The Indo-US nuclear deal – a decade after*

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On 18 July 2005, our former Prime Minister, Manmohan Singh and former President of USA, George Bush, had signed a historic Joint Statement on future strategic partnership between the two countries that included economic, energy and strategic components. In the Joint Statement, USA not only recognized India as a state with advanced nuclear technology, but also committed to achieve full civil nuclear energy cooperation with India. The genesis of the Joint Statement was a dialogue begun earlier in January 2004 between India and USA, 'Next Steps in Strategic Partnership (NSSP)', when the two countries agreed to negotiate and expand cooperation in the three areas that also included civilian nuclear activities. The Joint Statement was followed by a formal Civil Nuclear Cooperation Agreement, signed by the same two dignitaries on 2 March 2006 in New Delhi. While these were presented as natural steps in the direction of facilitating high-technology trade, there was considerable skepticism amongst us. I was part of the Indian delegation accompanying the Prime Minister to the US and had an opportunity to witness from close quarters some of the hectic parleys preceding the signing of the Joint Statement. How can one forget that for a large part of the 60 years of independent India, USA has not been our great ally? How can one also forget the US-led technology denial regime following the 1974 Pokhran Peaceful Nuclear Experiment by India? The NSSP and the Joint Statement therefore came as a surprise to many of us. The foremost question in everyone's mind was 'What is there in it for us and what is there in it for the US?'

Ten years down the line, where are we? The US Atomic Energy Act as it existed in 2005 did not permit civil nuclear cooperation with countries that have a weapons programme, are not signatories to the Non-Proliferation Treaty, and do not have full scope safeguards. To facilitate nuclear trade with India, the US had to provide in its Act a waiver with respect to India. The US Congress passed in 2006 an India-specific act, the Hyde Act, modifying the requirements of the US Atomic Energy Act to permit civilian nuclear cooperation agreement with India. On 28 September 2008, the US House of Representatives formally passed the bill to approve the US–India Civil Nuclear Cooperation Agreement, often referred to as the Indo-US Nuclear Deal. India on its part started working on a separation plan that identifies facilities to be placed under safeguards. An India-specific Safeguards Agreement (ISSA) was negotiated with the International Atomic Energy Agency (IAEA) and the Nuclear Suppliers Group relaxed its guidelines on 6 September 2008, thus enabling international civil nuclear trade with India. Today, India has Nuclear Cooperation Agreement not only with the US, but also with other countries, including France, Russia, Canada, Kazakhstan, Australia and many others.

What is there in it for the US?

The stated objective of the new India–US nuclear initiative was of course to strengthen India's ability to expand its nuclear energy programme, so that its large and rapidly growing electricity needs can be addressed (without increasing its reliance on unstable foreign sources of oil and gas such as nearby Iran – Secretary Condoleezza Rice in her testimony before the Senate Foreign Relations Committee). Considering that the contribution of nuclear energy to the overall energy needs of India is less than a few per cent and is not likely to reach two digit percentage value in the next few decades, one can only speculate on why the US has softened its stand on nuclear India.

With the US, it is always 'business first'. Considering the rapid growth of the Indian economy in the recent years, the economic advantages through increased exports of goods and technologies to India can no longer be ignored. Technology denial to India is actually business denial to the US, and this had to be stopped. The slew of concessions given by the US to clinch the deal was perhaps driven by the business potential for nuclear and other strategic defence sector business deals.

It is also perhaps a simple recognition that the post-1974 sanctions had not worked in the way they were supposed to. I will like to draw your attention to the comments of Siegfried S. Hecker (former Director of Los Alamos National Laboratory and presently co-director of the Stanford University Center for International Security and Cooperation) while speaking during the Hearing of the US Senate Committee on Appropriations, Subcommittee on Energy and Water Development on 30 April 2008. 'I found that whereas sanctions slowed progress in nuclear energy, they made India self-sufficient in nuclear technologies and world leaders in fast reactor technologies. While much of the world's approach to India has been to limit its access to nuclear technology, it may well be that today we limit ourselves by not having full access to India's nuclear technology developments.'

Yes, for the US, everything comes first with business, but there also exists a political agenda. It is not a question of India becoming nuclear independent or not. It is the prospect of increasing US presence monetarily or politically in South Asia, and to strike at China's growing presence in the global stage that the US wants to give such a nuclear deal to India. Insistence by the US for India to become a nuclear independent country is just media politics. The recent reports of the US negotiating a nuclear cooperation deal with Pakistan similar to the Indo-US nuclear deal could indeed point to such a geo-political driving force for the changed US perception.

Irrespective of the *raison d'etre* for the changed stance of the US, India is no longer a global nuclear untouchable.

What is there in it for us?

As mentioned earlier, the first reaction of the community, including the scientific community in India was one of skepticism. However, you will agree with me that getting out of the technology denial

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regime and getting into the world nuclear community as equal partners was no mean outcome of the deal. The increased availability of uranium has led to an improvement in capacity factors and greater generation of electricity. Based on the increased availability of uranium, more PHWRs are being planned. Negotiations are in progress with Russia, France and the US to set up more light water reactors.

What are the likely impacts of these developments on our long-term nuclear energy strategies? Let me start with a brief recollection of our long-term nuclear energy strategy. India is one of the few countries in the world that recognized very early that nuclear energy will become important not only for the developed countries but also the developing countries as a development tool. Way back in the 50s, Homi Bhabha, in addition to sowing the seeds for an ambitious nuclear programme, outlined a three-stage nuclear roadmap for India. He envisaged the programme to be indigenous and self-sustaining, without being overly dependent on foreign sources. Though the first Indian civilian nuclear power reactor was a turn-key purchase from the US and used enriched uranium as fuel, the Bhabha route was to build and operate natural uranium and heavy water-based reactors in the first stage, use the plutonium derived from reprocessed burnt fuel from stage I to breed more Pu-239 from uranium and U-233 from thorium in fast reactors in the second stage, and use U-233 in fast reactors regenerating U-233, thus resulting in an almost endless supply of nuclear power in the third stage. The reason for this three-stage strategy is of course India-specific. Not only does India have limited uranium resources, but it also has large deposits of thorium. The three-stage strategy of Bhabha is designed to maximize the energy potential of India's uranium and thorium resources. Each stage demanded new and high technology inputs as in the production of heavy water or mastering liquid sodium coolant technology or handling highly radioactive substances in large quantities for fuel production and fuel reprocessing. Over the past 50 years, India has had a sustained programme developing the needed technologies in all its aspects. Starting from exploration and mining, the activities have spanned enrichment, fuel fabrication, fuel re-processing and waste storage, and India can rightfully claim to have mastered the entire nuclear fuel cycle. Today we are on the threshold of the second stage of the three-stage road map of Bhabha and thanks to the technology denials, we can claim to have reached here through a totally indigenous route. What are the likely impacts of the recent developments on our long-term strategies for nuclear energy? In my view, the ready availability of uranium and reactors from the international marketplace will certainly accelerate the Indian three-stage programme, particularly the second stage. However, history tells us that easy access to the International marketplace has always hurt the indigenous industry. The political leadership operates on 5-year cycles. Programmes having long lead times are at a distinct disadvantage. We need to ensure that the present developments do not compromise our efforts to remain self-reliant in nuclear energy in the future also.

Challenges and opportunities

It is an irony of fate that the first public demonstration of the power of the atomic nucleus was for a destructive cause. The nuclear industry therefore had to carry the cross of a negative public image from its very inception. Concerns on nuclear proliferation stunted the dissemination and transfer of nuclear knowledge even for peaceful purposes with shrouds of secrecy and technology denials. Reprocessing of spent fuels and management of long-term nuclear waste are other unresolved issues related to nuclear electricity. While the increasing environmental concerns associated with continued burning of the hydrocarbons to satisfy the world's electricity needs had given a boost to nuclear electricity, a series of accidents, though far and few in between, has been eroding public confidence on the safety of nuclear power installations. The increasing role of the visual media to widely disseminate negative public perceptions on nuclear energy and an increasing public participation in policy making in democratic environments are putting new pressures on the global nuclear industry. Today, the biggest challenge for the growth of nuclear electricity globally is this lack of public confidence on the safety of the nuclear plants across the world. The possibility of another accident, however small it is, hangs like a Damocles sword on the head of the global nuclear industry. A focused effort to understand the public perceptions and manage it through effective communications is clearly the biggest challenge to the nuclear industry today.

The slowing down of the nuclear sector in some developed countries during the last few decades together with the increasing negative public perceptions has seriously disrupted the human resource pipeline and the knowledge management strategies across the world. Being a mature industry with more than five decades of existence, the nuclear sector certainly lacks among the young students the glamour of some of the emerging sectors such as information technology, biotechnology or nanotechnology-based industries. Being substantially under Government control, the sector also lacks the entrepreneurial opportunities which some of the emerging technologies offer. The decreasing job opportunities and constant battering by the anti-nuclear lobby, only add to this negative image of the sector. An unfortunate consequence of a declining student intake in the academic institutions is the declining faculty strengths in nuclear science and engineering disciplines. A number of nuclear facilities in educational institutions have also been closed during this time. Overall, there is a clear decline in nuclear research in the academic institutions with an unmistakable impact on new nuclear knowledge generation and nuclear knowledge management. At the plant level, the onset of retirement of the first-generation technologists is threatening to disrupt knowledge management since the human resource pipeline has been seriously disrupted, that too at a time when we are striving hard to improve safety levels of plant operation, to cope with the unavoidable post-lifetime management of the first-generation plants and long-term management of radioactive waste.

What is the future of nuclear energy in meeting the emerging global electricity demands? There is no doubt that continued use of fossil fuels for meeting the global energy demands is disastrous for the global climate and cannot be sustained. Meeting them fully by renewable energy resources while being a desirable objective, is unlikely to become a reality in the near future. While nuclear electricity will play a role in satisfying global electricity demands, long-term plans will remain unrealistic without taking into

account the challenges faced by the nuclear industry today.

With safety of the nuclear plants being a major public concern, are there safer options to the present-generation power plants? The GEN-IV project is an international initiative by the nuclear industry to specifically address this issue. While India has not been a participant in this initiative so far, the recent developments certainly open the doors for India's participation. Fusion power has always been seen as a safer option to harness nuclear power, but has not yet matured in spite of several decades of research. The international ITER project is a collective effort to take a step forward in this technology. Thanks to the Indo-US deal, India is now a formal member of the ITER team. Accelerator-driven subcritical reactors (energy amplifiers) is yet another concept that has been in the blackboards of research laboratories for a couple of decades. These systems are inherently safe compared to the traditionl reactors (controlled bombs). Fuelled by thorium, they also have unique advantages in spent fuel processing. Unfortunately, their engineering aspects, and more importantly, their commercial aspects are totally unexplored. India has a rich experience in handling thorium fuel with one U-233 reactor in operation and one power reactor in an advanced design stage. India has also been participating in several high-energy accelerator facilities across the world and collaborating with several accelerator laboratories. With India's commitment to thorium utilization for electricity, I believe that it is time for the country to launch a time-bound technology demonstration project on thorium-fuelled accelerator-driven sub-critical system for electricity generation and invite international partners.

Let me end with a little bit of day-dreaming. It has been suggested (by Buckminster Fuller) several decades ago that interconnection of electric power networks between regions and continents into a global energy grid (a worldwide web of electricity) can be an effective strategy to address the common aspiration of electricity on demand anywhere, anytime. While this suggestion was made in the context of tapping the abundant renewable energy resources across the globe, there exists a strong justification for integrating nuclear power into such a global electricity grid. This will of course call for international cooperation on an unprecedented scale, as well as, putting all nuclear assets under an international consortium.

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Essential oils of traditionally used aromatic plants as green shelf-life enhancers for herbal raw materials from microbial contamination and oxidative deterioration

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This commentary deals with recommendation of essential oils of selected traditionally used aromatic plants as shelf life enhancer of herbal raw materials in view of their efficacy to protect them from microbial and mycotoxin contaminations and oxidative deteriorations during post-harvest processing. Such documentation of pharmacological efficacy of traditionally used aromatic plants would be also helpful in bioprospection of plant diversity against the act of biopiracy.

India is a megabiodiversity country enriched with about 18,500 angiospermic species, out of which 9000 are of medicinal value. Such a large percentage of medicinal plant species is not found in any other mega biodiversity-rich countries. Use of herbal drugs in India is an age-old practice. Knowledge of ancient Indian herbal species was disseminated to the world through different routes like trade relationship with Mesopotamia, Gulf countries and Iran; cultural relationship with Arabia, Tibet and China; sites of knowledge like Nalanda and Taxila University; external scholars like Fahiyan, Ywan Chwang and Al Baruni, and also through invaders. According to a report by the World Health Organization, the present market of herbal drugs is 14 billion USD, which would reach approximately 5 trillion USD by 2050. People are getting attracted continuously towards herbal drugs because of their lesser side-effects, and frequent reports on the development of resistance against single molecule-based antibiotics. India's share in the world market of medicinal plants and products is a merely 2.5%. The main reason for this low percentage share in global herbal market is unscientific harvesting practices which have led to degradation in both quality and quantity of raw herbal drugs. In addition, tropical geography of the country is conducive for microbial growth and due to improper post-harvest processing, there are chances of microbial contamination of the herbal raw materials. The Indian forests, which are the major suppliers of herbal drugs, also act as nursery of phytopathogens. During post-harvest processing a number of pathogenic fungi and bacteria get associated with herbal raw materials, which consequently degrade them. Moulds produce hydrolytic enzymes: lipases, proteases and carbohydrases, as well as some volatiles such as dimethyl disulphide, geosmin, and 2-methylisoborneol, which are responsible for the deterioration of sensorial properties of the raw materials resulting in loss of