ENERGY TECHNOLOGIES AND ENERGY SECURITY IN INDIA

R. CHIDAMBARAM

It is a privilege to give the 10th Bharat Ratna Rajiv Gandhi Memorial Lecture. A symbol of youthful India, Rajiv Gandhi was and continues to be the youngest Prime Minister in Indian history. He not only catalyzed the introduction of computer technology in everyday life but also supported the development of other technologies – ranging from nuclear to rural. One of my definitions of a 'developed India' is an India where the quality of life in rural India becomes comparable to the quality of life in the non-urban areas of already developed countries. That is why I appreciate this initiative of Dr. Sundar Ram and his colleagues in setting up the "Academy of Grassroots Studies and Research of India". Inclusive national development demands sustainable rural development.

Sustainable Development has been defined by the Brundtland Commission (1997) as Development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Developing countries also want equity along with sustainable development. Energy Security for all countries is an essential component for such development.

The millennium Development Goals like Eradication of Extreme Poverty and Hunger, promotion of Gender Equality and empowering women, reduction of Child Mortality rate etc. can be compressed into a single goal of improvement in the Human Development Index (HDI). I have been saying for more than two decades that, in my opinion, HDI can be redefined in terms of twoparameters: Per Capita Electricity Consumption (PCEC)and Female Literacy. I prefer "Female Literacy" to "Adult Literacy" used by UN as one of three parameters to define HDI because the former (Female Literacy) is a measure not only of literacy but also of equity and justice in that society. It can be shown that the two other parameters used by UN to define HDI, viz. Per Capita GDP and Life Expectancy at Birth, for a developing country like India, can be replaced by just one parameter PCEC.

India can become a "developed country" only if it becomes near 100% literate,without gender discrimination, and its per capita electricity consumption goes up by 6 to 8 times. Also energy security demands that this increased level of per capita electricity consumption should besustained. The sources for energy security for India are fossil fuels, particularly coal; renewable sources (hydro, solar, wind etc.) ; and nuclear. There are future possibilities for helping in achieving energy security like bio-fuels, shale gas and nuclear fusion.

■ *Text of the* ***Tenth Bharat Ratna Rajiv Gandhi Memorial Lecture****, delivered by* ***Dr R. Chidambaram****,* Principal Scientific Advisor to Govt. of India, New Delhi, held on 29 February, 2012 at Hotel Bliss (Darbar Hall), Tirupati, under the aegis of Academy of Grassroots Studies and Research of India (AGRASRI), in Collaboration with Rajiv Rural Development Foundation (RRDF), Tirupati, Andhra Pradesh.

Energy Security has to be assessed in the context of the Climate Change Threat, to mitigate which the CO_2 omissions from fossil-fuelled (essentially coal-based as far as India is concerned) energy-producing systems have to be minimized. The higher the temperature of the steam that you produce, the lower is the production of CO_2 per MW. That is why we are starting an R&D programme for the design of an Advanced Ultra Supercritical coal-based thermal plant as part of an additional 9th Mission on 'Clean (or relatively cleaner) Coal Technologies' to the eight Missions in the National Action Plan on Climate Change, released by the Prime Minister in 2008. Since we shall be producing steam at 700□C, we need advanced materials development and testing (expertise for this exists in the Indira Gandhi Centre for Atomic Research: IGCAR), corresponding power engineering equipment has to be manufactured (capability for this exists in BHEL) and the 800 MWe Advanced Ultra Super Critical Prototype plant will be built by NTPC. A tripartite MoU has been signed by IGCAR, BHEL and NTPC for this project. A preliminary R&D project leading to this is being funded and coordinated by my Office.

The Renewables are very important for India. We need both large hydroelectric projects and mini and micro hydel plants. The displacement of people and working out compensation packages for them delays large hydro projects in India. Solar power for a developing country like India is very important, both photovoltaic and thermal. But unit energy costs are presentlyrelatively high(except for remote communities) and solar power has, therefore, to be subsidized, though there is great optimism among scientists that the costs will come down. Also the sun is not available 24x7. The capacity factors of wind power plants are low,though they are also very important. There is no question that renewables will play an essential role in a low carbon energy economy. Prof. S.P. Sukhatme, former Director, IIT Bombay, has recently calculated that renewables alone will, in any case, not suffice for meeting India's energy needs.

It is in this context that nuclear power becomes an important (in fact an inevitable) energy option for India. In a 2008 report on "Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond" prepared by an Independent Commission (I was a member of this Commission) at the request of the Director-General, International Atomic Energy Agency, the Commission said: "Expanded use of nuclear technologies offers immense potential to meet important development needs. In fact, to satisfy energy demands and to mitigate the threat of climate change – two of the 21st century's greatest challenges – there are major opportunities for expansion of nuclear energy in those countries that choose to have it". Lessons have been learnt from the recent Fukushima accident in Japan, particularly on the continued functioning of post-shutdown cooling systems after even remotely possible extreme natural events. Such safety reviews have been carried out in all leading nuclear countries in the world including India. But the above conclusion on the importance of the nuclear energy option remains unchanged.

This is particularly true of large energy-stressed countries like India and China. An already-developed country like Germany, which is near the top of the Human Development Index curve, can afford to ignore nuclear energy inputs (in the short term). Actually, in the IAEA General

Conference held on Vienna in September 2011, most of the countries have reiterated their support for Nuclear Power. For example, United Kingdome gave a list of eight potential sites for building new reactors. Eighty percent of all electricity in France comes from more than fifty nuclear power plants and they are strongly pursuing this technology.USA has nearly a hundred operating reactors. And they are not talking of shutting them down. The Chinese representative at the IAEA General Conference in September, 2011 quoted an old Chinese proverb after referring to Fukushima: "Should not stop eating for fear of choking!". You should only take precautions to avoid choking!.

India has an excellent track record in safety in more than four decades of operating nuclear reactors. Safety is in design and in operation; safety has to be ensured through regulation. But, most importantly, safety is assured through a safety culture, which exists in ample measure in the Department of Atomic Energy. The first person Homi Bhabha invited to join BARC was not the physicist Raja Ramanna, the metallurgist Brahm Prakash or the engineer Homi Sethna,but Dr. A.R. Gopal Ayengar, a biologist – this was because Bhabha was aware of the need for radiation safety. When I used to meet Julio Gonzales one or two decades back, the Argentenian scientist, who was a member/chairman of many committees dealing with radiation protection guidelines, he often said Dr. A.K. Ganguly of BARC was his Guru! Safety – including Radiation Safety – has always been a priority of DAE and, in fact, is the foundation for the safety culture of DAE and its excellent safety record.

For people in the neighbourhood of a nuclear power plant (existing or planned), the above facts and the benefit of nuclear energy – directly as power and as spin-offs in medicine, agriculture, hydrology, industry, etc. – must be conveyed through increased 'Neighbourhood Public Awareness Programmes."

To put things in perspective, the 900+MW that Tamil Nadu will get from the two Kudankulam VVER 1000 reactors (which have advanced safety features and are safe by a large margin against any conceivable tsunami event) is the power that is currently supplied to more than four million people in Tamil Nadu! From any energy producing system, a part goes to small towns and villages, which, therefore, get better drinking water, better sanitation, better primary health care, all of which have a positive impact on health parameters including the ultimate health parameter, life expectancy at birth, and therefore, on the Human Development Index. There is little doubt that sustained nuclear power growth is necessary for both rapid national development and rapid rural development in India. We have already seen that the local economy in the regions around our nuclear plants begins to flourish even during the execution of a nuclear power project and, of course, after its execution. And our reactors are located in rural areas.

There are many initiatives for rural development by the Government, voluntary organisations and the corporate sector. I must tell you something about the RuTAG initiative from my office.

- ❖ Research – Development – Delivery (Industrial Development Vs Rural Development)
- ❖ Problem in rural development is one of Technology Delivery
- ❖ RuTAG centres are now in Seven IITs
- ❖ Voluntary organisations like HESCO and Gandhigram
- ❖ Isotope Hyd (Utt) – Gravity Ropavay (Utt) – Vegetable Dyes (T.N.)
- ❖ Research and Innovation
- ❖ Concept Transfer and Re-Innovation for rural development.

To summarise, India's technology needs – as we more rapidly to the status of a developed country - range from nuclear to rural.

Padma Vibhushan Dr. R. Chidambaram, Principal Scientific Adviser to Govt. of India, delivering the ***Tenth Bharat Ratna Rajiv Gandhi Memorial Lecture*** on 29 February, 2012 at Hotel Bliss (Darbar Hall), Tirupati, Andhra Pradesh, under the aegis of AGRASRI.