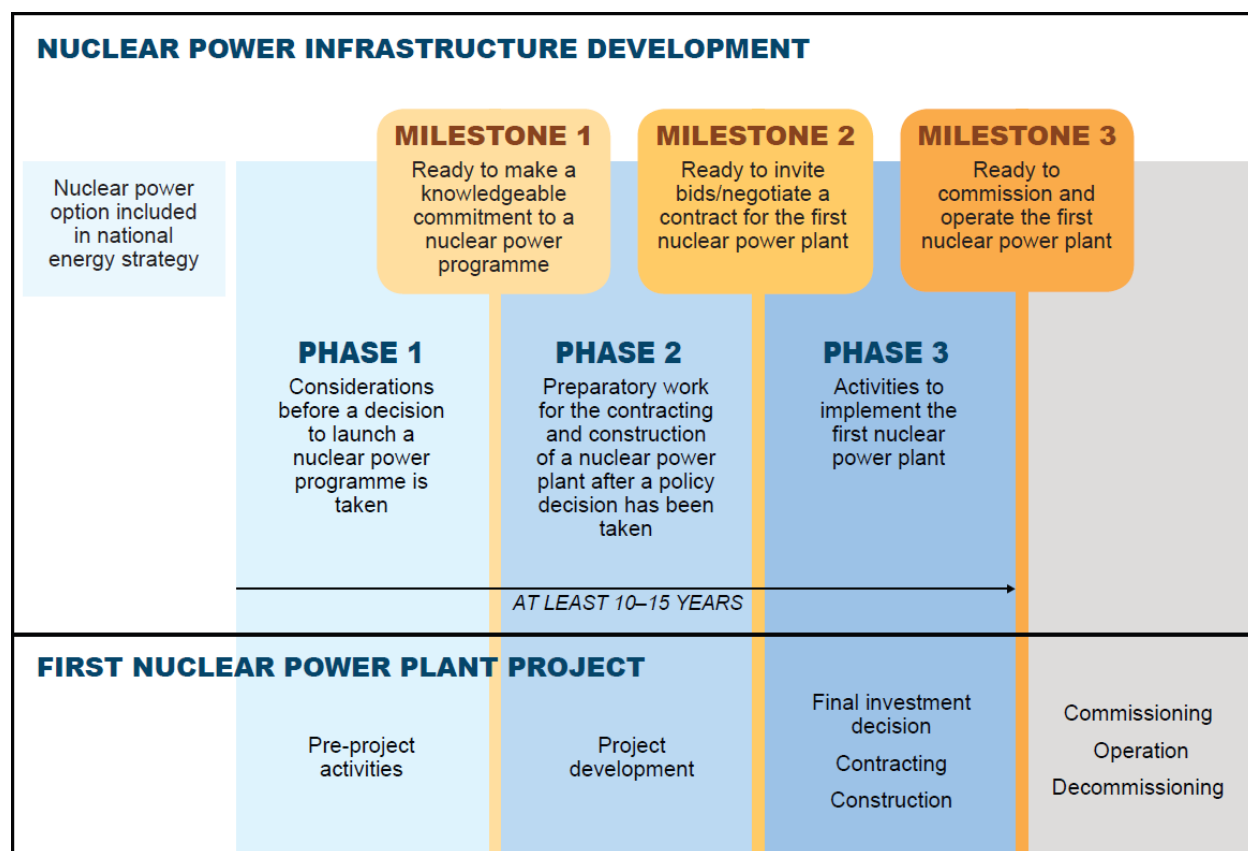
To provide guidance to countries that are just starting in their nuclear power programs and to help countries with old nuclear power plants expand their existing programs, the IAEA organized and outlined the activities needed for infrastructure building through what it calls the "Milestones Approach" (IAEA 2015). In the prescribed approach, the concept infrastructure covers both the hard infrastructure such as power grid and power plant as well as the soft infrastructure such as nuclear-specific laws, regulations, trainings, and systems.

In terms of organizational requirements, the government will have to create a high-level mechanism for coordinating the work of key organizations involved in the nuclear power program. In the IAEA guidelines, this is called the nuclear energy program implementing organization (NEPIO). There must also be an independent regulatory body, independent in the sense that it has adequate manpower and financial resources and is free from unwarranted influences. The owner-

operator of the nuclear power plant may be the government or a private firm, or ownership may be separated from operation and one or both may be by the government or a private firm. As preparation for the nuclear power program progresses, the organizational requirements and structure will become clearer.

The schematic diagram in Figure 6 provides a snapshot of the Milestones Approach. First and foremost, the country must articulate in its national energy strategy that it has included nuclear power among the options for energy generation. Then the country undergoes three phases in developing the necessary infrastructure and at the end of each phase a milestone must be reached before embarking on the next phase.

Figure 6. Schematic diagram of the phases and milestones in nuclear power infrastructure development



Note: The term “programme” (British English) in this IAEA diagram is replaced with “program” in all discussions throughout this discussion paper.

Source: IAEA (2015).

In Phase 1, the country analyzes all considerations and issues so that at the end of this phase, it is better informed and ready to commit to a nuclear power program, that is, the Milestone 1. During this phase, the country builds on the infrastructure for nuclear security, radiation safety, and

emergency preparedness that it currently has for nuclear-related activities. The NEPIO should also be actively coordinating national efforts and producing the studies needed for coming up with an informed national policy decision. By the end of Phase 1, the NEPIO should have produced a comprehensive report that justifies the national decision.

In Phase 2, as a result of the policy decision to build its first nuclear power plant, the country prepares the requirements for contracting and construction. The independent regulatory body should already be existing and capable of fulfilling its authorization and inspection duties. By the end of Phase 2, the country must have achieved Milestone 2 wherein it is ready to invite bids or negotiate a contract for its first nuclear power plant.

In Phase 3, the actual bidding or negotiation takes place, the licensing requirements are secured, and project implementation follows. Milestone 3, a major accomplishment, is achieved when the country is ready to commission and operate its first nuclear power plant. By this time, all systems and regulations reinforce the lasting commitment of the country to the safe, secure and peaceful uses of nuclear power.

Nineteen infrastructure issues (Box 2) must also be resolved in every phase. Specific actions corresponding to the 19 infrastructure issues must be undertaken in each phase before proceeding to the next phase. For instance, nuclear safety issues are addressed by the end of Phase 1 if the studies and the comprehensive report produced by the NEPIO have focused on: the international safety standards, the legal and regulatory framework for safety, the leadership and management requirements for safety, the siting or location with considerations for safety, the decommissioning of power plants, the long-term management of spent fuel and radioactive waste, the prevention and mitigation of accidents, and emergency preparedness and response. In addition, all entities involved in the nuclear power program should already be starting to develop a safety culture and the country should already be planning to sign up to international instruments on nuclear safety. In Phase 2, addressing nuclear safety means that all organizations involved should already have a safety culture, including government agencies, the regulatory body, the potential suppliers, the facility owner, and the operator. By the end of this phase, the owner and/or operator and the regulatory body should already have filled up the senior positions and the regulatory body should already have specified the competence requirements for the safety and security staff positions in the owner and/or operator. Moreover, communications protocol for licensing and safety issues should already have been formulated. In Phase 3, the safety culture development within organizations should be continued. By the end of Phase 3, the regulatory body should have independently verified the owner/operator's compliance with regulatory requirements. The owner/operator's documentation should have already included safety and security analyses of the plant and have established mechanisms for updating knowledge of and management over the plant's safety throughout its life.⁸

⁸ This summary for nuclear safety is for illustration purposes only. For details on the necessary specific actions to address each of the 19 infrastructure issues from Phase 1 to Phase 3, please refer to the IAEA guidebook "Milestones in the Development of a National Infrastructure for Nuclear Power" (IAEA 2015).

Box 2. Nineteen infrastructure issues that must be considered

IAEA (2015) highlights that these 19 infrastructure issues must be fully considered during Phase 1 and that the comprehensive report produced at the end of this phase must show how the issues are addressed. The order of presentation of the 19 infrastructure issues does not imply ranking of importance.

1. National position
2. Nuclear safety
3. Management
4. Funding and financing
5. Legal framework
6. Safeguards
7. Regulatory framework
8. Radiation protection
9. Electrical grid
10. Human resource development
11. Stakeholder involvement
12. Site and supporting facilities
13. Environmental protection
14. Emergency planning
15. Nuclear security
16. Nuclear fuel cycle
17. Radioactive waste management
18. Industrial involvement
19. Procurement

Source: IAEA (2015).

3.3 Analyzing the gaps

The creation of the NEPIO through Department Order 2016-10-0013 started the renewal of efforts to pursue a nuclear power program in the Duterte administration. Based on the IAEA methodology, part of the process is a self-evaluation by the country and the conduct of an Integrated Nuclear Infrastructure Review (INIR), a peer review service offered by the IAEA since 2009 to assist member states embarking on a new or expanded nuclear power program. As reported by the IAEA in October 2019, the Philippines submitted a self-evaluation report to the IAEA in July 2018. The IAEA in turn conducted a mission or technical visit to the Philippines, for the self-evaluation support and as a pre-INIR mission, on October 2-4, 2018. The Philippines then submitted a revised self-evaluation report and supporting documents in November and December 2018. The INIR process started afterwards. The IAEA then conducted a second mission, the Phase 1 INIR Mission (i.e., conducted for Phase 1 in the Milestones Approach or in preparation for the final decision to pursue a nuclear power development program), on December 10-17, 2018. The IAEA's Phase 1

INIR Mission Team turned over its report to the Philippine government on October 30, 2019 (IAEA 2019 and Dyck 2019).

Note that INIR missions are conducted for each of the three phases of the Milestones Approach. Funding for INIR missions and report preparation mainly comes from the IAEA Technical Cooperation Program, with some cost sharing by the host government and extrabudgetary contributions (i.e., outside the budget of the IAEA) from the Peaceful Uses Initiative, a facility for raising funding support from state parties to the Nuclear Non-Proliferation Treaty (IAEA 2020b).

The conditions that must be met corresponding to the 19 infrastructure issues were identified in the Phase 1 INIR Mission and the IAEA INIR Mission Team gave various recommendations and suggestions on how to meet these conditions. Table 4 summarizes the findings, recommendations, and suggestions of the INIR Mission Team.

Table 4. Summary of the Phase 1 INIR Mission Results

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
1. National position					
1.1 Long term commitment made and importance of safety, security and non-proliferation recognized		/			S-1.1.1 Finalize the consultations on the proposed executive order to achieve consensus on the way forward.
1.2 The NEPIO established	/			R-1.2.1 Implement the proposed expansion of the current NEPIO in order to enhance nuclear power program coordination	
1.3 National strategy defined	/			R-1.3.1 Implement the work proposed in the EO to define a national strategy for the nuclear power program	
2. Nuclear safety					
2.1 Key requirements of nuclear safety understood		/			S-2.1.1 Continue developing the NEPIO's own and all relevant stakeholders' understanding of nuclear safety
2.2 Support through international cooperation initiated			/		
3. Management					
3.1 Need for appropriate leadership and management systems recognized		/			S-3.1.1 Implement a leadership development program to ensure that future leaders in the key organizations gain the experience needed for a successful nuclear power program

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
					S-3.1.2 Gain awareness of approaches to promote a safety and security culture in the key organizations of the nuclear power program and to plan relevant activities at the appropriate time
4. Funding and financing					
4.1 Strategies for funding established		/			S-4.1.1 Develop a multi-year assessment of the costs of nuclear power infrastructure development activities.
					S-4.1.2 Consider arrangements to ensure the availability of adequate funds for radioactive waste management and commissioning
4.2 Potential strategies for financing identified	/			R-4.2.1 Review the viability of various financing options for a nuclear power project in the Philippines and identify any need for changes in the current legal framework	
5. Legal framework					

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
5.1 Adherence to all relevant international legal instruments planned		/			S-5.1. Complete the legislative approval process of the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management as well as the Amendment to the Convention on the Physical Protection of Nuclear Material
					S-5.1.2 Carry out an analysis and develop a plan to pursue legislative approval of the Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage, the Convention on Supplementary Compensation and the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention
5.2 Plans in place for development of comprehensive national nuclear law	/			R-5.2.1 Review some aspects of the current bills and ensure that its legislative plans include all necessary provisions of a comprehensive national nuclear law	
5.3 Plans in place to enact and/or amend other legislation affecting the nuclear power program	/			R-5.3.1 Complete an analysis of laws that may affect the nuclear power program and plan for their	

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
				enactment or amendment as appropriate	
6. Safeguards					
6.1 Terms of international safeguards agreement in place			/		
6.2 Strengthening of the State System of Accounting for and Control of nuclear material (SSAC) planned			/		
6.3 Recommendations from any previous reviews or audits being addressed			/		
7. Regulatory Framework					
7.1 Development of an adequate regulatory framework planned	/			R-7.1.1 Review the proposed structure and staffing requirements for the future regulatory body and ensure they are adequate to meet the needs of the nuclear power program	S-7.1.1 Identify regulators and organizations that can provide external support to PNRI or the future Philippine Nuclear Regulatory Commission (PNRC) and pursue opportunities for cooperation
				R-7.1.2 Develop a plan for the development of regulations that will be required for a nuclear power program	
8. Radiation protection					
8.1 Enhancements to radiation protection programs planned		/			S-81.1 Continue assessing and planning for enhancements to radiation protection programs

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
					with regard to the needs of the nuclear power program
9. Electrical grid					
9.1 Electrical grid requirements considered	/			R-9.1.1 Ensure that a preliminary study of the grid system is conducted covering the reliability of the grid and its compatibility with the introduction of a nuclear power plant	
10. Human resources development					
10.1 Necessary knowledge and skills identified, and gaps in current capability assessed			/		
10.2 Development of human resources planned	/			R-10.2.1 Outline plans for human resource development for each key organization to be integrated at the national level	
11. Stakeholder involvement					
11.1 Open and transparent stakeholder involvement program initiated		/			S-11.1.1 Further develop outreach activities and materials specific to nuclear power in the Philippines for engaging all relevant stakeholders
12. Site and supporting facilities					

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
12.1 General survey of potential sites conducted and candidate sites identified			/		
13. Environmental protection					
13.1 Environmental requirements considered			/		
13.2 Framework for environment protection reviewed			/		
14. Emergency planning					
14.1 Requirements of, and resources for, developing an emergency response capability recognized	/	/		R-14.1.1 Assess existing emergency preparedness and response (EPR) arrangements against the requirements for the nuclear power program	S-14.1.1 Ensure consistency between the comprehensive nuclear law and the Philippines' National Radiological Emergency Preparedness and Response Plan (RADPLAN, prepared in 2000) with regard to the responsibility for maintaining the RADPLAN
14.2 Recommendations from any previous reviews or audits being addressed			/		
15. Nuclear security					
15.1 Nuclear security requirements recognized and the actions of all relevant organizations coordinated		/			S-15.1.1 Review and adapt the national coordination mechanisms for nuclear security to meet the needs of the nuclear power program

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
15.2 Recommendations from any previous reviews or audits being addressed			/		
16. Nuclear fuel cycle					
16.1 Options for nuclear fuel cycle (front-end and back-end) considered	/			R-16.1.1 Further assess options for the nuclear fuel cycle, including the supply of nuclear fuel and the management of spent nuclear fuel	
17. Radioactive waste management					
17.1 The requirements for management of radioactive waste from nuclear power plant (NPP) recognized	/			R-17.1.1 Perform a preliminary evaluation of the amounts and types of radioactive waste generated by a nuclear power plant and consider options for their management	
17.2 Options for disposal of all radioactive waste categories understood	/			R-17.2.1 Consider disposal options for radioactive waste arising from the operation and decommissioning of the nuclear power plant	
18. Industrial involvement					
18.1 National policy developed with respect to industrial involvement	/			R-18.1.1 Seek further information from local industries and technology providers and develop a national policy for industrial involvement in the nuclear power program	
19. Procurement					

Condition or Requirement per Infrastructure Issue	Actions Needed			Recommendation	Suggestion
	Significant Actions	Minor Actions	None		
19.1 Requirements for purchasing NPP services recognized			/		

Notes:

Significant actions needed - means that important work still needs to be initiated or completed to meet the condition.

Minor actions needed - means that some additional work or steps are needed to meet the condition or that plans for the next phase need to be enhanced.

None or no actions needed - means that all the work to meet the condition has been completed.

Source: Lifted in full from IAEA (2019, p.16–77).

Per INIR definitions, a “recommendation” emphasizes what needs to be done based on the IAEA Milestones Approach or evaluation methodology while a “suggestion” proposes alternative approaches or identifies better alternatives to the current efforts. As can be seen from the summary above, the INIR Mission Team did not make any recommendation or suggestion on issue no. 6- Safeguards, a critical issue in ensuring the peaceful use of nuclear energy. The INIR Mission Team noted that the Philippines is compliant with the 1974 comprehensive safeguards agreement with the IAEA and the 2010 additional protocol on safeguards and concluded that the Philippines' use of all nuclear material are for peaceful activities. On issue no. 12 on site and supporting facilities, the INIR Mission Team did not give any recommendation or suggestion but it noted that site investigations were conducted in the 1970s and 1990s, and a technical workshop for agreeing on the criteria to validate potential sites was conducted in 2018. The INIR Mission Team was also assured that a workplan for validating and potential sites has already been developed. On issue no. 13 on environmental protection, the INIR Mission Team noted that the DENR procedures include the conduct of an environmental impact assessment (EIA) and identify nuclear power plants as environmentally critical projects that require a full EIA (IAEA 2019).

To augment the recommendations and suggestions, the INIR Mission Team shared three good practices (IAEA 2019, p. 16-77) that may be adopted by the Philippines, as follows:

For 5. Legal framework, condition 5.2 Plans in place for development of comprehensive national nuclear law:

Good Practice (GP)-5.2.1 Involving parliamentarians in briefings and workshops raised their awareness and understanding of the scope and content of a comprehensive nuclear law early in the legislative approval process

For 11. Stakeholder involvement, condition 11.1 Open and transparent stakeholder involvement program initiated:

GP-11.1.1 Routinely providing spokespersons training to both technical and communication staff, according to an annual schedule, supports clear and consistent messaging about the nuclear power program

For 12. Site and supporting facilities, condition 12.1 General survey of potential sites conducted and candidate sites identified:

GP-12.1.1 Organizing a workshop with a broad range of stakeholders and implementing a structured process led to the development of a comprehensive set of criteria for identifying candidate sites for a nuclear power plant

The consideration of the 19 infrastructure issues through the self-evaluation and initial INIR mission placed the Philippines under Phase 1 of the IAEA Milestones Approach. The IAEA when it conducted its 2018 INIR Mission assessed that a draft national position was prepared (referring at the time to the draft executive order on the national position), but also noted that energy planning studies (EPS) will be expanded. The INIR Mission Report observed that the DOE already issued a prefeasibility study in December 2017 and that EPS were reported in the document "Assessment of Energy Supply Options for the Philippines" that was submitted to the IAEA (IAEA 2019). Note

that the IAEA has a guidebook for countries on the desirable components of a prefeasibility study (see Box 3 for the summary).⁹

Box 3. Prefeasibility study requirement before issuing a national position

According to the IAEA, the prefeasibility study to be conducted before issuing a national position may consider all or a subset of the 19 infrastructure issues, as priorities and interests are state-specific. The prefeasibility study may include the following components:

- Results of the relevant energy planning studies;
- A macroeconomic study on the impact of introducing a nuclear power program;
- Considerations of nuclear safety, including the recognition of the non-zero possibility of a severe accident;
- An initial analysis of the domestic and international legal requirements and agreements required to proceed;
- A preliminary evaluation of the suitable sites capable of hosting a nuclear power plant;
- Initial analysis of the electrical grid requirements;
- An estimation of the government funding necessary to support the development of the appropriate infrastructure, especially regulatory oversight;
- An initial analysis of human resource needs and a strategy for their development;
- A review of existing nuclear reactor technologies;
- An acknowledgement of the responsibilities related to decommissioning, management of spent fuel and nuclear waste and environmental remediation;
- An evaluation of public opinion and considerations related to stakeholder involvement.

Source: IAEA (2016b, p. 7).

A positive national position was eventually issued by the Duterte administration through EO 164, s. 2022 titled “Adopting a National Position for a Nuclear Energy Program, and for Other Purposes”. However, it cannot be considered that the Philippines has already achieved Milestone 1 (ready to make a knowledgeable commitment to a nuclear power program) despite this national position. Many elements are still missing, as evident in the INIR report (Table 4).

Progress in addressing the recommendations and suggestions in the INIR report is also quite slow. Recommendation R-1.2.1 on the expansion of the NEPIO had already been done given the issuance of EO 116, s. 2020 replacing the department-level NEPIO with the high-level Nuclear Energy Program Inter-Agency Committee (NEP-IAC). However, recommendation R-1.3.1 is not yet addressed because the national strategy for the nuclear power program has not yet been developed. For instance, it is not yet articulated in broad strokes in the Philippine Development Plan 2023-2028 nor the Philippine Energy Plan (PEP) 2020-2040 whether the national strategy for

⁹ The 2017 prefeasibility study, however, was not made available to the PIDS study team.

investment is through the private sector or the government (especially given the legislated restriction to government investment in power generation) or through some form of public-private partnership. Work is still in progress for the other Phase 1 recommendations and suggestions. This means that the milestones and timetable that the government targeted, such as commissioning of the first nuclear power plant by 2027-2029 as articulated in the Nuclear Energy Roadmap section of the PEP 2020-2040 (DOE 2020, p. 159, Figure 87), must be revisited and adjusted.

4. Conclusion and ways forward

Nuclear energy remains a promising option for the Philippines. As the review of international experiences has shown, the success of nuclear energy in powering the development of economies, the recent advances in safeguards for ensuring nuclear safety during the life cycle of nuclear fuel, and the growing recognition of the role of nuclear energy in the clean energy transition continue to attract countries to undertake new power plant construction or expand their current portfolio. Recently, even the advanced countries that initially committed to nuclear energy phaseouts turned around and decided to extend the operation of their nuclear power plants. Despite setbacks, the Philippines' neighboring developing countries are also pursuing their nuclear energy ambitions, with Bangladesh leading as it expects to operate its first commercial nuclear power plant by 2023 or 2024.

But as the IAEA has reiterated, deciding to use nuclear energy is a long-term commitment and one that should consider a time frame of 100 years from construction to decommissioning and waste disposal or storage. Thus, it would do well for the Philippines to follow the IAEA's Milestones Approach and for every government administration to be consistent in seeking progress through this approach.

As mentioned in previous sections, the 19 infrastructure issues must be considered in every phase of the Milestones Approach. The first infrastructure issue, the national position, is a crucial one. The national position in Phase 1 is supposed to articulate the positive decision to develop nuclear power, define the national strategy for nuclear power development, and justify the decision and strategy based on a prefeasibility study and the NEPIO's comprehensive report. The national position in Phase 2 should already include the implementation structure and contractual arrangements. The national position in Phase 3 should communicate the key decision to commission and operate the first nuclear power plant (or small modular reactor, if such is the case) given its full compliance with national and international regulations (IAEA 2015).

As a demonstration of understanding the commitment involved in nuclear energy development, the positive national position adopted by the Duterte administration may have to be confirmed and reinforced by the Marcos Jr. administration by issuing a fresh mandate to the NEP-IAC and setting new targets and timetable for the Phase 1 requirements that remain unaddressed. The new administration may find it useful to refer to the IAEA guidebook *Building a National Position for a New Nuclear Power Programme* (IAEA 2016b) and assess if the previously submitted background studies, including the 2017 prefeasibility study, satisfy its requirement (see Box 3) for an informed decision to confirm and reinforce the positive national position. Moreover, as

promised by the past administration, the energy planning studies need to have more detailed analysis before nuclear power can be introduced in the national energy plan.

The Philippines also needs to ratify the international legal instruments that it signed in the past. The latest ratification by the Philippines at the time of writing is the June 16, 2021 Senate ratification of the 2005 Amendment to the 1979 Convention on the Physical Protection of Nuclear Material.¹⁰ The IAEA (2019) reported that the Philippines signed but has not yet ratified the following:

- 1994 Convention on Nuclear Safety
- 1998 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
- 1998 Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage Philippines
- 1998 Convention on the Supplementary Compensation for Nuclear Damage
- 1998 Joint Protocol Relating to the Application of Vienna Convention and Paris Convention

The existing legal framework in the Philippines for nuclear energy development and regulation also needs to be updated. The two main laws—RA 2067 and RA 5207—are outdated. RA 2067, as amended by RA 3589, or the Science Act of 1958 mandates the research on and development of the peaceful uses of nuclear energy, and RA 5207 or the Atomic Energy Regulatory and Liability Act of 1968 provides the licensing and regulatory procedures for the use of nuclear energy. These laws no longer respond to the needs of the times given the evolution of international standards on safety and security, as shaped by technological advances and rigorousness in safeguards after major nuclear accidents. The current fragmentation in the regulatory framework for ionizing radiation also needs to be harmonized. At present, the regulation of the use of ionizing radiation is performed by two regulatory authorities. The PNRI under the Department of Science and Technology is the regulatory authority for radioactive materials and atomic energy facilities including medical facilities, and the Food and Drug Administration-Center for Device Regulation, Radiation Health, and Research (FDA-CDRRHR) under the Department of Health is the regulatory authority for electrical or electronic devices capable of emitting radiation, including electrically generated ionizing radiation and non-ionizing radiation. Moreover, the PNRI, since it also has developmental functions given that it is also mandated to research and develop applications of nuclear energy, cannot yet be considered the independent regulator that the IAEA Milestones Approach is prescribing.

¹⁰ See the recorded entry of Philippines ratification on June 16, 2021 at: <https://cil.nus.edu.sg/databasecil/2005-amendment-to-the-1979-convention-on-the-physical-protection-of-nuclear-materials/>.

It is encouraging that in the current 19th Congress, both the House of Representatives and the Senate have pending bills on a comprehensive nuclear regulatory framework, namely, House Bill (HB) 6030 and Senate Bill (SB) 1194. Both bills propose to create an independent regulatory body, called the Philippine Atomic Energy Regulatory Authority in HB 6030 and the Philippine Nuclear Regulatory Commission in SB 1194. In addition to defining the features of an independent regulatory body and enumerating its functions and powers, both bills provide for the creation and buildup of a fund for dealing with nuclear waste throughout the life cycle of a nuclear facility. This is an important feature of a comprehensive nuclear regulation law and discussions on how to build this fund and ensure that it will not be used for any other purpose (as had happened in the Malampaya Fund, which was used in activities outside the energy sector) should be started as early as possible. Another important feature of a comprehensive nuclear law is the civil liability of the operator of nuclear power facilities for nuclear and radiation damage. The stipulation of this is clearer in SB 1194 than in HB 6030. The regulatory functions of the PNRI and the FDA-CDRRHR are also tackled in both bills by proposing that their regulatory functions be transferred to the independent regulatory body and that their previous regulatory issuances remain in force until superseded by new issuances by the independent regulator. Indeed, even without a nuclear power plant and despite the lack of decision on the BNPP, the enactment of a comprehensive Philippine nuclear regulation law must be done. An updated and clearer regulatory framework is necessary given the current applications of nuclear energy in the country and the imminent commercialization of small modular reactors that may be attractive to the private generation sector.

On the BNPP, the decision to rehabilitate it or not must be guided by project economics. The Korea study implies that rehabilitation is technically feasible. The Russian assessment implies that it will be very costly and raises whether it is worth it. The IAEA cases on restarting stalled power plants show the challenges to be hurdled. In some cases, the project economics involved totally writing off the amount previously invested and conducting the economic analysis based on the comparison of the new amounts to be invested up to completion versus the discounted value of future cash flows. In many cases, the costs were huge and the projects still suffered from time and cost overruns (IAEA 2008). The indicative USD3 billion to USD4 billion Russian estimate for BNPP that has a nameplate capacity of only 621 MW compares unfavorably with the construction of natural gas plants that can provide capacity more quickly than the BNPP project if red tape in approvals and technical delays in grid connection are minimized, if not entirely removed. Note that natural gas power plants are also considered reliable source of capacity to meet base load and deemed important in the clean energy transition. For instance, the 414 MW San Gabriel natural gas project which started commercially operating in 2016 was built for only USD600 million.¹¹ Nevertheless, the Lazard (2022) estimate of the unsubsidized levelized cost of energy (i.e., the average cost of construction and operation per unit of electricity generated over the lifetime of the project) of conventional nuclear, which can be operated for a longer time period and has a higher reliability factor, is at USD131 to USD204 per MWh. This is cost competitive compared with the levelized cost of gas peaking plants at USD151 to USD196 per MWh. Moreover, if the recent gas price spikes will be persistent and price levels will remain elevated for a long period of time, the levelized cost of gas may become less competitive. An updated assessment of the BNPP

¹¹ See Power Technology. 2022. San Gabriel Combined-Cycle Power Plant, Santa Rita. Project Profile, 08 May 2021. <https://www.power-technology.com/projects/san-gabriel-combined-cycle-power-plant-santa-rita/> (accessed on November 10, 2022).

rehabilitation cost is therefore crucial to enable a deeper analysis of the project economics and a more accurate comparison with the levelized costs of alternatives.

The alternative in the project economic analysis need not be natural gas only, but also newer nuclear power plant technology, which can be relied on not only for base load but for dispatchable capacity to accompany variable renewable energy generation. Note that newer nuclear power plants are already technically capable of flexible operation, that is, able to change their output over time through ramping or load following, thereby enabling the greater use of variable renewable energy in the generation mix (Jenkins et al. 2018). The alternative also need not be construction of a big nuclear power plant but deployment of small modular reactors (SMRs), which can have capacities of between 300 MW to 10 MW based on current technology. There are no commercially available SMRs yet but three prototypes are already operating based on the IAEA monitoring (IAEA 2022c). The levelized cost of electricity for SMR is not yet firmly determined but initial estimates placed it at GPB86 to GPB124 per MWh (USD103.44 to USD149.15 per MWh) for the first SMR in the UK, and AUD225 per MWh (USD161 per MWh) in South Australia (Green 2019). Should the Philippines opt to pursue a nuclear power program through the purchase and deployment of commercial SMRs, the Milestones Approach is still necessary. According to the IAEA's guidelines for SMR deployment, if key components of the infrastructure for a nuclear power program are not present in the country contemplating its first deployment of SMRs, then it has to develop such using the Milestones Approach (IAEA 2021).

Aside from the huge cost, the biggest hurdle in rehabilitating the BNPP is the fact that the government is no longer allowed under RA 9136 or the Electric Power Industry Reform Act (EPIRA) to engage in power generation except for missionary electrification. Amending the EPIRA to allow government investment again in the competitive power generation sector will throw away the years of reform implementation toward a level playing field in this sector. If the project economics of BNPP rehabilitation, or a new nuclear power plant at the same site with flexible dispatchability, would prove that this is worth undertaking, it is better to attract the private sector to the project economics of it through incentives rather than the government directly making the investments and competing in the generation sector. Public-private sector collaboration in nuclear power plant investments has been a prevailing practice anyway in many countries that have a nuclear power program (see, for example, Office of Nuclear Energy 2016). If it can be justified, legislating the incentives as part of the clean energy transition may also be pursued.

In case the Philippine government's interest in nuclear energy will be sustained and expanded, handling the opposing views must also be sustained. For instance, Greenpeace Philippines expressed the opinion that rather than pursuing nuclear energy, "the DOE's time and taxpayers money would be put to better use harnessing cheaper, safer and more sustainable renewable sources, such as solar and wind, which are abundant in the Philippines" (Greenpeace Philippines, 2020, par.4). It is reassuring that, based on the 2019 Social Weather Station survey commissioned by the DOE, most respondents view nuclear energy favorably, with 79 percent viewing the rehabilitation of the BNPP acceptable and 65 percent viewing the building of a new power plant acceptable. The communication strategy should include assurances on the safeguards, from the construction to operation and decommissioning. The prospects for nuclear energy development in the Philippines must not only be well argued before policy makers but be convincingly communicated as well to the general public.

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