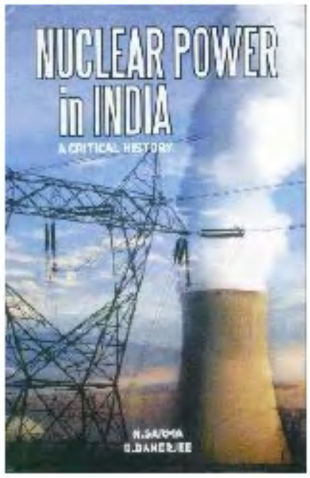

Nuclear Power In India: A Critical History. B. Banerjee and N. Sarma. Rupa & Co, 7/16, Ansari Road, Daryaganj, New Delhi 110 002. 2008. 198 pp. Price: Rs 395.

Much before the world came to know about the potential of nuclear energy through the bombing of Japanese cities in 1945, two Indian scientists with a vision dreamt of utilizing that potential for constructive applications in India's development. Bhabha and Saha had both set up institutes – the former in Mumbai in 1945 and the latter in Kolkata in 1948 – for basic R&D in the field. Bhabha was successful in enlisting the support of the Government in establishing the Atomic Energy Commission (AEC) first and then the Department of Atomic Energy (DAE) for implementing his plan. Saha contested and won the General Election and sat in the opposition. Not satisfied with the pace of work, he prodded the DAE into action. *Apsara*, Asia's first research reactor outside of the Soviet Union, was commissioned in August 1956, two years after the DAE was set up. Saha died six months before that.

Bhabha outlived Saha by about 10 years, but by then had managed to accomplish a great deal. This included the establishment of three research reactors, initiation of construction of two nuclear power stations with acquisition of the site for a third, basic infrastructure for manufacture of fuel for the reactors and for recovery of plutonium from the spent fuel. Besides these, steps were taken to train personnel for undertaking all the above activities. Sarabhai succeeded Bhabha and in the short time he was in charge, took the programme forward by establishing the needed heavy-water plants and launching the fast breeder programme with assistance from France. He came up with a ten-year plan for nuclear power generation. Construction of the third power station had begun.

During Sarabhai's tenure, there were plans for building larger PHWRs similar to those that had recently been commissioned in Canada then and prospects for collaboration with that country were bright. The French were willing to provide enriched uranium fuel for the FBTR that was modelled after one of their reactors. The political decision to carry out a nuclear test in Pokharan in 1974 led to withdrawal of the offer of assistance by France and Canada. Later, indigenous efforts to develop the design of the larger PHWR and fabricate an alternative fuel of a novel type for FBTR took time, but have been very successful. Since 1974, 11 reactors have been built and six more are nearing completion, including a large prototype fast breeder designed without help from outside, proof of progress of indigenous capability. Construction time for the reactors has been brought down to five years or so, and their performance has shown a marked improvement. Design of a reactor with many new safety features to demonstrate the thorium utilization has also been finalized and is being subjected to tests before its construction is undertaken.

Special materials required for building the reactors are now being produced in the country as they cannot be imported, off the shelf, from other countries. Nuclear fuel of different types needed for all of the reactors is being fabricated here. Three plants are operational for the recovery of plutonium from spent fuel and waste from all nuclear installations is being managed safely enough. These are no mean achievements, not highlighted sufficiently well in the book under review.

The programme has also had its fair share of criticism on a few counts. The authors dwell upon some of the well-known aspects. Bhabha's original projections for a rapid increase in nuclear power generation were based on the hope of success in a demonstration then underway in the US, of a reactor system using a mixture of molten salts of thorium, plutonium and uranium. That hope was belied since materials of construction for the system permitted by prevailing technology proved unsuitable. As a result, the plan has been shifted with reliance now primarily on the second phase of plutonium utilization through FBRs, deferring the third phase to be based on thorium by a few decades.

The test of the nuclear device in 1974 also set back the prospect of importing needed heavy water and some major equipment like pumps and instrumentation for the power reactors, till our own plants could commence production. The consequent delays in completing the power projects have been another cause for criticism.

Two other factors have affected realization of the proposed projections for power generation. Inadequate production of uranium from indigenous resources for all the PHWRs has received much press recently and has been cited as one of the reasons for the Government favouring of the civil nuclear cooperation agreement with the US. This has not escaped the authors' attention.

The lack of adequate capacity to recover plutonium from the spent fuel to power the fast breeders is likely to delay the addition of new FBRs beyond the prototype now under construction. This has not received attention in this book.

Non-realization of the proposed targets has given rise to the rather unfounded belief that the main focus of the DAE has been weapon design and production rather than power generation and that more money has been spent in that direction, an allegation that is echoed by the authors.

That the economics of nuclear power does not fare favourably in comparison to coal, is another complaint heard often and mentioned in the book. The authors conclude, however, that nuclear power has a place in India's energy basket, because the country is poorly endowed in energy resources and greater use of coal has adverse implications of climate change. It is a confirmation of the aphorism attributed to Bhabha that says, 'No power is as costly as no power!'. They recommend, and rightly so, greater transparency in safety review of the nuclear installations for the success of the programme. In particular, if one considers the likelihood of the entry of private sector in building and operating nuclear power stations, transparent and rigorous supervision of safety assumes greater importance.

It is always useful to look back from time to time and review past experiences. For, all learning can be said to be derived

from experiences, one's own and of others. Experiences comprise of thoughts and actions. Compilation of the former leads to knowledge and of the latter becomes history. Documentation of the experiences thus facilitates learning.

Documentation unfortunately is not part of the Indian culture. We generally have to read about our history from foreign authors, since few of our compatriots consider it worth their while to document our experiences. In a rare departure, an official history of the DAE came out about 10 years ago. Any new attempt by others in India to document its history should be a welcome addition, as it could provide new insights. The authors of this book have made such an attempt, but have limited themselves mainly to the nuclear power generation part of DAE's activities. Both had served in the DAE, though partaking in work unrelated to power generation. On the strength of their specialization in nuclear physics, they have also held the positions of Visiting Professors in well-known universities in the US and Europe.

Nuclear power is one of those topics that has its ardent supporters as well as vigorous opponents, each disinclined to consider the possibility that there could be after all a basis for the other point of view. This results in glossing over some relevant aspects and does not help in arriving at a proper assessment. This book makes a valiant attempt to strike a balance. But, it attracts our attention only to disappoint.

The main part of this book consists of nine short chapters, with a focus on nuclear power. Twelve appendices are included to provide additional information to the reader. Two of them relate to the nuclear weapons programme, and two more provide a summary of the Atomic Energy Acts of the Government of India. The texts of international agreements entered into by India, including the recent one with the US, form the subject of the last three. The merits and demerits of the agreement with the US and the attendant conditions are described in detail. The authors' conclusion is that the conditions impose no significant constraint and that the agreement would help in increasing the share of nuclear electricity in the country. It remains to be seen as to how quickly and to what extent an increase in nuclear power generation can be achieved, now that the hurdles for international cooperation have been removed.

The authors reveal their unfamiliarity with simple facts of nuclear reactors or nuclear weapons, resulting in misleading statements. They have also been careless with the units for the various parameters listed or their actual values. These matters could easily have been rectified with a bit of effort to verify them for correctness. The authors complain that they were not able to secure access to information direct from the Department's archives. Much of the verification needed could have been achieved even by reference to open sources of good authenticity. There are some hasty judgements as well, apparently arising from a failure to check out their bases. Perhaps, the publisher too must share the blame for some of the blemishes.

A real concern is that much of what the book says is likely to be given undue weightage because of the authors' impressive scientific background and service in the DAE and therefore taken as true, even when it is otherwise.

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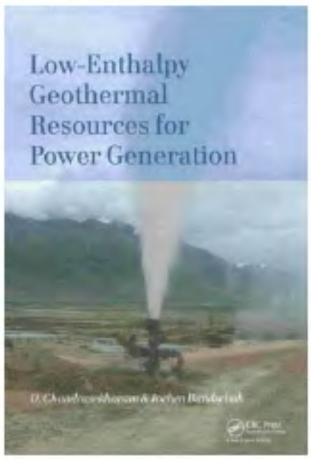

Low-Enthalpy Geothermal Resources For Power Generation. D. Chandrasekharam and Jochen Bundschuh. CRC Press, Balkema, P.O. Box 447, 2300AK Leiden, The Netherlands. 2008. 149 pp. Price not mentioned.

This book is what energy-starved and resource-hunting India needs to distribute among its policy makers, planners and engineers. Not only does this book demonstrate the energy potential of hot-springs world over and in India, but also shows how energy requirements can be successfully supplemented by tapping hot-springs, which have temperature less than 150°C. The forte of the book is the part dealing with modern methodology and techniques of exploring the geothermal resources, and beneficially converting the heat energy of geothermal waters into electricity. This part itself should persuade the planners and executives to opt for this so far little-tried venture.

The book brings out the potentials of low-temperature geothermal resources world over and in India, and suggests ways of overcoming obstacles and difficulties in tapping geothermal energy. It offers solutions for generation of power that would ensure that no greenhouse gases are formed. In other words, tapping the energy of hot-springs on a large-scale implies effective contribution to the lessening of global warming.

While chapters six and seven deal with details of geochemical and geophysical methods of exploration, chapter 8 is devoted to detailed description of electricity from geothermal resources, including resorting to efficient heat-exchangers, mechanisms of submersible pumps, etc. Chapter 9 is about economic implications of power generation by tapping hot-springs. There is a special chapter on the dimension of rural electrification, costs of and marketing for smaller plants, and efforts made in this direction in USA, Tibet, Thailand, Taiwan, Argentina and Iceland.

Preliminary chapters deal with the geological setting of geothermal springs and tectonics of their locations, occurrence in geothermal fields, including two belts in the Himalayan Province, the Konkan coast in west India, and the Tapi–Narmada–Son belt in Central India, and the Sabarmati Graben.

There is a comprehensive atlas of Indian hot-springs and geothermal fields, compiled by Ravi Shankar and published in 1991 by the Geological Survey of India as its special publication (No. 19). The summary of the atlas is available in a number of papers by the same author. There are 340 geothermal areas in five different heat-flow zones that together store heat, which have the potential of generating 10,600 million watts of electricity – equivalent to the energy produced by 5730 million tonnes of coal, or