Harnessing thorium for nuclear power: challenges ahead*

Anil Kakodkar

US EIA's recently released report, "International Energy Outlook 2013" (IEO2013) projects that world energy consumption will grow from 524 quadrillion British thermal units (Btu) to 820 quadrillion Btu between the years 2010 and 2040. This represents a rise of around 56%. During the same period, the relative share of non-fossil (renewable + nuclear) energy is likely to increase from 16.5% to 21.4% only, thus leading to an increase in CO_2 emission by as much as around 40%.

Current total Indian energy use stands at around 0.8 Btoe per year. To reach a human development index (HDI) comparable to advanced countries (~0.92), India's energy consumption needs to rise to around 4 Btoe per year. This level of energy use is unlikely to be sustained on the basis of available energy resources of the country unless the vast thorium resources of the country are tapped. Already India imports nearly a third of its energy requirement. Projections are that the energy imports would grow by 5-7 times in next 15 to 20 years mostly in the form of fossil energy. Clearly any emerging scenario, consistent with India's economic growth projections, in which thorium is not an important component, is not sustainable in terms of available energy resources, economics as well as climate change. Urgent implementation of the three stage Indian nuclear power programme is thus even more relevant today than any time before.

Just like India, most of the global growth in energy consumption is expected in non-OECD countries particularly in Asia. An aggressive push to non-fossil energy use in these countries is thus very important. The situation with regard to the choice of non-fossil energy mix may vary from country to country. However considering the crisis at hand, there must be emphasis on all available non-fossil energy forms to start with. Over a long term, countries may converge on specific non-fossil energy mix consistent with their respective long term energy needs and resource availability. In the Indian context, a look at available non-fossil energy resources would suggest strong emphasis on solar and thorium energy in the long term. Even in respect of most other countries, it seems that nuclear energy option would become inevitable.

We are already witnessing this phenomenon in Asia. There are however several barriers to rapid growth of nuclear power. These arise as a result of concerns related to possible disasters arising out of severe accidents like Chernobyl and Fukushima, nuclear weapons proliferation, long term radioactive waste disposal etc. It is well known that use of thorium can actually address several of these concerns in a significant way. With developments in nuclear fuel technology, it is now possible to realise these gains through the use of thorium- LEU mixed fuel even in existing reactor systems without losing out too much on energy output from mined uranium in comparison to contemporary uranium fuelled reactor systems.

Thorium thus offers an opportunity to facilitate a more rapid growth even with existing proven nuclear reactor designs while evolution of more optimum specific thorium reactor designs takes place. India with its experience base with thorium, while moving ahead with her domestic programme to evolve thorium reactor technology, could do well to facilitate growth of nuclear power through the use on thorium in currently established nuclear reactor designs. The presentation would discuss some of these possibilities.

Dr. Anil Kakodkar

Dr. Anil Kakodkar obtained his BE (Mech. Engineering) degree from the University of Mumbai in 1963 and Maters from the Nottingham University in 1969. Dr. Anil Kakodkar was the Chairman, Atomic Energy Commission and Secretary to the Government of India, Department of Atomic Energy, during the years 2000 -2009. The focus of his work has been on self-reliant development of nuclear reactor systems to address the Indian nuclear programme requirements. He has created a roadmap for shaping the third stage of India's nuclear power programme aimed at tapping vast energy potential of our thorium resources not only as source for electricity production but also as a primary source for other forms of energy use. Several new technology areas such as accelerator driven systems, high temperature reactors, materials and recycle technology etc. have been initiated by him. He played a key role in the Nuclear Tests conducted during 1998 at Pokhran. Dr. Kakodkar's leadership has had significant impact in every aspect of India's atomic energy programme right from augmentation of uranium exploration, maximizing power output of reactor cores with available uranium, relaxation of Nuclear Supplier's Group (NSG) restrictions, commencement of Prototype Fast Breeder Reactor (PFBR) project and fuel cycle facilities. He has, over the years, built competent teams of highly specialised scientists and engineers in the reactor engineering programme. He has brought out more than 250 scientific papers and reports on various aspects of his work.

He has received several accolades which includes Padma Vibhushan (2009), Padma Bhushan (1999), Padmashri (1998) and Maharashtra Bhushan (2012). He was DAE Homi Bhabha Chair Professor at BARC during 2010- 2015. Dr. Kakodkar was Chairman, Solar Energy Corporation in its formative stage. He was also Chairman of Inter University Centre for Astronomy and Astrophysics (IUCAA) during 2006 – 2012. Currently he is holding Indian National Academy of Engineers (INAE) Satish Dhawan Chair of Engineering Eminence at BARC and devotes his time primarily on issues related to energy, education and societal development.