

## ENVIRONMENT, NUCLEAR ENERGY AND PUBLIC PERCEPTION

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The famous Indian nuclear scientist, Dr. Homi Bhabha, coined the expression "no energy is more expensive than no energy". He meant that nothing is grimmer than living without any other energy than that of your own body. For a good life we need energy for cooking, heating, transportation, industrial production, communication, home appliances ...

We take our cars, elevators, dish-washers, central heating and computers for granted in the industrialized societies. When we need power, we just plug in. Our energy and especially electricity consumption is big. The US uses some 13,500 kWh per person and year; my own country, Sweden, some 15000. But at the other end of the spectrum we have countries like Chad and Tanzania with less than 100 kWh per person and year. Nothing is more certain - and reasonable - than that countries at the lower end will seek to improve the lives of their people by increasing their energy and electricity consumption.

China - with over a billion inhabitants - is planning to increase her electricity generating capacity by around 16 GW/year - or sixteen 1000 MW power plants. Most of this capacity may be coal-fired. Presently China has three nuclear power plants in operation and six more in the pipeline. India is planning to increase her electricity generation by some 200 GW by the year 2020 - i.e. 200 large power plants - again, it may be mostly coal fired. Considering the substantial increase in CO<sub>2</sub> emissions such electricity expansion programmes would cause, we would have reasons to wish good progress in the nuclear programmes of these countries. Solar cells or windmills are not likely to be alternatives to the coal-fired plants.

If the wish for a better life is one factor driving increased energy demand, population increase is the other. It has been calculated that at the time of Christ there were some 350 million people on the earth; by the year 1900

there were 1.5 billion; in 1990 we were 5 billion and we expect to be 6 billion by the year 2000. Thus in the last ten years of this century we are increasing almost as much as we did during the first 1900 years after Christ. Although there has been a significant slow down in the last decades, one must ask whether this is a "sustainable development" pattern. Where are we moving? To "standing room" only?

At this juncture, when fast developing countries are getting into gear to increase their energy use, we are discovering that, unfortunately, the largely fossil-fuelled energy fiesta which we have enjoyed so much in the industrialized world cannot continue. While the Rio Conference on Environment and Development in 1992 recognized that energy is essential to economic development, it declared that "the current global pattern of energy supply and use is not sustainable. Environmentally

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sound energy approaches are necessary to control atmospheric emissions of greenhouse and other gases and substances". Which are these "environmentally sound energy approaches"? The Rio Conference did not say, except that it expressly endorsed energy saving and modern renewable sources, like solar and wind power and biomass. Since Rio the dangers of our present global pattern of energy use seem to be on ever firmer scientific ground, but agreement on responses does not seem to be any closer.

I do remember that Groucho Marx once said: "Why should we do something for future generations? They never did anything for us ...". Well, he meant to be funny - as indeed he was. At any rate we do not want to damage life conditions for future generations.

There is no great mystery about the environmental threats coming from our increased energy use. While large hydro dams often cause opposition on the ground that they take away large areas of land from local populations, the major concerns are with the expanding use of coal, oil and gas. Thirty years ago the concerns related to acid rains, dying forests and lakes due to emissions of SO<sub>2</sub> and NO<sub>x</sub>. These emissions, as we know, can be removed or reduced - at a price - but in large areas of the world are not.

Today's chief concern is related to CO<sub>2</sub> emissions which along with other so-called "greenhouse gases", such as methane leaking from gas fields and pipelines, are believed to contribute to "global warming". There does not appear to be any viable technique in sight to remove or neutralize the CO<sub>2</sub> which is formed in the burning of all fossil fuels.

It is curious that in this situation we do not have much of a discussion between governments about energy policies. To be sure, what energy mix we rely on is decided inside States, not between them. And the mix varies considerably. In Norway, which uses more electricity per person than any other country in the world, practically all the electric power, so far, has come from abundant hydro power. In Poland, as in Australia, rich in coal, most electricity is generated by the burning of that coal. In my country, Sweden, about half the electricity

has been coming from hydro and the other half from nuclear power. Etc.

Of course the choice of national energy mix has an effect on the aggregate global energy mix and the global emissions of greenhouse gases, in particular C-. But at present these national energy mixes are left out of the intergovernmental discussions. Instead governments have chosen to discuss targets for restraint in greenhouse gas emissions, leaving it to themselves to decide on energy and tax policies which could lead to fulfilment of the targets. As often as these targets have been proclaimed, they seem to have had little effect:

- In 1988, the so-called Toronto target wanted to "reduce CO<sub>2</sub> emissions by approximately 20% by the year 2005". However, since that target was adopted in 1988, the global CO<sub>2</sub> emissions have, in fact, increased by some 16%;
- In 1992 there was the Rio target for industrialized countries to return to 1990 levels of CO<sub>2</sub> emissions by 2000. However, since that target was set, CO<sub>2</sub> emissions in OECD countries have, instead, increased by some 8%;
- This year, at the special session of the UN General Assembly, a 15% reduction of greenhouse gases by 2010 compared to the year 1990 was urged. There is at present much discussion about this target and somewhat more modest targets proposed by Japan and the US. However, it should not go unnoticed that a study by the International Energy Agency (OECD) projects global CO<sub>2</sub> emissions in 2010 to be 36 to 50% above their 1990 levels, with OECD emissions also higher than in 1990.

It is against this background that the Kyoto Conference on the Climate Convention will take place in a few weeks time and that G-8 Energy Ministers will meet in Moscow next year. As if the difficulty were not great enough to consider greenhouse gas restraints, in the OECD

group, there is now a growing risk of a North/South confrontation.

Simplified a bit, the arguments could go a little like this. Industrialized countries might say to the developing countries:

"We are sorry - without knowing the risks we have already put far too much greenhouse gas into the earth's atmosphere in our quest for decent standards of living. We will try to restrain ourselves a bit - especially by energy efficiency and taking advantage of the available gas, which releases half as much CO<sub>2</sub> per energy unit as does coal. But for heavens sake, now that we all begin to understand how dangerous these excessive emissions may be, don't you race ahead with a vastly increased burning of fossil fuels, especially coal. We only have one atmosphere. If you race ahead, you put us all in jeopardy - including yourselves. Indeed, we might not make any commitments at all unless you do it, too ..."

Developing countries, especially the fast developing populous ones, in Asia might reply:

"Are not all human beings equal? Do we not have the right to raise the standard of living for all our people by using more energy as you have done? If the earth's atmosphere has a limited capacity to absorb greenhouse gases without risk to the global climate, let us share it equally - equal emissions per person!"

It will certainly not be easy to reach some meaningful agreement. Meanwhile the already excessive greenhouse gas emissions increase further. It seems to me that at some point this dilemma must lead to serious discussions at the governmental level about energy sources and their relations to greenhouse gas emissions. And perhaps to a greater awareness that nuclear power could provide increasing amounts of base load electricity without adding greenhouse gases. At the General Conference of the IAEA in

October some government representatives did, indeed, acknowledge this. To take some examples, the representative of Japan said (29 Sept. 1991):

"... In our view, nuclear power will play an important role in responding to the question of global warming. Provided that safety is ensured, we look to nuclear power as a realistic energy option as it excels in supply stability and offers low environmental impact free from greenhouse gas emissions".

The representative of the United States, Secretary of Energy Federico Peña, said (29 Sept. 1997):

"It is essential that we remain capable of ensuring the safety of our nuclear reactors. With populations and standards of living increasing around the globe, nuclear energy could play a potentially significant role - helping the world meet an ever increasing demand for energy while also helping to reduce emissions of greenhouse gases".

The representative of Canada said (1. Oct. 1997):

"Nuclear energy is a safe, environmentally sound and cost-effective source of energy. Canada is a firm supporter of the nuclear energy option which is an important component of a sustainable energy supply mix for many countries. Among its many advantages, nuclear power significantly reduces emission of greenhouse gases and other noxious gases that otherwise would have been emitted to the detriment of the environment and or human health".

These statements are supported by solid data. We have calculated in the IAEA that if the present some 440 nuclear power reactors in the world were closed and replaced by fossil-fuelled plants, there

would be an 8% increase in global CO<sub>2</sub> emissions from energy.

I could also cite the Executive Director of the International Energy Agency of the OECD, Mr. Priddle, who noted that "nuclear power accounted for the greatest part of the lowering of carbon intensity of the energy economies of the OECD countries over the last 25 years".

Such data and comments were conspicuously absent at the special session of the UN General Assembly on sustainable development in June. As far as I have been able to see, I was, myself, the only speaker to suggest that the nuclear power option could be important to help restrain greenhouse gases. Government speakers were silent on the matter. A representative of Greenpeace did, however, pronounce himself. He called for, I quote: "the beginning of the phase out of fossil fuels and their replacement by clean renewable energy which exists in abundance". He added, "nuclear is not an alternative ...".

Let us remember that fossil fuels constitute 85% of the world's commercial energy, nuclear power about 6% and renewables less than 2% - most of it geothermal. Yet, many of the governments, like Greenpeace, seem to suggest in the UN - but not in the IAEA - that salvation lies in the non-hydro commercial renewables and in energy efficiency. With what conviction, I wonder ...

Let me first discuss the hopes pinned on solar and wind power and biomass. There is a good deal of support for these sources by governments around the world and there would certainly be a lot of money to make in technical breakthroughs making these sources economically competitive. It is surely not lack of resources for research and development that is the reason why these energy sources do not constitute even 2% of the world's energy. It seems more likely that their low energy density makes it hard for them to become competitive with fossil fuels or nuclear power for electricity production.

It is not suggested that it would be technically impossible to develop huge wind farms, vast biomass plantations or fields of solar cells. Some both electric and non-

electric niche applications have been found. For instance, solar energy is put to good use for the heating of household water and photovoltaic cells are used for electricity generation in distant places where it would be difficult or costly to build power lines. However, it is hard to imagine that these sources of energy could become economically viable for large-scale base load electricity generation. The reason is that harvesting energy sources that have low density is expensive. Achieving the electricity generating capacity of a 1000 MW(e) power plant by these sources requires cumbersome installations and operations:

- an area in the range of 25 to 50 km<sup>2</sup> of solar cells;
- 50 to 150 km<sup>2</sup> for windmills; or
- 3000-5000 km<sup>2</sup> of biomass plantations.

In spite of the progress made, investments remain high for solar cells and windmills and the intermittent character of solar and wind energy is a severe handicap so long as we do not have better means of storing electricity. It is hard to imagine the megacities - like Mexico City, Beijing, Jakarta or Calcutta - relying on intermittent and low energy density renewables.

Increasing energy efficiency - and thereby restraining CO<sub>2</sub> emissions - is another matter. It can be done from the stage of fuel extraction, through energy generation and to the end use. No one is opposed to it, but it does not happen overnight, but in the context of new investments. It will not, however, by any means neutralize the increasing demand for energy. The Chinese now use about 1000 kWh per person and year. We cannot expect them to try to attain Japanese standards of electricity services simply by increasing efficiency.

I am convinced that in the desperate search for ways of expanding the global energy supply without adding to the risk of global warming, governments will sooner or later rediscover nuclear power. I recall a story I once heard about a group of scientists on a boat somewhere in the

Pacific. They had lost their navigational tools and in desperation they asked an islander helping hand on board in what direction he thought Bora Bora lay. The man unhesitatingly pointed in one direction and after 30 hours steaming on the basis of this advice they sighted Bora Bora. They asked him how he knew that Bora Bora was there. He answered: "Bora Bora always was there ..." Those of us who have some familiarity with the nuclear island are also tempted to tell fellow passengers who seem at a loss to know in what direction they should go, that the nuclear island is there within reach all the time. ...

When will this advice be listened to? I don't know. I think governments must first recognize that they really stand almost empty handed in the face of the risk of global warming. Governments cannot, of course, come out overnight as advocates of nuclear power. They - and we - must begin by creating a more accurate understanding and image of the benefits and risks of nuclear power. However, time is of essence. The energy choices we make today decide the composition of the atmosphere for a long time, because the plants built today may have lifespan of 40-50 years. Thus it matters if "Coal plants decommissioned today are replaced by new coal plants or by gas plants or nuclear plants. Conversely, it matters if nuclear plants decommissioned today are replaced by new nuclear plants or by coal or gas plants. And it does matter what new power capacity China, India, Indonesia and other populous countries choose.

Even though the environmental aspects of the energy options today are central, I am not suggesting that the case for the nuclear power option should rest only on the fact that it hardly emits any CO<sub>2</sub>, SO<sub>2</sub> or NO<sub>x</sub>.

The nuclear option must also remain economically attractive. While this may be easy vis-vis non-hydro renewables for base load electricity, it will constitute a challenge as regards power supply where piped gas is available.

As after the oil crises the energy independence that can be provided by nuclear power for energy poor industrialized

countries like Japan, France, Sweden or Korea, remains a great asset. Nuclear fuel for several years of operation can be stored without great difficulty. By contrast, you do not have energy independence at the end of a gas pipeline from a foreign region. Armenia had only two hours of electricity per day when the gas pipeline from Azerbaijan was cut. Only the re-opening of one of the nuclear reactors at Medzamor restored the lights.

When nuclear power is written off, as it has often been in environment dominated UN discussions, it has usually been by reference to "public concerns" relating to safety, waste and non-proliferation. I find it puzzling and unacceptable that a major energy option can be left out simply by a reference to a public opinion without substantial discussion of whether there are justifications for this opinion.

Apart from that objection, what about the nuclear safety, the nuclear waste and non-proliferation?

No energy is to be had at zero risk and I am not suggesting that nuclear power is without some risk. However, that risk must be compared with the risk we would take if choosing another source of energy. The largest numbers of casualties from energy related accidents have been linked to the bursting of hydro dams ...

The fall-out from Chernobyl - the radioactive and especially the psychological - demonstrated that "a nuclear accident anywhere is an accident everywhere". This globalization is now meeting a globalized response: all nuclear operators now work together in the World Association of Nuclear Operators to learn from each other and to establish and uphold high safety standards. And within the IAEA an international nuclear safety culture, consisting of binding basic safety rules and more detailed recommended standards and of extensive expert services, is promoted. Under the latest conventions the State parties will also have the opportunity to insist on the full implementation of these rules through mutual peer review

concerning their respective nuclear activities.

The increasing safety and reliability of nuclear technology can be seen in the improved production figures for nuclear power around the world, lower doses to plant personnel and fewer unplanned outages. The availability factor for the world's nuclear power reactors is now close to 80%. Unplanned outages, on average below 5%, compares favourably with that of fossil fuelled plants.

The issue of nuclear waste is one in which there is a great distance between public perceptions and reality. There is all international consensus - now embodied in a new convention on basic principles for the safe disposal of nuclear waste and the safe management of spent fuel. The nuclear community knows very well what to do. The serious problems facing us in those places are political - not technical. Nuclear energy is following a path of confinement for its waste disposal, with hazard decreasing with time, while the waste from fossil fuels is dispersed into the atmosphere, and placed on the surface of the earth, with some pollutants remaining toxic forever. We know that it is difficult in all countries to find acceptance of sites for nuclear waste disposal. However, when it comes to the waste from coal, oil and gas, nobody asks anybody's acceptance. The site is the atmosphere we breathe or the earth we walk.

Finally, there is no doubt that the acceptance of civilian nuclear power has suffered from people associating to the military use. It has not helped to point out that there can be nuclear power without

bombs and bombs without nuclear power. China had the bomb long before it had a power reactor. And many countries have power reactors and no bombs.

In the wake of the global detente, fortunately, there is growing nuclear disarmament and the peaceful atom is gradually more present in our minds than the shrinking stocks of nuclear weapons. The IAEA is now discussing with the US and Russia how its inspectors can verify that fissile material - Pu and HEU - from dismantled weapons is safely stored or peacefully used. The talk is no longer about the MAD - mutually assured destruction. Rather about the more attractive perspective of making electricity out of the bombs. We still have a considerable way to go, however, to minimize the arsenals of the nuclear-weapon States, to persuade some States to roll back from the nuclear weapons - as South Africa did - and to prevent any further proliferation. However, I believe the President of Brazil was right when he recently expressed the view that the era of nuclear weapons is drawing to a close.

Competition between great powers and groups of nations will continue but it will probably be pursued in the fields of economy and information - and efficient, economic and environmentally acceptable energy production. In this perspective I am optimistic about nuclear power. As someone said: governments will act rationally - once they have exhausted all other options.