STATUS OF GLOBAL NUCLEAR ENERGY: A SURVEY

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INTRODUCTION

Nuclear energy today is in a state of flux. While several countries in the West are phasing out nuclear energy, numerous countries in Asia are in the process of developing their civil nuclear programmes. As various factors are at play, such as growing energy demands in some parts of the world and a plateau in energy demands in other parts, increasing climate change awareness, public concerns on nuclear safety, etc., the debate on the future of nuclear energy becomes complex. In this context, this paper attempts to analyse the contemporary nuclear power scenario in the world. The paper is divided into five sections. The first section looks at the history of nuclear power from the 1940s to 2011. The second section analyses the effect the Fukushima accident had on the course of global nuclear power and the following section analyses the current global nuclear trend. The fourth section explores the growth of nuclear energy in Asia and attempts to understand if a new nuclear renaissance is imminent. The fifth section is the concluding segment.

BACKGROUND

Breakthroughs in science and technology impact geo-politics and international relations. The case of the advent of nuclear power amply proves

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Post the 1945 nuclear bombings, there was widespread fear and trepidation among people around the world of the possibility of repeated use of such weapons. Eisenhower's speech, on an issue which had been shrouded in secrecy, was helpful in pacifying the public and his call for a peaceful solution was needed to placate the people.

this. Although the study of nuclear energy had been developing from the time the Greek philosophers first tried to understand and define atoms, it developed over the years through the cumulative efforts of various scientists around the world. However, nuclear technology for military purposes was used for the first time only at the end of World War II. In 1945, the United States of America dropped nuclear weapons on the Japanese cities of Hiroshima and Nagasaki. The consequence of this was not only harrowing for those in the two cities, it also changed the nature of international power dynamics. Thereupon, cognisant of the dangers of nuclear weapons, countries spearheaded by the United States tried to regulate the use and development of nuclear technology.

US President Dwight Eisenhower's speech titled "Atoms for Peace" at the United Nations General Assembly in 1953 turned out to be a watershed moment in this regard. The speech, which was part of a media and public relations campaign by the US government, sought to communicate to the American public the future of nuclear power. Eisenhower's speech was significant for multiple reasons. First, post the 1945 nuclear bombings, there was widespread fear and trepidation among people around the world of the possibility of repeated use of such weapons. Eisenhower's speech, on an issue which had been shrouded in secrecy, was helpful in pacifying the public and his call for a peaceful solution was needed to placate the people. Secondly, his speech was also meant to signal to countries to give up any pugnacious plans and, thus, is considered to be a part of the Cold War "containment" strategy. And, finally, the "Atoms for Peace" programme opened up nuclear research for peaceful purposes to other countries. In the

words of President Eisenhower, "This greatest of destructive forces can be developed into a great boon for the benefit of all mankind." In a way, this was promoted as an incentive for countries to not develop nuclear weapons.[1] The "Atoms for Peace", programme also led to the creation of the International Atomic Energy Agency (IAEA). Thus, in the 1950s, the attention was shifted towards peaceful use of nuclear energy, focussing on generating power.

The Three Mile Island accident in the United States in 1979 created panic and uncertainty around the further development of nuclear power, although it did not result in any casualties.

The US government also revised the Atomic Energy Act which enabled it to disseminate nuclear technology to other countries if they pledged to never develop nuclear weapons. In this regard, the US government provided training and assistance in building research reactors to several friendly countries. They also declassified many reports on nuclear technology and signed cooperation agreements with over 20 countries. These included countries like India, Pakistan, Argentina, Brazil and Iran among others. This heralded a period of nuclear optimism. The 1973 oil crisis also added to the nuclear appeal since many countries that used to rely on oil to generate electricity started considering nuclear energy. The French, for instance, summarised their rationale to adopt nuclear power in the following words: "We have no coal, we have no oil, we have no gas, we have no choice."[2]

However, the Three Mile Island accident in the United States in 1979 created panic and uncertainty around the further development of nuclear power, although it did not result in any casualties. Anti-nuclear protests started gaining in strength not only in the US but also in other countries which were developing civil nuclear programmes. In addition, in the 1980s,

1. Jesse Hicks, "Atoms for Peace: The Mixed Legacy of Eisenhower's Nuclear Gambit", Sciencehistory.org, July 19, 2014, https://www.sciencehistory.org/distillations/atoms-for-peace-the-mixed-legacy-of-eisenhowers-nuclear-gambit. Accessed on May 15, 2019.
2. George Dvorsky, "Is Nuclear Power Really on the Way Out?", *Gizmodo,* https://io9.gizmodo.com/is-nuclear-power-really-on-the-way-out-5917615. Accessed on May 15, 2019.

the prices of fossil fuel dropped. The 1986 Chernobyl disaster furthered the opposition against nuclear energy. Several countries even halted the construction of their reactors, while others contemplated phasing out of nuclear power altogether.

By the late 1990s and the beginning of the new millennium, this trend started to reverse as the economies of countries began to look up and the energy demand-supply gap increased. Many countries were in the process of achieving major economic development and faced a substantial energy deficit. Countries also became aware of the serious threat posed by climate change, and the search for cleaner sources of energy intensified. With the rising price of fossil fuels, recognition of the low carbon footprint of nuclear energy and high capacity factor of nuclear reactors, the nuclear appeal increased. Thus, by the beginning of the new millennium, more countries had started showing interest in going nuclear. This period, known as the "nuclear renaissance", saw growing optimism about the future of nuclear power, as 15 new nuclear projects started in 2010.[3] The IAEA corroborated this sentiment in its annual report of 2010 which stated that "60 member states have expressed interest in the introduction of a nuclear power programme".[4] In fact, the IAEA set up an integrated nuclear infrastructure group in response to the growing interest in nuclear power by various countries.[5]

THE FUKUSHIMA ACCIDENT AND ITS EFFECT ON NUCLEAR POWER

The Fukushima Daiichi accident that took place on March 11, 2011, altered the course of global nuclear development again. The accident took place after an earthquake and a tsunami struck Japan. Technically speaking, the Fukushima accident resulted in one casualty, where a worker died of cancer

3. Geert De Clercq, "Nuclear Newbuild Projects at Decade Low: Report", Reuters, September 12, 2017, https://www.reuters.com/article/us-nuclear-outlook/nuclear-newbuild-projects-at-decade-low-report-idUSKCN1BN1RM. Accessed on May 20, 2019.

4. Annual Report 2010, International Atomic Energy Agency, https://documents.pub/document/annual-report-2010-558445e3010d3.html. Accessed on May 28, 2019.

5. "Emerging Nuclear Energy Countries", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx. Accessed on June 1, 2019.

because of radiation exposure, while the earthquake and tsunami led to the unfortunate deaths of over 18,000 people. [6] However, the Fukushima nuclear accident severely impacted people's collective memory. Post this accident, there was a huge public outcry on nuclear safety, which pressurised governments to reconsider their national nuclear ambitions. Many countries that were on the verge of starting their nuclear programmes either stalled or cancelled them. According to the IAEA annual report of 2015, the number of countries that had showed interest in starting nuclear capabilities in 2010 had fallen by 50 per cent in 2015![7] Public acceptance of nuclear power was severely eroded. In 2011, after the Fukushima disaster, polls undertaken by Ipsos Mori, a British market research company and *Asahi Shimbun*, a Japanese newspaper, revealed a significant decline in support for nuclear power technology across most countries. The poll conducted by Ipsos Mori showed that the nuclear industry had the lowest amount of support (38 per cent) in comparison to other forms of technology used for generating electricity. While coal technology received 48 per cent support, solar, wind and hydro power received over 90 per cent support.[8]

Immediate Country Reactions Post Fukushima

As public concerns grew, different countries responded in different ways to the Fukushima accident. Table 1 describes the reactions of 36 countries in the immediate aftermath of the accident. The list has been compiled based on the official statements and reports made by countries that were very vocal about the accident. The table has been sequenced in the order of the severity of actions taken by countries.

6. "Japan Admits that Fukushima Worker Died from Radiation", *The Guardian,* September 05, 2018, https://www.theguardian.com/world/2018/sep/05/japan-admits-that-fukushima-worker-died-from-radiation. Accessed on July 26, 2019.

7. Manpreet Sethi, "The Asian Nuclear Power Landscape: A Contemporary Examination", in *Asian Strategic Review 2017: Energy Security in Times of Uncertainty* (New Delhi: Pentagon Press, 2018), p. 119.

8. Richard Black, "Nuclear Power 'Gets Little Public Support Worldwide'", BBC, November 25, 2011, https://www.bbc.com/news/science-environment-15864806. Accessed on May 18, 2019.

Table 1: Countries Reactions Immediately Post Fukushima

S. No.	Country	Reaction/Policy Change
1.	Japan	• Shut down all reactors. • All nuclear reactors undergoing two phase stress tests. • Ongoing construction of reactors halted. • Prime minister called for reduced dependence on nuclear power.
2.	Germany	• Reviewed the safety of all German nuclear power plants. • Permanently shut down eight reactors. • Intends to shut down remaining reactors by 2022. • Has decided to completely phase out nuclear energy.
3.	Italy	• Plans to reintroduce nuclear power given up. • Declared a nuclear moratorium for one year. • Passed a referendum with about 94% of its votes against government plans to start new nuclear power projects.
4.	Switzerland	• Banned the construction of new reactors. • Decision to gradually phase out nuclear power.
5.	Belgium	• Decision to continue with gradual phase out which was taken before the Fukushima accident.
6.	Bulgaria	• Plans to construct the Belene national plant terminated in 2012; the decision was influenced by other financial factors too.
7.	Mexico	• Abandoned plans to build new reactors and focus on natural gas instead.
8.	Venezuela	• Ceased plans of developing nuclear power project. • Energy Ministry ordered to look for alternate sources of renewable energy.
9.	Kuwait	• Shelved its civil nuclear project. Multiple factors influenced this decision, including the Fukushima accident.
10.	Indonesia	• Government announced a slowdown in its nuclear development.

11.	Israel	• Reconsidered nuclear projects and stated that it was "unlikely" that it would develop a nuclear project in the near future.
12.	The Philippines	• Was considering the revival of its nuclear project, but the Fukushima accident resulted in cancelling it yet again.
13.	Taiwan	• Suspension of plants until the completion of a safety review. • The president called for reduced dependence on nuclear power.
14.	Thailand	• The prime minister directed the Energy Ministry to review plans for establishing nuclear power plants. • Also asked to study in detail the emergency measures in nuclear plants during crises and the potential of a nuclear power plant being a target for terrorists.
15.	Australia	• Reaffirmed its already existing position of staying non-nuclear.
16.	Luxembourg	• Reaffirmed its already existing position of staying non-nuclear.
17.	Greece	• Reaffirmed its already existing position of staying non- nuclear.
18.	Latvia	• Reaffirmed its already existing position of staying non-nuclear.
19.	China	• Suspended authorisation of construction of new reactors until a safety review was completed. • Resumed projects soon after with continued commitment to develop nuclear power, with increased emphasis on safety.
20	Canada	• Continued commitment to develop nuclear power with increased emphasis on safety.
	Czech Republic	• Continued plans to build two more units.

21.	France	• Nuclear power plants underwent stress tests. • Continued with its existing nuclear plans, stressing on safety. • Holland government in 2012 declared gradual nuclear reduction. However, other reasons influenced this decision.
22.	Finland	• Reconfirmed plans to build a nuclear power station.
23.	Hungary	• Continued commitment to develop two more nuclear reactors.
24.	India	• Continued commitment to develop nuclear power. • However, the state government of West Bengal denied permission to construct a new facility in a town in West Bengal and construction of two power plants in Tamil Nadu was delayed.
25.	Niger	• Continued commitment to build civil nuclear programme, with increased emphasis on safety.
26.	Pakistan	• Continued commitment to develop nuclear power, with increased emphasis on safety.
27.	South Korea	• Continued commitment to develop nuclear power, with increased emphasis on safety.
28.	Slovakia	• Continued commitment to develop nuclear power, with increased emphasis on safety.
29.	South Africa	• Continued commitment to develop nuclear power, with increased emphasis on safety.
30.	Spain	• Called for review of existing nuclear plants.
31.	Sweden	• Continued commitment to develop nuclear power, with increased emphasis on safety.
32.	Turkey	• Reaffirmed its plan of continuing to build their first reactor.
33.	Ukraine	• Continued commitment to develop nuclear power, with increased emphasis on safety.
34.	United Kingdom	• Continued with its existing nuclear policies and plans, with additional emphasis given to the safety aspect.
35.	United States of America	• Continued with its existing nuclear policies and plans, with additional emphasis given to the safety aspect.

As elucidated in the table above, different countries reacted to the accident in different ways. While some countries decided to do away with nuclear power for good, others decided to continue with their existing nuclear power programmes. The accident also instigated a few other countries that were considering developing their civil nuclear programmes to give up their plans. Almost every country that owned nuclear power technology reviewed and reassessed its systems and practices, and tried to enhance its safety mechanisms. However, not all countries decided to do away with nuclear technology. In countries that were struggling with power shortages: the accident did not cause any major policy change. However, it did trigger all nuclear power countries to review their safety framework.

ASSESSING THE CURRENT GLOBAL NUCLEAR TREND

As is evident from the above analysis, the effects of the 3/11 nuclear accident were not limited to Japan but caused considerable consequences to the future of the nuclear energy industry as a whole. The accident happened at a time when many countries were considering the nuclear option. However, the accident prompted the shelving of plans for countries that had concerns about nuclear safety.

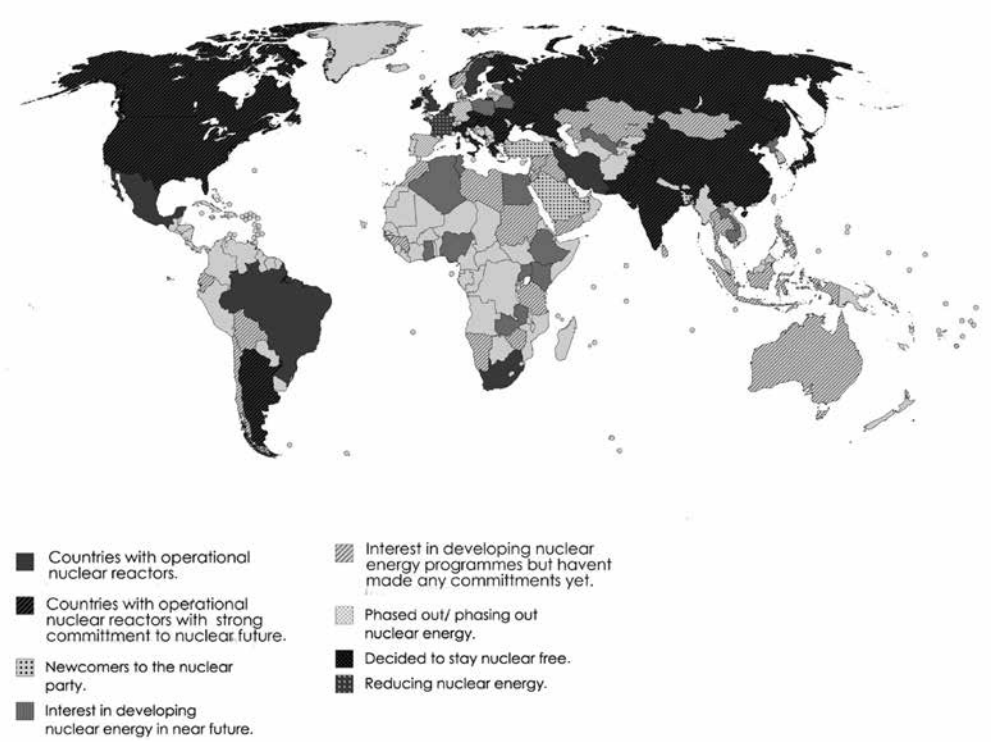
Eight years after Fukushima, the current nuclear trend is not necessarily all downhill. Even if the total number of operational reactors may have reduced, the nuclear generation capacity of the existing reactors has not. According to the World Nuclear Association, global nuclear generation has risen consistently from 2012 to 2017 with output of 142 TWh more than what it was in 2012.[9] In addition, with the population growth expected to see a pronounced rise, the demand for energy, especially renewable energy, is also expected to rise more significantly. While other sources of renewable energy have greater support from the civil society, they

9. "Nuclear Power in the World Today", World Nuclear Association, http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx. Accessed on May 17, 2019.

have their own share of challenges and limitations as well. In this regard: nuclear energy seems to be a worthy option towards achieving a clean energy future. In this context, let's look at the current global status of nuclear power to better understand and analyse the future of nuclear energy.

A graphic representation presented below (Fig 1) organises countries on various parameters to enable the understanding of the position of nuclear power in the world today. The countries marked in dark grey are the ones with operational nuclear reactors. The countries coloured in dark grey with black diagonal stripes represent the countries that have operational nuclear reactors and are committed to nuclear energy in their future. These countries are either developing their nuclear capabilities or are planning to do so. The countries coloured in light grey with black dots are the ones that are just joining the nuclear party. They are in the process of constructing their nuclear reactors. Countries in grey are the ones that are currently developing their nuclear power projects. They have either signed nuclear cooperation agreements or are in talks with other countries regarding the same and plan to construct their reactors soon. Grey with horizontal white stripes represents the countries that have at some point shown interest in developing nuclear energy but have not committed to it yet. They are mostly considering the nuclear energy option at the policy discussion level. The countries in white with black checks are the ones with operational reactors that plan to phase out nuclear power gradually. Likewise, the countries marked in black with white checks are the ones that have decided to stay non-nuclear. The countries in dark grey with white dashes are the ones with operational reactors that plan to scale down their nuclear capacities.

Fig 1: Current Global Status of Nuclear Energy Policies



Source: Data compiled by author from IAEA, World Nuclear Association and various newspaper articles.

Assessing the Nuclear Uptrend: The True Blues of Nuclear Energy

As depicted in the table above, there are currently 32 countries with operational nuclear reactors. They contribute to about 11 per cent of the global electricity.[10] An overall slightly upward trend is seen among these countries, with about 17 countries remaining committed to nuclear energy. Among these countries, China, India, Russia and the United States have been developing robust nuclear energy policies. China, which has 46 nuclear reactors, is in the process of constructing 15 more.[11]

10. Ibid.

11. China, "Peoples Republic of, Country Statistics", Power Reactor Information System, IAEA.org, https://pris.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CN. Accessed on June 14, 2019.

China, India, Russia and the United States have been developing robust nuclear energy policies. China, which has 46 nuclear reactors, is in the process of constructing 15 more. The Chinese government is expected to overtake the United States to become the global leading producer of nuclear energy.

Considering the pace of its development in civil nuclear energy, the Chinese government is expected to overtake the United States to become the global leading producer of nuclear energy.[12] In fact, nuclear energy is a vital part of its Belt and Road Initiative (BRI). India, likewise, is planning to develop its nuclear infrastructure project substantially. With nuclear energy contributing to just 3 per cent of its electricity generation (in 2016),[13] the government plans to increase this figure to 25 per cent by 2050 and, hence, has been focussing on increasing its installed nuclear capacity.[14] Though the pace has been slow due to a few challenges, the government's support for it continues to hold good. Russia, which is a leading player in nuclear technology, has ambitious plans in store. Russia's 2003 energy strategy calls for a cut-back in natural gas for power supply by doubling nuclear power generation by the year 2020. The country has 35 nuclear power stations[15] and is rapidly exporting its nuclear technology to other countries. In 2017, Russia was said to be working on 20 nuclear reactors for exports. It is also experimenting with a floating nuclear power plant. Another leading figure in nuclear technology is the USA. As of 2016, the USA

12. Miles A Pomper, "China Has Big Plans for Its Nuclear Energy Industry. But Will They Pan Out?" *World Politics Review,* April 29, 2019, https://www.worldpoliticsreview.com/articles/27799/china-has-big-plans-for-its-nuclear-energy-industry-but-will-they-pan-out. Accessed on June 3, 2019.

13. Aniruddh Mohan, "The Future of Nuclear Energy in India", *ORF Occasional Papers*, August 9, 2016, https://www.orfonline.org/research/the-future-of-nuclear-energy-in-india/

14. "Nuclear Power in India." World Nuclear Association, http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/India/. Accessed on June 10, 2016.

15. Ben Arris, "Russia's Nuclear Power Exports Are Booming", *The Moscow Times*, May 9, 2019, https://www.themoscowtimes.com/2019/05/09/russias-nuclear-power-exports-are-booming-a65533. Accessed on June 10, 2019.

was the largest producer of nuclear energy.[16] It is currently focussing on nuclear research and development and energy commerce.

Japan, which saw a major pushback in its nuclear power projects after the 2011 Fukushima disaster, is also making a comeback.[17] It has begun to restart its power plants gradually after the passage of stringent safety clearances. France, where 70 per cent of the electricity generation is through nuclear power, has been at the forefront of nuclear energy development. However, the country is reducing its dependence on nuclear energy in a move to reorganise its energy basket.

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Finland, where nuclear energy is contributing to the production of 30 per cent of its electricity, is seeking to further boost this figure to 60 per cent. With the construction of one more nuclear reactor in progress and the planning of another one in tow, the Finnish government is bidding to replace coal by cleaner forms of energy.[18] The Czech government, although facing financing troubles, envisages nuclear energy becoming the main source of electricity production in the country.[19] In the case of Hungary, about 50 per cent of the electricity in the country is being generated by nuclear power. The Hungarian government is planning to further enhance

16. "Nuclear Power Producing Countries' Ranking", *Parcol News,* December 15, 2017, https://www.parcolnews.com/2017/12/top-nuclear-power-producing-countries/. Accessed on May 12, 2019.
17. "Japan Plans Carbon Emission Cuts, More Nuclear Energy", *The Rahnuma Daily*, https://www.therahnuma.com/japan-plans-carbon-emission-cuts-more-nuclear-energy/. Accessed on June 15, 2019.
18. "Nuclear Power in Finland", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/finland.aspx. Accessed on June 14, 2019. Also see "Energy Policies of IEA Countries: Finland 2013", IEA (Paris: 2013), https://doi.org/10.1787/9789264190788-en. Accessed on May 14, 2019.
19. Jo Harper, "Czech Republic Weighs Nuclear Options", DW.com, April 17, 2018, https://www.dw.com/en/czech-republic-weighs-nuclear-options/a-43419787. Accessed on May 18, 2019.

this figure by building two more reactors.[20] In Slovakia, nuclear power contributes to generating half of its electricity and the government plans to continue this momentum by signing contracts with Rosatom for nuclear fuel supply for the years 2022 to 2026 and is even considering extending it further.[21] Slovenia, too is considering increasing its nuclear capacity.[22] Romania, likewise, has strong government support to develop nuclear power with nuclear energy contributing to approximately 20 per cent of its electricity.[23] Ukraine is also focussed on increasing its nuclear energy capacity. Currently, half of the country's electricity is generated by nuclear power and the government intends to keep a substantial share of nuclear energy in its energy basket.

In the case of the United Kingdom, nuclear energy is an important component in its energy basket too, with about 20 per cent of its electricity generated by nuclear energy. Although half of its existing nuclear capacity is anticipated to be retired by 2025, the government has begun constructing a new generation of nuclear power plants. Nuclear power has also been a significant part of Canada's energy basket. In fact, in 2016, nuclear energy provided 61 per cent of Ontario's electricity generation, and in 2018, a decision was taken to enhance its reliance on nuclear energy further.

Argentina, which has three nuclear reactors, is in the process of signing a nuclear deal worth $8 billion with China for the construction of a new reactor.[24] The Armenian government too, apart from renewing the operating

20. "Nuclear Power in Hungary", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/hungary.aspx. Accessed on May 19, 2019.

21. "Russia and Slovakia Agree to Continue Cooperation", *Nuclear Engineering International*, June 11, 2019, https://www.neimagazine.com/news/newsrussia-and-slovakia-agree-to-continue-co-operation-7254850. Accessed on June 20, 2019.

22. "Nuclear Power in Slovenia", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/slovenia.aspx. Accessed on June 1, 2019.

23. Nuclear Power in Romania", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/romania.aspx. Accessed on June 24, 2019.

24. "Argentina, China Still Discussing Nuclear Power Project: Undersecretary", Reuters, April 2, 2019, https://www.reuters.com/article/us-china-nuclearpower-argentina/argentina-china-still-discussing-nuclear-power-project-undersecretary-idUSKCN1RE0O5, Accessed on June 13, 2019.

lifetime of its nuclear plant, has begun considering development of a new unit.[25] Pakistan too has been bolstering its nuclear power project. It currently has five nuclear power plants but plans to increase this capacity by building 32 nuclear power plants by 2050.[26]

Newcomers to the Nuclear Party

There are five new additions to the nuclear club. Bangladesh began construction of its first nuclear unit in 2017, followed by construction of a second unit in the subsequent year. It is expecting the first unit to be commissioned in 2023. Belarus too has its first nuclear power plant under construction. Construction of Saudi Arabia's first reactor too is almost complete. Turkey has also begun the construction of its nuclear power plant in 2018. There are plans to construct three more plants. Likewise, the UAE recently completed the construction of its first unit.[27]

Prospective Entrants to the Nuclear Club

Approximately 20 countries are now in the process of either signing cooperation deals with other countries, developing legal and regulatory infrastructure, or preparing for the construction of nuclear plants. They include countries like Nigeria, which is in talks with the Russian State Nuclear Energy Corporation (Rosatom) to start the construction of nuclear power plants soon, with an official even having acknowledged that the talks between the countries have reached an "advanced stage".[28]

25. "Nuclear Power in Armenia", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/armenia.aspx. Accessed on June 14, 2019.
26. Rabia Akhtar, "Pakistan's Nuclear Energy Vision 2050", *South Asian Voices,* March 6, 2014, https://southasianvoices.org/pakistans-nuclear-energy-vision-2050/. Accessed on June 12, 2019.
27. "UAE Recently Completed the Construction of its First Unit", *The Arab Weekly,* April 1, 2018, https://thearabweekly.com/arab-worlds-first-nuclear-reactor-completed-uae-cooperation-south-korea. Accessed on June 14, 2019.
28. "Nigeria Engages Rosatom on Nuclear Development", *Power Engineering*, June 11, 2019, https://www.power-eng.com/articles/2019/06/nigeria-engages-rosatom-on-nuclear-development.html. Accessed on June 19, 2019.

Uzbekistan is expected to start construction of its nuclear power plant in 2022. Cambodia, too, has nuclear cooperation agreements with Russia and China to develop nuclear energy for peaceful purposes.

Algeria plans to have its first nuclear plant by 2029.[29] Tunisia, which plans to replace gas with nuclear energy, signed a Memorandum of Understanding (MoU) with Russia in 2015 for the construction and operation of nuclear power plants and research reactors. The Zambian government too is in the process of developing its nuclear power programme. Ghana is expecting to produce nuclear energy from 2029 onwards.[30] Kenya has also joined the nuclear bandwagon. It was expected to start building its nuclear power plant by 2027 but has revised the date and postponed it to 2036.[31] In 2018, Uganda signed a deal with China for the construction and operation of a nuclear power plant. It has also signed an MoU with Rosatom for nuclear cooperation. Earlier this year, Ethiopia also signed an agreement with Russia to build a nuclear power plant.

Egypt, too, is expecting to start the construction of its nuclear power plant by 2020.[32] Kuwait, which had shelved its plans owing to financial concerns, started talks with Russia in 2018 to discuss the construction of a nuclear power plant.[33] Uzbekistan is expected to start construction of its nuclear

29. "Algeria Aims to Become a Nuclear Power Producer by 2029", *The Economist*, October 23, 2014, http://country.eiu.com/article.aspx?articleid=1742415758&Country=Algeria&topic=Economy&subtopic=Forecast&subsubtopic=Policy+trends&u=1&pid=801443464&oid=801443464. Accessed on May 20, 2019.

30. "Nuclear Energy for Power Production to Begin 2029", Ghana Atomic Energy Commission, June 29, 2018, https://gaecgh.org/nuclear-energy-for-power-production-to-begin-2029/. Accessed on June 12, 2019.

31. Patrick Alushula, "Kenya Now Pushes Nuclear Power Plant Plan to 2036", *Business Daily*, September 25, 2018, https://www.businessdailyafrica.com/economy/Kenya-now-pushes-nuclear-power-plant-plan-to-2036/3946234-4777866-b05oauz/index.html. Accessed on June 22, 2019.

32. "El Dabaa Nuclear Power Plant", Power Technology, https://www.power-technology.com/projects/el-dabaa-nuclear-power-plant/. Accessed on June 14, 2019.

33. Baset Asaba, "Rosatom In Talks To Build Nuclear Plant In Kuwait", *Middle East Utilities*, January 26, 2018, https://www.utilities-me.com/article-5236-rosatom-in-talks-to-build-nuclear-plant-in-kuwait. Accessed on June 21, 2019.

power plant in 2022. Cambodia, too, has nuclear cooperation agreements with Russia and China to develop nuclear energy for peaceful purposes. Laos also signed an MoU in 2016 with Rosatom that is helping in the designing, construction and operation of nuclear plants.[34] The Government of Estonia has approved a nuclear power plant to be built by 2023.[35] Poland is expecting its first nuclear plant to start operating in 2033.[36]

There are about 31 other countries that have expressed interest in nuclear power but have not made any commitment yet.

Betwixt and Between

Apart from these countries, there are about 31 other countries that have expressed interest in nuclear power but have not made any commitment yet. For example, in 2014, Sri Lanka had listed nuclear power as a possible option to generate power in the future. This was put across in a study undertaken by the Ceylon Electricity Board which was considering Sri Lanka's long-term electricity generating capacities and options.[37] Mongolia too has been contemplating development of nuclear power, considering its well-endowed uranium reserves.[38] Indonesia has been deliberating about nuclear energy for some time now but has not made any commitment owing to safety concerns. The debates are still on and it is expected to have its first experimental nuclear power plant by 2030. The Philippines, which

34. Prashanth Parameswaran, "What's Behind Russia's New Nuclear Pact With Laos?", *The Diplomat*, April 25, 2016, https://thediplomat.com/2016/04/whats-behind-russias-new-nuclear-pact-with-laos/. Accessed on May 19, 2019.

35. "Atomic Policy in Estonia", *Nuclear Heritage.net*, http://www.nuclear-heritage.net/index.php/Atomic_Policy_in_Estonia. Accessed on June 13, 2019.

36. "Poland Expects First Nuclear Power Plant to Start in 2033", *Reuters,* November 23, 2018, https://www.reuters.com/article/us-poland-nuclearpower/poland-expects-first-nuclear-power-plant-to-start-in-2033-idUSKCN1NS1DB. Accessed on June 11, 2019.

37. "Sri Lanka Eyes Nuclear Power Plant after 2030", *Lanka Business Online*, January 13, 2015, https://web.archive.org/web/20150112182058/; http://www.lankabusinessonline.com/news/sri-lanka-eyes nuclear-power-plant-after-2030/894022769. Accessed on June 16, 2019

38. Rujun Shen, "Mongolia Eyes First Nuclear Power Plant by 2020: MonAtom", Reuters, April 7, 2007, https://www.reuters.com/article/us-mongolia-nuclear/mongolia-eyes-first-nuclear-power-plant-by-2020-monatom-idUSTRE73625A20110407. Accessed on May 19, 2019.

imports about 90 per cent of its energy, has been considering adding nuclear in its mixed energy basket in the future.[39] Thailand, likewise, is considering developing its nuclear power facilities soon. The previous King of Tonga, Tupou 5th had also expressed interest in developing nuclear power, but the idea did not gain much support.[40]

Bahrain, which had plans to start operating its nuclear power plant by 2017, had to defer it. In 2018, the electricity and water affairs minister of Bahrain, reaffirmed the country's interest in adopting nuclear energy and even invited a nuclear expert to discuss the prospects of nuclear energy in Bahrain.[41] Recently, in 2017, even Iraq showed interest in developing nuclear power reactors. In a United Nations General Assembly summit, the foreign minister of Iraq requested assistance from countries to help it develop nuclear power for peaceful purposes.[42] Israel, which was considering developing nuclear power, abandoned its plans post Fukushima. While the interest was rekindled again in 2015 in response to the worldwide clamour for reducing greenhouse emissions, the future of nuclear energy in Israel seems obscure and uncertain. Jordan is also planning on joining the nuclear energy bandwagon by building small modular nuclear reactors. The Ministry of Energy and Mineral Resources of Jordan is currently conducting a comprehensive study on the same. There were discussions among the higher echelons of policy-makers in Lebanon to develop nuclear energy in 2012. The then Prime Minister Najib Mikati not only spoke to officials from the IAEA but also discussed it with

39. Ronnel W. Domingo, "Revival of Nuclear Power Plans Seen", *Inquirer.net*, December 26, 2018, https://business.inquirer.net/262735/revival-of-nuclear-power-plans-seen. Accessed on May 20, 2019. Also see Nur Azha Putra and Philip Andrews-Speed, "Prospects for Nuclear Power in ASEAN", *The Diplomat*, June 28, 2018, https://thediplomat.com/2018/06/prospects-for-nuclear-power-in-asean/. Accessed on May 19, 2019.

40. "King says Tonga Should Move to Nuclear Power", *North West Asian Weekly*, June 17, 2010, http://nwasianweekly.com/2010/06/king-says-tonga-should-move-to-nuclear-power/. Accessed on June 19, 2019.

41. "Minister Receives Nuclear Expert", Press Release, *Electricity and Water Authority*, Government of Bahrain, June 26, 2018, http://www.ewa.bh/en/Media/PressReleases/Pages/Minister-receives-nuclear-expert.aspx

42. "Iraq Asks UN for Help to Build New Nuclear Power Reactor", *Financial Express*, September 24, 2017, https://www.financialexpress.com/world-news/iraq-asks-un-for-help-to-build-new-nuclear-power-reactor/868142/. Accessed on May 19, 2019.

Lebanese scientists as well, after which he asked for a study to be undertaken on the same. In 2010, the Syrian government undertook a long-term study to understand the future energy needs of the country and develop a strategy based on it. The study indicated that a nuclear power plant could perhaps enter its electricity generating system after 2020.[43] Yemen is also developing its nuclear power project and expects to have it started around 2035.[44]

The Republic of Guinea, which had discovered substantial deposits of uranium recently, has also engaged in discussing its nuclear future with the IAEA.[45] However, no significant commitment has been made in this regard yet. Libya too has showed significant interest in developing its nuclear energy shown project but progress remains uncertain. Morocco, which is anticipating a significant increase in electricity consumption in the near future, is similarly considering adoption of nuclear energy. Sudan is in discussions with Russia to develop its nuclear power project.[46] Tanzania, which has huge uranium reserves, has also been considering developing nuclear energy.[47] Namibia, which has significant uranium reserves, has shown interest in developing nuclear energy too.[48] Rwanda has signed an agreement with Rosatom to help in building a nuclear research centre in the next couple of years. It hopes to extend the application of nuclear energy for electricity generation along with other purposes.[49]

43. Syrian Arab Republic, Country Nuclear Power Profiles, IAEA, https://cnpp.iaea.org/countryprofiles/SyrianArabRepublic/SyrianArabRepublic.htm. Accessed on May 21, 2019.
44. "Emerging Nuclear Countries", World Nuclear Organisation, http://www.world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx. Accessed on May 18, 2019.
45. Will Ross, "Guinea in Nuclear Energy Ambition", *BBC*, August 23, 2007, http://news.bbc.co.uk/2/hi/africa/6961067.stm. Accessed on May 23, 2019.
46. "Sudan, Russia to Sign Accord to Develop Nuclear Power: SUNA Agency", Reuters, March 13, 2018, https://af.reuters.com/article/topNews/idAFKCN1GP0ME-OZATP. Accessed on May 21, 2019.
47. Aabha Dixit,"URAM-2018: Five Years on, Tanzania's Progress in Uranium Exploration", IAEA, June 18, 2018, https://www.iaea.org/newscenter/news/uram-2018-five-years-on-tanzanias-progress-in-uranium-exploration. Accessed on May 20, 2019.
48. "Uranium in Nambia", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/namibia.aspx. Accessed on May 16, 2019.
49. "Rwanda to Get Nuclear Research Centre in 5 Years", *Rosatom Overseas*, April 25, 2019, http://www.rusatom-overseas.com/media/mass-media-about-us/dominican-republic-to-get-nuclear-research-centre-in-5-years.html. Accessed on June 18, 2019.

Bolivia, which had showed interest in developing a nuclear power programme since the last few years, was grappling with various challenges including problems related to the storage, transit and deposit of nuclear and toxic waste which is deemed unconstitutional. However, in 2019, it was announced that the country is working on developing new nuclear laws. Chile has also considered the nuclear energy option and is planning to develop it after 2020.[50]

In Jamaica, interest in developing the country's nuclear power capabilities in the future—owing to its extensive use of imported fossil fuels, increasing electricity prices and the advancement of smaller, more economical nuclear reactors—is evident across party lines.[51] Albania showed interest in developing nuclear energy in 2007. However, it has not been able to take it ahead due to concerns from its neighbouring country, Montenegro.[52] Azerbaijan too is discussing the scope of developing nuclear power with Russia.[53] Some other countries like Denmark, Ireland and Italy that do not possess nuclear reactors of their own, import nuclear energy from other countries through regional transmission grids.

The Anti-Nuclear Club

While a substantial number of countries are showing interest in developing nuclear power, there also are several countries that have taken a more anti-nuclear stand. In a few countries, developing nuclear energy in itself is unconstitutional. As for example, in the case of Austria, which interestingly, has had a nuclear power plant since the 1970s, but has not made it operational due to the anti-nuclear sentiments of its citizens who pressurised the government to do away with it. Hence, in 1997, the country

50. "Emerging Nuclear Energy Countries", World Nuclear Organisation, http://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx. Accessed on June 18, 2019.

51. "Inside the Caribbean's Only Nuclear Reactor", *Power Technology* , November 22, 2017 https://www.power-technology.com/features/inside-caribbeans-nuclear-reactor/.

52. "Environmental Risks Arise from Hydro-Plant in Vjosa Riverbed", *Tirana Times*, May 22, 2019, http://www.tiranatimes.com/?p=141786. Accessed on May 29, 2019.

53. "Rosatom Suggests Implementing NPP Construction Project to Azerbaijan, Says Source", *Tass.com,* December 12, 2018, http://tass.com/economy/1035711. Accessed on June 14, 2019.

passed a legislation to remain anti-nuclear. From 2015 onwards, Austria even stopped importing nuclear sourced electricity in its attempt to be "completely nuclear free". Similarly, according to the Electricity Regulation Act of 1999, it is prohibited to develop nuclear energy in Ireland.

Understandably, many countries which are located at places that are prone to volcanos and earthquakes have decided to steer away from nuclear energy due to safety concerns. Greece, for example, has taken a decision not to pursue nuclear energy considering the frequent occurrence of earthquakes there and due to its size. Taiwan, which is situated in a seismically active zone, has also grappled with public protests and anti-nuclear movements amidst safety concerns. In 2019 the Taiwanese government declared that the existing nuclear power plants would not be granted any life extensions, aiming to phase out nuclear energy by 2025.[54]

A few countries have also decommissioned their nuclear plants like in the case of Lithuania, which had to decommission two nuclear reactors as a requisite to join the European Union. The Krško nuclear power plant, co-owned by Slovenia and Croatia, is also due to be decommissioned in 2043.[55]

Strong public opposition to nuclear power development has also resulted in the abandonment of nuclear power projects. For example, countries like Germany which faced major civil disapproval about nuclear technology, decided to permanently shut eight of its reactors immediately after Fukushima. This was a part of a bigger plan of energy transition called *Energywiende*. The *Energywiende* plans on moving the country towards a low carbon economy and developing renewable energy, while phasing out nuclear power at the same time. Germany intends to shut down the remaining reactors by 2022.[56] Luxembourg was considering building a nuclear power plant owing to its

54. "Taiwan Government Maintains Nuclear Phase-Out", World Nuclear News, February 1, 2019, http://world-nuclear-news.org/Articles/Taiwan-government-maintains-nuclear-phase-out. Accessed on May 20, 2019.

55. Vedran Pavlic, "Slovenia Expanding Nuclear Power Plant of Border with Croatia?", Total Croatia News, September 13, 2017, https://www.total-croatia-news.com/business/21979-slovenia-expanding-nuclear-power-plant-of-border-with-croatia. Accessed on June 12, 2019.

56. Justin Huggler, "Germany Faces Growing Calls to Delay Phase-Out of Nuclear Energy", *The Telegraph*, June 6, 2019, https://www.telegraph.co.uk/news/2019/06/06/germany-faces-growing-calls-delay-phase-out-nuclear-energy/. Accessed on June 15, 2019.

A recent addition to the naysayers to nuclear energy is South Korea which has a vibrant nuclear power industry. Public paranoia on the safety concerns of nuclear power, increasing exposes of corruption in the nuclear industry and nuclear accidents such as the Fukushima accident, have resulted in public distrust towards the nuclear industry.

energy crisis. However, with the opposition to it getting stronger, the government was forced to drop the project. Another case where public opinion has managed to change the course of nuclear power is that of Italy. Post Chernobyl, a referendum was held in Italy to decide the course of its nuclear future. With a significant anti-nuclear outcome, the nuclear plants were shut down. In 2008, nuclear debates reemerged in the country. However, soon after the Fukushima accident, a referendum was held again and an overwhelming majority of the people decided to continue to stay clear of nuclear energy, hence, plans to revive the nuclear programme were cancelled.

A recent addition to the naysayers to nuclear energy is South Korea which has a vibrant nuclear power industry. Public paranoia on the safety concerns of nuclear power, increasing exposes of corruption in the nuclear industry and nuclear accidents such as the Fukushima accident, have resulted in public distrust towards the nuclear industry. President Moon Jae-in won the election with his promise of gradually phasing out nuclear energy. Within a couple of months of taking power, he started developing policies to fulfil these promises. Switzerland, where nuclear energy powered 40 per cent of electricity needs, decided in a 2017 referendum to gradually phase out nuclear energy. This decision was influenced by the Fukushima accident, which saw widescale public protests to do away with nuclear energy.[57]

Malaysia, too, which was well prepared to commence its nuclear power project, had to forsake it. The new Prime Minister Dr Mahathir Mohamad cancelled the nuclear project owing to concerns regarding the safe disposal of nuclear waste. In this regard, the leadership also plays a vital role in

57. "Switzerland Votes to Phase Out Nuclear Power", BBC, May 21, 2017, https://www.bbc.com/news/world-europe-39994599. Accessed on June 2, 2019.

determining the future of nuclear energy in a country.

There are also countries like France which want nuclear energy to continue in its energy basket, but are also reducing its share in the energy segment. In France, over 70 per cent of the electricity generation is through nuclear power. However, a new policy aims to reduce the figure to 50 per cent by 2035 by shutting down 14 reactors, in a move to reorganise the country's energy basket. France plans to increase the solar and wind power output by balancing it with the reduction of nuclear power.[58]

An effective perception management and communication strategy could go a long way in clarifying the qualms that people have and help in promoting the development of nuclear energy. This proves the importance of public diplomacy of a country with its own people to develop sustainable policies.

It is interesting to note that public pressure is one of the biggest reasons for the countries to do away with nuclear energy. In this regard, an effective perception management and communication strategy could go a long way in clarifying the qualms that people have and help in promoting the development of nuclear energy. This proves the importance of public diplomacy of a country with its own people to develop sustainable policies.

ASIA: NUCLEAR RENAISSANCE 2.0?

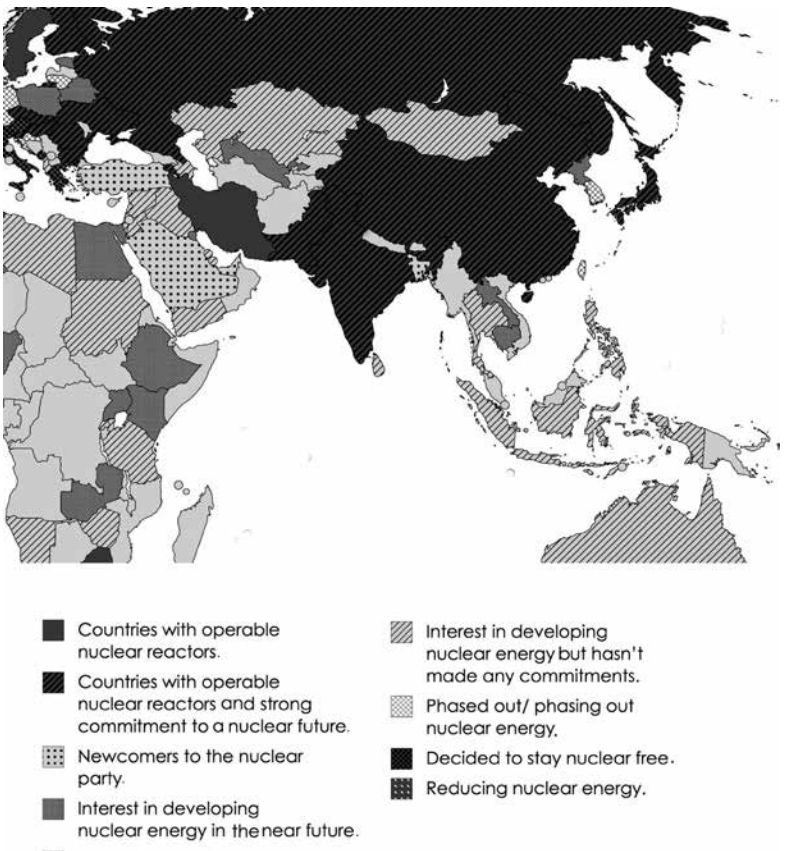
According to the IAEA, among the 31 countries that are operating 437 nuclear plants for electricity generation, 114 nuclear plants are in Asia.[59] This trend seems to be growing: the World Nuclear Association has stated that as of 2018, more than two-thirds of the reactors that were being

58. "Macron Clarifies French Energy Plans", World Nuclear News, November 27, 2018, http://www.world-nuclear-news.org/Articles/Macron-clarifies-French-energy-plans. Accessed on May 14, 2019.

59. "Atomic Power Plants in Asia", *RECAP Asia*, http://recap.asia/climate-asia/Atomic-Power-Plants-in-Asia.html. Accessed on June 12, 2019

constructed around with world were in Asia.[60] This leads to the question: is Asia witnessing a nuclear renaissance again?

Fig 2: Nuclear Energy Policies in Asia



As apparent in Fig 2 above, the nuclear energy trend in Asia gives a mixed picture, with a tilt towards a more positive trend. Asia was, in fact, at the forefront of the nuclear renaissance that emerged at the beginning of this century. As countries in the Asian continent were working towards rapid

60. "Asia's Nuclear Energy Growth", World Nuclear Association, http://www.world-nuclear.org/information-library/country-profiles/others/asias-nuclear-energy-growth.aspx. Accessed on May 19, 2010.

economic development, two important issues contributed to the nuclear appeal. First, an increase in electricity demand; and, second, the recognition of the problem of climate change and the need for more sustainable sources of energy. The growing interest in nuclear energy in the Asian countries was evident when, in the annual Association of Southeast Asian Nations (ASEAN) summit in Singapore in 2007, the Southeast Asian countries signed a declaration on climate change, energy and the environment. This declaration urged states to adopt more sustainable and cleaner forms of energy to tackle the issue of greenhouse gas emissions by "cooperating for the development and use of civilian nuclear power".[61] Amidst this period of nuclear optimism in Asia, the Fukushima accident in 2011 created a period of uncertainty in the development of nuclear energy. However, the region seems to be recovering from this hiatus and the nuclear energy trend seems to be on the upswing again.

Southern Asia

Southern Asia has been witnessing significant developments in the field of nuclear energy. In fact, according to a study, in the last decade, "the nuclear generation has more than doubled in India and Pakistan and more than tripled in China".[62] Among the eight Southern Asian countries, four countries show substantial commitment to a nuclear future. India is looking for cleaner and more sustainable sources of energy to feed its growing economy that is marred with an ailing energy infrastructure. India is currently planning on ratcheting up nuclear technology in its future energy mixes. Its discourse was set back until 2009 because of being out of the nuclear Non-Proliferation Treaty (NPT). Later on, the incompatibility between India's civil liability law and international concords also complicated cooperation in acquiring foreign technology. However, regardless of this, India has managed to fare well for itself. It currently has 22 nuclear reactors and construction

61. Sethi, n. 7, pp. 118-119.

62. "Asia Remains Biggest Area for Nuclear Growth, Says Report", *World Nuclear News,* October 24, 2017, http://world-nuclear-news.org/Articles/Asia-remains-biggest-area-for-nuclear-growth,-says. Accessed on June 25, 2019.

of seven more is underway. In Asia, after China, it is India that has been rapidly developing its nuclear power. India has also been developing its indigenous designs. While the government support for nuclear energy is strong, public acceptance remains a challenge. Mass protests were witnessed in the development of the Jaitapur nuclear power project and the Kudankulam nuclear power project. Even the state government of West Bengal has denied approval for the construction of nuclear reactors. To clear apprehensions about safety concerns, the Government of India is now trying to communicate with the public to garner support. While there are other challenges too, the government seems determined to tackle them and strengthen its nuclear power programme.

Pakistan's budding nuclear power project has 1,355 MWe operating capacity. Pakistan's government has shown immense interest in intensifying its civil nuclear project. However, considering that Pakistan is a non-signatory to the NPT because of its weapons programme, it has also faced challenges in the nuclear trade. But its strong developing ties with China are making Islamabad hopeful of expanding its nuclear energy capabilities. The Pakistan Atomic Energy Commission has expressed interest in building seven new reactors by 2030, with help from the Chinese.[63] This process has begun, with Pakistan currently constructing 2,300 MWe reactors with Chinese assistance.

Bangladesh, a country experiencing frequent power cuts, having a high dependence on fossil fuels, and being one of the countries most susceptible to the effects of climate change, has been ramping up its energy security policies to adapt to these challenges. In this regard, Bangladesh has developed its civil nuclear programme with the establishment of the Rooppur Nuclear Power Plant Company in 2015. The construction of the first reactor began in 2017 and officials estimate that the first unit will be commissioned in 2023, followed by the commissioning of the second unit in the succeeding year.[64]

63. Thomas Latschan, "Nuclear Energy Booming in Asia", DW, March 11, 2016, https://www.dw.com/en/nuclear-energy-booming-in-asia/a-19110848. Accessed on June 23, 2019.

64. Laura Gill, "Construction Progresses on Bangladesh's First Nuclear Power Plant", IAEA, January 31, 2019, https://www.iaea.org/newscenter/news/construction-progresses-on-bangladeshs-first-nuclear-power-plant. Accessed on June 18, 2019.

Sri Lanka has also been exploring the possibility of developing a civil nuclear programme in the recent past. In 2010, the Sri Lankan government enabled its Atomic Energy Board to conduct a pre-feasibility study to assess the potential of generating power from 2025 onwards.[65] The following year, Colombo announced its decision to establish an Atomic Regulatory Council to commence development of nuclear power technology and address other concerns regarding radiation and nuclear safety. In 2015, Sri Lanka signed a civil nuclear cooperation agreement to enable knowledge sharing, capacity building, radioactive waste management and other nuclear developments. The government is also altering the Atomic Energy Authority Act No. 19 to make the relevant changes to meet the current and future requirements with regard to nuclear issues in the country.

While Nepal has not developed its nuclear power capabilities, it has taken steps towards developing its nuclear science capabilities. In 2007, the Government of Nepal adopted the National Nuclear Policy (NNP). The NNP has clearly indicated that nuclear science will be used only for peaceful purposes, i.e. for medical and agricultural applications. In fact, the background section in the NNP also includes energy in the scope of the peaceful uses of nuclear technology.[66] While the major countries in South Asia are developing their nuclear power capabilities, other countries like Afghanistan, Bhutan, Maldives and Nepal that have not shown interest in developing nuclear energy, have not decided to stay anti-nuclear either.

Southeast Asia

There is significant interest in nuclear energy among the Southeast Asian countries too. Studies and reports on nuclear energy development in ASEAN were mostly published by think-tanks or independent researchers. Thus, when the ASEAN Centre for Energy (ACE) published a "Pre-Feasibility Study on the Establishment of Nuclear Power Plants in ASEAN" in 2017, it generated a lot of interest. One of the most interesting points in the report

65. M. P. Ram Mohan, *Nuclear Energy and Liability in South Asia: Institutions, Legal Frameworks and Risk Assessment within SAARC* (New York: Springer, 2015), p. 77.

66. Ibid., pp. 77-78.

Indonesia has shown interest in developing its civil nuclear project since the 1950s, but various challenges prevented it from advancing its plans each time. For example, it conducted a pre-feasibility test in 1995. However, the Asian slowdown, in addition to the discovery of the Natuna gas field, scaled back this project.

was that five of the 10 ASEAN states were described as "frontrunners" in establishing a civil nuclear power programme.[67]

In 2016, the Ministry of Energy and Mines of Laos signed a Memorandum of Cooperation with Rosatom to collaborate in the designing, construction and operation of Laos' nuclear power project. Cambodia, likewise, is deliberating over the use of nuclear power. The MoU signed with Rosatom concentrated on a research reactor but with consideration of nuclear power.[68] In 2016, Cambodia signed another MoU with Rosatom, according to which a nuclear energy information centre is to be constructed to engage with, and educate, students and the public. In 2016, Cambodia also held discussions with the China National Nuclear Corporation (CNNC) regarding the construction of a nuclear power plant.

Indonesia has shown interest in developing its civil nuclear project since the 1950s, but various challenges prevented it from advancing its plans each time. For example, it conducted a pre-feasibility test in 1995. However, the Asian slowdown, in addition to the discovery of the Natuna gas field, scaled back this project.[69] It was only after a decade that Indonesia signed a nuclear cooperation agreement with Russia, under circumstances of major power shortages. The work began rapidly and the construction of the power plant was expected to start in 2010. However, this effort too got stalled as various

67. Eijas Ariffin, "Will we see Nuclear Energy in Southeast Asia?", The ASEAN Post, July 11, 2018, https://theaseanpost.com/article/will-we-see-nuclear-energy-southeast-asia. Accessed on June 18, 2019.

68. "China, Cambodia Agree to Nuclear Energy Cooperation", World Nuclear News, September 13, 2017, http://www.world-nuclear-news.org/NP-China-and-Cambodia-agree-to-nuclear-energy-cooperation-1309174.html. Accessed on June 10, 2019.

69. "Thousands Protest Against Indonesian Nuclear Plant", ABC.net, June 12, 2007, https://www.abc.net.au/news/2007-06-12/thousands-protest-against-indonesian-nuclear-plant/66650. Accessed on June 14, 2019.

environmental groups and other local protesters posed objections. In 2011, the Fukushima disaster furthered the protests and safety concerns, considering that Indonesia was located in the Ring of Fire – an area around the Pacific Ocean, prone to a majority of the world's earthquakes and tsunamis. The Indonesian government then decided to tweak the scope of its nuclear project and start off with the construction of a small reactor in Jakarta, instead of the original plans to build large units for the Java Bali grid. In December 2015, Minister for Energy and Mineral Resources Sudirman even stated that while Indonesia will continue to develop technology, it would, however, remain as a last resort for potential use post 2050.[70] However, the following year, Indonesia signed an agreement with China to develop high-temperature gas-cooled reactors, and as of now, Indonesia plans to start building the reactors around 2027.

Malaysia too had strong plans to develop its nuclear energy programme. It undertook a feasibility test in 2008, with plans to operationalise its reactors by 2024. As per IAEA standards, the country had met all the requirements to develop its nuclear programme. But the new government has decided to scrap its nuclear project citing concerns of nuclear waste disposal as an important reason.

Thailand, which majorly relies on fossil fuels, has also been drawn to the idea of developing its civil nuclear programme. Its new Power Development Plan 2010-30 has determined to start five 1,000 MWe units between 2020 and 2028.[71] In 2017, Thailand signed an agreement with China to develop peaceful use of nuclear energy.

The Philippines is also gearing up to develop its nuclear power project. Although it already has a nuclear power plant which was built around 30 years

70 Rangga Prakoso, "Indonesia Vows No Nuclear Power Until 2050", *Jakarta Globe*, December 12, 2015, https://jakartaglobe.id/context/indonesia-vows-no-nuclear-power-2050. Accessed on May 21, 2019.

71. "China, Thailand Agree to Nuclear Energy Cooperation", World Nuclear News, April 5, 2017, http://world-nuclear-news.org/Articles/China,-Thailand-agree-to-nuclear-energy-cooperatio. Accessed on May 30, 2019.

ago, it is not operational. The nuclear power plant was built under the leadership of President Marcos in response to the 1973 oil crisis. However, Marcos was overthrown in 1986 and the new leadership under President Corazon decided not to operationalise the power plant. The Chernobyl disaster, along with public protests, also furthered this decision. Now, after a few decades, Philippines is once again considering restarting its civil nuclear power programme under the presidentship of Rodrigo Duterte. Citing safety as the main concern, in 2016, he mandated a study on the potential of reopening the nuclear power plant. Russia, that is said to be persuading the Philippines to take up its nuclear project again, is rumoured to have sent experts from Rosatom to the Philippines for an inspection of the nuclear power plant.[72] More recently, in March 2019, the IAEA sent a team of experts to review the infrastructure development of the Philippines for nuclear power. The Filipino government seems determined to develop nuclear energy, with Alfonso Cusi, the country's energy secretary, stating that it was "high time we put the framework in place to bring nuclear power into the energy mix. We should learn lessons from the past and catch up with the missed opportunities."[73]

Vietnam, too, had an enthusiastic start in developing its civil nuclear capabilities. In 2006, it signed an agreement with Russia which was to help in the building and financing of two units of 1,200 MWe each. This was followed by a similar agreement with Japan in 2010. The project was moving well, with plans to begin construction in 2015 and have an operationalised nuclear power plant by 2025. However, in 2016, amidst the growing public debt, the Vietnamese government decided to rescind these plans, citing financial challenges. After the Fukushima accident, safety concerns also increased, with former President Truong Tan San admitting that the Fukushima disaster played an important factor in influencing the decision to scrap the nuclear power project.[74]

72. "Philippines Considering Nuclear Energy" *The ASEAN Post*, March 22, 2019, https://theaseanpost.com/article/philippines-considering-nuclear-energy. Accessed on May 24, 2019.

73. Ibid.

74. David Albright, "Phased International Cooperation with North Korea's Civil Nuclear Programs", Institute for Science and International Security (ISIS), March 19, 2007, http://www.isis-online.org/publications/dprk/CivilNuclearNK.pdf. Accessed on June 25, 2019.

Like Vietnam, Malaysia too had strong plans to develop its nuclear energy programme. It undertook a feasibility test in 2008, with plans to operationalise its reactors by 2024. As per IAEA standards, the country had met all the requirements to develop its nuclear programme. But the new government has decided to scrap its nuclear project citing concerns of nuclear waste disposal as an important reason. However, with examples, such as that of the Philippines, a decision to do away with nuclear energy is not necessarily permanent and could also be reversed, depending on the changing leadership.

Other countries in the region like Brunei, Myanmar, Singapore and Timor Leste do not have any plans for nuclear power projects currently. But neither have they taken a strong stance against nuclear power. The developing nuclear energy landscape in Southeast Asia, along with domestic factors would perhaps influence these countries to take more proactive decisions regarding nuclear energy in the near future.

East Asia

East Asia has been displaying interesting trends in the nuclear energy domain. Japan, which experienced the horrors of both the nuclear bomb and a nuclear accident, immediately shut down all its reactors after Fukushima. The accident took a huge toll not only in terms of cost and logistics involved in the generation of electricity, but also had a huge impact on the psyche of the people. However, Japan has made an impressive comeback. While other countries called off their nuclear power programmes in the light of the Fukushima accident, Japan decided to continue to tread the nuclear path. Understanding the importance of nuclear energy, while also taking extra precautions to make sure another accident does not occur, Japan gradually started reopening its reactors. In 2018, Japan topped the list of countries with the highest increased amount of nuclear consumption in comparison to the previous year, with a growth rate of 68.9 per cent.[75]

75. Firdevs Yüksel, "US Leads World in Nuclear Energy Consumption", *AA.com*, June 20, 2019, https://www.aa.com.tr/en/americas/us-leads-world-in-nuclear-energy-consumption/1511161. Accessed on June 21, 2019.

In June 2019, the Japanese government came out with its energy White Paper which called for a reduction in carbon emissions by using renewable sources, including nuclear energy.[76] Challenging times lie ahead for Japan, but it will be interesting to see how it manages the rebalancing of its energy basket, achieving more self-dependency and assuring thorough safety of the reactors while dealing with the public disapproval.

China is currently one of the leading countries in terms of development in nuclear energy. According to the World Nuclear Association, more than half of the world's nuclear plants are currently under construction in the Asian continent. Among the ones that are being constructed, almost 40 per cent are being built in China, and the rest of Asia accounts for the remaining 60 per cent. In fact, it is predicted that by 2030, with about 110 operational nuclear power plants, China will surpass the United States with the highest number of nuclear power plants connected to the grid.[77] After the Fukushima accident, the Chinese government suspended the construction of new power plants, and a thorough inspection of all safety regulations was made. The following year, China lifted this moratorium and has been bolstering its civil nuclear project ever since. Not only is China increasing its capacity to produce more nuclear energy, it is also trying to establish itself as the next big exporter of nuclear technology. China has been helping in building nuclear power stations in several countries as a part of its Belt and Road Initiative (BRI).

Taiwan, which had been getting a steady supply of about 20 per cent of electricity from nuclear reactors for the past three decades, is currently witnessing the phasing out of nuclear energy. Public disapproval for nuclear energy was always prevalent in Taiwan, however, after the Fukushima accident, the protests only increased. In February 2019, the Taiwanese government announced the abolishment of nuclear energy by 2025. Officials stated opposition from local government bodies and citizens, issues regarding

76. "Japan Plans Carbon Emission Cuts, More Nuclear Energy", *The Economic Times,* June 7, 2019, //economictimes.indiatimes.com/articleshow/69687420.cms?from=mdr&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst. Accessed on June 10, 2019.

77. Latschan, n. 63.

nuclear waste disposal and decommissioning plans for active plants as reasons that prompted this decision.

South Korea, with nuclear energy contributing to 38 per cent of its electricity in 2003, had a well-established nuclear power project with more ambitious projects in tow. Under President Lee Myung Bak's visualisation of "Green Growth" as a part of the national development strategy, there were plans to increase the share of nuclear energy to generate electricity to 45 per cent by 2015. In addition, the South Korean nuclear sector also started expanding outwards. In 2009, the Korea Electric Power Corporation (KEPCO) beat other nuclear suppliers and won the bid to build four nuclear units in the UAE. However, this sanguine momentum was struck by the 2011 Fukushima accident. Not only did the accident bring up safety concerns among the people, it also exposed the shortcomings in safety management in nuclear power reactors in the country. As it turns out, a lot of sub-standard components were being used in five of the operational nuclear power plants, with fake certification. As the exposure threw light on scams and corruption within the nuclear industry, it also led to loss of public confidence. Approval ratings for nuclear energy also dropped immensely. The current President, Moon Jae-in, decided to gradually reduce the share of nuclear power in the country and not build any new plants. The future of nuclear energy in South Korea will most likely be dependent on the future governments—whether they decide to stick on to the current decision of nuclear phaseout or decide to once again bolster their nuclear power programme.

North Korea too has been interested in developing its civil nuclear energy since the 1950s. In 1959, it signed an agreement with the Soviet Union. In 1963, a research reactor was supplied by the Soviet Union to North Korea, which was operationalised in 1965. However, since the disintegration of the Soviet Union, the reactor is rumoured to be run only to produce iodine-131 for the purpose of thyroid cancer radiation therapy. In the 1970s, the Democratic People's Republic Korea (DPRK) started building a second research reactor and in the 1980s, it recognised that light water reactors were better suited for the country and started their development. In 1994,

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North Korea signed the US-North Korea Agreed Framework, with the United States. As per this framework North Korea agreed to conclude its graphite moderated nuclear reactor programme but, in return, asked for the construction of two light water reactors. However, this agreement was suspended in 2003. Again in 2005, North Korea pledged to complete all its nuclear programmes and sign the nuclear Non-Proliferation Treaty (NPT). It would allow international inspections in exchange for certain benefits such as becoming a recipient of energy aid and normalisation of relations with the US and Japan among others.[78] In 2008, North Korea promised to end its nuclear programme with the eventual handing over of the nuclear devices to China in the near future. However, North Korea's nuclear testing in 2006, 2009 and 2013 raised questions about its promise of denuclearisation. Considering the secrecy and ambiguity around North Korea's nuclear programme—for both energy and weapons development—it is difficult to track North Korea's future trajectory in terms of nuclear energy.

New among the nuclear aspirants is Mongolia, which is blessed with abundant uranium resources. The country is currently exploring the possibility of developing a civil nuclear power programme and is at a nascent stage in this regard.

The future of nuclear energy in Asia suggests a mixed picture but leaning towards a more positive and upbeat trend. Although affected by the Fukushima accident, the Asian countries seem to be drawn to the nuclear option yet again. The economic and development climate in Asia is such now that many developing countries are looking for stable, independent and cleaner forms of energy that will support the pace of their development

78. Albright, n. 74.

while helping them to reduce greenhouse emissions as well. Nuclear energy in this regard ticks all the boxes.

CONCLUSION

The impact of the Fukushima accident evidently was not just limited to Japan. It influenced nuclear power programmes around the world. The global response to the Fukushima accident was heterogenous. For countries that were already grappling with issues of public discontent, this became a moment to call off, or reduce, their nuclear power programmes. However, for countries that were struggling with power shortages and were developing their civil nuclear projects, the accident did not cause any major policy change. However, it did make all the nuclear power countries review their safety frameworks. The differences in policy responses to Fukushima also, to an extent, reflect the level of trust people have in their governments. It is possible that it could also be linked to the larger cultural attributes of countries.

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There seems to be a slow decline in the nuclear energy trend in the West. This coincides with factors such as the plateau in energy demand, economic slowdown, availability of alternate sources of energy and greater expression of public concern on nuclear safety. However, a more upbeat trend is noticed in the Eastern European countries. The lull in Western Europe is made up by the increasing interest in nuclear energy in the Asian, African, West Asian and Latin American countries. Asia, especially, is witnessing a positive trend in civil nuclear energy. This is linked to other trends in the fields of geo-politics and international relations, with a significant shift of the centre of gravity from the West to the East. The Asian continent has emerged as the new pivot, with many countries in the region striving for major economic development. Being the most populous continent, many countries in Asia

are witnessing economic growth that has naturally increased the demand for electricity. The imperatives of economic development in Asia necessitate a diversification of energy sources, keeping in mind the long-term demands. It is here that nuclear power gains prominence.

Nuclear power is becoming an important component in the national electricity basket to power the socio-economic growth of these countries. Furthermore, its low carbon footprint adds to its appeal as a clean and environmentally sustainable source of energy. This makes nuclear power a worthwhile solution to not just meet Asia's energy needs, but also to do so without adding to the problem of climate change. It is also interesting to see how these countries are not limiting their nuclear capabilities to just generating electricity for themselves, but are also looking at exporting their nuclear technology. The nuclear export market which was largely dominated by the US, France and Russia, is now witnessing diversification with new players such as South Korea and China.

Political will is also an important factor that determines a country's nuclear energy future. As examined earlier, nuclear energy policies in various countries keep varying with the changing leaderships. While most leaders look for public acceptance to win the mandate of the next elections, the term which lasts usually for a couple of years, it requires a strong and stable leadership that plans ahead, considering that it takes a long time to discuss, develop and start nuclear power projects.

Overall, the future of nuclear energy seems affirmative. The IAEA predicts nuclear power production will grow by around 46 per cent by 2040. However, over 90 per cent of this increase is expected to come from China and India.[79] With about 20 countries already developing their nuclear power projects and nearly 30 countries showing interest in going nuclear, it seems to be balancing the number of reactors that are expected to be retired and phased out soon. In this regard, Asia is expected to be the new leader in the growth in nuclear energy.

79. Melissa Goh, "China and India will Lead the World's Nuclear Power Growth, Experts say", CNBC, November 7, 2018, https://www.cnbc.com/2018/11/08/china-india-will-lead-global-nuclear-power-production-growth-experts.html. Accessed on June 15, 2019.