India's Nuclear Power Development and Nepal's Hydropower after the Fukushima Accident

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Abstract: When President George W. Bush and Indian Prime Minister Manmohan Singh signed the Indo-US Nuclear Declaration in 2005 and subsequently the Nuclear Suppliers Group waived off the embargo on India in 2008, there were tremors in Nepal that her hydropower would be displaced by India's nuclear power plants. Nepal's two quick hydropower plans − 10,000MW in 10 Years and 25,000MW in 20 Years − may be interpreted as indication of that tremor. But is India really banking on Nepal's so called 'huge' hydropower potential? In a mere two decades, by 2032, India is planning to have 63,000MW of installed nuclear power. Will the recent Fukushima nuclear accident in Japan have any impact on her ambitious nuclear power development? To understand the issues, this article deals with India's interesting nuclear history that had to innovate and indigenize when the 'embargo' was imposed after the 1974 Pokhran nuclear explosion. The article argues that the fast developing India is after Nepal's stored water, that valuable resource getting increasingly scarce. Hydropower for her is a mere by-product, perhaps a bonus if she can get it at a cheap rate!

Key words: Nuclear power, hydropower, Fukushima incident, India, Nepal

Foreword: India's Nuclear Power Plan, Nepal's Hydropower and the Fukushima Accident

When US President George W. Bush and Indian Prime Minister Manmohan Singh signed the joint Indo-US nuclear declaration on July 18, 2005, there were perceptible tremors in Nepal's 'hydrocracy' lobby; tremors because this lobby believed that India's huge power deficit would be catered by India's own nuclear power plants and thus displace Nepal's hydropower. With the waiver on 'embargo' of nuclear supplies to India by the 46 nation Nuclear Suppliers Group (NSG) in September 2008, the tremors increased in Nepal. The Nepal government's two hydropower development plans – 10,000MW in 10 Years and 25,000MW in 20 years – developed within a span of nine months, were an apparent indication of this tremor.[1] India, however, has an ambitious plan to install 63,000MW of nuclear power plants by 2032 AD. An attempt has been made to briefly analyze the impact of India's nuclear power development on Nepal's Hydropower in the aftermath of March 2011. Fukushima/ Japan nuclear plant accident. To understand these issues, an in-depth background to India's chequered but interesting history of nuclear power development has been dealt.

The Humble Beginning: India's Nuclear Czar from a Rented Mumbai House

In December 1945, under the initiative of Dr. Homi Jehangir Bhabha, the Tata Institute of Fundamental Research (TIFR) began nuclear research work at Kenilworth/Mumbai, India in a rented house that eventually become the cradle of India's nuclear program. India's Constituent Assembly, despite being busy framing the Indian Constitution, passed the Indian Atomic Energy Act of 1948.[2] Though this Act was modeled on the British Atomic Energy Act of 1946, it was made far more secretive than the British law. Prime Minister Jawaharlal Nehru's defense of the necessity of secrecy was that the "advantage of our research would go to others before we even reaped it..." (Sarma and Banerjee 2009). In August 1948, Nehru appointed Dr. H.J. Bhabha Chairman of the Atomic Energy Commission (AEC) overriding M.N. Saha who had worked longer in nuclear physics and shared the same socialist ideology with Nehru. Saha, then, became a strong critic of atomic energy program particularly of the secrecy surrounding the program. His was a lone voice, however, and his sudden death in February 1956 silenced forever an authoritative critical voice. Nehru's stand on atomic energy program was ambiguous. While he condemned the use of atomic bombs on Hiroshima and Nagasaki, he provided Dr. Bhabha "unlimited funds and facilities" for nuclear energy programs and "perhaps even nuclear weaponry" (Sarma and Banerjee 2009).

Nehru to Bhabha in 1960: "Can You Make an Atom Bomb?"

On the nuclear weaponry issue, an interesting episode is related by American Major General KD Nichols, a military engineer who had supervised the secretive Manhattan Project, America's atom bomb project during the Second World War.[3] In 1960 Dr. Bhabha had invited General Nichols to India for discussing plans to construct India's first nuclear power reactor and a meeting was arranged with Prime Minister Nehru. In General Nichols' own words: "After agreeing to allow American companies to bid for reactors and not restrict it only to British companies, Nehru turned to Bhabha and asked 'Can you make an atom bomb?' Bhabha assured him that he could and in reply to Nehru's next question about time, he estimated that he would need about a year to do it. I was really astounded to be hearing those questions from the one I thought to be one of the world's most peace-loving leaders. He then asked me if I agreed with Bhabha and I replied that I knew of no reason why Bhabha could not do it. He had the men who were as qualified or more qualified than our young scientists were fifteen years earlier. He concluded by saying to Bhabha 'Well, don't do it until I tell you'."

This episode reflected the mindset of an astounded American General who, while carrying the burden of Hiroshima and Nagasaki nuclear holocausts, saw India as the peaceful land of Mahatma Gandhi. It also reflected an ambiguous Nehru who, despite spearheading the non-alignment movement with the likes of Tito, Nasser and Sukarno, was distinctly toying with the idea of making the atom bomb.

Dr. Bhabha's 1966 Death: 1974 and 1998 Nuclear Tests, "India, a Nuclear Weapon State"

In August 3, 1954, the Indian government created the Department of Atomic Energy with Dr. Bhabha as Secretary and the Prime Minister in direct charge of that department. Dr. Bhabha by then was holding four crucial posts simultaneously: Chairman of Atomic Energy Commission, Secretary of Atomic Energy Department, Director of Atomic Energy Research Establishment/Trombay, and his first original post as Director of the Tata Institute of Fundamental Research. He became India's nuclear czar with total unfettered control over nuclear research and development and was accountable only to the Prime Minister. Nehru's death on May 27, 1964, was a big blow to India's nuclear program as Prime Minister Lal Bahadur Shastri believed the fight against poverty was far more important than building nuclear arsenal (Sarma and Banerjee 2009). After China exploded her first nuclear device at Lop Nor in October 16, 1964, Shastri did permit research on peaceful nuclear programs. But he died on January 10, 1966, in the immediate aftermath of signing the Soviet Union brokered Tashkent Declaration following the 1965 Indo-Pak war.

The biggest blow to India, however, was the death of Dr. Bhabha in a plane crash on Mount Blanc/Switzerland on January 24, 1966. This plane crash was also a big blow to Nepal, for travelling on the same plane was Amrit Prasad Pradhan, a leading pioneer of education. Pradhan was the driving force who established Kathmandu's Public Science College, which is now named after him as Amrit Science College. Vikram Sarabhai succeeded Bhabha, but Sarabhai was opposed to a nuclear bomb program and only his own sudden death in 1971 altered the situation. Homi Sethna was then appointed Chairman of India's Atomic Energy Commission and on May 18, 1974, India exploded her first nuclear device at Pokhran in Rajasthan, India. Fourteen years later on May 11, 1998, India again exploded three devices in the deserts of Rajasthan, whereupon Prime Minister A.B. Vajpayee triumphantly claimed that India was now a "nuclear weapons State – the due right of one-sixth of humankind" (Sarma and Banerjee 2009). The Department of Atomic Energy claimed that the first two were fission bombs, whereas the third one was a thermonuclear/hydrogen bomb. Two more explosions were carried out a few days later in a tunnel.

India's Nuclear Power Plants in Operation:

Since Dr. Homi Bhabha's humble 1945 beginning at the Tata Institute of Fundamental Research at Kenilworth, Mumbai in a rented house, India has in commercial operation (as of January 2011) 20 nuclear reactors with an installed capacity[4] of 4,780MW at the following six sites:

Tarapur, Maharashtra: 1,400MW (Units 1 and 2 160MW each and Units 3 and 4 540MW each). After the USA signed an agreement with India in 1963 to supply low enriched uranium fuel for 30 years, the American General Electric (GE) Company was contracted to build two 160MW light water reactors[5] at Tarapur in 1964. These two reactors were commissioned in October 28, 1969, but after India's May 18, 1974, Pokhran detonation, America refused to supply fuel. Indian metallurgists mastered the technology to make reprocessed plutonium mixed oxide fuel (MOX) and India informed the USA that if fuel was not supplied as per the agreement then MOX would be used at Tarapur. The USA then coaxed France into supplying the fuel until the 1993 agreement date with "partial safeguards."

After 1993 France insisted on "full scope safeguards" for more fuel supply and when India refused France also stopped the supplies. Interestingly, two years later in 1995, it was China that came to India's rescue by supplying fuels to Tarapur with "limited safeguards." But China also stopped the supplies completely when India conducted the 1998 nuclear tests. The 1960 vintage GE reactors are still making valuable contributions to India's energy starved industries. Units 3 and 4 of much larger 540MW sizes were commissioned much later in August 18, 2006, and September 12, 2005, respectively.

Rawatbhata, Rajasthan: 1,180MW (Unit 1 100MW, Unit 2 200MW, Units 3, 4, 5, and 6 220MW each). Around the same period of American involvement at Tarapur, India and Canada signed an agreement in April 1964 to build a 200MW Pressurized Heavy Water Reactor at Rawatbhata near Rana Pratap Sagar in Rajasthan. The reactor started commercial operation from December 16, 1973, but when India tested her nuclear device on May 18, 1974, Canada[6] stopped all nuclear supplies. The reactor, soon after operation, started to give problems and eventually the 200MW unit was de-rated to 100MW. Despite the de-rating, this unit was prone to frequent failures leading to it being labeled "the eternal problem child."

Despite the difficult embargo period, India improvised and indigenized the nuclear equipments and commissioned the second 200MW unit in April 1, 1981. By the time she announced herself as a "Nuclear Weapons State" in 1998, India had already mastered the technique of building 220MW Pressurized Heavy Water Reactors. India preferred the use of heavy water, for it acted both as a moderator and coolant to the reactor. Though India did have several heavy water plants, they did not have

the capacity to fulfill the requirements. The procurement of heavy water was a major headache and India had to resort to dubious methods.[7]

At Rawatbhata, India commissioned units 3 and 4 in year 2000 and Units 5 and 6 in year 2010, each of 220MW capacity. Like Tarapur's Unit 1 and 2, Rawatbhata's Unit 1 and 2 should have been decommissioned by now, but India's unquenchable thirst for energy has not allowed that to happen.

Kalpakkam, Madras: 440MW (Unit 1 and 2 220MW each). Unit 1 was commissioned on January 27, 1984, and Unit 2 on March 21, 1986. Both reactors are indigenous, the product of India's difficult 'embargo' period.

Narora, Uttar Pradesh: 440MW (Unit 1 and 2 220MW each). Unit 1 came into commercial operation in January 1, 1991 and Unit 2 in July 1, 1992. Both are indigenous 'embargo' period units like those at Kalpakkam.

Kakrapar, Gujarat: 440MW (Unit 1 and 2 220MW each). Unit 1 was commissioned in May 6, 1993, and Unit 2 in September 1, 1995. By early 1990s, India had, despite the Nuclear Suppliers Group international embargo, mastered the art of building indigenous "home grown" nuclear power stations.

Kaiga, Karnataka: 880MW (Unit 1, 2, 3 and 4 220MW each). Units 1 and 2 in 2000, Unit 3 in 2007, and Unit 4 in 2011.

India's 1974 and 1998 Nuclear Explosions: Initial Labor Pains but subsequent Joys for All!

In the aftermath of 1974 Pokhran detonation, the 46 developed nation Nuclear Suppliers Group (NSG) cartel imposed an embargo on India that severely constrained her plans to expand nuclear power generation capacity. India underwent intense labor pains not only to continue her three units operational but to commission more nuclear power plants. It took seven years for India to commission her 200MW Unit 2 at Rawatbhata in 1981 that the Canadians had left midway. This was then followed up by the commissioning of 220MW Units 1 and 2 at Kalpakkam, Madras in 1984 and 1986. Narora, UP's two 220MW units were commissioned in 1991 and 1992. As India could not obtain the nuclear fuel, power plant components and services from international market, she was forced to innovate and indigenize. This was at the expense of increased capital and operating costs and compromised safety standards of power plants.[8] The beneficial impacts of NSG embargo, however, was that it forced the Indian Government and bureaucracy to support and fund development of nuclear technologies to create a domestic Indian nuclear industry. This created a large pool of nuclear scientists, engineers and technicians that developed new and unique innovations in the areas of nuclear reactors and in particular the development of Thorium fuel cycle. India's Uranium reserves are very limited but her Thorium reserves are vast and she has already become a global leader in the development of this fuel.

With India declaring herself as a Nuclear Weapons State after the 1998 detonation, the Nuclear Suppliers Group cartel realized that its embargo had no impact on India's nuclear development activities. A confident 'go alone' India commissioned a series of indigenous nuclear power plants: (1) two additional 220MW units at Tarapur in 2005 and 2006, (2) two additional 220MW units at Rawatbhata in 2000, and (3) two 220MW units at Kaiga in 2000. Eyeing the huge nuclear businesses developing in India, the Nuclear Supply Group finally decided to change the goal post they themselves had erected. President George W. Bush and Prime Minister Manmohan Singh then signed the Indo-US Nuclear Declaration on July 18, 2005. The separation of India's military nuclear facilities from the civilian ones, specifically tailored for India, was negotiated. India only then agreed to International Atomic Energy Agency (IAEA) inspection of her civilian nuclear facilities.

It is reported that 22 power and research nuclear reactors would be subjected to this IAEA safeguards but the Bhabha Atomic Research Center, a weapons development centre, would not be subjected to IAEA inspection (Sarma and Banerjee 2009). The Nuclear Supply Group waiver of September 2008 availed the badly needed fuels from Avera/France and Kazatomprom/Russia to substantially increase nuclear power generation. Agreements have been signed with various companies (Avera of France, Westinghouse Electric Company of the USA, General Electric Hitachi of the USA, and Atomstroexport of Russia, etc.) to set up nuclear power plants in technical cooperation in various parts of India.[9] The same Nuclear Supply Group cartel that declared India a nuclear outcaste for three decades, suffered no bad conscience in fervently wooing her for weighty nuclear contracts. Despite the initial labor pains, there were, without doubt, joys for all!

India's Nuclear Power Plants under Construction and Planned

Under final construction at Kundankulam, Tamil Nadu with Russian cooperation are two large units each of 1,000MW capacity. The Government of India has already given permission for full development of Kundankulam which will mean six units of 1,000MW each. Kalpakkam, Madras will have a third unit added but this will be of a larger 500MW size. At Kakrapar, Gujarat two more Units (3rd and 4th) of a larger 700MW size will be added. Similarly, at Rawatbhata, Rajasthan two larger Units (7th and 8th) of 700MW will be added. This will mean that by 2017, when these power plants get commissioned, India would have a total installed nuclear capacity of 10,080MW.

India has already awarded Areva/France the Jaitapur, Maharashtra nuclear site for full potential development of 9,900MW with 6 units each of 1,650MW. The Government of India has also given the 'in principle' approval[10] to five new Greenfield sites: inland sites at Kumbaria, Haryana and Bargi, Madhya Pradesh will have Units of 700MW size; coastal sites at Chhayamithi Virdi, Gujarat, Kavvada, Andhra Pradesh and Haripur, West Bengal will have Units of 1,000MW size. By 2032, India plans to install[11] 63,000 MW of nuclear power plants.

Conclusion: Post March 2011 Fukushima Accident, Whither?

So will the March 2011 Fukushima accident in Japan have any impact on India's ambitious 63,000MW of nuclear power development by 2032? Switzerland has decided not to install any nuclear power plants. Germany has shut down its old seven nuclear power plants pending further evaluation of their safety. And although President Obama has constituted a Commission on America's Nuclear Energy Future, many believe there will be no substantive changes, as America is hostage to her muscular corporate sector. Turkey announced that it will go ahead with the construction of its two nuclear power plants. France, with 58 nuclear power plants with a total installed capacity of 63,000MW, is the world's leading producer[12] of nuclear energy since she adopted the energy security policy after the 1974 'oil shock'. In the aftermath of Fukushima accident, France, presently constructing third generation nuclear reactors, has announced research plans for fourth generation reactors worth over a billion Euros. It is believed that both China and India, with their fast galloping economies, will continue to move ahead with their nuclear power development plans. Many interpret the Fukushima nuclear accident to be nature-made not human-made as it was not the earthquake but the earthquake-generated tsunami that disabled the backup safety system of the power plant.

So India's 63,000MW of nuclear power plants in the coming 20 years should definitely ring bells in Nepal. Of Nepal's venerated 83,000MW of hydropower potential, 42,915MW is believed to be economically viable. The Nepal government constituted Task Force 2066 Report (in 2009 AD) concluded: "Thus, within the twenty year period (2010-2029) including the Pancheshwar, Karnali Chisapani and Saptakoshi multipurpose projects, total electricity generation of 37,628MW is possible." On the basis of this Report, a group in Nepal is lobbying that India's massive nuclear power development will automatically displace Nepal's hydropower development. Nepal, thus, needs to hit the iron when it is hot.

But Nepal needs to coolly mull over what India's former Union Minister, Saif Uddin Soz, said: "Our main interest is flood control and irrigation. Those are our first and second priority. If we get hydroelectricity as a byproduct, it will be a bonus for us."[13] In her scheme of things, India is not banking on Nepal's hydropower. In Minister Soz's own words this is a mere by-product, a bonus perhaps! Hydropower could be replaced by coal, gas, oil, wind, solar and nuclear.

But India can never replace the water flowing from Nepal into the Ganges river that supports India's 500 million people, 42 percent of her 1.21 billion population. Freshwater is a valuable resource that is getting increasingly scarce in South Asia. To address that freshwater deficit, India is slowly but certainly moving ahead with her mammoth Rs 5,600 billion (US$124.44 billion) National River Linking Project. In India's scheme of things, Nepal's Pancheshwar, Karnali/Chisapani, Saptakoshi, Budhi Gandaki, West Seti, Nyasalgad, etc., are all means to supply the valuable resource, water, during the critical dry period. Nepal need not fear that her hydropower will be displaced by India's nuclear power. What Nepal really needs to fear is that her water, stored by submerging her valuable scarce valleys and displacing thousands and thousands of her people will not be availed *free of cost* to the people across the border!

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Endnotes

1 Task Force-2065 was constituted in 2008 (2065 BS), while Task Force-2066 was constituted in 2009 (2066 BS).
2. Perhaps a reminder to our own Constituent Assembly that "where there is a will, there is a way"!
3. Sarma and Banerjee (2009), quoting K.D. Nichols, The Road to Trinity (1987).
4. India's total installed power capacity as of May 31, 2011 was 174,911MW (113,859MW Thermal, 37,817MW Hydro, 18,454MW Renewable Sources, and 4,780MW Nuclear), with nuclear being a mere 2.7 percent (www.cea.nic.in).
5. The Nuclear Power Corporation of India Limited's website (www.npcil.nic.in) lists it at 160MW unit size. But in Sarma and Banerjee (2009) it is listed as 190MW unit size. It appears that due to various teething problems, the unit sizes were derated.
6. In fact, Canada accused India of breaching the agreement by using the plutonium extracted from the Canada-India-Reactor-US (CIRUS) for making the nuclear device. India denied the accusations. Nuclear Power in India (Banerjee and Sarma).
7. Sarma and Banerjee (2009: 53) state that "...USA have revealed that India received clandestine shipments of Chinese, Norwegian and Soviet heavy water in the 1980s through a German nuclear materials broker named Alfred Hempel, now deceased."

8. Sarma and Banerjee (2009: 75) state that "Several minor but serious accidents have also been known to have occurred in India.... As is usual with all government agencies, the Department of Atomic Energy did not publish any details of the accident."
9. www.npcil.nic.in.
10. www.npcil.nic.in.
11. Nuclear Power Corporation of India Limited www.npcil.nic.in
12. www.world_nuclear.org/info/info40.html.
13. In his interview with BBC Nepali Service in the aftermath of Kosi embankment breach at Kushah of August 18, 2008, as reported by the weekly Nepali Times on 19-25 September 2008 (Issue No.418).

References

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CALENDAR OF EVENTS

Water Resources

1-5 August, 2011: 2nd annual International Law & Transboundary Freshwaters Workshop Dundee, Location: United Kingdom. More info: http://www.hydroworld.com/index/events/more_events.html.

23-25 August, 2011: Regional Sharing Workshop on Assessment of Potentials and Opportunities in the Asia Pacific Region for Rio+20. Location: ICIMOD Headquarters, Kathmandu, Nepal. Contact Persons: Madhav Karki, Email: mkarki@icimod.org, and Tek Jung Mahat, Email: tmahat@icimod.org. *Note: Participation in this workshop is by invitation only.*

20-28 September, 2011: First International Advanced Training Workshop on Water and Soil Conservation, Location: Beijing, China. More info: http://www.hydroworld.com/index/events/more_events.html.

22-23 September, 2011: Small Hydro Workshop, Location: Bend, Oregon, USA. More info: http://www.nwhydro.org/events_committees/low_impact_hydro_workshop.htm; Contact: jan@nwhydro.org.

25-29 September, 2011: DamSafety2011Conference, Location: Washington, D.C., USA. More info: http://www.damsafety.org/conferences/?p=b52df768-9387-4038-b1ad-39c20f0f6ff3.

25 September, 2011: Seminar on Operation and Maintenance of CFRDs, Location: Yichang Three Gorges, China. More info: http://hydrou.com; Email: hydrou@hydrou.com.

25-29 September, 2011: 14th IWRA World Water Congress, Location: Porto de Galinhas/ Pernambuco, Brazil. More info: http://www.worldwatercongress.com/en/; E-mail: info@worldwatercongress.com.

25-29 September, 2011: 6th Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, Location: Dubrovnik, Croatia. More info: http://www.dubrovnik2011.sdewes.org/

27-29 September, 2011: 5th International Conference on Flood Management (ICFM5), Location: Tsukuba, Japan. More info: http://www.hydroworld.com/index/events/more_events.html.

4-6 October 2011, Training Workshop for professionals of UN-Water members and partners on "IWRM as a tool for adaptation to climate change"; Location: Geneva, Switzerland (WMO headquarters), Press Room; More Info: Sophia Sandström, Project Officer, WMO, Email: ssandstrom@wmo.int

12-13 October, 2011: Management of Water in a Changing World: Lessons Learnt and Innovative Perspectives, Location: Dresden, Germany. More info: http://www.bmbf.iwrm2011.de.

15-19 October, 2011: 84th Annual Water Environment Federation Technical Exhibition and Conference, Location: Los Angeles Convention Centre, USA. More info: http://www.weftec.org.

23-25 October, 2011: International Forum on Integrated Water Management: Storm water management in urban area, Location: Sherbrooke, Quebec, Canada. More info: http://www.rv-eau.ca.

23 -26 October, 2011: 28th National Seminar on Large Dams, Location: Brazil. More info: More info: http://www.cbdb.org.br.

10-11 November, 2011: Flood Risk Analysis Management (Training), Location: Wallingford, UK. More info: http://events.hrwallingford.co.uk/acatalog/Flood_Risk_Analysis_Management_Nov11.html.

15-17 November, 2011: The Fourth South Asian Water Forum (SAWAF-Y), Islamabad, Pakistan. More info: jvs@wlink.com.np.

17-18 November, 2011: Water Management 2011: Integration of Renewable Energy Sources, Location: Las Vegas, USA. More info: http://www.ceati.com/Meetings/WM2011.

5-7 December, 2011: First International Conference on Water and Society, Location: Las Vegas, Nevada, USA. More info: http://www.wessex.ac.uk/11-conferences/waterandsociety-2011.html.

15-17 December, 2011: 38th National Conference on Fluid Mechanics and Fluid Power is being organized at MANIT, India during under auspices of National Society of Fluid Mechanics and Fluid Power, Location: Bhopal, India. More info: http://manit.ac.in/content/view/494/142/; Contact: fmfp2011@gmail.com.