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Asian Nuclear Energy Landscape: Major Expansion Post-Fukushima

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The Fukushima nuclear disaster in 2011 in Japan has had an impact on the overall pace of building of new nuclear reactors in particular, and on the attitude towards nuclear energy, in general. However, it could not bring an end to "the nuclear renaissance in several countries".[1] A scrutiny of the half-decade of nuclear energy trend worldwide since the Fukushima event reveals that most countries with, or planning for, nuclear programmes opted for a slowdown or temporary halt, rather than complete cessation of their programme, except Germany. The trend in Asia seems to be interesting as increasing number of states have shown interest in nuclear energy; while those countries already having nuclear programme like India, China, etc., are also planning for major expansion.

Meanwhile, sporadic anti-nuclear movements have cropped up in many countries. In the past, there have been cases in Australia and USA where near-complete reactors have been halted by the weight of public opinion. In November 2016, Vietnam decided to rollback its nuclear power programme after many decades of nuclear preparations.[2] Will other Asian countries face the same fate? What is the likely future of nuclear energy in Asia? Will India be able to pursue its ambitious expansion programme smoothly? Though the Indo-US civil nuclear deal has unshackled India of the international technology embargo, its nuclear programme seems to be shackled within given the sporadic domestic opposition during the last few years. The sections that follow, attempt to fathom the trends in nuclear energy production, planning, and current public concerns in the leading Asian countries included within the framework of global nuclear energy discourse.

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Global and Asian Scenario

Nuclear energy continues to represent a major energy source – supplying roughly 10 percent of the world's electricity and 21 percent in OECD countries,[3] "making up around one-third of the world's low-carbon electricity supply".[4] At the end of 2010, the total global capacity fell from 375 GW to 369 GW (366.5 GWe according to the World Watch Institute at the end of 2011), but has since gradually risen to 374.3 GW by January 2014.[5] The year 2014 started with 435 operable reactors along with 71 under construction, totalling around 75 GWe – the highest number since 1989.[6] "In 2015, 13 countries relied on nuclear energy to supply at least one-quarter of their total electricity".[7] Comparatively, the year 2015 seems to be the best year for the nuclear industry in the last quarter of a century. A record ten new reactors with a total capacity of over 9 GW were put into operation. This was less than the new solar and wind capacity.[8] From November 2016, 450 nuclear power plant units with an installed electric net capacity of about 392 GWe are in operation in 31 countries, and 60 plants with an installed capacity of 60 GWe are under construction in 16 countries.[9] As per IAEA projection 2016, nuclear power generating capacity will expand between 1.9 per cent and 56 per cent by 2030.[10]

Status of Post-Fukushima Global Nuclear Industry

Year	New Reactors Connected to the Grid	Permanently Shutdown	Construction Started	Construction Cancelled
2011	7	13	4	-
2012	3	3	7	3
2013	4	6	10	-
2014	5	1	3	1
2015	10	7	8	-
2016	10	1	2	-

Compiled by the author from various sources

More importantly, a large number of Asian countries have shown more interest in the nuclear energy programme than any other part of the world has shown. According to the World Nuclear Association, there are currently 123 nuclear power reactors operable in this region – a total of more than 109 GWe; 41 units are under construction, plans are in place to build 92 more, and there are proposals for many more. In addition, there are about 56 research reactors in fourteen countries of the region. The greatest growth in nuclear

generation is expected in China, South Korea and India.[11] Moreover, 43 of the last 53 new reactors to be connected to the grid since 2000 are also in Asia.[12] Given this trend, should one argue that Asia is leading the global nuclear energy resurgence or renaissance that is back on track half a decade after Fukushima disaster? What lessons have the Asian countries learnt from the Fukushima event?

What does it mean to be Post-Fukushima?

A "rare combination of events" led to the Fukushima Daiichi nuclear event in Japan. Interestingly, some literature on the Fukushima event describes it as an "accident", many view it as a "disaster", and a few even call it a "catastrophe", although all three terms suggest different degrees of severity, consequence, and responses required.[13] Generally, accidents happen in all technological endeavours and all learn from them, incorporate improvements if needed, and move on. On the other hand, a disaster in any domain poses greater challenges and calls for more extended reflections leading to substantial changes in policy and practice. But a catastrophe suggests something more profound, fundamental, and irrevocable changes.

Keeping in mind the upward trend in the global nuclear energy trajectory, largely driven by the Asian nuclear industry in the aftermath of the Fukushima event, one can find that the Asian countries (except Japan for which it is both an "accident" and "disaster") have viewed Fukushima event as an accident, learnt many lessons and moved ahead; whereas many European countries are on the back foot as they seem to have taken Fukushima event as a "catastrophe" and decided to phase-out.

The Asian Nuclear Energy Landscape

Asia is the only region where electricity generating capacity, specifically nuclear power, is growing significantly. According to IAEA, "...between 1980 and 2010, nuclear capacity in Asia quadrupled, led primarily by South Korea, Japan, and India. …More recently, growth in nuclear capacity has been led primarily by China, whose capacity has nearly quadrupled in the past 10 years, followed by India and South Korea".[14]

In East and South Asia alone there are 119 operable nuclear power reactors, 49 under construction, and around 100 are planned.[15] As per the World Nuclear Association data, up to 2010, the projected new generating capacity in this region involved the addition of some 38 GWe per year; and from 2010 to

2020 it is projected to be 56 GWe per year. Much of this growth is expected to be considerable in four countries – China, Japan, India, and South Korea.[16] The major nuclear power vendors like Toshiba, Hitachi, MHI, Korea Electric Power Co. (KEPCO), Doosan, and others, headquartered in developed countries, are now leading their export ambitions aimed at Asia.

In analysing the global nuclear power growth, it is no surprise that Asia will be the leader given the existence of conducive drivers of nuclear energy growth – most Asian countries are rapidly developing economies, fast growing populations, have high energy and electric power demand growth, relatively poor indigenous energy resources, and strong central governments.[17] However, Asia is a multi-dimensional region having differing attitudes, commitments, and plans for nuclear energy. While China, India, South Korea, and Japan have already embarked on ambitious plans, countries like Indonesia, Malaysia, Pakistan, Bangladesh, Sri Lanka, and Thailand have long-term plans.

Thus, the role of Asian countries in determining the future of global nuclear power is crucial. A cursory look at the programmes of prominent Asian countries reveals that the story of nuclear power in Asia is one of consistency and growth. Especially, China, India, Japan, and South Korea have kept nuclear development active during the 1990s and early 2000s. Some of them are expected to also emerge as global leaders in nuclear technology export in the near future.

Japan: The Forerunner

Japan is the first country in Asia to develop nuclear power for peaceful purposes, beginning in the early 1960s. In the aftermath of the Arab oil embargo of 1973, Japan embarked on rapid development of reactors; from the mid-1970s through the year 2000, it built 47 reactors reaching a peak nuclear generating capacity of nearly 48 GW from 55 units in 2008 (roughly 35 percent of the total power supply). However, the trajectory of nuclear power in Japan changed dramatically after the massive earthquake and tsunami of 11 March 2011. Since then, Japan's public has become extremely sceptical of nuclear power, leading the government to become much stricter in its regulatory supervision of the industry. The newly created Nuclear Regulation Authority (NRA) has "implemented very rigorous requirements on the remaining 48 operable reactors in the country, all of which have stayed offline for inspections and safety upgrades since 2012".[18]

Since August 2014, applications have been submitted for the restart of 20 units, and the NRA has already approved the restart of the first two units at

Kyushu Electric Power Co.'s Sendai plant. Kyushu Electric Power Co. On 8 December 2016, began the process of restarting Sendai 1.[19] The company expects to boost profits by $97 million a month for each reactor it restarts.[20]

The reactor restart process in Japan is now somewhat clearer but many of its reactors are approaching their last phase of lifespan, and there is uncertainty over whether the NRA will allow old plants to operate beyond stipulated timeframe. Moreover, several nuclear plant sites are being evaluated for possible earthquake faults. Meanwhile, the fate of two reactors under construction – Shimane 3 and Ohma 1 – is uncertain. However, "...it is still too early to tell how many reactors will continue to operate in Japan over the long-term, but it would seem likely that somewhere between 30 to 40 units could remain on the grid for the coming decades".[21] In the worst case, if the public continues to oppose and the political leadership does not push through a strong pro-nuclear agenda, it is possible that the share of nuclear energy will slowly decline after 2020. However, given the difficulty in availability of alternative sources of energy, anti-nuclear sentiments in Japan may not last longer.

China: The Most Favoured Partner

For obvious reasons, China is likely to determine the trends of the future global nuclear energy industry more than any other country. "Both in terms of domestic expansion of nuclear power capacities as well as the role of Chinese companies in the international marketplace, its position in the industry is destined to grow dramatically" in the decades ahead.[22]

China's nuclear energy programme was a late bloomer; its first reactor was connected to the grid only in 1991. However, nuclear additions in subsequent decades have accounted for 18 GWe of the 22 GWe added globally between 2009 and 2015. Of the 60 reactors currently under construction worldwide, 20 are in China, (which would bring the total capacity to 46 GW by 2019), and "China has formally told the IAEA that it plans to build another 20 reactors".[23] China expects that if things move right, potentially 100 units could be added by 2030. However, doubts remain over its ability to reach the official target of 58 GWe by 2020 as projected "in a revamped plan after Fukushima; but the long-term expectation is that China will remain committed to rapid growth of nuclear power to satisfy extremely high energy demand coupled with clean air requirements".[24]

One of the main factors that will determine the role of nuclear power in China over the long-term is its decision on the location of the plants. After Fukushima, the Chinese government decided to allow construction of only

coastal sites. Once the ban on inland sites is lifted, more new projects will resume. A final factor that is being watched closely by many is its effort to expand into the international nuclear market. Following a two-pronged strategy comprising both outbound activities and domestic capacity building, Beijing is fast becoming the "favoured nuclear partner" for nuclear development across the world.

The four major policy decisions by China after the Fukushima nuclear disaster certainly stretch its nuclear clout far beyond its borders. First, it has released the long awaited safety plan that will result in the lifting of a moratorium on new nuclear reactor projects. Second, the approval of Initial Public Offering (IPO) by China National Nuclear Power (CNNP) to raise the equivalent of US $27.3 billion is a first of its kind financial offering. Third, building of new nuclear power plants has been listed as part of the "seven strategic industry initiatives" by the central government to counter down-turn in economic growth.[25] Lastly, the CNNC and CGN have won stakes in the Hinkley Point C project in the UK, and they have additional ambitions in Romania, South Africa, Argentina, Turkey, etc. This indicates Beijing's long-term outbound nuclear plans.

Especially in the post-Fukushima phase, the global clout of China's nuclear sector is ascending more as the "favoured guest",[26] both as an investor in international projects and as a customer for its own domestic demands. In its neighbourhood, China has enormously aided Pakistan's nuclear weapons as well as energy programme. It has supplied Pakistan with equipment for two reactors at Chashma. In the Middle East, China has become a favoured partner of Saudi Arabia among other nuclear technology giants like France, Argentina and South Korea. Saudi Arabia has inked an agreement with China to enhance cooperation on atomic energy for peaceful purposes. The deal, signed in January 2012, sets a legal framework that strengthens scientific, technological and economic cooperation between Riyadh and Beijing.[27] China has also emerged as a leader in the international contest to build a new nuclear power station in Turkey. In contrast to the South Korean terms, Beijing did not demand state guarantees for the Turkish projects, and therefore was preferred by the Turkish authorities.[28]

China has set foot in the European nuclear market with much confidence. In 2011, the China Dongfang Electric Corporation, one of China's top component manufacturers, has signed its first nuclear export contract in a deal to supply France's Electricite de France (EDF) with low-pressure heaters.[29]

China has signed a Memorandum of Understanding with South Africa to develop the pebble bed nuclear reactor technology.[30] China's Institute of Nuclear

and New Energy Technology of Tsinghua University is working in collaboration with Pebble Bed Modular Reactor Pty Ltd. of South Africa with the commitment to develop efficient and clean nuclear power. Reportedly, the SNPTC has approached the South African government for the financing of its planned 9GW tender.

On the demand side, China is expected to account for 20 percent (the largest share) of global uranium demand. In this respect, it is also found to be a favoured guest around the globe. China at present buys 95 percent of its uranium from Kazakhstan, Uzbekistan, Namibia and Australia. In a strategy to diversify its uranium import, China has spread out to all major uranium producing corners of the globe: Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan), Africa (Namibia, Niger, Nigeria, South Africa, Mongolia), Canada, and Australia.[31] It seems to have calibrated a sound strategy to deal with corruption, political instability and other problems in the source countries. It has increased its engagement with its suppliers creatively. All these show that China does want to go out and it is "going to be aggressive in providing the financing so that some countries accept the offer".[32]

India: From Apartheid to Multi-alignment

India's nuclear energy journey has a chequered history. First, it started with a purely civilian programme unlike all other countries whose nuclear energy programme is an extension of their nuclear weapons programme. Second, for three decades India was treated to "nuclear apartheid" and its civil nuclear programme was hostage to the sanctions imposed by multilateral export control regimes after its 1974 nuclear test. Its clean non-proliferation record finally won it the image of a "responsible state with advanced nuclear technology" leading to withdrawal of all sanctions, culminating in the Indo-US civil nuclear deal and the India-specific NSG waiver. Ever since, India has initiated civil nuclear cooperation with multiple global players, and aspires for membership in the supplier cartels, to harness the atom as a viable source of its energy security.

The "Integrated Energy Policy of India" considers the role of nuclear power, among other options, as "the most potent means to long-term energy security", and therefore prescribes "accelerated development of nuclear source for sustainable development of the country".[33] The Nuclear Power Corporation of India Ltd. (NPCIL) has planned to launch sixteen more reactors – eight 700 MW Pressurised Heavy Water Reactors (PHWRs) and eight Light Water Reactors (LWRs), based on cooperation with Russia, France, and the US – at an outlay of Rs 230,000 crores (approximately $3.8 billion USD) (September

2014 rates) during the 12th Five Year Plan period (FYP) (2012–17).[34] The total installed capacity is scheduled to reach 9,980 MWe during this planning period, which will help India in "building strategic stockpile of nuclear fuel to counter the risk of disruption of international fuel supply".[35]

Today, nuclear energy constitutes around 3 percent of the total electricity produced in the country and the vision is "to have 14,600 MWe nuclear capacity on line by 2020"; in the long-term, India aims "to supply 25% of electricity from nuclear power by 2050".[36] The nuclear power output has increased by over 80 percent (i.e. from 18,634 million units (MUs)[37] in 2006–07 to 35,333 million units during 2013–14).[38] Uranium supplies from Canada, France, Kazakhstan, and Russia have helped Indian reactors to operate with high capacity. The capacity factor rose to 79 percent in 2011–12 from 71 percent in 2010–11. Nine reactors recorded an unprecedented 97 percent capacity factor during 2011–12, and with imported uranium from France, the Kakrapar reactors recorded 99 percent capacity factor during 2011–12.[39] The target of nuclear energy generation in the 11th Five Year Plan (20072012) was 163,395 MUs, which was revised to 124,608 MUs. However, "…the actual generation in the 11th Five Year Plan was 109,642 MUs".[40] Reportedly, this "target could not be achieved because of non-availability of uranium".[41] The Unit 1 reactor at Kudankulam Nuclear Power Plant (KNPP) attained its full power status on 7 June 2014.[42]

On 19 April 2014, India and Russia signed a framework agreement for building the third and fourth units of the KNPP.[43] A Memorandum of Understanding (MoU) has been signed for an Early Work Agreement (EWA) between NPCIL and Westinghouse for the Mithivirdi plant in Gujarat.[44] Meanwhile, India and France have reportedly agreed on the cost of power that will be generated by Jaitapur Nuclear Power Plant (JNPP) in Maharastra.[45] India is set to carry its ambitious nuclear energy programme forward with its new found bonhomie with previously reluctant partners like Australia and Japan. During his July 2014 visit to Bhabha Atomic Research Centre (BARC), Prime Minister Narendra Modi said, "…the DAE should strive to meet the target of increasing nuclear capacity threefold from the present level of 5,780 MW by 2023-24, within the projected cost".[46]

India imports about 40 percent of its uranium requirements.[47] While reaching out to potential uranium suppliers across the globe, India also plans for optimal utilisation of the country's scarce uranium resources. In four states, thirteen uranium mining projects are currently in different stages of exploration.[48] The two Processing Plants at Jaduguda and Turamdih prepare yellow cake and send them to the Nuclear Fuel Complex at Hyderabad for

further processing into UO2 pellets.

To achieve the target and judicious mobilisation of expertise and resources, India has put in place an integral and coordinated framework involving specialised agencies, academic institutions, public sector undertakings, and private industrial houses. As a long-term strategy, India has plans to diversify its nuclear industry, involving both domestic and international private industrial houses such as Larson & Toubro (L&T), Tata, Reliance, Punj Lloyd, Westinghouse, Areva, GE, Sandpit, etc. In order to reduce the burden of the two Public Sector Undertakings (PSUs) in charge of nuclear-related activities, namely NPCIL and BHAVINI, India aims to diversify the operational and management responsibilities of nuclear plants among other PSUs in the long-run.[49] After gaining NSG membership, India in cooperation with Russia would explore "opportunities for sourcing materials, equipment and services from Indian industry for the construction of the Russian designed nuclear power plants in third countries".[50]However, there seem be lack of an upbeat trading plan to project India's credentials as a powerful global stakeholder, compared to the Chinese activism worldwide.

South Korea: A Unique Growth Trajectory

The Republic of Korea (ROK) has been a unique growth story for nuclear power. When all other parts of the globe were stagnant, South Korea was active. It "not only has in-country nuclear construction continued throughout the time, but also technology advancement and a government-level commitment to export has propelled South Korea into an emerging position in the global nuclear industry".[51] Today, South Korea's 25 reactors provide about one-third of South Korea's electricity from 23 GWe installed capacity.[52] Meanwhile, it has good built-in safety and reliability features to operate at high utilisation rates. South Korea has been growing a strong and highly self-sufficient nuclear supply chain.

South Korea plans to increase nuclear power by 70 percent to 38 GWe by 2029.[53] Its vibrant economy demands a larger share of nuclear energy and the revised government targets aim at 29 percent of generation from nuclear reactors by 2035. It will take another 20 units to meet that target in addition to the five to six projects underway today. Meanwhile it aims to play a major role in the global nuclear market as a supplier. In 2009, KEPCO succeeded in winning the competition for the United Arab Emirates' first four units. It expects to construct many such units in the Middle East in the decades ahead. Its APR1400 reactor is now considered a leading design for the future, in Asia as well as in other global locations.

However, during 2012–13 "serious safety and certification issues…surfaced" in the South Korean nuclear industry. As a result, at least five plants were taken offline to replace components that did not meet quality standards. The resulting shutdowns for investigation and replacement of components ended in decrease of production. By mid-2014, South Korea seems to have addressed most loopholes and is now renewing its development activities both inside and outside the country.

Pakistan: Small, but Looking Ahead

Pakistan has a small nuclear power programme – four reactors with 1040 MWe capacity – but is planning to increase this substantially with Chinese help. China's CNNC is constructing two 300-MW units at the Chashma site, and there are plans to build a larger 1,000-MW advanced CNNC design at the Karachi site.[54] Given the acute power shortage, Pakistan will continue to look to China, the only reactor exporter willing to do business in Pakistan. Arguably, "…beyond the basic commercial considerations, the benefit for China to building in Pakistan is that it offers a relatively amenable test bed to prove its capabilities as a full-fledged nuclear exporter".[55]

In January 2014, the Pakistan Atomic Energy Commission (PAEC) expressed its intention to build five more 1100 MWe nuclear plants to meet anticipated electricity demand, and have 8.9 GWe of nuclear capacity on line by 2030.[56] In April 2015, China Nuclear Engineering & Construction Group Co (CNEC) won the tender to install the Chinese ACP1000 reactor. In December 2016, Pakistan's Prime Minister Nawaz Sharif inaugurated the China-helped 340 MW Chashma-3 nuclear power plant in its Punjab province.[57] Another plant Chashma-IV is also being built within the same plant. Three other reactors are under construction, which will add another 2662 MWe. The PAEC has also been ambitiously planning for eight sites for 32 units, four 1100 MWe units at each, so that nuclear power supplied one quarter of the country's electricity requirement of 40 GWe of capacity by 2030. If Sino-Pak relations remain smooth, and its nuclear weapons programme does not land into muddy waters, Pakistan will achieve some growth in its nuclear energy programme in the years ahead.

Taiwan: Waiting to Shift Opinion Favourably

Taiwan's history with nuclear power dates back to the 1970s, when it first imported two BWRs from GE. As an island with a rapidly expanding economy

and few domestic sources of energy, "Taiwan turned to nuclear power to provide nearly 20 percent of its electricity for the past three decades from six reactors at three nuclear power plants". A fourth nuclear power station at Lungmen is under construction since 1999 but marred by changes in the domestic political situation over the past 15 years.[58] Anti-nuclear sentiment has grown in Taiwan since the Fukushima event. Major protests in the spring of 2014 led the government to mothball the Lungmen project temporarily. Unit 1 of the two GEH advanced boiling water reactors (ABWRs) has completed pre-operational testing but was sealed for three years. Construction on Unit 2 has also been halted. The government is preparing for a public referendum to decide the fate of the Lungmen project. If protestors get their way, Taiwan could be completely nuclear-free by 2030. At the same time, without many good options for replacing this power, many people in Taiwan are still hopeful that anti-nuclear sentiment will evaporate.

Newcomers and U-Turns

Asia is also home to both new entrants and a reversal in the nuclear energy domain. Seven new countries – Lithuania, UAE, Turkey, Belarus, Poland, Bangladesh, and Sri Lanka – have either expressed desire for, or already launched, nuclear programmes.

The **UAE** is embarking upon a nuclear power programme in close consultation with the International Atomic Energy Agency (IAEA), and with huge public support. It approved a $20 billion bid from a South Korean consortium to build four commercial nuclear power reactors, giving a total of 5.6 GWe by 2020 at Barakah. All four units are now under construction. The first is more than 85 percent complete and is expected to start functioning in 2017.[59] By 2020, the UAE hopes to have four of the 1400 MWe nuclear units running and producing 25 percent of its electricity at a quarter the cost of that from gas. More importantly, "…it plans to export electricity to Gulf neighbours via the regional power grid. An operating company, Nawah Energy Company, was set up in May 2016 to operate and maintain the four Barakah units, with 82% ENEC equity and 18% KEPCO".[60] In October 2016 ENEC and KEPCO signed a joint venture agreement for "long-term partnership and cooperation in the UAE's peaceful nuclear energy program". The two companies also announced the establishment of Barakah One PJSC to be a long-term partnership enhancing the operation of the nuclear power plant and to "represent the commercial and financial interests" of the Barakah project.[61]

Bangladesh aims to address its energy deficit through the nuclear route. In December 2016, it demarcated $50m (Tk400 crores) for construction of the main phase of the Rooppur Nuclear Power Plant.[62] The Rooppur plant will host two 1200 MWe nuclear power units constructed by Russia with the investment of $12.65 billion. An agreement has been signed on 25 December 2016 by the Bangladesh Atomic Energy Commission (BAEC) and Russia's Rosatom. Work is expected to start in early 2017. The first unit is expected to start operations by 2022 and the second by 2023.[63] As per the agreement, Rosatom will maintain the plant for the first year of its commercial operation and bear the fuel costs before handing it over to Bangladesh.

On the other hand, **Vietnam** has recently made a U-turn in its plan for nuclear energy, and decided to go without it in its national energy mix. Way back in 1995, Vietnam decided to go for nuclear power generation. However, it brought out a firm proposal only in 2006 approaching Russia to finance and build 2400 MWe of nuclear capacity from 2020. Japan also agreed to collaborate for another 2200 MWe. However, it abruptly abandoned plans to build the two multi-billion-dollar nuclear plants citing "lower demand forecasts and other economic reasons". It would be interesting to observe which other Asian country might think of reversing their nuclear energy drive following Vietnam.

Social Acceptance Issue

Though Asia is at the take off stage of an ambitious nuclear energy trajectory, sporadic opposition to nuclear projects are visible in various parts and are likely to intensify in the years ahead. In China, South Korea and India, pockets of resistance to new nuclear projects and alleged corruption or negligence in regulatory matters have been reported. Though there is no "green politics" *per se* in Asia yet, apprehensions and negative effects of Fukushima disaster are often highlighted by anti-nuclear movements in all these countries.

Interestingly, a series of anti-nuclear movements can be seen in China in the post-Fukushima years. Anti-nuclear demonstrations in the Chinese city of Lianyungang have led Chinese authorities to call off the construction of a planned 15 billion dollar nuclear fuel reprocessing facility.[64] Also, an anti-nuclear petition campaign has been sparked against the proposed nuclear plants by the Dahai Commune. Another anti-nuclear campaign happened in Hunan on 25 July 2016 when the CNNC signed an agreement with the Hunan provincial government to build the Taohuajiang Nuclear Power Station.[65]

Equally strong anti-nuclear sentiments in South Korea have been seen in the post-Fukushima years. Largely, environmental groups, religious groups, unions, co-ops, and professional associations have raised alarms. In December 2011, protesters demonstrated in Seoul and other areas after the government announced it had picked sites for two new nuclear plants. In South Korea, public sentiment against nuclear power was exacerbated particularly in the provinces of North Gyeongsang, South Gyeongsang, South Jeolla and Busan, where most of the reactors in operation or planned are located. The opposition, the Democratic United Party has launched a group to push for the country's abolition of nuclear power and transformation toward renewable energy. Korea's largest environmental NGO, the Korean Federation for Environmental Movement (KFEM) leads campaigns for denuclearisation, both in terms of weapons reduction and power generation solutions.[66] Another group, the "East Coast Solidarity for Anti-Nuke Group" was formed in January 2012, brings one the sense of the growing institutionalisation of anti-nuclear movement in the country.

In India, anti-nuclear movement is centred round Kudankulam and Jaitapur locality. It is not a pan-Indian phenomenon. There is no visible "green politics" in the Indian political mainstream, unlike in Europe. The movement around Kudankulam plant organised by the Peoples Movement Against Nuclear Energy (PMANE) and its leader S.P. Udaykumar resorted to a political route, and contested the parliamentary election as an Aam Admi Party (AAP) candidate but lost. Subsequently, he quit the party saying, "…the AAP high command failed to fulfil its assurance". The AAP leader Arvind Kejriwal reportedly told him, "…the middle class may not support him if he takes a stand against the nuclear plant since they saw these as employment opportunities for their children". Rightly so, a major chunk of the Indian population is not against nuclear energy. After many futile politicisation attempts, Udaykumar launched his own political party, Pachai Tamizhagam (Green Tamil Nadu) with the aim of contesting forthcoming elections. With a "manifesto dedicated to fighting against nuclear energy", the party will "not contest to win but to make people aware" of the nuclear risks. As this is not his first foray, Udaykumar's self-assumed leadership for heralding "green politics" in India would be tested this time for how big a dent he can make in the next election.

Despite sporadic societal opposition in Asia, nuclear power still has a strong foothold throughout the region, and public opinion is mixed. Popular concept of nuclear risk seems heavily influenced by the imagination of the consequences of catastrophic accidents – a "burden of perception". Therefore, each time a problem related to nuclear technology arises anywhere, a section

of the media and civil society groups draw baseless parallels to their national programmes. They tend to forget that the nuclear risks, to a great extent are location-, and technology-specific.

Undeniably, public reaction is legitimate; after all, public money is involved in these projects. However, public panic, based on the idea that "nuclear activity anywhere is a threat to humanity everywhere" is manufactured, misplaced and over emphasised; in the process, the specificities and achievements are overlooked. Nobody bothers to unravel why anti-nuclear champions do not protest against the disasters that take place in the oil or aviation industry. Accidents happen, people die, and pollution spreads because of man-made reasons, but the world has not abandoned using oil or air travel. Rather, all strive to find on the root of the problems and their solutions. Surprisingly, the case with the nuclear industry is totally in contrast. It is high time that demonising nuclear technology is stopped and attempts to create related socio-political panic are isolated.

Positive Future, if not Renaissance

It is clear that the growth story for nuclear energy in the foreseeable future will mostly focus on Asia. As we look back at the past decade, Fukushima, while it has seriously affected nuclear power in Japan, may prove to be only a brief interregnum in the nuclear growth of Asia. Even though the Fukushima accident has negatively affected the industry, it will by no means halt, or even slow down, the overall growth of new nuclear powers in Asia. Over the past two years, an upward trend in the number of new reactors can be seen. Having dropped from sixteen in 2010 to four in 2011,[67] the sites where construction had started increased to six in 2012 and reached ten in 2013.[68]

Meanwhile, the Asian growth story will not just be centred on the domestic expansion because a number of Asian countries already have well-developed nuclear supply chains, globally recognised reactor designs and leading vendors and suppliers. Countries like Japan, South Korea and China are likely to remain or become world leaders in nuclear power and their influence will be felt worldwide.

Critics do not believe that the risks associated with nuclear projects have technological solutions. The challenge, therefore, is how to increase social acceptance of nuclear energy while addressing the inherent risks in nuclear technology. The bottom line, therefore, is that nuclear power is more attractive where energy demand is growing rapidly, such as China and India; where alternatives are scarce or expensive, for example in Japan and South Korea; where energy supply security is a priority, such as Japan and Korea again,

and possibly Europe looking ahead; where reducing air pollution is a priority.[69] Second, the growth in nuclear energy will continue because, with or without Fukushima, the entire world faces the same challenge of energy scarcity. Specific substantial expansion plans in key countries like China and India have a big impact on overall global expectations. Therefore, all these developments indicate a very positive future for nuclear energy, if not a renaissance right away.

Notes :

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