

For the country's long-term energy needs

'What are your plans to solve the ever-growing energy problems of this country?', a boy asked me at the 100th Indian Science Congress held at Kolkata during 3–7 January 2013, where we, the Nuclear Power Corporation of India Limited (NPCIL), had set up a gallery. What truly struck me was that the boy had asked me a question that was not thought of by the so-called anti-development lobby in India. 'The moment we say nuclear power, some people get scared for no reason. But from your question I can understand you are not. Am I right?', I asked the boy. He said 'Yes'. And his reply was confident. To test his confidence, I further asked him 'Why?'. He replied, 'Any technology has its own pluses and minuses. And since science is a thing that is always evolving, most of the minuses are converted into pluses. And for me, nuclear technology is no different. I don't have fear and I believe in science.'

How rational his thinking was! Truly commendable! I admired his understanding of the way science works – systematically, progressively and explicably – with no room for unfounded fears or superstitious mind-play. 'I am glad to hear your words and to see your rational approach', my senior colleague and a specialist in reactor safety, Santanu, said as he joined us in our conversation. Santanu continued, 'One more thing I want to share with you is that the Indian nuclear power sector has an impeccable safety record'. The boy said, 'True, I have not heard or read about any nuclear accidents in our country. Also, I have gone through many of your publications related to nuclear power safety and I am totally convinced of the nuclear power safety'. He then added, 'But I am little worried...'. 'Worried... about what?', I asked. '...about the long-term energy security of India', he replied.

Before I gave any answer, I asked him, 'What are your suggestions to this big problem?'. He replied enthusiastically, 'At present, our country depends mainly on thermal power like coal power, and I think we need a good alternative to this, as the energy resources are depleting fast.' The boy was right. In India, about 60% of electricity is produced from thermal power plants, which pose a problem and a challenge. The problem is that these power plants emit gases like carbon

dioxide, sulphur dioxide and nitrous oxide, which contribute much to the global warming, while sulphur dioxide causes acid rain. And there is this challenge of availability of fuel. The coal resources are running out rapidly not just in India, but worldwide. As a matter of fact, India is importing coal from foreign countries to run several of its coal-based power stations. With this scenario, it is highly challenging to meet the ever-growing electricity demands of the country with the thermal power plants alone even at present, leave aside energy security for the future.

A young citizen of the country has worries about the nation, about the energy requirements. These were the worries of young Homi Bhabha, too. But then, Bhabha did not just worry; he contemplated for a solution. And came up with a plan as well. He strongly believed that nuclear power was a viable source of energy that could provide for the electricity needs of the nation on a sustainable basis. In 1950s, Bhabha presented his plan for India at the second United Nations conference on the 'Peaceful Uses of Atomic Energy'. He knew India had limited uranium reserves. Uranium is one of the elements that are used as fuel in nuclear reactors. But, he was also aware of the large thorium reserves of the country, about 30% of the world's reserves. He thought that using thorium as fuel would be the best option for India to meet the huge electricity demand in the coming years. But, the biggest challenge in front of him was that thorium could not be used directly as fuel and there was no such technology existing in the world. So, he meticulously devised a three-stage nuclear power programme for India in order to exploit the abundant thorium available across the country.

Stage 1, comprising pressurized heavy water reactors (PHWRs) can use naturally available uranium (U_{238}) as fuel. It is possible to produce 320 GWe-year using this technology in this stage. At present there are 18 such PHWRs in different parts of India (and two boiling water reactors, or BWRs), with a total installed capacity of 4780 MWe. With natural uranium as fuel, the PHWRs generate energy while producing plutonium as by-product. This plutonium is not considered as waste, but a potential fuel.

Yes, the spent fuel of the PHWRs is the fuel for the second-stage reactors. The fast breeder reactor (FBR), which is now under the advanced stage of construction located at Tamil Nadu, can use plutonium as fuel, with thorium as blanket. This reactor, once commissioned, is designed to breed more fuel than it consumes and will produce U_{233} in addition to electricity. Through this second stage, India can produce up to 42,000 GWe-year.

The key answer for the country's long-term energy needs lies in the third stage of the programme in which the plentiful thorium that exists will be exploited. Upon implementation, it can go up to 155,000 GWe-year, which can manage the huge and growing electricity demand in the country.

The country is pursuing this idea and has mastered the technology for stage 1 and is about to accomplish stage 2. Meanwhile, developmental work for the third stage is underway.

Having listened to this somewhat lengthy lecture keenly the boy said, 'an excellent idea', and after a brief pause he added, 'so, there is some hope for the future generations of this country and we have something for them – the reserves, the technology and the idea to meet the energy requirements'.

I smiled at him.

'Ok, I also have an idea', he said. I looked at him curiously.

He continued, 'The algae-based biofuels called third generation biofuels, on which I am planning to do my research, can play a vital role, particularly in the long run.'

I said, 'Good idea'.

He replied, 'Once I complete my research, I can be in a better position to suggest a plan on the utilization of biofuels. However, for a country like India that has large water bodies and land, the algae-based biofuel would be apt.'

Probably one day he may become a scientist who can devise another innovative plan for the development of the country, like Bhabha did years ago. I wished him all the very best.

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