Nuclear Fission: Humanity Is Missing Out on a Good Opportunity

Dr. Banerjee gave this interview to EIR, at the Aug. 25-29, 2014 Pacific Basin Nuclear Conference in Vancouver, Candada.

Dr. Srikumar Banerjee

EIR: Dr. Banerjee, at the Pacific Basin Nuclear Conference here in Vancouver, B.C. today, you gave the luncheon lecture in honor of Dr. Wilfred Bennett Lewis. You are the Homi Bhabha Chair Professor at the Bhabha Atomic Research Centre in India. In your lecture, you said that these two people—Dr. Homi Bhabha from India and Dr. Wilfred Bennett Lewis from Canada—are the people most responsible for the development of the Heavy Water Pressurized Reactor (HWPR), also known in Canada as the CANDU reactor. Could you tell us something about who these two people were and what they did?

Dr. Srikumar Banerjee: For me, Dr. Bhabha was definitely the main architect of the Indian nuclear program. I mentioned in my lecture that he and Lewis were together at the Cavendish Laboratory. Then Homi Bhabha came back to India, just before the war, and stayed on; although he came for a vacation, he could not go back to Europe. Then he continued his work on physics, and later he got involved in the development of the atomic energy program in the country.

He was a great scientist. He was a good artist. He had a tremendous taste in architecture. And the most important of his contributions was in building great scientific institutions.

At that time, of course, it was just after the Second World War, when Bhabha and Lewis were thinking of the prospect of nuclear energy, primarily nuclear fission energy. Both of them also talked about fusion, but the emphasis was on fission, which was almost realized at that time as a deployable source for electricity generation. Their concern was, how to control the way of doing it on a commercial scale, and getting the energy solution for the world.

Both Lewis and Bhabha put a big emphasis on the issue of sustainability of nuclear energy.

It is not often stressed, but if you are only taking into account the uranium 235 as the fissile isotope, and that's the only fissionable isotope available in nature, then nuclear energy's life will not be very long. With the global increase in demand for energy, uranium-235 will get exhausted very quickly. Of course, I am not taking into account the large uranium reserves in seawater. But extracting uranium from seawater and exploiting that energy is perhaps a bigger challenge than something which is competitive, even with fusion.

But if you take the fertile isotopes into account, uranium 238 and thorium 232, then we have really an inexhaustible form of energy in nuclear fission. Early in this period, both Bhabha and Lewis realized that, and have emphasized this point in their papers.

Nuclear Is Declining in the West

EIR: At the conference today, it was mentioned that there are presently 72 new nuclear reactors under construction in the world today. However, it is notable that almost two thirds of these new reactors are being built in just a handful of countries, namely, the BRICS (Brazil, Russia, India, China, and South Africa) and Argentina.

Do you have any thoughts on why one part of the world would be undergoing this kind of development, which largely does not exist in the rest of the world?

Banerjee: You see, it is due to the development aspiration in a large part of the world. In places like Canada, the United States, and Western Europe, energy demand is not growing! And it will not grow in the foreseeable future. The reason is the population in these places has stabilized and in some cases is slightly declining. Per capita energy consumption has reached a level of saturation; machinery and buildings are becoming much more energy efficient. I am often asked this question: When Germany is gradually reducing the contribution of nuclear energy and finally has a plan to abandon it, why in India are we talking of expansion in the nuclear contribution?

The point is, one cannot compare the situations in Germany and India. If you look at the German situation for the last ten years, if I am not incorrect, there is a decline in the total electricity demand in Germany, whereas in India, total electricity consumption has more than doubled during this period.

Germany also has the option of imports of a lot of energy, from France, from the Czech Republic—they are nuclear. So one can manage the total supply; particularly, supplying the base load.

Solar and wind energy have a very important role to play and nobody should neglect them. They have to be exploited to the fullest extent. But the point is, even if you exploit them to the fullest extent, you cannot meet the base load requirement in countries where the growth in demand for energy is phenomenal.

In India, in the last six to seven years, total energy production has doubled. Even now there is a big scarcity. I just showed in my presentation, that from today to 2032, another 18 years, the total electricity production has to increase four times to sustain an economic growth of 8-9%. But if all the additional capacity is built on the basis of thermal power, we will be generating 3 to 4 billion tons more of CO_2 annually. A major part of the coal needs to be imported, as Indian coal has about 40% ash. We must, therefore, increase the share of primary energy sources, namely, solar, wind, and nuclear, substantially, though thermal power will continue to dominate in the immediate future.

In China today, of the total electricity, only 2.1% is nuclear. But the expansion programs in nuclear, solar, and wind are quite impressive.

EIR: China is now building 27 new nuclear reactors, which sounds like a lot. But, if you ask how many new nuclear plants they are building per capita; that drops it dramatically.

Banerjee: Yes. And then you have to see how much nuclear is going to contribute. Even for China: They will still be depending on coal burning to a substantial extent. India also cannot avoid it.

EIR: Something like 79% of China's electricity production comes from coal.

Banerjee: Growth in electricity consumption cannot be slowed down. It is the most essential ingredient for development. It is not in the domain of luxury. Consumption is 700 kilowatt-hours per capita in India, which is one-fourth of the world average. This is what is available for everything. Electricity is needed for transportation, education, health care, agriculture, and industry, and each of these sectors is growing rapidly. Such growth scenarios are not there in countries where these basic needs have been grossly met.

As far as other forms of primary energy are concerned, India is rapidly expanding the installed capacity in wind and solar. But one cannot exceed the capacity factor beyond 25%. The Sun does not shine all the time. Neither does the wind blow. What is the implication of that? Say you need 100 megawatts. But, if the capacity factor is 25%, you have to install 400 MW and also have suitable means of storage.

EIR: At the conference today, the share of nuclear power in electricity generation by 2030 was actually projected to go down, which is an alarming trend. If there were a significant increase in demand for new nuclear plants, would there be enough capacity to build them?

Banerjee: The big damage which has been done worldwide is to the supply chain. The manufacturing places are now extremely few, for example, for the light water reactors, which are, I would say, the fastest to construct.

EIR: The pressure vessels.

Banerjee: Pressure vessel manufacturing is now available only in a limited number of countries—Japan, Korea, China, and Russia. India still doesn't have it, but we have a plan to enter into that. Steelmaking in India is reasonably good; also, the forging and making the large welded vessels of specialty steels. These technologies are available. A joint venture company is set up which can take up manufacturing of nuclear pressure vessels, and Indian industries have the capability of making many critical components of nuclear reactors.


IAEA

"It is very easy to debate on this in the comfort of an air conditioned room," said Dr. Banerjee. "But if you have a really cold Winter in Europe or America, then you realize the importance of power." Shown: the Kalpakkam prototype fast breeder reactor in Tamil Nadu, India.

Right now the limited manufacturing capability is an impediment in the rapid growth of nuclear power in the world.

Fourth-Generation Reactors

EIR: Do you see a role for fourth-generation nuclear reactor technologies, for example, the molten salt thorium reactor?

Banerjee: Enhanced safety, better utilization of fissile and fertile materials, and reduction of radioactive waste burden, are the major incentives for the development of fourth-generation reactors. The molten salt reactor is very important because it addresses all these points. It is inherently safe, as the molten salt core can be dumped through some passive frozen valves in a few safe storage units in case of any temperature rise beyond a safe limit. The reactivity in terms of fissile content in the core can be precisely adjusted with on-line introduction of fuel and removal of poison. The reactor operates at near ambient pressure and there is no issue of high-pressure containment structure. It has on-line reprocessing facility and, therefore, facilitates conversion of fertile to fissile and incineration of long lived radioactive waste. Finally, it can use thorium, which gets converted into fissile uranium-233 and can operate with a rather small addition of extra fissile material. But the molten salt reactor requires reprocessing. If you are not doing reprocessing on-line, then the molten salt reactor is no great fun.

We have just started work on the molten salt reactor. But in the initial phase of thorium utilization, India has made quite a bit of progress, as we have irradiated thoria fuel in PHWRs, studied their performance, and also studied reprocessing of the spent fuel. The design of the advanced heavy water reactor, to which I devoted some time in my lecture, is essentially a technology demonstrator in which about two thirds of the energy output will be from thorium. This, however, will be in solid oxide fuel.

Fusion and Helium-3

EIR: Perhaps you could also say something about the role of thermonuclear fusion in the longer term, particularly given China's recent lunar landing and their interest in setting up the space infrastructure to mine the lunar surface for helium-3, an ideal fusion fuel.

Banerjee: It is very important. India is also a partner on ITER [the International Thermonuclear Experimental Reactor], as China is. So we are working as a community of nations towards fusion. I fully support that as a scientific endeavor. But, as an energy solution, that is still way ahead of us. And while you are talking of fusion, you must also see, where will the fuel come from? In fact where do we get tritium from, for first-generation deuterium-tritium fusion?

If you look at the PHWR, it is a good source of tritium. If you use deuterium, when it is neutron irradiated, it becomes tritium. We always say that there is plenty of fuel available in seawater. Deuterium is only a tiny portion of seawater. But you can collect it, like we are doing.

India is the largest producer of deuterium today in the form of deuterium oxide [heavy water]. Now deuterium alone is not enough; you need tritium. And tritium production, again, requires neutrons. So neutron is a very important resource, as I emphasized in my lecture.

EIR: I was just thinking about the role of China, Russia, and India, which you have just mentioned. There are common themes which we have seen in the investigation into molten salt thorium reactors, into breeder reactors, into fusion. What ways do you see the collaboration of these countries and other countries with India into the future?

Banerjee: It is happening. One is a scientist-to-scientist interaction, and doing something for curiosity satisfaction. But once it becomes a major effort, the resources are to be shared, and things like that, then it means an interaction on a much higher plane, a government-to-government level. Fortunately, with ITER, this has happened. There are seven members in ITER. It has a big price tag. We know that India is not a rich country. But, I think we give fusion its due importance. That's why, in spite of that, India is providing the finance which is required, towards the development of fusion power.

With fusion power, when they ask, "Can you give us a time when it will tie your city to the grid?" I think if somebody gives an answer, it will be premature.

In my opinion, in the energy debate we are definitely neglecting something that is technologically proven, environmentally benign, commercially attractive, and has a very good overall safety record. That is fission energy, which may need a little bit of tweaking, I would say. With that you can make the molten salt reactor and the breeder reactor, and make them successful and commercially operative.

But I think that some doubts come in terms of fear. Fear of radiation or fear of accidents. This is why I think that humanity as a whole is perhaps missing out on a good opportunity. Fifty years ago these fears were not there and we could go forward to make energy available in plenty in many countries.

EIR: Well certainly we need a society that is much more educated in real science if this is going to advance properly.

Banerjee: Yes. See, it is very easy to debate on this in the comfort of an air-conditioned room. But if you have a really cold Winter in Europe or America, then you realize the importance of power.