Proceedings of the China-India-US Workshop on Science, Technology and Innovation Policy

Section IV
Session II – Power Generation by Coal

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Remarks by the chair

Prof. Arcot Ramachandran

Ladies and gentlemen, let me at the outset welcome you all to this trilateral dialogue between China, India and the US on Science and Technology for Innovation.

Last evening, we had an excellent inaugural session. It was quite exciting. Quite a lot of things were said and I understand that all of you would have been stimulated by the discussions yesterday.

There are two observations I wanted to make before I start my short address. I missed one word yesterday in the talk on Science, Technology and Innovation. That was (being an engineer) "design". Design is a key to innovation. And I think it should be repeatedly said, because in most of our engineering colleges or institutions, design is nowadays neglected. Everybody wants to do Information Technology, ICT, etc. Engineering is the pursuit of the possible – always necessary, seldom perfect. Therefore, innovation should be a continuing thing if anybody wants to practice engineering. And that must be impressed on our students in our universities, whether it is in China, India or the US.

The other thing that I wanted to mention before I start my address is that some of you may have seen the latest issue of *The Economist*. The Future of Energy is an article. I don't know how many of you had the opportunity to see it. I will read only the last sentence, because I was surprised when coal was introduced as the first topic of today's Science and Technology for Innovation. The last sentence of that article says, 'It will be a long time before King Coal and Queen Oil are dethroned completely. But the reigns, as absolute monarchs, of all they survey, are coming slowly to an end.' I think, as far as King Coal is concerned, this is a premature indictment. Queen Oil is probably heading towards that end, because the price of oil is now $ 146 a barrel and everybody says it will be $ 200 before the end of the year.

But King Coal reigns supreme because in all the three countries – India, United States and China – coal is plentifully available indigenously and will easily last for more than a hundred years according to all estimates, and probably more. It is only in recent times that coal is coming into the picture, especially after the IPCC report on global warming and climate change because of the effect of greenhouse gases. But we have to develop technologies that will ensure that coal can be utilized at least for power generation. For transport, that is another problem. We are not discussing it this morning.

The world's population consumes 15 tera-watts of power today. And it is estimated that it will reach 30 tera-watts by 2050. The per-capita consumption of electricity in the United States of America is about 15,000 units, that of China 2000, and that of India, around 550 at the present time. The Integrated Energy Policy document of the Planning Commission of the Government of India, assuming a GDP growth rate of 8 per cent, has indicated that India will need to have an installed capacity of about 7,50,000 megawatts by 2031, whereas our present capacity is only about 1,50,000 megawatts. This means that India

will have to install 25,000 megawatts of power plant equipment each year in the next 25 years.

What then will be the energy mix that India can do to have a sustainable energy system? Coal, oil, nuclear, renewables – all of them will play a part. No one will displace the other completely. Historically speaking, over the last 200 years – as I indicated in a seminar last week when they were talking about underground coal gasification – that coal, oil, gas, hydro and nuclear power have all come at intervals of fifty years, and none of them has displaced an early one but only supplemented them. This historical trend will continue in the foreseeable future, at least during this century.

In all countries, oil is no longer cheap, and there is a growing concern that oil supplies may peak soon. Some say it has already peaked in 2006 and that new resources will become harder to find. Nuclear energy for power is now receiving favourable attention in the context of global warming and climate change, because it is completely devoid of CO_2. However, no new nuclear power station has been built in the United States for the last 30 years. Nuclear power stations have been built in China, Korea, Japan, etc. and India to some extent. The problem here is the lack of available natural uranium to increase our capacity. However, in Europe, public acceptance for nuclear power is necessary so as to realize its share in the total energy mix, with the exception of France, which has over 70 per cent of its electricity generated by nuclear power.

Coal is the most abundant fossil fuel that nature has provided to China, India and the United States. In India, the proven resources of coal are about 80 billion tonnes and reserves amount to about 300 billion tonnes, including 30 billion tonnes of lignite. It is expected to last a hundred years or more, even considering the increased consumption rate in the coming years. Coal will continue to remain a major energy source for power generation. In all countries with significant use of coal, attention is increasingly turning towards clean coal technologies. R&D efforts in this direction for clean coal technologies are not proceeding at the rate at which they should. But possibly, it is receiving increasing attention in the last few years.

A variety of clean coal technologies are at various stages of development and deployment. In the short term, the options as all of you are aware, are pulverized coal-firing plants with flue-gas desulphurization, oxides of nitrogen and particulate emission control. Atmospheric fluidized-bed combustion and circulating fluidized-bed combustion plants are already in operation in some countries and even in India.

The successful experience with super-critical power PC plants with efficiency of 45-48 percent at steam temperatures of 600º Centigrade and above indicate the trend that countries need to pursue. R&D is under way to reach the target steam temperatures of 700º Centigrade and a net efficiency between 52 and 55 per cent. We must encourage the utility industries to keep up with this new international trend of higher efficiency, because in my own country, the efficiency of our power plants varies between 31 and 38 per cent.

What are the technologies for the longer term – maybe beyond ten years? The next generation technologies include coal gasification and combustion of the synthesis gas and the combined cycle (IGCC), pressurized fluid bed in combined cycle, direct and indirect coal-fired turbines, fuel and pure oxygen gas turbines, and carboniferous fuel cells. IGCC plants are already in operation in Spain, the Netherlands and the United States. It is only just a few weeks ago that I read that an IGCC plant of 125 megawatt electrical capacity has been planned, and work has started on it, in India – in Andhra Pradesh.

India's clean coal technology options are best served by certain development efforts across a range of technologies involving AFBC, CFBC and IGCC to meet our short-term, medium-term and long-term goals. Coal, as far as India is concerned, will be an important power-generation source this century.

Key aspects of other advanced technologies that might play a role in the longer term are underground coal gasification, in-situ coal-bed methane, coal to liquid and carbon sequestration technologies. Capture and storage of CO_2 will be likely to increase the cost by $10-30 per megawatt hour to the cost of generating electricity and reducing emissions from a power plant by 80-90 per cent. Unfortunately, we do not have the technology for capturing CO_2 and sequestration for power plants. We have technologies for smaller process plants which are in operation in many countries.

Worldwide investment in energy R&D is considered to be totally inadequate. I am speaking particularly of coal. Despite declining investments in energy R&D during periods of soft oil option prices, more recently, industrialized countries are going after next generation technologies through government support and incentives for industry. The European Union has recently announced and approved € 6 billion for supporting the development of clean energy technologies. The US Energy Policy Act of 2005 indicates an allotment of $ 25 billion over the next three years for energy research. As far as my own country is concerned, government support for energy R&D is not commensurate with the magnitude of the task involved in moving into the next-generation technologies.

It is imperative in our country to have a mission – a national coal power mission – to be established involving government, utilities, manufacturing organizations like BHEL, Thermax, L&T and others, and research institutions for a time-bound goal-oriented program to develop next-generation technologies to utilize our high-ash coals in a sustainable way. I mention this because in our country, energy is spread over five ministries and there is still lack of total coordination of what is happening. Each ministry thinks its energy resource is the best to serve the country. We have a Ministry of Oil, we have a Ministry of Coal, we have a Ministry of Power, we have a Ministry of New and Renewable Energy and a Ministry dealing with Atomic Energy.

Finally, just as we think about global cooperation in various fields, especially in monetary policy, trade, trans-boundary health issues, also concerned with food security, it is imperative that we cooperate in technology development to meet the challenges of global warming and climate change which threaten our planet. We cannot leave it to the marketplace for developing the technologies in this case. And I believe, to save our planet

and our future generations, it is imperative that we proceed in the direction of international cooperation in technology development for CO2 capture, transport and sequestration. There are many questions raised about storing it underground. But the geological features have to be known.

Prof. Jeffrey Sachs of Columbia University spoke in New Delhi at the Delhi Sustainable Summit organized by TERI in January this year. He wrote in a recent article, and I quote, "all this will require a new global approach to problem-solving. We will need to embrace global goals and thus establish scientific, engineering and political processes to support that achievement. We will have to give new budgetary incentives to promote demonstration projects and to support technology transfer, particularly to the poorer developing countries." He continues, and I quote, 'Rich countries should fund these efforts heavily and they should be carried out on collaboration with poor countries and the private sector. Successful technological breakthroughs can provide strong benefits for humanity. This will be an exciting time for scientists and engineers facing the challenges of sustainable development.'

I have great pleasure in now requesting our colleagues from the United States, India and China to make their presentations. The first presentation will be made by Prof. Wang Yi. Thank you.